Bell Quarry Rehabilitation Project

Volume 3 - Appendix D to H

August 2018

Appendix D

Biodiversity Assessment

Bell Quarry Rehabilitation Project Pty Ltd
Biodiversity Impact Assessment

July 2018

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1. Introduction

1.1 Background

Bell Quarry is located on Sandham Road at Newnes Junction approximately 10 kilometres east of Lithgow in NSW (see Figure 1-1). Extraction operations commenced in 1967 however active quarry operations at the site have now ceased. Bell Quarry has recently been purchased and Bell Quarry Rehabilitation Project Pty Ltd (BQRP) are seeking to rehabilitate the site through the importation of virgin excavated natural material (VENM), excavated natural material (ENM) and other clean fill material sourced from earthworks projects across Sydney and the local regional area (the Project). The aim of the rehabilitation will be to emplace clean fill within the existing footprint to enable the site to be returned to a condition more closely representing the original landform and that of the adjoining Blue Mountains National Park.

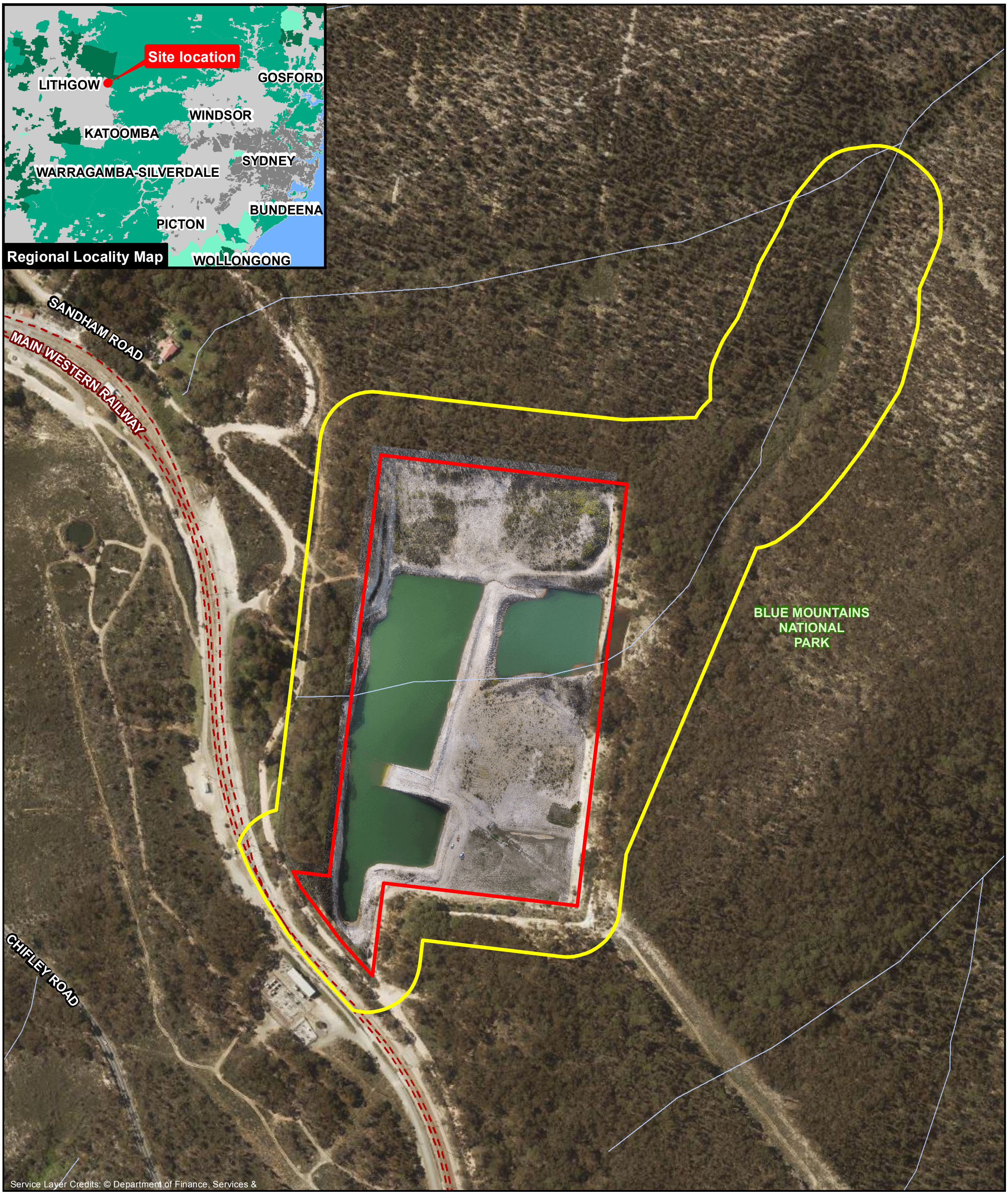
This report has been prepared by GHD as part of the environmental assessment of the Project. It assesses the potential impacts of the Project on biodiversity values, with particular emphasis on threatened ecological communities, populations and species listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994* (FM Act), and Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.2 The Project

The project is seeking to rehabilitate Bell Quarry through the importation of virgin excavated natural material (VENM), excavated natural material (ENM) and other clean fill, generated from major infrastructure Projects across Sydney and the local regional area. The rehabilitation process will involve:

- Importation of up to 1.2 million cubic metres of clean fill consisting of VENM and ENM or material permitted under a specific resource recovery order and associated exemption
- Vehicle haulage at a rate of up to 140,000 tonnes per annum (tpa)
- Progressive dewatering of voids
- Emplacement and consolidation of clean fill material within the existing quarry voids to closely represent the pre-quarry landform
- A water management system to control surface water discharges throughout the rehabilitation program and from the final landform
- Revegetation of the site with native plant species representative of vegetation communities in the local area to provide effective integration with the surrounding landscape and Blue Mountains National Park.

Staging of the Project is outlined in Table 1-1.



LEGEND

Bell Quarry site

Rail

Study area

Waterways

National Park

Paper Size A4

0 25 50 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation
Biodiversity Assessment

Job Number	21-25774
Revision	A
Date	29 May 2018

Site location

Figure 1-1

G:\21\25774\GIS\Maps\Deliverables\Biodiversity\21_25774_Z005_Biodiversity_SiteLocation.mxd

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: Aerial imagery - AStute 2015 & sixmaps 2016, Inset map - Geoscience Australia, General topo - NSW LPI DTDB 2012, Landuse zoning - SILEP LZN. Created by:afoddy

Table 1-1 Staging of the Project

Stage One

Volume: 88,800 m^3

- Filling works over the north western corner of the site to achieve the rehabilitation landform. The completed fill surface would generally grade to the north and east.
- The southern fill batter will be graded at 1 (vertical) to 3 (horizontal) and an intermediate cap placed.
- In preparation for Stage 2, dewatering of the existing voids will occur. The main void will need to be dewatered and the water level maintained below RL 1032m to allow the south void to be completely dewatered in preparation for filling.
- No revegetation to occur in this stage.

EXISTING SURFACE
DESIGN CONTOURS
CATCHMENT AREAS
CLEAN WATER FLOW
SEDIMENT LADEN FLOW
ACTIVE FILLING AREA
REHABILITATED AREA
AMENITIES AREA
ACCESS ROAD

Stage Two

Volume: 271,700 m^3

- Filling works in the south void to the south of the access ramp. Once above the surrounding ground level, surface water runoff will be directed to the main void. The completed fill surface will have a central ridge line, allowing water to drain to the east and west. The northern batter of filling in Stage 2 is shaped at 1 (vertical) to 3 (horizontal) and will be capped.
- Areas of Stage 1 at final levels revegetated.
- Development access road and extension of the stormwater drainage system to divert around the south eastern corner of the site, in preparation for Stage 3

EXISTING SURFACE
DESIGN CONTOURS
CATCHMENT AREAS
CLEAN WATER FLOW
SEDIMENT LADEN FLOW
ACTIVE FILLING AREA
REHABILITATED AREA
AMENITIES AREA
ACCESS ROAD

Stage Three

Volume: 52,000 m^3

- Filling undertaken in the south eastern corner of the site, to the south of the east void. The filled surface will have a ridgeline near the southern extent, such that the southern portion falls to the south and the northern area will flow to the north. The western batter of filling in Stage 3 would be shaped at 1 (vertical) to 3 (horizontal) and an intermediate cap placed.
- Areas filled in Stage 2 at final levels will be revegetated.
- The main void will be dewatered in preparation for filling. A temporary sump installed in the north east corner of the main void will manage stormwater.

EXISTING SURFACE
DESIGN CONTOURS
CATCHMENT AREAS
CLEAN WATER FLOW
SEDIMENT LADEN FLOW
ACTIVE FILLING AREA
REHABILITATED AREA
AMENITIES AREA
ACCESS ROAD

Stage Four

Volume: 357,600 m^3

- Stage 4 filling is anticipated to be in the southern portion of the main void. The filled area would fall to the north and east. The northern batter of filling in Stage 4 would be shaped at 1 (vertical) to 3 (horizontal) and an intermediate cap placed.
- Stage 4 fill works will allow the surface water running onto the site from the west to flow over the fill area. Appropriate erosion and sediment controls will be installed along this drainage line.
- During the filling of Stage 4, areas of Stage 3 which have reached final levels would be revegetated.

EXISTING SURFACE
DESIGN CONTOURS
CATCHMENT AREAS
CLEAN WATER FLOW
SEDIMENT LADEN FLOW
ACTIVE FILLING AREA
REHABILITATED AREA
AMENITIES AREA
ACCESS ROAD

Stage Five

Volume: 293,800 m^3

- The northern portion of the main void will be filled in Stage 5. The final fill surface in this area will generally fall to the east. The eastern batter of filling in Stage 5 would be shaped at 1 (vertical) to 3 (horizontal) and an intermediate cap placed.
- During the filling of Stage 5, areas of Stage 4 which have reached final levels would be revegetated.
- To prepare Stage 6 for filling, the east void will require dewatering and desilting.

EXISTING SURFACE
DESIGN CONTOURS
CATCHMENT AREAS
CLEAN WATER FLOW
SEDIMENT LADEN FLOW
ACTIVE FILLING AREA
REHABILITATED AREA
AMENITIES AREA
ACCESS ROAD

Stage Six

Volume: 140,500 m^3

- The final area of filling would be the east void to create a surface which generally falls to the east. Throughout the filling of this stage, temporary sumps will need to be maintained in the fill area to allow for the collection and treatment of sediment laden surface water
- During the filling of Stage 6, areas of Stage 5 which have reached final levels would be revegetated. Upon completion of filling of Stage 6, the remaining areas will be revegetated.

EXISTING SURFACE
DESIGN CONTOURS
CATCHMENT AREAS
CLEAN WATER FLOW
SEDIMENT LADEN FLOW
ACTIVE FILLING AREA
REHABILITATED AREA
AMENITIES AREA
ACCESS ROAD

1.3 Environmental assessment requirements

The Project is both designated and integrated development under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Secretary's Environmental Assessment Requirements (SEARs) for the preparation of an Environmental Impact Statement (EIS) for the Project were provided on 18 November 2016. The requirements that relate to biodiversity are presented in Table 1-2.

Table 1-2 Secretary's environmental assessment requirements – biodiversity

Secretary's environmental assessment requirements	Addressed in this report
Accurate predictions of any vegetation clearing on site or for any road upgrades	Section 5.2.1
A detailed assessment of the potential impacts on any threatened species, populations, endangered ecological communities or their habitats, groundwater dependent ecosystems and any potential for offset requirements	Sections 5 and 6
A detailed description of the measures to avoid, minimise, mitigate and offset biodiversity impacts	Section 7

As the proposed activity is a Part 4 application pursuant to the EP&A Act and has not been classified as State Significant Development, the Office of Environment and Heritage (OEH) would only have a statutory role in assessing the Project if the consent authority determines that the activity is likely to significantly affect a threatened species, population, ecological community, or its habitat, as listed under the TSC Act. In their letter dated 25 January 2017, OEH advised that the DA should include an adequate assessment of impacts on flora, fauna, threatened species, populations, communities and their habitats. Negative impacts to native vegetation (e.g. clearing) should be avoided where possible. Where impacts cannot be avoided, the EIS should detail how a "maintain or improve" outcome for biodiversity will be achieved. If the Project cannot adequately avoid or mitigate impacts on biodiversity, then a biodiversity offset package is expected.

A site meeting was also held on the 10th of October 2017, with the Acting Area Manager for the Upper Mountains for the NSW National Parks and Wildlife Service. The outcome of the meeting was that NPWS were generally supportive of the objective to return the site to condition representing the original landform and vegetation and included the following specific recommendations:

- A site survey to establish the exact eastern boundary so the EIS can accurately consider all impacted areas consistent with the land ownership and appropriately manage fencing.
- The immediate treatment of invasive weeds (Pampass Grass and Broome) over the site and prior to any significant machinery movement as this will exacerbate and relocate seed.
- The use of local provenance seed and plants for stabilisation.
- A baseline study for plant pathogen over the site and some allowance for ongoing monitoring.
- The project should consider ground water flows and consider impacts from nutrient and toxicity changes associated with foreign fill.

This issues have been considered in preparation of this biodiversity assessment and the overall EIS.

1.4 Purpose of this report

This report has been prepared to support the EIS for the Project and addresses the biodiversity assessment requirements of the SEARs. The aims and scope of this report are to:

- Outline the methods used for the biodiversity assessment
- Describe the existing environment of the study area, including the results of the desktop assessment and site surveys
- Identify the presence or likely presence of threatened species, populations and ecological communities and their habitats listed under the TSC Act and FM Act
- Assess the potential for any MNES listed under the EPBC Act to occur within the site and/or to be affected by the Project
- Identify the potential impacts of the Project on biodiversity values, including threatened biota and their habitats
- Recommend mitigation and environmental management measures to avoid or minimise adverse impacts on threatened biota and biodiversity values
- Assess the likely significance of impacts on threatened biota listed under the TSC Act and EPBC Act that would be affected by the Project
- Assess the requirement for a biodiversity offset.

1.5 Scope and limitations

This report: has been prepared by GHD for Bell Quarry Rehabilitation Project Pty Ltd and may only be used and relied on by Bell Quarry Rehabilitation Project Pty Ltd for the purpose agreed between GHD and the Bell Quarry Rehabilitation Project Pty Ltd as set out in section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than Bell Quarry Rehabilitation Project Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 2.1.2 and 3.2 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Legislative context

2.1 NSW State legislation

2.1.1 Environmental Planning and Assessment Act 1979

The EP&A Act forms the legal and policy platform for Project assessment and approval in NSW and aims to, amongst other things, 'encourage the proper management, development and conservation of natural and artificial resources'. All development in NSW is assessed in accordance with the provisions of the EP&A Act and the Environmental Planning and Assessment Regulation 2000. The Project is being assessed by a development application (DA) prepared in accordance with Part 4 of the EP&A Act. The development will be notified and assessed by the local Council, however the consent authority is the Joint Regional Planning Panel.

Section 111(4) of the EP&A Act states that the determining authority must consider the effect of an activity on:

- 'Critical habitat' (as defined under the TSC Act and FM Act)
- Species, populations or ecological communities, or their habitats (as listed under the TSC Act and FM Act) and whether there is likely to be a 'significant effect' on those species, populations or ecological communities.
- Other protected fauna or protected native plants listed under the *National Parks and Wildlife Act 1974*.

Section 5A of the EP&A Act lists seven factors that must be taken into account when determining the significance of potential impacts of a proposed activity on threatened species, populations or ecological communities (or their habitats) listed under the TSC Act and the FM Act. The 'seven-part test' is used to assist in the determination of whether a Project is 'likely' to impose 'a significant effect' on threatened biota and thus whether a species impact statement (SIS) is required. Seven part tests have been prepared for threatened biota that would be impacted or are likely to be impacted by the Project (see Section 6.1).

2.1.2 Threatened Species Conservation Act 1995

The TSC Act provides legal status for biota of conservation significance in NSW. The TSC Act aims to, amongst other things, 'conserve biological diversity and promote ecologically sustainable development'. It provides for:

- The listing of 'threatened species, populations and ecological communities', with endangered species, populations and communities listed under Schedule 1, 'critically endangered' species and communities listed under Schedule 1A, and vulnerable species and communities listed under Schedule 2
- The listing of 'Key Threatening Processes' under Schedule 3
- The preparation and implementation of Recovery Plans and Threat Abatement Plans
- Requirements or otherwise for the preparation of a SIS.

The TSC Act has been addressed in this assessment through:

- Desktop review to determine the threatened species, populations or ecological communities that have been previously recorded within the locality and hence could occur subject to the habitats present

- Targeted field surveys for listed threatened species, populations and ecological communities
- Identification, assessment and mapping of listed threatened communities and threatened species (or their habitat)
- Assessment of potential impacts on listed threatened species, populations and ecological communities, including identification of key threatening processes relevant to the Project
- Identification of suitable impact mitigation and environmental management measures for listed threatened species, where required.

Note that the TSC Act was repealed on August 25 2017, and replaced with the *Biodiversity Conservation Act 2016* (BC Act). Since the SEARs for this Project were received in November 2016 and the ecological field work completed in December 2016, this Project is being assessed under the TSC Act under the transitional arrangements.

2.1.3 Fisheries Management Act 1994

The objects of the FM Act are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. It provides for:

- The listing of threatened species, populations and ecological communities, with endangered species, populations and communities listed under Schedule 4, critically endangered species and communities listed under Schedule 4A, vulnerable species and communities listed under Schedule 5
- The listing of ‘Key Threatening Processes’ under Schedule 6
- Diseases affecting fish and marine vegetation under Schedule 6B
- Noxious fish and noxious marine vegetation under Schedule 6C
- The preparation and implementation of Recovery Plans and Threat Abatement Plans
- Requirements or otherwise for the preparation of a SIS.

One of the objectives of the FM Act is to 'conserve key fish habitats ' which includes aquatic habitats that are important to the maintenance of fish populations generally and the survival and recovery of threatened aquatic species. To assist in the protection of key fish habitats, DPI has produced the *Policy and guidelines for fish habitat conservation and management* (2013 update). This policy applies to the following developments, works or activities, each of which can impact on key fish habitat:

- Dredging or reclamation
- Impeding fish passage
- Damaging marine vegetation
- De-snagging.

The FM Act has been addressed in this assessment through undertaking:

- A desktop review to determine the threatened species, populations or ecological communities that have been previously recorded within the locality of the Project and hence could occur subject to the habitats present
- Assessment of aquatic habitats
- Assessment of potential impacts on aquatic habitats, including identification of key threatening processes of relevance to the Project, impacts on key fish habitat and fish passage

- Assessment of the potential for impacts on listed threatened species, populations and ecological communities
- Identification of suitable impact mitigation and environmental management measures to avoid or mitigate impacts on the aquatic environment.

2.1.4 Biosecurity Act 2015

The NSW *Biosecurity Act 2015* provides for modern, flexible tools and powers that allow effective, risk-based management of biosecurity in NSW. It provides a streamlined statutory framework to protect the NSW economy, environment and community from the negative impact of pests, diseases and weeds. The primary object of the Act is to provide a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, dealing with biosecurity matter, carriers and potential carriers, and other activities that involve biosecurity matter, carriers or potential carriers.

In NSW, all plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.

One priority weed was recorded in the study area. Legal requirements to minimise the potential for the introduction and/or spread of weeds as a result of the Project are discussed in Section 4.2.2.

2.2 Commonwealth legislation

2.2.1 Environment Protection and Biodiversity Conservation Act 1999

The purpose of the EPBC Act is to ensure that actions likely to cause a significant impact on ‘matters of national environmental significance’ undergo an assessment and approval process. Under the EPBC Act, an action includes a Project, a development, an undertaking, an activity or a series of activities, or an alteration of any of these things. An action that ‘has, will have or is likely to have a significant impact on a matter of national environmental significance’ is deemed to be a ‘controlled action’ and may not be undertaken without prior approval from the Australian Minister for the Environment.

The EPBC Act identifies MNES as:

- World heritage properties
- National heritage places
- Wetlands of international importance (Ramsar wetlands)
- Threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mining)
- A water resource, in relation to coal seam gas development and large coal mining development.

The EPBC Act has been addressed in this assessment through:

- Desktop review to determine the listed biodiversity matters that are predicted to occur within the locality of the Project and hence could occur, subject to the habitats present

- Targeted field surveys for listed threatened biota and migratory species
- Assessment of potential impacts on threatened and migratory biota, including assessments of significance where relevant
- Identification of suitable impact mitigation and environmental management measures for threatened and migratory biota, where required
- Identification of the need or otherwise for biodiversity offsets for impacts on listed biodiversity matters.

3. Methods

3.1 Desktop assessment

A desktop database review was undertaken to update the list of threatened flora and fauna species, populations and ecological communities (biota) listed under the TSC Act and FM Act, and MNES listed under the EPBC Act, that could be expected to occur in the locality, based on previous records, known distribution ranges, and habitats present. The database review assisted with focusing field survey techniques and effort. Biodiversity databases pertaining to the Project area and locality (i.e. within a 10 kilometres radius of the site) that were reviewed prior to conducting field investigations included:

- The NSW Office of Environment and Heritage (OEH) Atlas of NSW Wildlife for records of threatened species listed under the TSC Act and EPBC Act which have been recorded within the locality (report generated on 4 November 2016) (OEH, 2016a);
- The NSW Department of Primary Industries (DPI) Threatened species distributions for records of threatened aquatic species listed under the FM Act that have been recorded within the locality (database queried on 20 July 2017) (DPI, 2016a);
- The Australian Government Department of the Environment and Energy (DEE) Protected Matters Search Tool for MNES listed under the EPBC Act which may occur in the area (report generated on 20 July 2017) (DEE 2016a);
- OEH threatened species profiles online database (OEH 2016b);
- DoEE online species profiles and threats database (DEE 2016b);
- DPI list of threatened species, populations and ecological communities (DPI 2016b);
- the NSW VIS Classification 2.1- Community Identification (OEH 2016c) and NSW vegetation types database (OEH 2014) to identify matching plant community types (PCTs) in the overall study area;
- OEH and DoEE critical habitat registers (OEH 2016d, DoEE 2016c);
- Regional-scale vegetation mapping presented in the *The Vegetation of the Western Blue Mountains* (DEC 2006)*;*
- The Bureau of Meteorology (BOM) Atlas of Groundwater Dependent Ecosystems (GDEs) (BOM 2016a);
- Noxious weed declarations for Lithgow local government area (LGA) (DPI 2016c).

Nominations and preliminary listings under the TSC Act, FM Act and the EPBC Act were also considered.

Following collation of database records and species and community profiles, a 'likelihood of occurrence' assessment was prepared with reference to the broad habitats at the overall study area. This was further refined following field surveys and assessment of habitats present (see Section 3.3). The results of this assessment are presented in Appendix A.

3.2 Field survey

A field survey was conducted by two senior ecologists on 8 and 9 December, 2016. Survey effort included:

- broad-scale vegetation survey, vegetation mapping, opportunistic fauna and threatened flora observations

- four 20 metre x 50 metre BioBanking plot / transects
- random meander searches for threatened plants
- fauna habitat assessment
- fauna surveys.

Survey techniques and effort were conducted with reference to DEC (2004) survey guidelines and as appropriate to the habitats present and landscape context. The locations of survey sites are shown in Figure 4-1. Further details on survey methodology are provided in sections 3.2.1 to 3.3.

Weather conditions during the field survey are summarised in Table 3-1 below (BOM 2016b). Weather was warm on the first day. In the evening, a brief thunderstorm passed over the site and high winds followed. High winds remained into the following day, which was cooler than the preceding day.

Table 3-1 Weather conditions during the field survey

Date	Minimum temperature	Maximum temperature	Rainfall in preceding 24 hours	Weather conditions
8/12/2016	13.2°C	28.0°C	0.0 mm	Warm with an evening thunderstorm
9/12/2016	7.5°C	17.6°C	0.0 mm	Cool and windy

3.2.1 Flora sampling

Prior to flora sampling, the site was traversed and stratified into different vegetation units. Initial site stratification was guided by a combination of available regional-scale native vegetation mapping (DEC 2006) and assessment at the time of the field survey.

Following stratification, four plot/transect surveys were conducted in accordance with the BioBanking methodology (BBAM) (OEH 2014) (see Figure 4-1), comprising:

- Identification of all plant species within a 20 x 20 metre plot;
- Collection of native plant cover, vegetation structure data and exotic plant cover data along a 50 metre transect;
- Counts of the number of hollow-bearing trees and amount of woody debris within a 50 metre x 20 metre plot.

In addition, cover-abundance data was collected for each species within each 20 metre x 20 metre plot in order to establish a more robust measure of vegetation composition. The condition of native vegetation was measured by recording ten site condition attributes within plot/transects, to be compared against benchmark values. Benchmarks are quantitative measures of the range of variability in condition in vegetation with relatively little evidence of alteration, disturbance or modification by humans since European settlement. Plots were distributed between vegetation units and condition classes.

A systematic traverse was conducted throughout the overall Project area and any additional plant species not detected in plot/transects were recorded.

All vascular plants (i.e. not mosses, lichens or fungi) observed were recorded on proforma field data sheets. Each species list was accompanied by a detailed biophysical description, including vegetation structure, soils, geology and geomorphology, habitat and disturbance history. Plant specimens that could not be identified rapidly in the field were collected and subsequently identified using standard botanical texts and/or PlantNet (NHNSW, 2016). Plant specimens which were difficult to identify (either insufficient sample collected or buds/fruiting bodies were not available at the time of the survey) were identified to genus level only.

3.2.2 Vegetation mapping

Vegetation community mapping produced by DECC (2006) was used as initial references for vegetation mapping works, and verified during the field survey. Exotic or planted native vegetation was defined based on structure and species composition. All plant community types (PCTS) were then mapped using aerial photographic interpretation within a geographical information system (GIS) as guided by the field survey results.

PCTs were classified according to vegetation structure, species composition, soil type and landscape position. PCTs were further split into broad condition classes with reference to the FBA to yield condition classes of the vegetation types as follows:

- ‘Moderate condition’, comprising Moderate/good or Moderate/good – moderate condition vegetation which featured over storey and mid storey vegetation at benchmark levels for the equivalent vegetation type.
- ‘Poor condition’, comprising Moderate/good – poor condition regenerating or planted vegetation with over storey and mid storey cover substantially below benchmark levels for the equivalent PCT but greater than 50% of the groundcover present was native species (i.e. derived native shrubland, scrub or low open woodland structure).
- Cleared land and exotic grassland, comprising Low or Cleared condition vegetation which featured native over storey and mid storey vegetation cover substantially below benchmark levels for the expected PCT and less than 50% of the groundcover present was native species or greater than 90% of the ground surface was bare earth or infrastructure.

PCTs within the study area were assessed against identification criteria for State and Commonwealth listed threatened ecological communities (critically endangered ecological communities [CEECs], endangered ecological communities [EECs] and vulnerable ecological communities [VECs]). Vegetation and habitats were compared with descriptions provided in OEH (2016b) and DEE (2016a) profiles.

3.2.3 Targeted flora surveys

Targeted surveys were undertaken for threatened flora species (or potential habitat for threatened flora species) which could potentially occur within the overall study area given known distributions, previous records in the overall study area and locality and habitat requirements for each species. An assessment of threatened flora species that are likely to occur is provided in Appendix A. Random meander surveys (as per Cropper 1993) were conducted throughout suitable habitat within the overall study area. Consideration was given to previous threatened species records within the locality and within close proximity to the overall study area (e.g. OEH 2016a) when identifying areas of potentially suitable habitat (refer to Appendix A).

3.2.4 Fauna survey

Fauna habitat assessment

General fauna habitat assessments were undertaken throughout the study area, including active searches for potential shelter, basking, roosting, nesting and/or foraging sites. Specific habitat features and resources such as water bodies, food trees, the density of understorey vegetation, the composition of ground cover, the soil type, presence of hollow-bearing trees, leaf litter and ground debris were noted.

Indicative habitat criteria for targeted threatened species (i.e. those determined as having the potential to occur within the overall study area following the desktop review) were identified prior to fieldwork. Fauna habitat assessments aimed to identify potential habitat for these species.

Habitat criteria were based on information provided in OEH and DoEE threatened species profiles, field guides, and the knowledge and experience of GHD field ecologists. Habitat assessment assists in the compilation of a comprehensive list of threatened fauna species that are predicted within the vicinity of the overall study area, rather than relying solely on single event surveys that are subject to seasonal limitations and may only represent a snapshot of assemblages present.

Habitat assessments included active searches for:

- Trees with bird nests or other potential fauna roosts
- Tracks or animal remains
- Evidence of activity such as feeding scars, scratches and diggings
- Presence of hollow-bearing trees
- Specific food trees and evidence of foraging
- Leaf litter and fallen timber suitable for reptiles
- Presence of potential habitat for frog species.

Diurnal bird surveys

Diurnal bird surveys were performed in the early morning on one morning, targeting the various habitats within the study area. This survey comprised area searches of at least 1 hour duration to compile a list of native birds present in the Project area and adjacent national park (refer to Appendix B). Species were identified by sight and call. Incidental observations made outside the targeted survey period were also recorded.

Diurnal fauna surveys

Opportunistic and incidental observations of fauna species were recorded at all times during field surveys. Survey effort was concentrated in areas that supported habitat resources, for instance fallen timber was scanned and/or turned for reptiles and mature trees were scanned for roosting birds. Emergent vegetation in the swamp was scanned for basking lizards, and dragonflies were recorded when observed. Tadpoles in the small drainage line were photographed for later identification.

Microchiropteran bat surveys

Microbat ultrasonic echolocation call recordings (Anabat^{TM} SD1 surveys) were undertaken using two units on one night within the study area, to target both common and threatened species (see Appendix A for threatened species which may occur in the study area). Fixed recordings were undertaken from dusk until the following morning. *The Bat calls of NSW: Region based guide to the echolocation calls of microchiropteran bats* (Pennay et al. 2004) was used to assist call analysis. Call identification was also assisted by consulting distribution information for possible species (Pennay et al 2011; Churchill 2008; van Dyck and Strahan 2008) and records from the Atlas of NSW Wildlife (OEH 2016a).

Calls were identified using zero-crossing analysis and AnalookW software (version 4.1z, Chris Corben 2015) by visually comparing the time-frequency graph and call characteristics (e.g. characteristic frequency and call shape) with reference calls and/or species call descriptions from published guidelines. A confidence rating was applied to calls Table 3-2.

Table 3-2 Confidence call rating applied to microchiropteran bat calls

Identification	Description
D - Definite	Species identification not in doubt.
Po - Possible	Call most likely to represent a particular species, but poor data quality and/or interspecific call similarities precluded reliable identification.

Spotlighting and call playback

Spotlight searches included dedicated listening periods for fauna vocalisations and targeted areas of higher quality habitat with hollow-bearing trees for nocturnally active mammals and birds. Spotlighting was conducted in the Project area and also along Sandon Road. Due to high winds, spotlighting was not conducted in forested areas in the Blue Mountains National Park.

Nocturnal call playback surveys were conducted for the Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*) and Masked Owl (*Tyto novaehollandiae*). Surveys involved an initial listening period of five minutes, followed by call playing for five minutes, followed by a listening period of five minutes (undertaken separately for each species), with a final listening period of about 10 minutes. Potential roost sites in the immediate area were scanned using spotlights following call playback.

3.2.5 Aquatic habitat assessment

A visual aquatic habitat assessment was undertaken in the study area. The following general information was recorded:

- general waterway morphology and status
- flow regime
- observable indicators of water quality
- fish habitat features (refuge areas, - snags / undercut banks / reedbeds; potential breeding areas – gravel beds, fallen trees, etc);
- barriers to fish movement – upstream or downstream.

The sensitivity of key fish habitat and the functionality of the waterways at the Project area was classified according to the *Policy and guidelines for fish habitat conservation and management* (DPI 2013) as indicated in Table 3-3 and Table 3-4. Aquatic habitat was also compared with the habitat requirements of threatened aquatic fauna known to occur in the region according to DPI and DEE threatened species profiles (DPI 2016a, DEE 2016b).

Table 3-3 Key fish habitat and associated sensitivity scheme (DPI 2013)

Key Fish Habitat Type	Description
Type 1 - highly sensitive fish habitat	• Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants • Any known or expected protected or threatened species habitat or area of declared ‘critical habitat’ under the FM Act.
Type 2 - moderately sensitive key fish habitat	• Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in TYPE 1 • Weir pools and dams up to full supply level where the weir or dam is across a natural waterway
Type 3	• Coastal and freshwater habitats not included in TYPES 1 or 2.

Key Fish Habitat Type	Description
- minimally sensitive key fish habitat	• Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation.
Not key fish habitat	• First and second order streams on gaining streams (based on the Strahler method of stream ordering) • Farm dams on first and second order streams or unmapped gullies • Agricultural and urban drains • Urban or other artificial ponds (e.g. evaporation basins, aquaculture ponds)

Table 3-4 Classification of waterways for fish passage (DPI 2013).

Fish Habitat Classification	Characteristics of Waterway Type
Class 1 Major key fish habitat	• Permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.
Class 2 Moderate key fish habitat	• Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi - permanent to permanent waters in pools or in connected wetland areas. • Known fish habitat and/or fish observed inhabiting the area.
Class 3 Minimal key fish habitat	• Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). • Semi - permanent pools form within the waterway or adjacent wetlands after a rain event. • Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.
Class 4 Unlikely key fish habitat	• Named or unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools after rain events (e.g. dry gullies or shallow floodplain depressions with no permanent aquatic flora present).

3.3 Assessment of likelihood of occurrence

Following collation of database records and species and community profiles, a threatened biota 'likelihood of occurrence' assessment was prepared with reference to the broad habitats contained within the overall study area. Identification of potential habitat for threatened and migratory species was based on information provided in the species profiles (DoEE 2016b, OEH 2016b), recovery plans, journal articles, and the field staffs' knowledge of species habitat requirements. The likelihood of occurrence assessment was further refined following field surveys. The likelihood of threatened and migratory biota occurring in the study area was assessed based on presence of records from the locality since 1995, species distribution and habitat preferences, and the suitability of potential habitat present. The results of this assessment are provided in Appendix A.

Table 3-5 Key to likelihood of occurrence for threatened biota

Likelihood	Definition
Present	Threatened species, population or community was recorded in the study area.
Likely	Species, population or community previously recorded within a 10 km radius of the study area and suitable habitat occurs within the study area.
Possible	Species, population or community previously recorded within a 10 km radius of the study area but only marginal suitable habitat recorded, OR Species, population or community not previously recorded within a 10 km radius of the study area, but the study area is within the species known distribution and suitable habitat occurs within the study area.
Unlikely	Species, population or community previously recorded within a 10 km radius of the study area but no suitable habitat recorded.
Nil	Species, population or community not previously recorded within a 10 km radius of the study area, suitable habitat not recorded within study area, and/or study area outside species known distribution.

3.4 Survey effort considerations and limitations

The Project area is a highly modified environment, consisting generally of cleared land with disturbance from previous quarrying activities. Some areas of regenerating or planted vegetation are present, as well as small areas of intact native vegetation. The quarries have filled with water since the cessation of quarrying activities, and some aquatic vegetation is present. The survey effort focussed on identifying vegetation types and condition, and features of importance for fauna. Given the disturbed nature of the Project area, the level of survey conducted is considered reasonable.

The Project area is located immediately adjacent to the Blue Mountains National Park, and good condition native vegetation is present outside the Project area.

Given the duration and timing of the field survey (summer) it is likely that many species that utilise the overall study area (permanently, seasonally or transiently) were detected during the survey. However, it is likely that some species that occur in the overall Project area were not detected during the surveys. Species not detected may include annual, ephemeral or cryptic flora species; fauna that are migratory and do not occur in the locality during summer (eg Regent Honeyeater); and mobile or transient fauna in general. To make an assessment of their likelihood of occurring within the overall Project area the habitat assessment identified habitat resources for such species. As such, the survey was not designed to detect all species, rather to provide an overall assessment of the ecological values within the Project area and adjacent areas. This information was used to predict potential impacts of the Project on ecological values.

4. Existing environment

4.1 Landscape context

4.1.1 Site location and description

Bell Quarry is located on Sandham Road at Newnes Junction approximately 10 kilometres east of Lithgow in NSW (see Figure 1-1). The site is located to the east of Chifley Road (continuation of Bells Line of Road) and the Main Western Rail Line. The site is rectangular in shape covers an area of 9.5 ha.

The quarry was progressively developed in a series of eight cells isolated from adjacent cells by in-situ sandstone barriers. The quarry now contains three large voids which are partially filled with water. The quarry has been subject to some progressive revegetation and these revegetated areas are at varying stages across the site with several areas still subject to active erosion. It is noted that the Soil Conservation Service of NSW has recently prepared the Bell Sand Quarry Closure Review and implemented some improvements to ground cover and drainage at the site.

4.1.2 Surrounding land use

Newnes Junction is located approximately 250 metres to the north-west of the Project area and contains a small number of residential dwellings. Dargan and Clarence townships are located on the western side of Chifley Road and the Main Western Rail Line approximately one kilometre to the south and west of the site respectively. Bell is located approximately four kilometres to the south.

The Clarence Colliery pit top, rail loop and loading facilities are located around 750 metre to the north and the Hansen Quarry is located to the west of the mining operations.

The Blue Mountains National Park is located to the east of the Project area and is one of the eight protected areas making up the Greater Blue Mountains World Heritage Area (UNESCO 2013). The Newnes State Forest is located to the north and west of the Project area.

Bell Quarry is located within the upper reaches of the Wollangambe River catchment. This river flows towards the east where it eventually drains into the Colo River which forms part of the broader Hawkesbury-Nepean catchment area.

4.1.3 Topography

The study area is located on the southern edge of the Newnes Plateau (within the Sydney Basin) and adjacent to the Lithgow Valley. Newnes Plateau is characterised by gentle to moderate slopes and undulating topography. Towards the edge of the plateau, the landscape is typically rugged with steep cliffs adjacent to water courses, talus slopes and near vertical relief. This is typical of many erosional sections of the Newnes Plateau, which are often associated with deep gullies, pagoda rock formations, creeks, gullies, gorges and bottleneck valleys. Elevation of the study area ranges from 900 to 1,200 metres above sea level (Department of Commerce 2004)

4.1.4 Hydrology

The hydrology and water quality for receiving waters in the vicinity of the site are described in detail in the Water Resources Assessment for the EIS included as Appendix C in Volume 2 of this EIS. An ephemeral tributary of the Wollangambe River runs in a north-easterly direction from the Project area. The quarry intersected this tributary's catchment, which has its headwaters in the vicinity of the rail line upstream of the Project area. Surface flows from this area of the catchment now enter the site at the western edge of the northern void, where some erosion form high flow events is evident.

Surface water and groundwater environments at the Project area are interrelated due to the depths of the site and seepage of groundwater into the voids. Groundwater from upstream of the Project area influences the water quality and quantity in the voids, and likewise, the quality of the surface water at the Project area is likely to influence the groundwater quality downstream of the site. Surface water in the catchment is naturally slightly acidic (ph below 6.5), and dissolved metal concentrations are generally low. Within the voids, pH ranged between 6.33 and 7.19, while downstream of the Project area pH values were found to be between 5.36 and 5.73 . Nutrient concentrations are currently generally low, though the concentrations of nitrate (a potential toxicant) and nitrite and nitrate (considered together as chemical stressors) exceed the relevant ANZECC (2000) guideline values at sites within and downstream of the Project area. Within the Project area, this may be indicative of inhabitation of the standing water bodies by bird species, and also some algal activity, noting that the limited shading of the voids may at times lead to eutrophication. Downstream of the Project area the nitrate concentrations are more likely to be the result of the decomposition of stream detritus (GHD 2018).

Discharge from the site only occurs when the balance of rainwater, groundwater flow and evaporation are such that the voids are full and overflowing. The results of this is that whilst natural conditions would result in regular runoff from natural catchment baseflow, runoff from the existing site is intermittent, only occurring approximately 50 percent of the time. However, during very high rainfall periods runoff from the existing site is greater than the natural condition. This is because during these periods, the quarry voids, full of water, would result in a higher proportion of rainfall being converted to runoff than natural conditions (GHD 2017).

Approximately 200 metres downstream of the site the drainage line enters a swamp which receives both groundwater and surface water flows.

Water from this drainage line eventually enters the Wollangambe River, about 1.5 kilometres from the Project area. The Wollangambe River winds eastwards through narrow canyons and is one of four tributaries of the Colo River. The Wollangambe River, to its intersection with Bungleboori Creek, forms part of the declared Colo Wild River (DECC 2008a). The upper reaches of the Wollangambe River near Clarence Colliery are not part of the declared area as these areas have been disturbed by historic mining (DECC 2008a).

4.2 Flora and vegetation

4.2.1 Flora species

A total of 105 flora species from 38 families were recorded within the study area, comprising 95 native and 10 exotic species. Proteaceae (shrubs, 13 species, 12 native), Myrtaceae (flowering shrubs and trees, 12 species, all native), Poaceae (grasses, 10 species, 8 native) and Fabaceae (9 species, 7 native) were the most diverse families recorded. The full list of flora species recorded is presented in Appendix B. Species recorded are discussed below in relation to the vegetation types occurring within the study area.

4.2.2 Weeds

Only one priority weed listed under the Biosecurity Act for the Lithgow LGA was recorded in the Project area (see Table 4-1).

Table 4-1 Noxious weeds

Scientific name	Common name	Control measures
Cytisus scoparius subsp. *scoparius*	English Broom	**Mandatory Measure**: must not be imported into the State or sold **Regional Recommended Measure**: land managers should mitigate the risk of new weeds being introduced to their land

English Broom is also a weed of national significance. This weed species is spread solely by seeds, which are ejected explosively as the pods dry out on warm, sunny days during summer. Most of the seeds fall within a few metres of the parent plant. They are further dispersed by water (particularly if near streams), mud on machinery, vehicles and footwear (DEE 2017). Mitigation measures to prevent the spread of this species into the adjacent national park are provided in Section 7.3.

There are a number of other environmental weeds throughout the Project area including Pampas Grass (*Cortaderia selloana*), African Lovegrass (*Eragrostis curvula*), Common Centaury (*Centaurium erythraea*) and Lamb's Tongues (*Plantago lanceolata*) (see Appendix B for a full list of exotic plants recorded during the field survey). These environmental weeds occur as relatively minor, localised infestations and are mainly concentrated in cleared land and poor condition vegetation in the former quarry. Exotic plants were only very occasionally observed in intact native vegetation outside the former quarry.

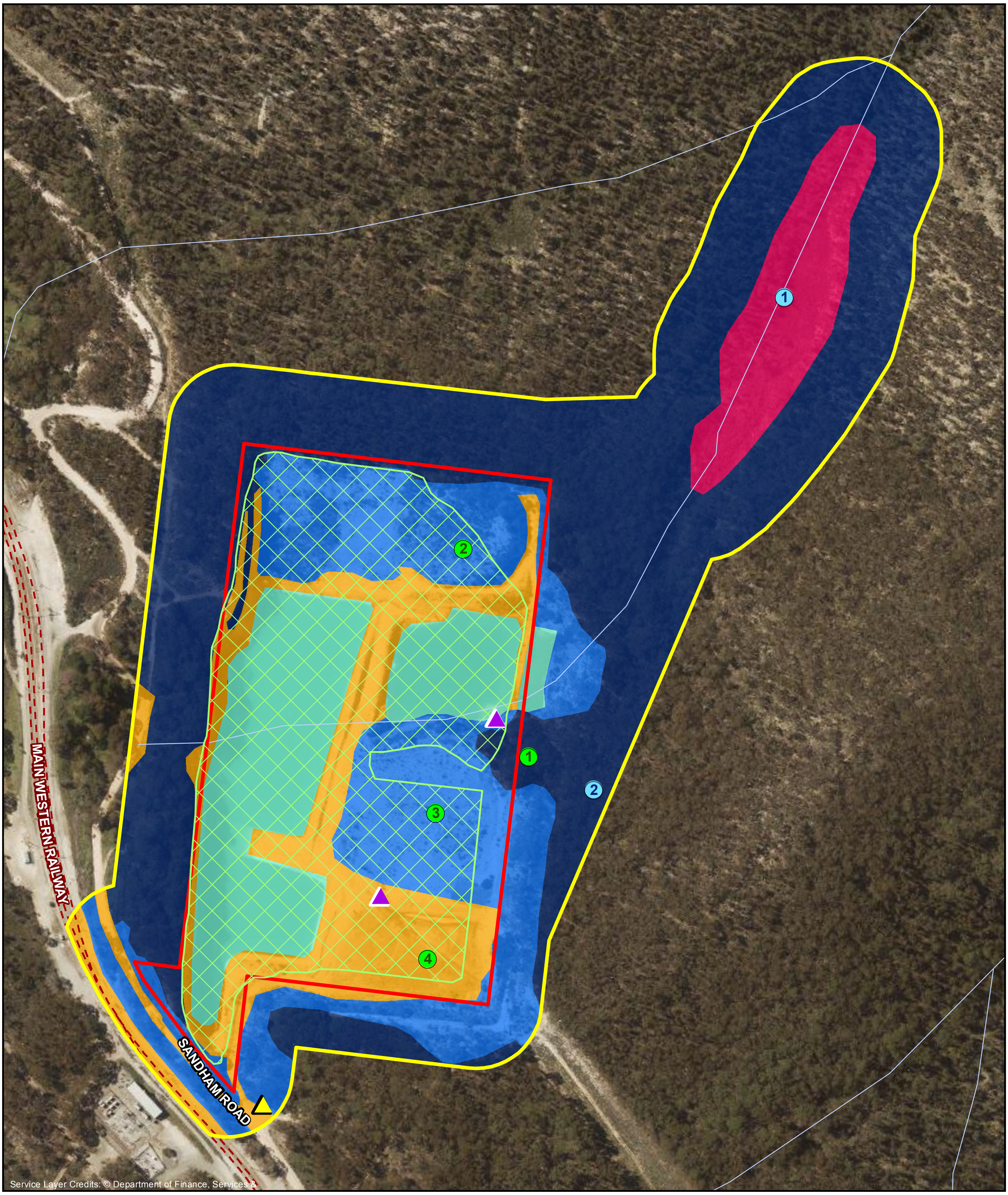
4.2.3 Vegetation

The Project footprint comprises highly modified landforms, with most vegetation present the result of previous rehabilitation activities. Modified native vegetation is also present outside the Project area within the adjacent national park. Some intact native vegetation is present within the Project area, located around the perimeter. Extensive tracts of intact native vegetation are present in the surrounding area.

Field surveys confirmed the presence and distribution of two plant community types within the study area in varying condition: one of these vegetation types occurs as intact vegetation in Moderate/good-high condition as well as partially cleared or regrowth vegetation in poor condition, while the second occurs as intact vegetation in Moderate/good condition. Areas of cleared dry land and artificial wetlands have also been mapped as separate vegetation zones. Vegetation zones at the study area are shown on Figure 4-1, summarised in Table 4-2 and described below.

One vegetation zone at the study area (downstream of the Project area) comprises a local occurrence of a threatened ecological community (TEC) listed under the TSC Act and a related TEC listed under the EPBC Act (see Table 4-2 and Section 4.4.1).

The distribution of vegetation zones in the study area is mainly tied to geomorphic position and associated soil type and frequency and duration of inundation.



LEGEND

- Bell Quarry site
- Study area
- Project area
- Waterways
- Rail
- Plot/transect
- Area search
- Anabat
- Call playback

Vegetation zones

- 1, Sydney Peppermint - Silvertop Ash heathy open forest
- 2, Poor condition Sydney Peppermint - Silvertop Ash heathy open forest
- 3, Cleared land
- 4, Artificial wetland
- 5, Prickly Tea-tree - sedge wet heath

Paper Size A4

0 25 50 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation
Biodiversity Assessment

Job Number	21-25774
Revision	A
Date	29 May 2018

Vegetation and survey effort

Figure 4-1

\\ghdnet\ghd\AU\Sydney\Projects\21\25774\GIS\Maps\Deliverables\Biodiversity\21_25774_Z006_Biodiversity_Vegetation.mxd Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: Aerial imagery - AStute 2015 & sixmaps 2016, Inset map - Geoscience Australia, General topo - NSW LPI DTDB 2012, Landuse zoning - SILEP LZN. Created by:afoddy

Table 4-2 Vegetation zones in the study area

Plant Community Type	Veg Type ID	Condition	Conservation significance
Sydney Peppermint - Silvertop Ash heathy open forest	HN600	Moderate/good-high	Native vegetation. Not listed as a threatened ecological community.
Poor condition Sydney Peppermint - Silvertop Ash heathy open forest	HN600	Moderate/good-poor	Modified or planted native vegetation. Not listed as a threatened ecological community.
Prickly Tea-tree - sedge wet heath	HN563	Moderate/good	Native vegetation. Newnes Plateau Shrub Swamp (EEC under the TSC Act) and Temperate Highland Peat Swamps on Sandstone (EEC under the EPBC Act)
Artificial wetland	HN630	Moderate/good - poor	Modified native vegetation. Not listed as a threatened ecological community.
Cleared land	n/a	Cleared	

The structure, species composition and condition of each of the vegetation zones within the study area are described below. Species lists are provided in Appendix B. Plot/transect data is also provided in Appendix B along with benchmark values for each vegetation type.

Table 4-3 Sydney Peppermint - Silvertop Ash heathy open forest in medium condition

Sydney Peppermint - Silvertop Ash heathy open forest in medium condition		
Plant community type (OEH, 2016c)	Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin Bioregion	
PCT ID	1248	
NSW Vegetation Type ID	HN600	
Survey effort	Plot/transect 1, area search 2	
Condition class(OEH, 2014)	Moderate/good - medium.	
Condition description	Remnant or regrowth native vegetation with near-intact over storey and mid storey that was slightly below benchmark values in the plot/transects sampled. All other attributes comprising species richness, shrub, grass and forb cover and woody debris were within benchmark values for this plant community type. All canopy species were observed regenerating. There were no hollow-bearing trees in the plot/transect sampled. Exotic plant cover was sparse (none within the /transects sampled) mainly consisting of isolated individuals in the under storey.	
Conservation significance	Native vegetation. Not listed as a threatened ecological community.	
Evidence used to define vegetation unit	The dominant plant species described below are consistent with the description of the PCT in the VIS (OEH, 2016c). Characteristic landscape position and Narrabeen sandstone geology. Equivalent vegetation communities (MU29 and MU30) were mapped in the study area by DEC (2006).	
Landscape position	Mid slopes on undulating sandstone hills on sandstone plateau.	
Structure	Open forest or woodland.	
Over storey	Dominated by large stands of Sydney Peppermint (*Eucalyptus piperita*) and Silvertop Ash (*Eucalyptus sieberi*). Lower densities of Blue Mountains Ash (*Eucalyptus oreades*), White Stringybark (*Eucalyptus globoidea*) and Hard-leaved scribbly Gum (*Eucalyptus sclerophylla*). There was 16.5 per cent over storey cover in the plot/transect sampled.	
Mid storey	Moderate cover of sclerophyllous shrubs (20.5 per cent cover in the plot/transect sampled, including Woolly Teatree (*Leptospermum grandifolium*) and Slender Tea-tree (*Leptospermum trinervium*).	
Groundcover	Sparse, but species rich and structurally variable with abundant leaf litter between understorey plants.	
grasses	Characteristic species include Wiry Panic (*Entolasia stricta*), a Speargrass (*Austrostipa rudis* subsp. *nervosa*), Snowgrass (*Poa sieberiana*), Weeping Grass (*Microlaena stipoides*) and *Rytidosperma* sp. There was eight per cent grass cover in the plot/transect sampled.	
shrubs	Characteristic species include Bitter-pea (*Daviesia latifolia*), *Pomaderris andromedifolia* subsp*. andromedifolia*, Blue Flax Lily (*Dianella revoluta* var. *revoluta*), Variable Sword-sedge (*Lepidosperma laterale*), Laurel-leaf Grevillea (*Grevillea laurifolia*) and Crinkle Bush (*Lomatia silaifolia*). There was 10 per cent under storey shrub cover in the plot/transect sampled.	

Sydney Peppermint - Silvertop Ash heathy open forest in medium condition	
'other' (herbs, ferns and sedges)	Characteristic species include Silky Purple-Flag (*Patersonia sericea*), Bracken (*Pteridium esculentum*), *Lomandra filiformis* subsp. *filiformis*, Woolly Xanthosia (*Xanthosia pilosa*), *Amperea xiphoclada*, Variable Stinkweed (*Opercularia varia*), Small Poranthera (*Poranthera microphylla*), *Baloskion gracile*, *Hybanthus vernonii* and Blue Trumpet (*Brunoniella australis*). There was 14 per cent under storey shrub cover in the plot/transect sampled.
Exotic species	Exotic species were sparse and low in diversity. Catsear (*Hypochaeris radicata*), *Solanum* sp. and Lamb's Tongues (*Plantago lanceolata*) were recorded as occasional individuals within the broader vegetation zone and the plot sampled.

Table 4-4 Poor condition Sydney Peppermint - Silvertop Ash heathy open forest

Poor condition Sydney Peppermint - Silvertop Ash heathy open forest		
Plant community type (OEH, 2016c)	Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin Bioregion	
PCT ID	1248	
NSW Vegetation Type ID	HN600	
Survey effort	Plot/transects 2 and 3	
Condition class(OEH, 2014)	Moderate/good -poor.	
Condition description	Regrowth and remediated native vegetation comprising a derived shrub land and partially cleared woodland with sub-mature regrowth on remediated portions of the quarry. Remediated areas appear to include a mix of planted native species and natural regrowth from re-spread topsoil. Native over storey was absent and well below benchmark. Understorey forb and grass cover and mid storey cover were variable across the plot/transects sampled There are no hollow-bearing trees. There are good quantities of woody debris. Low cover of exotic species was present throughout the vegetation zone, mainly comprising isolated individuals.	
Conservation significance	Native vegetation. Not listed as a threatened ecological community.	
Evidence used to define vegetation unit	The dominant plant species described below are consistent with the description of the PCT in the VIS (OEH, 2016c). It is surrounded by intact example of this vegetation type associated with characteristic landscape position and Narrabeen sandstone geology. Equivalent vegetation communities (MU29 and MU30) were mapped in adjoining areas by DEC (2006).	
Landscape position	Mid slopes on undulating sandstone hills on sandstone plateau.	
Structure	Derived scrub or shrubland.	
Over storey	Absent.	
Mid storey	Moderate to dense cover of sclerophyllous shrubs (in the plot/transects sampled) including *Acacia longifolia*, Red-fruit Saw-sedge (*Gahnia sieberiana*), Tantoon (*Leptospermum polygalifolium*) and Slender Tea-tree (*Leptospermum trinervium*). Occasional patches of sub-mature *Eucalyptus* species, which appeared to be Sydney Peppermint, Silvertop Ash and Blue Mountains Ash. Mid storey cover was 11 to 46 per cent cover in the plot/transects sampled.	
Groundcover	Sparse, but species rich and structurally variable with abundant leaf litter between understorey plants.	
grasses	Characteristic species include A Wallaby Grass (*Rytidosperma tenuius*), Wiry Panic (*Entolasia stricta*) and Snowgrass (*Poa sieberiana*). Other grass species occurring in lower densities include Speargrass (*Austrostipa rudis* subsp. *nervosa*). Grass cover was 4 to 44 per cent cover in the plot/transects sampled.	
shrubs	Characteristic species include Sunshine Wattle (*Acacia terminalis*), Dolly Bush (*Cassinia aculeata*), Bitter-pea (*Daviesia latifolia*), *Hakea laurina*, Woolly Teatree (*Leptospermum grandifolium*), Conesticks (*Petrophile pulchella*) and *Leptospermum macrocarpum*. Shrub cover was 8 to 26 per cent cover in the plot/transects sampled.	

‘other’ (herbs, ferns and sedges)	Characteristic species include Poverty Raspwort (*Gonocarpus tetragynus*), *Lepyrodia scariosa*, Spiny-headed Mat-rush (*Lomandra longifolia*), *Goodenia paniculata*, *Amperea xiphoclada*, *Baloskion gracile* and Button Everlasting (*Coronidium scorpioides*). Other groundcover was 2 to 30 per cent cover in the plot/transects sampled.
Exotic species	The following species were recorded within the broader vegetation zone: Pampas Grass (*Cortaderia selloana*), English Broom (*Cytisus scoparius* subsp. *scoparius*), Catsear (*Hypochaeris radicata*), *Hakea laurina* and African Lovegrass (*Eragrostis curvula*).

Table 4-5 Prickly Tea-tree - sedge wet heath in moderate/good condition

Prickly Tea-tree - sedge wet heath in moderate/good condition	
Plant community type (OEH, 2016c)	Prickly Tea-tree - sedge wet heath on sandstone plateaux, central and southern Sydney Basin Bioregion
PCT ID	1078
NSW Vegetation Type ID	HN563
Survey effort	Area search 1
Condition class(OEH, 2014)	Moderate/good
Condition description	Intact native vegetation located in the Blue Mountains NP. Native plant species richness and native vegetation cover are consistently high and representative of undisturbed vegetation. There are no hollow-bearing trees. There are good quantities of woody debris. There was a low cover of exotic species throughout the vegetation zone, mainly comprising isolated individuals.
Conservation significance	Comprises an occurrence of ‘Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion’ which is listed as an EEC under the TSC Act. Also comprises an occurrence of the related community ‘Temperate Highland Peat Swamps on Sandstone’ which is listed as an EEC under the EPBC Act.
Evidence used to define vegetation unit	The dominant plant species described below are consistent with the description of the PCT in the VIS (OEH, 2016c). Characteristic landscape position in a valley floor on a high elevation Narrabeen sandstone plateau. Moist, peaty alluvial soils that are clearly distinct from sandy, colluvial soils on adjoining slopes. Equivalent vegetation communities (MU50) were mapped in equivalent landscape positions in adjoining areas by DEC (2006) (noting that the patch in the study area is outside the extent of this mapping).
Landscape position	Poorly drained alluvial flats on a valley floor.
Structure	Shrubland or closed sedgeland.
Over storey	Absent.
Mid storey	Moderate to dense cover of sclerophyllous shrubs between 1 to 3 metres tall and 40% cover (in the plot/transect sampled). Characteristics species include Finger Hakea (*Hakea dactyloides*), Tantoon (*Leptospermum polygalifolium*), Woolly Teatree (*Leptospermum grandifolium*) and Hairpin Banksia (*Banksia spinulosa*). The patch in the study area was burnt in 2014 which probably reduced the mid storey cover.

Prickly Tea-tree - sedge wet heath in moderate/good condition	
Groundcover	Dense, species rich and structurally variable mix of shrubs and sedges with occasional herbs and grasses between 0.2 to 1 metre and 55% cover.
grasses	Low cover of native grasses with no species recorded in the current survey.
shrubs	Characteristic species include *Lepidosperma limicola*, Coral Heath (*Epacris microphylla*), Weeping Baeckea (*Baeckea linifolia*) and *Leucopogon* sp.
'other' (herbs, ferns and sedges)	Characteristic species include Sundew (*Drosera peltata*), *Lepyrodia scariosa*, *Empodisma minus*, *Baloskion australe*, a Rush (*Juncus sp*.), *Dampiera stricta*, *Eurychorda complanata* and *Schoenus* sp.
Exotic species	No exotic species were recorded in this vegetation zone.

Table 4-6 Artificial wetland

Artificial wetland		
Plant community type (OEH, 2016c)	Artificial wetland (closest native match is *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion)	
PCT ID	Closest match is 1071	
NSW Vegetation Type ID	Closest match is HN630	
Survey effort	Not directly sampled due to access and health and safety limitations.	
Condition class(OEH, 2014)	Moderate/good - poor	
Condition description	A derived vegetation type associated with waterbodies in excavations. Most vegetation cover is composed of native species, though cover and species richness is generally low.	
Conservation significance	Derived native vegetation. Does not comprise an occurrence of Newnes Plateau Shrub Swamp, Temperate Highland Peat Swamps on Sandstone or any other wetland TECs because it is associated with modified landforms and does not occur on characteristic natural geomorphological features. Further the substrate is exposed sandstone or coarse grained sediments, not the characteristic peaty soils associated with Newnes Plateau Shrub Swamp or Temperate Highland Peat Swamps on Sandstone.	
Evidence used to define vegetation unit	The dominant plant species described below are consistent with the description of the PCT in the VIS. The VIS also states how derived wetland vegetation associated with modified landforms such as dams or flooded excavations fit within this PCT (OEH, 2016c).	
Landscape position	Flooded excavation and sediment basin within the former quarry.	
Structure	Open wet herb field or sedge land.	
Over storey	Absent.	
Mid storey	Absent.	
Groundcover	Sparse, patchy cover of sedges and herbs.	
grasses	Absent.	
shrubs	Absent.	

Artificial wetland	
‘other’ (herbs, ferns and sedges)	Sparse, patchy cover, mostly restricted to shallow water margins of excavations. Characteristic species include Cumbungi (*Typha orientalis)* and a Spike Sedge (*Eleaocharis* sp.).
Exotic species	Absent.

Table 4-7 Cleared land

Cleared land		
Plant community type (OEH, 2016c)	Not applicable.	
PCT ID	Not applicable.	
NSW Vegetation Type ID	Not applicable.	
Survey effort	Plot/transect 4	
Condition class(OEH, 2014)	Low	
Condition description	No native over storey or mid storey cover. All groundcover attributes lower than benchmark scores. Less than 50 per cent of the ground cover present is native and native cover is frequently less than 10 per cent	
Conservation significance	Exotic vegetation	
Evidence used to define vegetation unit	Clearly associated with highly modified landforms with no natural topsoil or geomorphic features. Very little natural regeneration or evidence of active regeneration.	
Landscape position	Within the quarry void on exposed sandstone or fill.	
Structure	Exotic grassland	
Over storey	Absent.	
Mid storey	Absent	
Groundcover	Herbaceous under storey of exotic weeds.	
grasses	Occasional Common Wheatgrass (*Elymus scaber*) and Wallaby Grass (*Rytidosperma tenuius*). Grass cover was six per cent cover in the plot/transect sampled.	
shrubs	Sparse and include emergent Dolly Bush (*Cassinia aculeata*) and *Acacia longifolia*. No shrub cover was recorded along the transect sampled.	
‘other’ (herbs, ferns and sedges)	Sparse and patchy. These hardy species include Star Cudweed (*Euchiton sphaericus*), a Rush (*Juncus* sp.) and Spiny-headed Mat-rush (*Lomandra longifolia*). No foliage cover was recorded along the transect sampled.	
Exotic species	Low diversity but high cover of exotics in the groundcover dominated by Subterranean Clover (*Trifolium subterraneum*) and some unidentified annual grasses. Lower densities of Catsear (*Hypochaeris radicata*), Pampas Grass (*Cortaderia selloana*) and Common Centaury (*Centaurium erythraea*) were also present. Exotic cover was 62 per cent cover in the plot/transect sampled.	

4.2.4 Groundwater dependent ecosystems

No groundwater-dependent ecosystems (GDEs) are mapped in the study area on the national atlas. Sydney Peppermint - Silver-top Ash Shrubby Woodland is identified as being a low potential GDE (BOM 2017). Hanging and upland swamps in the Blue Mountains are identified as being high probability groundwater dependent wetland communities (Kuginis et al 2012). As such, the Prickly Tea-tree - sedge wet heath downstream of the Project area is likely to be a GDE.

4.3 Fauna and fauna habitats

4.3.1 Fauna species

A total of 54 native fauna species were positively recorded during the field survey, including 28 bird species, four terrestrial mammal species, three bat species, seven reptile species, six frog species and six dragonfly species (Appendix B). Two additional bat species were possibly recorded using echolocation call analysis, including one threatened species, the Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*), but poor data quality and/or interspecific call similarities precluded reliable identification of this species. No introduced species were recorded during the survey.

4.3.2 Fauna habitats

Fauna habitats in the study area are described in Table 4-8 to Table 4-12.

Table 4-8 Fauna habitats: regenerating and planted vegetation

Fauna habitats: Regenerating and planted vegetation	
Habitat values	Parts of the Project area contain regenerating and planted vegetation (Poor condition Sydney Peppermint - Silvertop Ash heathy open forest), and areas of exotic grassland planted to stabilise loose surfaces. These contain a combination of low shrubs and some immature trees. In some areas logs have been placed to help stabilise soils, and more dense plantings occur. In these areas leaf litter and trailing groundcover species are also present. Other areas contain sparse planting and loose rubble.
Typical fauna species	The most commonly recorded woodland bird at the site was the Superb Fairy-wren (*Malurus cyaneus*). Other bird species recorded in this habitat type included the New Holland Honeyeater (*Phyllidonyris novaehollandiae*) and Brown Thornbill (*Acanthiza pusilla*). Welcome Swallows (*Hirundo neoxena*) and Tree Martins (*Petrochelidon nigricans*) were observed foraging on the wing above these areas. A Swamp Wallaby (*Wallabia bicolor*) was observed and scats were present throughout parts of this habitat type. Microchiropteran bats typical of open habitats may forage in this area from time to time. These areas provide habitat for a range of reptile species. The Jacky Dragon (*Amphibolorus muricatus*), Southern Forest Cool-skink (*Niveoskincus coventryi*) and the Dark-flecked Garden Sunskink (*Lampropholis guichenoti*) were observed in association with leaf litter and logs. The Smooth Toadlet (*Uperoleia laevigata*) was heard calling from revegetation areas near the lower dam and individuals were observed.
Threatened or migratory biota	Threatened fauna such as the Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*) may forage over these areas on occasion.

Table 4-9 Fauna habitat: quarry voids

Aquatic habitats: quarry voids	
Description	Three water-filled quarry voids and a sediment basin are present in the Project area. The two larger ones have little fringing vegetation. A small artificial drainage line runs from the main void to the east void. This is mainly rocky with some plants present. The sediment basin has a large area of *Typha* growing. There is also fringing vegetation on the boundary with the east void. Water flows from the east void to the sediment basin via a small waterfall (about 1.5 m high). The sediment basin flows into a creek in the Blue Mountains National Park. This eventually flows through a swamp about 200 m from the Project area. The voids and sediment basin are not key fish habitat.
Typical fauna species	Little Black Cormorants (*Phalacrocorax sulcirostris*), Australian Wood Ducks (*Chenonetta jubata*) and Pacific Black Ducks (*Anas superciliosa*) were observed in the two larger voids. An Australasian Grebe (*Tachybaptus novaehollandiae*) was observed foraging in the sediment basin. Peron's Tree Frog (*Litoria peronii*) and Verreaux's Frog (*Litora verreauxii*) were heard calling from the two larger voids. A number of metamorph Eastern Banjo Frogs (*Limnodynastes dumerilii*) were observed in the drainage line between the main and eastern voids. This species was also heard calling from the sediment basin, as was Peron's Tree Frog. A Tyler's Tree Frog (*Litoria tyleri*) was observed on the rocks near the sediment basin. Snakes and turtles may also occur, particularly in the sediment basin which has more emergent vegetation. Fish were possibly observed in the middle void. This void is separated from the bottom void and creek in the adjacent National Park by the small waterfall. About five species of dragonfly were observed at the lower swamp. These included the Red and Blue Damsel (*Xanthagrion erythroneurum*), Eastern Pygmyfly (*Nannophya dalei*), Blue Skimmer (*Orthetrum caledonicum*) and various ringtails (*Austrolestes* spp.).
Threatened biota	The Large-footed Myotis (*Myotis macropus*) may forage over open water in the voids on occasion. It is possible that the Giant Burrowing Frog (*Heleioporus australiacus*) could occur at the sediment basin, although it is not preferred habitat. Breeding habitat is usually soaks or pools within first or second order streams ,although this species occurs infrequently in semi-permanent to permanent constructed dams with a sandy silt or clay base (DoEE 2016b). The Giant Dragonfly (*Petalura gigantea*) would not breed in the Project area due to the rocky substrate of the void. This species does not utilise areas of standing water wetland, although it may utilise suitable boggy areas adjacent to open water wetlands. Eggs are normally laid into moss, under other soft ground layer vegetation, and into moist litter and humic soils, and larvae dig long burrows under swamps (OEH 2016b).

Aquatic habitats: quarry voids	
Photograph	
	East void and internal drainage line viewed from main void

Table 4-10 Fauna habitats: intact native vegetation

Fauna habitats: intact native vegetation	
Description	Forested areas are present outside the Project area, in the adjacent National park, as well as on the margins of the Project area in the north. Poorer quality forest is present where this vegetation has been subject to disturbance, such as clearing for tracks and electricity easements. Forested areas exhibit high habitat complexity, with a canopy of eucalypts over a typically dense and floristically diverse shrub layer, with a groundcover of native herbs, grasses and occasionally ferns. Flowering and nectar-producing trees and shrubs would provide a range of foraging resources throughout the year for a variety of fauna. Hollow-bearing trees and stags, which could provide potential nesting habitat for arboreal mammals or birds, are present throughout the forested area. A range of hollow sizes and shapes are present, catering for a variety of native fauna species. Around 300 native vertebrate fauna species use tree hollows and shedding bark in Australia, and the shelter provided by these habitat features is essential for the survival of many of these species (Gibbons and Lindenmayer 2002). The understorey of the forest habitat is generally composed of low shrubs, which provide refuge for small birds, mammals and reptiles. Fallen timber and leaf litter in the study area would provide habitat resources for a range of native reptiles and small mammals. Occasional termite mounds were recorded throughout the study area and would provide potential habitat and a food resource for a range of fauna, including threatened species such as Rosenberg's Goanna (*Varanus rosenbergi*) which lays its eggs in termite mounds (OEH 2012). Rock outcrops are present, providing shelter habitat for reptiles and small mammals. Large rock outcrops may provide shelter habitat for larger species such as the threatened Spotted-tailed Quoll (*Dasyurus maculatus*).
Typical fauna species	A range of bird species were recorded in this habitat type. These included the large Yellow-tailed Black-cockatoo (*Calyptorhynchus funereus*), observed foraging in forest along the road, and the Wedge-tailed Eagle (*Aquila audax*), observed high above the study area. Few honeyeaters were recorded, likely due to the low incidence of flowering

Fauna habitats: intact native vegetation	
	eucalypts during the survey. Those recorded included the Eastern Spinebill (*Acanthorhynchus tenuirostris*) and Yellow-faced Honeyeater (*Lichenostomus chrysops*). Small birds included the Grey Shrike-thrush (*Colluricincla harmonica*), Rufous Whistler (*Pachychephala rufiventris*), Grey Fantail (*Rhipidura albiscapa*), White-throated Treecreeper (*Cormobates leucophaea*) and Spotted Pardalote (*Pardalotus punctatus*). The Superb Lyrebird (*Menura novaehollandiae*) was also heard. Mammals recorded included the Red-necked Wallaby (*Macropus rufogriseus*) and Eastern Grey Kangaroo (*Macropus giganteus*), as well as the Wombat (*Vombatus ursinus*). No possums were observed, however the forest is likely to support a variety of possums and gliders. Hollow-bearing trees would provide nesting habitat for a range of species, including microchiropteran bats.
Threatened or migratory biota	There is potential for many threatened fauna to occur in this habitat. These may include Rosenberg's Goanna and the Spotted-tailed Quoll, as mentioned above, as well as various microchiropteran bats. Various threatened woodland birds, owls and parrots are likely to occur. Migratory woodland birds would also occur on occasion. Threatened and migratory fauna that could occur in the wider area are identified in Appendix A.

Table 4-11 Fauna habitat: drainage line

Aquatic habitats: drainage line	
Description	A narrow drainage lines runs from the sediment basin at the discharge from the site through the Blue Mountains National Park. It drains through the swamp, eventually to the Wollangambe River. This drainage line is about 60 cm wide, with steep sided banks near the Project area. A wide, shallow pool is present about 100 m from the Project area. The drainage line then narrows as it approaches the swamp. Fringing vegetation is present, although no emergent aquatic vegetation was observed. Leaf litter covers the bottom of the creek.
Typical fauna species	An Eastern Water Dragon (*Intellegama lesueurii*) and a Yellow-bellied Water Skink were observed on rocks in the upper portion of the creek. The Common Eastern Froglet (*Crinia signifera*) was heard calling. A number of tadpoles of the Eastern Banjo Frog were observed in the pool. Various smaller tadpoles were also observed, likely species of *Litoria* or *Crinia.*
Threatened biota	Tadpoles of the Giant Burrowing Frog could occur in this creek. Eggs are usually laid in ephemeral pools, or slow or standing water such as small soaks formed in eroded sandstone drainage lines. These can then be flushed downstream with tadpoles occurring in semi-permanent to ephemeral sand or rock based streams (DoEE 2016b). There are records of this species in the locality.

Aquatic habitats: drainage line	
Photograph	
	Creek downstream of sediment basin

Table 4-12 Fauna habitat: swamp

Aquatic habitats: swamp	
Description	A large swamp is located about 200 metres downstream of the sediment basin. Water from the Project area drains through this swamp. During the time of survey there was little standing water in the swamp. A narrow drainage line (about 30 cm wide) with water was observed in the lower portion, while the remainder of the drainage line appeared to be dry. The remainder of the swamp did not appear to be boggy. Parts of the swamp appear to have deep peaty soils, however little leaf litter is present.
Typical fauna species	The New Holland Honeyeater was observed foraging in the Hakeas in the swamp. A Black-bellied Swamp (Marsh) Snake (*Hemisaspis signata*) and a Pale-flecked Garden Sunskink (*Lampropholis guchenoti*) were also observed. A number of tracks were observed through the swamp, likely from the Swamp Wallaby or Red-necked Wallaby (*Macropus rufogriseus*). No frogs were heard calling at this swamp during the survey.
Threatened biota	The Blue Mountains Water Skink (*Eulamprus leuraensis*) could occur at this swamp, although it does not appear to be preferred habitat. This species is restricted to of sedge and shrub swamps that have boggy soils and appear to be permanently wet (OEH 2016b). The soil appeared to be mostly dry at the time of the survey, with only a short, narrow area of open water present in the drainage line through the middle. The Giant Dragonfly (*Petalura gigantea*) could occur at this swamp, although the general lack of free water may make this swamp unsuitable.
Photograph	
	Swamp located about 200 m downstream of Project area

4.3.3 Habitat connectivity

Limited habitat connectivity is present within the Project area. Revegetated areas provide some connectivity in the Project area. The adjacent national park and other areas are predominantly intact native vegetation and provide connectivity for flora and fauna around the site.

4.4 Conservation significance

The full list of threatened and migratory biota predicted to occur or previously recorded in the locality is presented in Appendix A along with their habitat requirements, conservation status and an assessment of their likelihood of occurrence in the study area or being affected by the Project. Threatened and migratory biota and other MNES that have been recorded, are likely to occur in the study area or be affected by the incident are discussed below.

4.4.1 Threatened ecological communities

No threatened ecological communities are present in the Project area.

There is a patch of Prickly Tea-tree - sedge wet heath along the drainage line approximately 200 metres downslope from the Project area (refer to Figure 4-1) that comprises an occurrence of Newnes Plateau Shrub Swamp, which is listed as an EEC under the TSC Act, and the related Temperate Highland Peat Swamps on Sandstone, which is listed as an EEC under the EPBC Act.

4.4.2 Threatened flora species

No threatened plants were recorded in the Project area or in the broader study area.

Database searches indicate 26 threatened plant species listed under the TSC Act and/or EPBC Act which have been previously recorded, or are predicted to occur in the locality. An assessment of broad habitat requirements for these threatened species indicates that up to three threatened flora species are likely to occur in the study area based on the presence of suitable habitat and known populations in the locality (see Table 4-13). None of these species were observed in the Project area or are likely to occur as adult individuals given the highly modified nature of the majority of the site and that they were not detected despite the survey effort employed within the 0.13 ha of native vegetation with natural soil profiles. There is a chance that these species could be present in the soil seed bank or may colonise the Project area in the future. On this basis the Project would remove potential habitat for these species in the Project area and may affect habitat downstream of the site through factors such as changes to surface or groundwater flow regimes or through mobilisation of sediments.

Table 4-13 Threatened plant species with potential habitat in the Project area

Scientific Name	Common Name	EPBC Act Status	TSC Act Status
Veronica blakelyi	-	-	Vulnerable
Boronia deanei	Deane's Boronia	Vulnerable	Vulnerable
Persoonia hindii	-	-	Endangered

There is broadly suitable habitat for a further 11 species in the study area (see Appendix A). There is a very low risk of impacts to any of these species because there is not any evidence of a population in the Project area or in the locality.

4.4.3 Threatened fauna species

Database searches identified 45 fauna species listed under the TSC Act and/or EPBC Act which have been previously recorded, or are predicted to occur in the locality. An assessment of the broad habitat requirements for these threatened species indicates that there is potential for 33 threatened fauna species to occur within the study area (see Appendix A).

One threatened fauna species, the Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*) was recorded at the Project area. This is a wide ranging species that forages over forested and cleared areas. No roosting or breeding habitat for this species is present in the Project area.

Most threatened fauna species that may occur are highly mobile species, and would only occur in the Project area on a transient basis if at all given the highly disturbed nature of the site. Lack of mature trees with suitable tree-hollows limits breeding habitat for hollow-dependent fauna, such as arboreal mammals, microchiropteran bats and owls and parrots, in the Project area.

Species with the potential to be impacted by the Project are those that are dependent on watercourses or swamps. These are detailed in Table 4-14.

Table 4-14 Threatened fauna species that may be impacted by the Project

Scientific Name	Common Name	EPBC Act Status	TSC Act Status
Petalura australis	Giant Dragonfly	-	Endangered
Heleioporus australiacus	Giant Burrowing Frog	Vulnerable	Vulnerable
Pseudophryne australis	Red-crowned Toadlet	-	Vulnerable
Litoria littlejohni	Littlejohn's Tree Frog	Vulnerable	Vulnerable
Eulamprus leuraensis	Blue Mountains Water Skink	Endangered	Endangered

4.4.4 Migratory species

Database searches identified migratory species that have either been recorded or are predicted to occur within the locality. Based on a desktop review of known habitat associations, five migratory species listed under the EPBC Act were considered to have the potential to occur within the study area, at least on occasion (see Appendix A).

Important habitat for these migratory birds is defined in the significance criteria for listed migratory species (DotE 2013) as follows:

- Habitat utilised by a migratory species occasionally or periodically within the region that supports an ecologically significant proportion of the population of the species.
- Habitat that is of critical importance to the species at particular life-cycle stages.
- Habitat utilised by a migratory species which is at the limit of the species range.
- Habitat within an area where the species is declining.

Habitat in the Project area is not considered important for these migratory species as it is highly disturbed and modified and extensive areas of high quality habitats are present in the adjacent national park. The study area would only ever support a small number of individuals of any migratory species and not an ecologically significant proportion of the population of any species.

4.4.5 Greater Blue Mountains World Heritage Area

The Blue Mountains National Park is located along the eastern boundary of the Project area. This national park is part of the Greater Blue Mountains World Heritage Area (GBMWHA). A significant proportion of the Australian continent's biodiversity occurs in the area (UNESCO 2015). The GBMWHA protects a large number of pristine and relatively undisturbed catchment areas, including the Colo Wild River (DECC 2009).

Areas of the Blue Mountains National Park adjacent to the Project area have been disturbed through edge effects, clearing for the boundary fence, disturbance from historical quarrying, and electricity easements.

5. Impact assessment

5.1 Proposed works

The Project would rehabilitate the Bell Quarry through the importation of 1.2 million cubic metres of clean fill generated from earthworks Projects across Sydney. The quarry surface would be reprofiled following filling with the potential final landform reflecting the estimated geometry of the land's surface prior to the commencement of quarrying at the site. The final landform would be progressively revegetated with plant species representative of native vegetation in the local area to provide effective control or erosion and integration with the surrounding landscape.

5.2 Impacts of importation of fill and reprofiling

5.2.1 Direct impacts

Clearing of vegetation

The majority of the Project is to be undertaken in areas which have previously been disturbed. Portions of the land have previously been revegetated to assist with stabilisation of soils. Remnant native vegetation is present around the edges of the Project area. In total, 0.13 ha of remnant vegetation would be removed and 2.48 ha of planted vegetation would be removed (Table 5-1). Clearing of vegetated areas would be temporary as the staging process allows for clearing of vegetation followed soon after by reprofiling and revegetation.

Table 5-1 Removal of vegetation and habitats

Plant Community Type	Project area (ha)
Sydney Peppermint - Silvertop Ash heathy open forest	0.13
Poor condition Sydney Peppermint - Silvertop Ash heathy open forest (planted)	2.48
Total clearing of native vegetation	**2.61**
Artificial wetland	3.19
Cleared land	2.41

The Project would not directly impact any threatened ecological communities or known populations of threatened flora species.

This reduction in the extent of native vegetation in the locality as a result of reprofiling would not threaten the persistence of local populations of native plants. Flora populations would persist within adjoining areas of alternative habitat outside the site. This temporary reduction in extent is also highly unlikely to affect the viability of remnant vegetation in the study area or locality or reduce the extent of habitat below a minimum size required for any fauna species. Further, much of the vegetation is disturbed, and has a much lower diversity than the adjacent intact native vegetation. The final landform would be revegetated progressively during the Project, which would result in a more natural environment in the long-term.

Removal of terrestrial habitat resources

The Project footprint contains mainly foraging and shelter resources for common native fauna. The 2.61 ha of native and planted vegetation that would be removed for reprofiling provides foraging, breeding, roosting and nesting resources for a range of fauna species. The majority of vegetation to be removed consists of shrubs and groundcover, with only a small canopied area to be removed. Shrubs would provide shelter and nesting habitat for small birds and lizards. Eucalypts would provide some foraging and nesting habitat for common birds. No hollow-bearing trees would be removed. The Project would remove fallen logs, rocky areas and leaf litter, which would lead to the loss of foraging and shelter habitat for small ground-dwelling species such as lizards and ground frogs. The magnitude of impact is likely to be low given extensive areas of good quality habitat in the adjacent national park.

Removal of aquatic habitats

The importation of fill will progressively remove the two large waterbodies at the site (3.19 ha in area). This will result in the loss of breeding and foraging habitat for a number of common frog species, as well as foraging habitat for a variety of waterbirds. The small void on the eastern side of the Project area with emergent vegetation would be retained.

Fauna injury and mortality

As described above, the Project footprint provides habitat resources for native fauna species and would contain mainly foraging and shelter resources for common native fauna. Groundcover vegetation, leaf litter and woody debris would provide shelter and foraging substrate for mammals, reptiles, frogs and invertebrates. Construction is likely to result in the injury or mortality of some individuals of these less mobile fauna species and other small terrestrial fauna that may be sheltering in vegetation within the Project footprint during clearing activities. There no hollow-bearing trees in the Project footprint which reduces the risk of injury or mortality of arboreal mammals or hollow-nesting birds. Alternative habitat resources and refuge from construction activities is available in native vegetation adjoining the site. The potential injury or mortality of individuals within a maximum of 8.2 hectares of habitat (including only 2.61 ha of vegetation), is highly unlikely to affect an ecologically significant proportion of any local populations.

The draining of the two large waterbodies is likely to result in the mortality of many eggs and tadpoles of common frog species. Habitat will be retained in the small void to the east of the Project area.

Recommendations have been made in Section 7.3 to minimise the risk of vegetation clearing activities resulting in the injury or mortality of resident fauna.

Fragmentation or isolation of habitat

The Project is located in a highly disturbed portion of land, with large expanses of native vegetation surrounding it. Vegetation at in the Project area is predominantly planted. The importation of fill is unlikely to result in the isolation of any areas of native vegetation or fauna habitats. Revegetation in the future following reprofiling will improve connectivity in the area (see section 5.3.

5.2.2 Indirect impacts

Surface water

GHD (2018) has predicted ENM soil water quality in order to assess potential impacts on water quality downstream of the site. pH is predicted to remain slightly acidic during all stages except stage 6, with all predicted pH values being above those which were observed during the site visit on 9 March 2017. It is likely that pH would become more acidic downstream due to inflow from other sources as appears to be the case at present.

No exceedances of the ANZECC (2000) guideline values (GV) for metals are predicted for any phase for the Project, with the exception of pH and zinc when assessed with extremely conservative assumptions for the potential leachability of emplacement material. This exceedance is considered minor, however, considering the predicted zinc concentration is lower than that observed by OEH (2015) at a monitoring site upstream of the Clarence Colliery discharge. Electrical conductivity (EC) is predicted to remain below the ANZECC (2000) GV for upland rivers for all stages except stage 6. Given that there is little change in water quality as a result of the Project, and most variables would remain within the ANZECC (2000) GV, there is likely to be minimal impact on habitat values downstream of the Project area.

As discussed in Section 4.1.4, the existing conditions result in less frequent flows than would occur in the natural scenario, with peak flows during heavy rainfall increasing compared to the natural scenario. Dewatering during the Project will reduce the overflow frequency from the system compared to current conditions as the water will be temporarily stored in the remaining void areas. This impact will be most significant during stages where voids are maintained empty such as Stage 4 when no flow will occur approximately 86% of the time over a period of around 4-6 years.

Moderate discharges will be more regular during stages involving significant dewatering (particularly Stage 3, which would last less than one year). This is due to discharges occurring at a higher rate than the existing conditions to allow water to be progressively pumped from the existing voids to allow for the emplacement of fill . After completion of the Project, rehabilitation flows will generally be restored to natural conditions and will be significantly closer to natural conditions than is currently the case (GHD 2017).

Changes in flows would impact fauna that occur in the drainage line. High flow conditions may not be suitable for all species, and small fauna such as tadpoles and frogs may be flushed further downstream. The existing voids will be progressively dewatered at moderate flow rates of between 1 and 2 ML/Day. This is considerably less than the current site discharges associated with storm flows during wet weather events of up to 10 ML/day and are unlikely to substantially alter local geomorphology or otherwise have a significant negative effect on the community.

In the long-term, with the return to pre-quarry natural conditions, the habitat conditions would improve along the drainage line as a result of more frequent flows. This return to natural conditions should improve habitat within the swamp downstream of the Project area in the long-term. Notably, the post rehabilitation conditions would include increased frequency and duration of low flow events which would be expected to have a positive effect on the moisture-dependant plant species that characterise this community.

Groundwater impacts

As detailed in GHD (2018) groundwater at the site flows to the northeast, in the direction of the tributary. Borehole surveys found that the voids appear to gain groundwater faster than it is lost to the receiving environment. Groundwater inflow will occur in all stages of the Project, and at a greater rate during stages where void water levels are maintained low. Groundwater will be discharged along with catchment run-off during dewatering activities and rainfall events as discussed above. The project is not anticipated to impact groundwater quality or levels in adjacent habitats.

Weed invasion and edge effects

‘Edge effects’ refers to factors, including increased noise and light, weed invasion, tree failure or erosion and sedimentation at the interface of intact vegetation and cleared areas. Edge effects can result in impacts such as changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna.

Edge effects have occurred previously as a result of operation of the quarry, including provision of a boundary tracks along the perimeter fence. Native vegetation occurs on the edges of the

Project area. Some of this would be removed as part of the reprofiling of the site. Edge effects currently occur within the adjacent national park and other vegetated areas. There would be limited increase in edge effects as there is only limited additional clearing. Revegetation works will improve vegetation connectivity and assist in decreasing the adverse impacts of edge effects within and adjacent to the Project area in the long term.

Pests and pathogens

Construction activities within the Project area have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*), Myrtle Rust (*Uredo rangelii*) and Chytrid fungus (*Batrachochytrium dendrobatidis*) into adjacent native vegetation through vegetation and soil disturbance, through the movement of plant, machinery and vehicles, as well as through any landscaping works following construction. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys. Phytophthora and Myrtle Rust may result in the dieback or modification of native vegetation and damage to fauna habitats. Chytrid fungus affects both tadpoles and adult frogs and can cause 100% mortality in some populations once introduced into an area.

Mitigation measures would be included in the CEMP to prevent the introduction or spread of disease that could potentially impact threatened biota in the study area (see Section 7.3).

Dust generation

Dust as a result of wind and vehicle movement may currently affect native vegetation located adjacent to the existing landfill, however there was little evidence of dust in adjacent vegetation. Dust is likely to be generated during clearing, filling and reprofiling activities. High dust levels could reduce habitat quality for flora and fauna species by reducing plant and animal health in areas of adjoining vegetation.

Mitigation measures would be included in the CEMP to minimise impacts of dust (section 7.3). Dust is unlikely to substantially impact habitat for any threatened biota due to the mitigation measures proposed.

Rehabilitation of the final landform would substantially reduce dust generation at the Project area in the long-term.

Noise

There would be noise impacts during the construction phase as a result of the movement of vehicles and operation of plant during importation of fill and reprofiling activities. The Project footprint previously operated as a quarry and surrounding land was subject to noise from quarrying activities. Currently, noise is generated by vehicle movement along the nearby road, the rail line and operation of the Clarence Colliery.

There is the potential for individuals that nest in trees that are close to the Project edge abandoning their nests as a result of noise during reprofiling activities. Noise may also affect general fauna activity in these areas. Given the existing noise levels in the vicinity of the Project, any localised and temporary increase in noise levels during the rehabilitation activities are unlikely to substantially impact on native biota.

Following rehabilitation activities, noise levels would substantially reduce at the site.

Vibration

Vibration impacts may result from works associated with the Project, such as heavy vehicle movement and construction and operational activities. Vibration may deter native fauna from using the area surrounding the source of vibration. This may potentially interrupt dispersal within the immediate area if an individual is unwilling to travel through an area where vibration is detectable, or may cause some species to abandon an area in search of areas where vibration is not detectable.

Historically vibration would have been substantially higher during quarrying activities, however since quarrying ceased, vibration levels within the Project area are low. The Project would increase vibration throughout the Project site and adjacent areas during construction. Typical vibration levels from activities such as use of a vibratory roller are generally negligible at distances greater than 100 metres and would have minor impacts upon habitat values surrounding the site.

5.3 Post rehabilitation impacts

Following reprofiling of the quarry, the new surface would be progressively revegetated with native plant species that are representative of the native vegetation communities adjoining the Project area and using local provenance seed. Rehabilitation activities would aim to progressively provide a landform vegetated by locally occurring grasses, shrubs and trees suitable for a range of land uses. Vegetation would be selected in consultation with the National Parks and Wildlife Service and Royal Botanic Gardens and revegetation monitored annually by a specialist.

There would be few, if any, ongoing impacts within the Project area as the site would be returned to a natural landform and vegetated with native woodland and forest. Post rehabilitation impacts may include further generation of dust or erosion and sedimentation before vegetation becomes fully established or if there are failures in mitigation measures. These risks are more likely in the event of severe storms and/or prolonged dry periods. There is a possible residual risk of weeds becoming established on the post rehabilitation landform and spreading into adjoining native vegetation. Monitoring of the rehabilitated areas and active management of any detected risks or impacts would minimise the duration, extent and severity of any impacts (see Section 7.3).

In the long-term, with the return to pre-quarry natural conditions, the habitat conditions would improve along the drainage line as a result of more frequent flows. This return to natural conditions should improve habitat within the swamp downstream of the Project area in the long-term. Notably, the post rehabilitation conditions would include increased frequency and duration of low flow events which would be expected to have a positive effect on the moisture-dependant plant species that characterise this community, and thus would also improve habitat for fauna dependent on this community.

5.4 Cumulative impacts

The Project would temporarily increase the extent of vegetation clearing in the locality, and increase the removal of habitats for flora and fauna species. This habitat consists predominantly of planted and sub-mature vegetation, with only a small area of intact remnant vegetation to be removed. In the long-term, the Project would improve vegetation and terrestrial fauna habitats at the site. There would be a permanent loss of the artificially created aquatic habitat resulting from the infill of the quarry voids.

Any other development external to the Project such as future road works, extractive industries, rail upgrades or power line easement upgrades could result in loss of native vegetation. Given that much of the surrounding locality is national park, extensive areas of flora and fauna habitats in the locality are protected.

6. Impacts on listed biota and protected areas

6.1 Key threatening processes

A key threatening process (KTP) is defined in the TSC Act as an action, activity or Project that:

- Adversely affects two or more threatened species, populations or ecological communities
- Could cause species, populations or ecological communities that are not currently threatened to become threatened.

KTPs potentially relevant to the Project are discussed in Table 6-1.

Table 6-1 Key Threatening Processes of relevance to the Project

KTP	Status	Comment
Clearing of native vegetation	TSC Act EPBC Act	The Project includes the temporary removal of 2.61 ha of native vegetation, the majority of which is sub-mature planted native vegetation on a highly modified landform. Around 0.13 ha of remnant native vegetation with natural soil profiles would be removed. Extensive areas of intact native vegetation are present in the locality, including many thousands of hectares conserved in national parks. This temporary reduction in vegetation extent is highly unlikely to affect the viability of remnant vegetation in the study area or locality or reduce the extent of habitat below a minimum size required for any fauna species. The Project includes the rehabilitation of the final landform to a natural landscape, which would improve flora and fauna habitat in the long-term. Mitigation measures are proposed to minimise impacts on surrounding vegetation during the reprofiling and rehabilitation phases (see Section 7.3.1).
Removal of dead wood and dead trees	TSC Act	The Project area contains areas of fallen timber. The Project will result in the removal of this timber during the rehabilitation activities. The implementation of habitat management procedures is recommended to limit impacts on fauna and their habitats (see Section 7.3.1).
Invasion of plant communities by perennial exotic grasses	TSC Act	The Project area features large areas of exotic grassland. There is the potential for perennial exotic grasses to invade adjacent native vegetation through disturbance during construction of the Project and a shift of the disturbed edge into intact native vegetation. The Project includes the rehabilitation of the final landform to a natural landscape. Mitigation measures are proposed to prevent the spread of weeds into surrounding vegetation during the reprofiling and rehabilitation phases (see Section 7.3.1).
Infection of native plants by *Phytophthora cinnamomi*	TSC Act; EPBC Act	Construction activities have the potential to introduce Phytopthora into the study area, through the movement of plant, machinery and vehicles, as well as through any landscaping works following construction. The Project would include environmental management measures, including specific consideration of measures to reduce potential impacts on soil, water and native vegetation (see Section 7.3.1).
Introduction and establishment of Exotic	TSC Act	Construction activities have the potential to introduce Myrtle Rust to the study area. The Project would include

KTP	Status	Comment
Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae		environmental management measures, including specific consideration of measures to reduce potential impacts on soil, water and native vegetation (see Section 7.3.1).
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	TSC Act; EPBC Act	Construction activities have the potential to introduce amphibian chytrid to the study area, which could lead to frog mortality. The Project would include environmental management measures including specific consideration of measures to reduce potential impacts on soil, water and native vegetation (see Section 7.3.1).
The degradation of native riparian vegetation along NSW water courses	FM Act	The Project will change the flow of water across the Project area and into the surrounding area. There are unlikely to be direct impacts on riparian vegetation outside the Project area. Mitigation measures are recommended to limit the potential for indirect impacts resulting from reprofiling (see Section 7.3.1).
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	TSC Act; FM Act	The hydrology of the study area is already substantially modified by the existing quarry. The Project would alter the landform through placement of fill and modify surface water flows. The final landform has been designed to provide natural flows along the drainage lines leading from the Project area. Mitigation measures are recommended to limit the potential for adverse impacts on aquatic habitats (see Section 7.3.1).
Human-caused climate change	TSC Act EPBC Act	Combustion of fuels associated with construction and operation of the Project would contribute to anthropogenic emissions of greenhouse gases. The increase in greenhouse gases could impact average temperatures, rainfall patterns and bushfires, which can impact vegetation and habitats for flora and fauna.

6.1 Impacts on threatened biota listed under the TSC Act

6.1.1 Identification of affected species

The desktop assessment, field surveys and habitat assessments described in this report have been used to identify the threatened flora and fauna species, and ecological communities, that may be affected by the Project, through either direct or indirect impacts. The outcome of these assessments is summarised in Appendix A.

The Project area is highly modified as a result of previous quarrying activities, and little intact native vegetation is present. Most vegetation at the Project area is the result of previous revegetation activities. As such, little habitat for threatened biota is present.

There would be no direct impacts on any threatened ecological communities in the study area. One threatened ecological community, Newnes Plateau Shrub Swamp is located downstream of the Project area and may be indirectly impacted by the Project. An assessment of significance pursuant to Section 5A of the EP&A Act has been prepared for this community and is discussed further in section 6.1.2.

Assessments of Significance pursuant to Section 5A of the EP&A Act have been prepared for three threatened flora species for which a moderate level of impact is possible: *Veronica blakelyi*, *Boronia deanei* and *Persoonia hindii*. The Project would remove potential habitat for these species in the Project area and may affect habitat downstream of the site through factors such as changes to surface or groundwater flow regimes or through mobilisation of sediments. The Project would restore more natural flow regimes to the catchment downstream of the Project area which is likely to have neutral or positive effects on habitat for these species.

Potential indirect impacts are likely to be mitigated through the purposeful staging of earthworks and water discharges and installation of appropriate sediment controls.

Assessments of Significance pursuant to Section 5A of the EP&A Act have been prepared for those fauna species for which a moderate level of impact is possible dependent on whether these species are present. These include species that may be impacted by changes to water quality and flows, and include threatened frogs, the Giant Dragonfly and the Blue Mountains Water Skink (see section 6.1.4).

A number of other mobile threatened fauna species such as birds and bats may occur on occasion in the Project area. Potential habitat in the Project area is of poor quality given its disturbed nature and limited breeding resources present. Potential habitat in the Project area represents a negligible proportion of available foraging habitat in the locality for these wide ranging species. The loss of a very small area of predominantly regrowth and planted habitat adjacent to the national park would have a very minor potential for adverse impact upon these species. No assessments of significance are considered necessary for these species.

6.1.2 Threatened ecological communities

There is an approximately 1.5 hectare occurrence of Newnes Plateau Shrub Swamp downstream and around 200 metres to the northeast of the Project area. This EEC is dominated by moisture-dependant shrubs and sedges and in narrow, elongated swamps formed in low-slope headwaters of the Newnes Plateau, in predominantly sandstone catchments of Triassic Narrabeen Group geology, at approximately 900-1200 m elevation on deep sandy organic sediments that are permanently to periodically waterlogged (OEH 2016b). The occurrence of the ecological community in the study area is associated with alluvial flats along an unnamed first order drainage line that drains the pit void and flows to the northeast.

The Project would not clear any vegetation within an occurrence of this community. The Project would modify surface and groundwater flows within the catchment of the ecological community and potentially affect water quality. There would be increased frequency of low flow events following the completion of site rehabilitation, when compared to the existing situation. This is because these low flow events are being stored in the quarry voids under the current situation (GHD 2017). The increased frequency and duration of low flow events would be expected to have a positive effect on the moisture-dependant plant species that characterise this community. There will increased frequency of moderate flows during stages 1 and 3 of the project associated with void dewatering.

The existing voids will be progressively dewatered at moderate flow rates of between 1 and 2 ML/Day during stages 1 and 3 of the project. The flow rate is considerably less than the current site discharges associated with storm flows during wet weather events of up to 10 ML/day and are unlikely to substantially alter local geomorphology or otherwise have a significant negative effect on the community.

Changes to environmental conditions as a result of the Project are likely to be within the range of conditions tolerated by species within the ecological community and are unlikely to modify the composition of the ecological community or alter habitat such that its local occurrence is likely to be placed at risk of extinction.

The post-rehabilitation hydrological regime is expected to more closely match natural conditions than the current situation (GHD 2017) and as such is likely to comprise suitable environmental conditions for maintenance of the community. Notably, the post rehabilitation conditions would include increased frequency and duration of low flow events which would be expected to have a positive effect on the moisture-dependant plant species that characterise this community.

An assessment of significance pursuant to Section 5A of the EP&A Act has been prepared for these threatened plant species (see Appendix C). The Project is unlikely to have a significant impact negative effect on the local occurrence of Newnes Plateau Shrub Swamp.

6.1.3 Threatened flora species

Deanes Boronia (*Boronia deanii*) grows on the margins of high altitude swamps, in wet heath on sandstone, and in drier open forest (OEH 2016b). There are relatively abundant populations of this species associated with Newnes Plateau Shrub Swamp communities similar to the occurrence in the study area throughout the locality of Bell, Clarence and the Newnes Plateau. There is potential habitat for this species in native vegetation throughout the study area, though the most likely habitat is around the margins of the Newnes Plateau Shrub Swamp downstream of the Project area.

Persoonia hindii is restricted to the Newnes Plateau region and mostly occurs as discrete populations of clonal, suckering populations (OEH 2016b). Within this range it is frequently associated with Sydney Peppermint - Silvertop Ash heathy open forest on sandstone-derived soils equivalent to that within the study area.

Veronica blakelyi is restricted to the western Blue Mountains, and occurs as patchy and generally small populations. It occurs in eucalypt forest, often in moist and sheltered areas (OEH 2016b). There is potential habitat for this species in native vegetation throughout the study area, though the most likely habitat is associated with Sydney Peppermint - Silvertop Ash heathy open forest on more sheltered aspects such as lower slopes adjoin the unnamed drainage line that flows northeast from the Project area.

None of these threatened plant species were observed in the Project area or are likely to occur given the highly modified nature of the site and the survey effort employed within the 0.13 ha of native vegetation with natural soil profiles. The Project would remove 0.13 ha of potential habitat for these species in the Project area and may affect habitat downstream of the site through factors such as changes to surface or groundwater flow regimes or through mobilisation of sediments.

An assessment of significance pursuant to Section 5A of the EP&A Act has been prepared for these threatened plant species (see Appendix C). The Project is unlikely to have a significant impact on local populations of these species should they occur, as: no individual plants or known occupied habitat would be removed; the Project would have a minor and localised effect on habitat with moderate value; and the post-Project environment would more closely resemble natural conditions and in the longer term would improve the extent and connectivity of habitat in the locality.

6.1.4 Threatened fauna species

The Giant Burrowing Frog (*Heleioporus australiacus*), listed as a vulnerable species under the TSC Act, is known to occur in the locality (OEH 2017a, DECC 2007). Preferred breeding habitat includes ephemeral pools and soaks formed in eroded sandstone drainage lines, and the species is rarely associated with permanent ponds or streams (Mahony 1993, Watson & Martin 1973). Giant Burrowing Frog breeding sites are generally in the upper parts of the topography where slopes are gentle (6-11°). Flat areas and steep sections were not found to be inhabited by this species (Stauber 2006). Little open water was observed at the swamp in the study area, however it may represent breeding habitat. Tadpoles have been recorded in clear water with a pH between 4.3–6.5 (Recsei 1997). The Giant Burrowing Frog spends the majority of the year away from breeding areas, burrowing under leaf litter in the forest floor (Stauber 2006). The Giant Burrowing Frog is likely to shelter in deep leaf litter in the national park adjacent to the Project area, but is not likely to shelter in the Project area given the lack of suitable habitat.

Individuals may forage in the Project area on occasion. During the rehabilitation process flow magnitudes will vary, with moderate flows occurring in early stages. This may impact suitability of breeding habitat for the species in the short term, particularly during long periods of low flows. Changes to environmental conditions as a result of the Project are likely to be within the range of conditions tolerated by species within the drainage line. In the long-term, the Project is likely to improve potential breeding habitat in the swamp downstream of the Project area, with flows returning to natural conditions. This is likely to result in areas of permanent water that are more suitable breeding habitat for this species. This species is not likely to be dependent on this single drainage line as it is spends the majority of the year away from breeding areas, and can travel to more suitable locations in the area for breeding.

The Red-crowned Toadlet (*Pseudophryne australis*), listed as a vulnerable species under the TSC Act, generally breeds in soaks and depressions in the upper parts of the topography where slopes are gentle (6-11°) and within 200 m of cliffs. Flat areas and steep sections such as gullies were not found to be inhabited by this species (Stauber 2006). Red-crowned Toadlets are sensitive to environmental changes, and require a pH range between 5.5 and 6.5 (OEH 2015b). Red-crowned Toadlet aggregations show fidelity to leaf litter piles, and will move with the leaf litter as it is washed down a drainage line. Individuals disperse outside the breeding period, when they are found under rocks and logs on sandstone ridges and forage amongst leaf-litter (Stauber 2006). This species could occur in small drainage lines and soaks adjacent to the Project area. During the rehabilitation process flow magnitudes will vary, with moderate flows occurring in early stages, which could result in flushing of tadpoles, eggs or frogs further downstream, and also mortality of individuals. During the long periods of low flows, the local population would be dependent on rain events to create pools suitable for breeding. Outside the breeding season, individuals would continue to forage and shelter away from the drainage line. Changes to environmental conditions as a result of the Project are likely to be within the range of conditions tolerated by species within the drainage line. In the long-term, the Project will result in flows returning to natural conditions. More permanent water along the drainage line and in the swamp may improve breeding habitat in the area. pH levels are likely to remain within a suitable range downstream of the Project area.

Littlejohn's Tree Frog (*Litoria littlejohni*), listed as a vulnerable species under the TSC Act, is often found in creeks draining upland swamps. It was not recorded during targeted surveys for the Wollangambe and Upper Wolgan area (DECC 2009), but is known to occur on the Newnes Plateau (OEH 2017a). This species is notoriously difficult to detect and is one of the least recorded frogs in NSW for this reason (Lemckert 2005, in DECC 2009). Littlejohn's Tree Frog attaches clusters of eggs to submerged twigs, stems or branches, often near the banks of still pools in clear, slowly flowing streams. Potentially suitable breeding habitat for this species is present along the drainage line running from the Project area. During the rehabilitation process flow magnitudes will vary, with moderate flows occurring in early stages and long periods of low flows occurring in the middle stages. This may impact suitability of breeding habitat for the species in the short term if present. Low flows could result in death of tadpoles and eggs if a breeding event has recently occurred. Adult frogs are likely to be able to disperse to other areas of suitable habitat in the wider area. Changes to environmental conditions as a result of the Project are likely to be within the range of conditions tolerated by species within the drainage line. In the long-term, the Project is likely to improve potential breeding habitat, with flows returning to natural conditions and water being present on a more permanent basis along the drainage line.

The Blue Mountains Water Skink (*Eulamprus leuraensis*), listed as a vulnerable species under the TSC Act, has been recorded at a number of locations near Clarence (OEH 2017a) and may occur in swamps located near the Wollangambe River. The Blue Mountains Water Skink is a high elevation species and is restricted to an isolated and naturally fragmented habitat of sedge and shrub swamps (NPWS 2001a) that have boggy soils and appear to be permanently wet (LeBreton, 1996). The vegetation in these swamps typically takes the form of a sedgeland interspersed with shrubs, but may be a dense shrub thicket. The species appears to prefer sites with deeper leaf litter and moister soil (LeBreton, 1996). This species could occur in the swamp near the Project area, although none were observed during the survey. During the rehabilitation process flow magnitudes will vary, with moderate flows occurring in early stages. Changes to environmental conditions as a result of the Project are likely to be within the range of conditions tolerated by species dependent on the swamp. In the long-term, the Project is likely to improve potential breeding habitat in the swamp downstream of the Project area, with flows returning to natural conditions. This may improve habitat quality for this species, as it prefers sites that are permanently wet.

The Giant Dragonfly (*Petalura gigantea*), listed as a vulnerable species under the TSC Act, occurs in swamps in the Blue Mountains area, and has been recorded from near Clarence and Bell (OEH 2017a). Giant Dragonflies live in permanent swamps and bogs with some free water and open vegetation. Potential breeding swamps include Newnes Plateau Shrub Swamps, particularly those with wetter perennial swamp vegetation and organic-rich or peaty substrate (Baird, 2012). The majority of the ovipositing or emergence locations occur in lower gradient valley floor mires (<5°), rather than steeper slope mires or hanging swamps. Adults spend most of their time settled on low vegetation on or adjacent to the swamp hunting for flying insects. Females lay eggs in to moss or other soft vegetation bordering swamps. Larvae dig long branching burrows under the swamp leaving their burrows at night to feed on insects and other invertebrates on the surface and also use underwater entrances to hunt for food in the aquatic vegetation. The hanging swamp along the impacted drainage line could represent breeding habitat for this species. During the rehabilitation process flow magnitudes will vary, with moderate flows occurring in early stages. Changes to environmental conditions as a result of the Project are likely to be within the range of conditions tolerated by species dependent on the swamp. In the long-term, the Project is likely to improve potential breeding habitat in the swamp downstream of the Project area, with flows returning to natural conditions. This is likely to result in areas of permanent water that are more suitable breeding habitat for this species.

Assessments of significance pursuant to Section 5A of the EP&A Act have been prepared for these species (see Appendix C). The Project is unlikely to have a significant impact on any of these species given that no habitat will be cleared, and conditions along the drainage line should improve post rehabilitation. Changes to environmental conditions as a result of the Project are likely to be within the range of conditions tolerated by species within the swamp and are unlikely to modify the composition of the ecological community or alter habitat such that its local occurrence and species present are likely to be placed at risk of extinction.

6.2 Impacts on matters of national environmental significance

6.2.1 Threatened ecological communities

The 1.5 hectare occurrence of Newnes Plateau Shrub Swamp downstream and around 200 metres to the northeast of the Project area also comprises an occurrence of the related Temperate Highland Peat Swamps on Sandstone, which is listed as an EEC under the EPBC Act. Based on the assessment of significance pursuant to Section 5A of the EP&A Act included in Appendix C, the Project is unlikely to have a significant impact on this ecological community. The proposed soil and water management and monitoring plan for the Project should be developed with reference to the *Temperate Highland Peat Swamps on Sandstone: ecological characteristics, sensitivities to change, and monitoring and reporting techniques, Knowledge report* (Commonwealth of Australia 2014). The proposed monitoring and adaptive management approach should mitigate potential impacts that could arise to the ecological community through measures such as: setting fill material quality standards that would ensure that the water quality of discharges does not exceed relevant guidelines; and varying flows during dewatering to avoid the risk of downstream scouring (GHD 2017).

No other threatened ecological communities listed under the EPBC Act occur in the study area or are likely to be affected by the Project.

6.2.2 Threatened flora

Boronia deanii is listed as a vulnerable species under the EPBC Act. Based on the assessment of significance pursuant to Section 5A of the EP&A Act included in Appendix C, the Project is unlikely to have a significant impact on *Boronia deanii*.

No other threatened flora species listed under the EPBC Act are likely to occur in the study area or to be affected by the Project.

6.2.3 Threatened fauna

The Giant Burrowing Frog and Littlejohn's Tree Frog are listed as vulnerable species under the EPBC Act and the Blue Mountains Water Skink is listed as an endangered species under the EPBC Act. Based on the assessments of significance pursuant to Section 5A of the EP&A Act included in Appendix C, the Project is unlikely to have a significant impact on these species.

No other threatened fauna species listed under the EPBC Act are likely to occur in the study area or to be affected by the Project.

6.2.4 Migratory fauna

As described in section 4.4.4, the Project area is not considered important habitat for any migratory species, according to the significant impact criteria for migratory species (DEWHA 2009b). The removal of a small area of highly modified vegetation is unlikely to have a significant impact any of these species. Revegetation of the final landform in the future would improve habitat for some migratory woodland species. No assessments of significance have been prepared for these species.

6.2.5 Greater Blue Mountains World Heritage Area

An assessment of significance pursuant to the EPBC Act significant impact guidelines (DotE 2013) has been prepared for the GBMWHA (Appendix C). No significant impact is likely as:

- There would be no clearing of vegetation within the GBMWHA
- The water management system for the Project has been designed so that in the long-term (following rehabilitation of the site), flows are returned to natural conditions (improved from current conditions).
- Following rehabilitation, vegetation condition in the Project area and adjacent areas of the national park are likely to improve given reduced edge effects and other indirect impacts associated with the former use of the Project area as a quarry.
- Weed management measures would prevent the spread of weeds into the GBMWHA.

6.3 Impacts on the Blue Mountains National Park

Potential impacts on biodiversity values of the Blue Mountains National Park have been assessed above in section 5, and potential impacts on threatened biota that may occur in the Blue Mountains National Park have been assessed in sections 6.1 and 6.2 above. The Project would not clear any vegetation within the national park, and weed management measures would control existing weeds and prevent further invasion of weeds in adjacent areas to the

Project. The Project would modify surface and groundwater flows within the drainage line exiting the Project area and potentially affect water quality in this area of the national park. These changes would be relatively minor and temporary. The post-rehabilitation hydrological regime is expected to more closely match natural conditions than the current situation (GHD 2017). Changes to environmental conditions as a result of the Project are likely to be within the range of conditions tolerated by species within the downstream area and are unlikely to modify the composition of the vegetation or place any species at risk of extinction.

The proposed monitoring and adaptive management approach should mitigate potential impacts that could arise to the ecological community through measures such as: setting fill material quality standards that would ensure that the water quality of discharges does not exceed relevant guidelines; and varying flows during dewatering to avoid the risk of downstream scouring. As such, the Project is likely to have only minor impacts on the national park in the immediate vicinity of the Project, and in the long-term, the area's biodiversity values should improve as a result of the Project.

7. Mitigation and management measures

7.1 Introduction

The general principle to minimise impacts to biodiversity, should in order of consideration, endeavour to:

- avoid impacts on habitat, through the planning process
- mitigate impacts on habitat, though the use of a range of mitigation measures
- offset any residual impact that cannot be avoided or mitigated.

7.2 Avoidance of impacts

The Project will remediate past impacts at an existing quarry and return it to a natural landform. Most impacts have already occurred.

7.3 Mitigation of impacts

7.3.1 Construction

In order to address the potential impacts of the Project on biodiversity as discussed in Chapter 5, the mitigation and management measures outlined in Table 7-1 would be implemented as part of the Construction Environment Management Plan (CEMP) for the site.

Table 7-1 Mitigation measures (construction)

Impact	Mitigation
General	• Ensure all workers are provided an environmental induction prior to starting work on site. This would include information on the ecological values of the site, protection measures to be implemented to protect biodiversity and penalties for breaches. • Prepare a flora and fauna management sub-plan as part of the CEMP, incorporating recommendations below, and expanding where necessary. • Measures to suppress dust would be put in place during clearing, construction and operation.
Vegetation clearing	• Limit disturbance of vegetation to the minimum necessary to construct the Project. • Undertake a baseline study for plant pathogens in the Project area and monitor as required. • Vehicles must be appropriately washed prior to work on site to prevent the potential spread of Cinnamon Fungus (*Phytophthora cinnamomi*) and Myrtle Rust (Pucciniales fungi) in accordance with the national best practice guidelines for Phytophthora (DEH 2006) and the Myrtle Rust factsheet (DPI 2011c) for hygiene control. • Where the Project area adjoins native vegetation mark the limits of clearing and install fencing around the Project area prior to the commencement of construction activities to avoid unnecessary vegetation and habitat removal. • Stockpiles of fill or vegetation should be placed within existing cleared areas (and not within areas of adjoining native vegetation). • Sediment fences should be installed to prevent transfer of sediments into adjacent vegetation.
Weeds	• Develop a weed management plan to manage weeds during the construction phase of the Project, including the priority weeds listed in Table 4-1 in accordance with the Biosecurity Act. • This would include the management and appropriate disposal of the weeds that are present within the Project area prior to commencement of

Impact	Mitigation
	earthworks and throughout the duration of the Project (to avoid mobilisation of weeds such as Pampas Grass and Broom into the adjacent National Park as a result of works). • Vehicles and other equipment to be used on site should be cleaned to prevent the introduction of further exotic plant species or disease. • Incorporate control measures in the design of the Project to limit the spread of weed propagules downstream of Project area. Sediment control devices, such as silt fences, would assist in reducing the potential for spreading weeds. • Revegetation should utilise native over storey, mid storey and groundcover species that are representative of the native vegetation communities adjoining the Project area and local provenance seed. • Exposed soil should be sown or planted immediately to help prevent colonisation by weeds.
Fauna habitat	• Protocols to prevent introduction or spread of chytrid fungus should be implemented following Office of Environment and Heritage Hygiene protocol for the control of disease in frogs (DECCW, 2008). • A trained ecologist should be present during the clearing of native vegetation or removal of potential fauna habitat to avoid impacts on resident fauna and to salvage habitat resources as far as is practicable. Clearing surveys should include: – Any hollow-bearing trees to be felled should be marked prior to clearing of vegetation. The removal of hollow bearing trees is to be undertaken in accordance with a hollow-bearing tree management protocol and would include the presence of a qualified ecologist or wildlife expert experienced in the rescue of fauna. – Habitat features (fallen logs and tree hollows) removed from site would be salvaged and relocated within adjacent areas of vegetation. – Inspections of native vegetation for resident fauna and/or nests or other signs of fauna occupancy – Deferral of vegetation removal and associated construction activity in areas occupied by more mobile threatened fauna until the fauna has vacated the Project area
Water Quality and aquatic habitats	• Erosion and sediment control plans should be prepared in accordance with Volume 2E of Managing Urban Stormwater: Soils and Construction (DECC 2008c). The erosion and sediment control plans would be established prior to the commencement of construction and be updated and managed throughout as relevant to the activities during the construction phase. The proposal soil and water management and monitoring plan for the Project should be developed with reference to the *Temperate Highland Peat Swamps on Sandstone: ecological characteristics, sensitivities to change, and monitoring and reporting techniques, Knowledge report* (Commonwealth of Australia 2014). • Erosion and sediment control measures should be established prior to construction. • Erosion and sediment control measures would be regularly inspected, particularly following rainfall events, to ensure their ongoing functionality. • Stabilised surfaces should be reinstated as quickly as practicable after construction. • Water should be applied to exposed surfaces that are causing dust generation. Surfaces may include unpaved roads, stockpiles, hardstand areas and other exposed surfaces (for example recently graded areas). • Vehicles must follow appropriate speeds to limit dust generation. • All stockpiled material should be stored in bunded areas and kept away from waterways to avoid sediment entering the waterway. • Spill kits would be made available to construction vehicles. A management protocol for accidental spills would be put in place.

7.3.2 Revegetation

Following reprofiling of each stage, revegetation activities would commence to stabilise the soil and return the landform to a natural environment. Fill material would be revegetated with native plant species that are representative of the native vegetation communities adjoining the Project area and using local provenance seed. Mitigation measures proposed for biodiversity following rehabilitation of the Project area are provided in Table 7-2.

Table 7-2 Mitigation measures (post closure)

Impact	Mitigation
Vegetation and weeds	• Management of priority weeds according to legislative requirements for at least 10 years following final reprofiling. • Management of environmental weeds according to best practice methods for at least 10 years following final reprofiling. • Monitoring and adaptive management of revegetation outcomes for at least 10 years following final reprofiling.

7.4 Improve or maintain

The Project is located in an already highly disturbed site that has been subject to many years of quarrying. Little intact native vegetation is currently present in the Project area. Most vegetation present is the result of previous rehabilitation activities. The Project includes reprofiling following importation of fill to create a more natural landform, and the revegetation of the final landform with locally sourced native plant species to create a more natural forest environment. Revegetation would utilise native over storey, mid storey and groundcover species that are representative of the native vegetation communities adjoining the Project area and local provenance seed. In the longer term, the Project would improve the condition of native vegetation and the quality and connectivity of habitat in the Project area.

The post-rehabilitation hydrological regime is expected to more closely match natural conditions than the current situation which is likely to improve the quality of habitat and help avoid threats for the Newnes Plateau Shrub Swamp ecological community and threatened fauna populations downstream of the Project area. Notably, the post rehabilitation conditions would include increased frequency and duration of low flow events which would be expected to have a positive effect on the moisture-dependant plant species that characterise this community.

Residual impacts of the importation of fill will be compensated for by the revegetation program. No formal offsets are considered necessary.

8. Conclusion

Bell Quarry is located on Sandham Road at Newnes Junction approximately 10 kilometres east of Lithgow in NSW. The Blue Mountains National Park is located to the east of the Project area and the quarry is located within the upper reaches of the Wollangambe River catchment. The quarry currently contains three large voids which are partially filled with water and has been subject to some progressive revegetation.

The Project area comprises highly modified landforms, with most vegetation present the result of previous rehabilitation activities. Modified native vegetation is also present outside the Project area within the adjacent national park. Some intact native vegetation (Sydney Peppermint - Silvertop Ash heathy open forest) is present within the Project area, located around the perimeter. There is a patch of Prickly Tea-tree - sedge wet heath along the drainage line approximately 200 metres downslope from the Project area that comprises an occurrence of Newnes Plateau Shrub Swamp, which is listed as an EEC under the TSC Act and the related Temperate Highland Peat Swamps on Sandstone, which is listed as an EEC under the EPBC Act.

The majority of the Project is to be undertaken in areas which have previously been disturbed. In total, 0.13 ha of remnant vegetation and 2.48 ha of planted vegetation would be removed. Clearing of vegetated areas would be temporary as the staging process allows for clearing of vegetation followed soon after by reprofiling and revegetation.

Dewatering during the Project will reduce the overflow frequency from the system compared to current conditions. This impact will be most significant during stages where voids are maintained empty. During these low flow periods , the lower reaches of the drainage line and the swamp would be dependent on rainfall events and surface flow from the surrounding area. Moderate flows will be more regular during stages involving significant dewatering, however these are likely to be much shorter in duration. After completion of the Project and rehabilitation flows will generally be restored to natural conditions and will be significantly closer to natural conditions than is currently the case. This will result in more regular flows than is currently occurring.

There would be no clearing of vegetation within the EEC downstream of the Project area. The Project would modify surface and groundwater flows within the catchment of the ecological community and potentially affect water quality. Given the scale of the Project area relative to the catchment surrounding the community, these changes would be relatively minor and temporary. The post-rehabilitation hydrological regime is expected to more closely match natural conditions than the current situation, and will comprise more regular flows. The post rehabilitation conditions would include increased frequency and duration of low flow events which would be expected to have a positive effect on the moisture-dependant plant species that characterise this community.

The Project would remove potential habitat for flora species such as Deanes Boronia, *Persoonia hindii* and *Veronica blakelyi* in the Project area and may affect habitat downstream of the site through factors such as changes to surface or groundwater flow regimes or through mobilisation of sediments. Similarly, changes to surface flow regimes could temporarily impact threatened fauna species such as the Giant Burrowing Frog, Red-crowned Toadlet, Littlejohn’s Tree Frog, Blue Mountains Water Skink and Giant Dragonfly that may occupy habitats downstream of the Project area. During periods of low flows adults (if present) are likely to disperse to more suitable habitat areas further downstream or in other drainage lines. No significant impacts are likely as the post-rehabilitation hydrological regime is expected to more closely match natural conditions (resulting in more regular flows) than the current situation.

The Project is unlikely to have a significant impact on the Greater Blue Mountains World Heritage Area. There would be no clearing of vegetation within the GBMWHA and the post-rehabilitation hydrological regime is expected to more closely match natural conditions than the current situation. Management measures such as weed control and revegetation with locally sourced native species representative of the locality would improve biodiversity values along the boundary of the Project area.

Importation of fill will result in an improved outcome compared to current conditions. No formal offsets are considered necessary.

The Project would not result in any significant impacts on any threatened biota listed under the EPBC Act. Additional assessment is unlikely to be required and there is unlikely to be a requirement for biodiversity offsets under the EPBC Act.

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Appendices

Appendix A – Assessment of the likelihood of occurrence of threatened and migratory biota

Threatened ecological communities

Name	TSC Status	EPBC Status	Habitat Association	Likelihood of occurrence	Likelihood of impact
Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion	EEC		Recorded from Lithgow and Blue Mountains City LGAs. Characteristically dominated by shrubs, with a variable cover of sedges. Shrubs have dense to open cover, and include Weeping Baeckea, *Grevillea acanthifolia* subsp. *acanthifolia*, Swamp Heath and *Leptospermum* species. The cover of sedges varies inversely with shrub cover. Floristic composition varies locally in relation to soil moisture gradients within the swamps. With decreasing altitude, grades into Blue Mountains sedge swamp communities around Bell and Clarence at approx 850-950 m asl. Blue Mountains sedge swamps typically have less cover of shrubs and a greater cover of sedges (particularly Button Grass). Occurrences on peat may be included in the EPBC Act listed Temperate highland Peat Swamps on Sandstone EEC.	Present in the study area. There is a patch of Prickly Tea-tree - sedge wet heath along the drainage line approximately 200 metres downslope from the Project area that comprises this EEC.	Low - Potential for indirect impacts through factors such as changes to surface or groundwater flow regimes or through mobilisation of sediments.
Temperate Highland Peat Swamps on Sandstone		EEC	Occurs on sandstone in temperate highland regions from around 600–1100 m above sea level. Known from the Blue Mountains, Lithgow, Southern Highlands, and Bombala regions. Swamps occurring across a range of locations in the landscape, from hanging swamps to depressions in the landscape, or along watercourses. Wetter parts are occupied by sphagnum bogs and fens, with sedge and shrub associations in the drier parts.	Present in the study area. There is a patch of Prickly Tea-tree - sedge wet heath along the drainage line approximately 200 metres downslope from the Project area that comprises this EEC.	Low - Potential for indirect impacts through factors such as changes to surface or groundwater flow regimes or through mobilisation of sediments.

Key: EEC – endangered ecological community

Threatened flora species known or predicted to occur in the locality and their likelihood of occurrence

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Acacia bynoeana	Bynoe's Wattle	E	V	Species or species' habitat may occur within 10km (DEE 2017a)	Endemic to central eastern NSW, currently known from only 34 locations, many of only 1-5 plants. Grows mainly in heath/ dry sclerophyll forest on sandy soils, prefers open, sometimes slightly disturbed sites such as trail margins, road edges, and in recently burnt open patches. Flowers September to March, and fruit matures in November.	Possible. Broadly suitable habitat present in the study area but not previously recorded in the locality.	Low. Small area of potential habitat would be removed.
Acacia flocktoniae	Flockton Wattle	V	V	Species or species' habitat likely to occur within 10km (DEE 2017a)	Occurs in the southern Blue Mountains (Mt Victoria, Megalong Valley and Yerranderrie), between 500-1000m asl in areas with average annual rainfall of 800-1200 mm. Grows in dry sclerophyll forest on low nutrient soils derived from sandstone. Associated species include Straight Wattle and Prickly Shaggy Pea.	Possible. Broadly suitable habitat present in the study area but not previously recorded in the locality.	Low. Small area of potential habitat would be removed.
Acacia meiantha		E		1 record within 10km (OEH 2016a)	It is found in three disjunct populations, all within the Central Tablelands and within 100kms of each other. These populations include Clarence, which covers an area of approximately 1 hectare; Mullions Range, covering approximately 5 hectares; and Aarons Pass, which is confined to 2.5km of road easements. Vegetation associations and geologies vary substantially between these populations.	Possible. Broadly suitable habitat present in the study area based on the habitat associated with the Clarence population.	Low. Small area of potential habitat would be removed
Asterolasia buxifolia		E		4 records within 10km (OEH 2016a)	Known from a single site in the riparian zone of the Lett River in the Lithgow area. Grows in dense riparian scrub on granitic substrate.	Unlikely. No suitable riparian habitat on	Nil.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
						granitic substrate in the study area.	
Asterolasia elegans		E	E	Species or species' habitat may occur within 10km (DEE 2017a)	Occurs north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby LGAs, may also occur in the western part of Gosford LGA. 7 known populations. Occurs on Hawkesbury sandstone, commonly amongst rocky outcrops and boulders in sheltered forests on mid- to lower slopes and valleys.	Possible. Broadly suitable habitat present in the study area but not previously recorded in the locality.	Low. Small area of potential habitat would be removed.
Astrotricha crassifolia	Thick-leaf Star-hair	V	V	1 record within 10km (OEH 2016a)	Occurs near Patonga (Gosford LGA), and in Royal NP and on the Woronora Plateau (Sutherland and Campbelltown LGAs). There is also a record from near Glen Davis (Lithgow LGA). Grows on dry ridgetops to 300 m altitude, associated with very rich heath, or dry sclerophyll woodland on sandstone.	Unlikely. Recorded within locality but only known from much lower elevations than the study area.	Very low. Small area of unlikely habitat would be removed.
Boronia deanei	Deane's Boronia	V	V	3 records within 10km (OEH 2016a); Species or species' habitat likely to occur within 10km (DEE 2017a)	This small erect shrub is found in scattered populations between the far south-east of NSW and the Blue Mountains (including the upper Kangaroo River near Carrington Falls, the Endrick River near Nerriga and Nalbaugh Plateau), mainly in conservation reserves. The species grows on the margins of high altitude swamps, in wet heath on sandstone, and in drier open forest.	Likely. Suitable habitat in the study area, downstream of the Project area.	Low. Potential for indirect impacts on habitat through factors such as changes to surface or groundwater flow regimes or through mobilisation of sediments.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Caladenia tessellata	Thick-lipped Spider-orchid	E	V	Species or species' habitat likely to occur within 10km (DEE 2017a)	Occurs from Central Coast NSW to southern Victoria. Mostly coastal but extends inland to Braidwood in southern NSW. In NSW grows in grassy dry sclerophyll woodland on clay loam or sandy soils, and less commonly in heathland on sandy loam soils (Duncan 2010).	Unlikely. Not previously recorded within the locality and known from lower elevations closer to the coast than the study area.	Very low. Small area of unlikely habitat would be removed.
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	Species or species' habitat may occur within 10km (DEE 2017a)	Occurs in coastal areas from East Gippsland to southern Queensland. Habitat preferences not well defined. Grows mostly in coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland, and lowland forest. Prefers open areas in the understorey and is often found in association with Large Tongue Orchid and the Bonnet Orchid. Soils include moist sands, moist to dry clay loam and occasionally in accumulated eucalypt leaves. Flowers November-February.	Unlikely. Not previously recorded within the locality and known from lower elevations closer to the coast than the study area.	Very low. Small area of unlikely habitat would be removed.
Eucalyptus aggregata	Black Gum	V	V	Species or species' habitat likely to occur within 10km (DEE 2017a)	Occurs on the central and southern tablelands of NSW, and in a small disjunct population in Victoria. Grows in grassy woodlands on alluvial soils in moist sites along creeks on broad, cold and poorly-drained flats and hollows. Commonly occurs with Candlebark, Ribbon Gum, and White Sally with a grassy understorey of Tussock.	Unlikely. No suitable grassy woodland habitat on alluvial substrate in the study area.	Nil.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Eucalyptus pulverulenta	Silver-leaved Mountain Gum	V	V	Species or species' habitat likely to occur within 10km (DEE 2017a)	The Silver-leafed Gum is a distinctively wattle-like, straggly mallee or small tree to about 10 m tall. This species grows in shallow soils as an understorey plant in open forest, typically dominated by Brittle Gum, Red Stringybark, Broad-leafed Peppermint, Silvertop Ash and Apple Box. The Silver-leafed Gum is found in two quite separate areas, the Lithgow to Bathurst area and the Monaro (Bredbo, Bombala areas).	Possible. Broadly suitable habitat present in the study area but not previously recorded in the locality.	Low. Small area of potential habitat would be removed.
Euphrasia arguta		CE	CE	Species or species' habitat may occur within 10km (DEE 2017a)	Recently rediscovered near Nundle on the north-western slopes and tablelands, once known from scattered locations between Sydney, Bathurst and Walcha. Known populations occur in eucalypt forest with a mixed grass/shrub understorey, while previous records are described as occurring in open forest, grassy country and river meadows. Annual and dies back over winter. Dense stands observed in cleared firebreak areas, suggesting it may respond well to disturbance.	Possible. Broadly suitable habitat present in the study area but not previously recorded in the locality.	Low. Small area of potential habitat would be removed.
Haloragis exalata subsp*. exalata*	Wingless Raspwort	V	V	Species or species' habitat may occur within 10km (DEE 2017a)	Occurs in 4 widely scattered localities in eastern NSW, in the central coast, south coast and north-western slopes. Requires protected and shaded damp situations in riparian habitats.	Possible. Broadly suitable habitat present in the study area but not previously recorded in the locality.	Low. Small area of potential habitat downstream of the Project area may potentially be subject to indirect impacts.
Haloragodendron lucasii		E	E	Species or species' habitat likely to occur within 10km (DEE 2017a)	Known from 9 sites in a 10km range in the Gordon-Hornsby area. Occurs on Hawkesbury Sandstone in moist sandy loam soil. Prefers sheltered aspects and gentle slopes below cliff lines near creeks in low open woodland or open forest. Distribution correlated with high soil moisture and phosphorus levels.	Nil. Outside species' known range. No suitable habitat in the study area.	Nil

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Isopogon fletcheri	Fletcher's Drumsticks	V	V	3 records within 10km , last recorded 2005 (OEH 2016a); Species or species' habitat likely to occur within 10km (DEE 2017a)	Restricted to a very small area in the Blackheath district of the Blue Mountains on the Central Tablelands. The entire known population occurs within Blue Mountains National Park. Restricted to moist sheltered cliffs within the spay zone of a waterfall. Grows in dry sclerophyll forest and heath on sandstone and is confined to sheltered moist positions.	Unlikely. No suitable cliff line habitat within the spray zone of waterfalls in the study area.	Nil
Lepidium hyssopifolium	Basalt Pepper-cress	E	E	Species or species' habitat may occur within 10km (DEE 2017a)	Currently known near Bathurst and Bungendore, with historic records near Armidale. Grows on light to heavy, often friable clay loams, often in highly modified environments amongst exotic pasture grasses and weeds. Requires bare ground to establish (Tumino 2010).	Nil. Outside species' known range. No suitable habitat in the study area.	Nil
Leucopogon fletcheri subsp. fletcheri		E		1 record within 10km (OEH 2016a)	Restricted to northwest Sydney between St Albans and Annangrove, within the Hawkesbury, The Hills and Blue Mountains LGAs. Occurs in dry eucalypt woodland or shrubland on clayey lateritic soils, generally on flat to gently sloping terrain along ridges and spurs. Flowers August to September.	Possible. Broadly suitable habitat present in the study area	Low. Small area of potential habitat would be removed.
Pelargonium sp. Striatellum (G.W.Carr 10345)	Omeo Stork's-bill	E	E	Species or species' habitat likely to occur within 10km (DEE 2017a)	Omeo Storksbill *Pelargonium* sp. (G.W. Carr 10345), syn. *P. striatellum*, is a tufted perennial forb known from only 3 locations in NSW, with two on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. It has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities.	Nil. Outside species' known range. No suitable habitat in the study area.	Nil
Persoonia acerosa	Needle Geebung	V	V	Species or species' habitat likely to occur within 10km (DEE 2017a)	Recorded on central coast and in Blue Mountains, from Mt Tomah to Hill Top (though now believed extinct in Hill Top). Mainly in Katoomba, Wentworth Falls and Springwood areas. Inhabits dry sclerophyll forest, scrubby low woodland and heath on sandstone. Occurs in well-drained soils including sands, laterite and gravels between 550- 1000m asl. May occur in disturbed areas eg roadsides.	Possible. Broadly suitable habitat present in the study area but not previously	Low. Small area of potential habitat would be removed.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
						recorded in the locality.	
Persoonia hindii		E		91 records within 10km (OEH 2016a)	A yellow-flowered, multi-stemmed suckering shrub to 1m that occurs in dry sclerophyll forests and woodlands on sandy soils. Stoloniferous (has underground horizontal stems) and is thought to be clonal. Hence, each location may comprise only one to a few individuals. Restricted to the Newnes Plateau in the Blue Mountains, north of Lithgow. Was only discovered in 1989 and all known locations occur within Newnes State Forest. Flowers January to March, possibly with sporadic flowering in other months.	Likely. Suitable habitat present in the study area and the species has been recorded in similar habitat in the locality.	Low. Small area of potential habitat would be removed. Low risk of indirect impacts on potential habitat downstream of the site through factors such as changes to surface or groundwater flow regimes or through mobilisation of sediments.
Persoonia marginata	Clandulla Geebung	V	V	1 record within 10km , last recorded 2005 (OEH 2016a)	The Clandulla Geebung occurs between Kandos and Clarence in the western Blue Mountains. It grows in dry sclerophyll forest and woodland communities on sandstone. Its recorded flowering period varies and includes December and Winter	Possible. Broadly suitable habitat present in the study area.	Low. Small area of potential habitat would be removed.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Prasophyllum fuscum	Tawny Leek-orchid	CE	V	Species or species' habitat likely to occur within 10km (DEE 2017a)	Restricted to an area of less than $4km^2$ in the upper catchment of the Georges River, southwest of Sydney in the Wilton district. There has been much taxonomic confusion with the species falsely identified as at least two others. Grows in moist sandy soil on sandstone amongst sedges and grasses in a disturbed roadside area.	Possible. Broadly suitable habitat present in the study area but not previously recorded in the locality.	Low. Small area of potential habitat would be removed.
Pultenaea glabra	Smooth Bush-pea	V	V	Species or species' habitat likely to occur within 10km (DEE 2017a)	In NSW restricted to higher Blue Mountains in the Katoomba-Hazelbrook and Mt Victoria areas. Unconfirmed sightings in Mt Wilson and Mt Irvine areas. Grows in swamp margins, hillslopes, gullies and creekbanks and occurs within dry sclerophyll forest and tall damp heath on sandstone.	Possible. Broadly suitable habitat present in the study area but not previously recorded in the locality.	Low. Small area of potential habitat downstream of the Project area may potentially be subject to indirect impacts.
Rhizanthella slateri	Eastern Underground Orchid	V	E	Species or species' habitat may occur within 10km (DEE 2017a)	The species grows in eucalypt forest but no informative assessment of the likely preferred habitat for the species is available (DECC 2005b; c). Currently known only from 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. Flowers during October and November (Harden 1993).	Possible. Broadly suitable habitat present in the study area but not previously recorded in the locality.	Low. Small area of potential habitat would be removed.
Thesium australe	Austral Toadflax	V	V	Species or species' habitat likely to occur within 10km (DEE 2017a)	Found in small, scattered populations along the east coast, northern and southern tablelands. Occurs in grassland or grassy woodland, and is often found in association with Kangaroo Grass.	Nil. Outside species' known range. No suitable habitat in the study area.	Nil

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Veronica blakelyi		V		11 records within 10km (OEH 2016a)	Restricted to the western Blue Mountains, near Clarence, near Mt Horrible, on Nullo Mountain and in the Coricudgy Range. Over this range, occurrences are patchy and generally small in in size. Occurs in eucalypt forest, often in moist and sheltered areas. Associated canopy species include Broad-leaved Peppermint, Mountain Gum, Inland Scribbly Gum and White Sally.	Likely. Potential habitat present in the study area and the species has been recorded in similar habitat in the locality.	Low. Small area of potential habitat would be removed. Low risk of indirect impacts on potential habitat downstream of the site through factors such as changes to surface or groundwater flow regimes or through mobilisation of sediments.

Key: CE – critically endangered, E – endangered, V - vulnerable

Threatened fauna species known or predicted to occur in the locality and their likelihood of occurrence

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
BIRDS							
Rostratula australis	Australian Painted Snipe	E	E	Species or species' habitat may occur within 10km (DEE 2017a)	Normally found in permanent or ephemeral shallow inland wetlands, either freshwater or brackish. Nests on the ground amongst tall reed-like vegetation near water. Feeds on mudflats and the water's edge taking insects, worm and seeds. Prefers fringes of swamps, dams and nearby marshy areas with cover of grasses, lignum, low scrub or open timber.	Unlikely. Limited cover present around artificial wetlands.	Nil
Oxyura australis	Blue-billed Duck	V		3 records within 10km , last recorded 2005 (OEH 2016a)	Partly migratory, travels short distances between breeding swamps and over-wintering lakes. Young birds disperse in April-May from breeding swamps in inland NSW to Murray River system and coastal lakes. Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. Nests in Cumbungi over deep water or in trampled Lignum, sedges or spike-rushes. Completely aquatic, swimming along the edge of dense cover.	Unlikely. May occur on rare occasions on a transient basis.	Nil
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V		25 records within 10km (OEH 2016a)	Occurs from Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell to the east. Most common on the inland slopes and plains. Inhabits eucalypt woodlands and dry open forest, usually dominated by stringybarks or rough-barked species with open grassy understorey. Fallen timber is important foraging habitat. Nests in hollows in standing trees or stumps.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Artamus cyanopterus	Dusky Woodswallow	V		14 records within 10km (OEH 2016a)	The Dusky Woodswallow is widespread from the coast to inland, including the western slopes of the Great Dividing Range and farther west. It is often recorded in woodlands and dry open sclerophyll forests, and has also been recorded in shrublands, heathlands regenerating forests a. The understorey is typically open with sparse eucalypt saplings, acacias and other shrubs, often with coarse woody debris. The nest is an open shallow untidy cup frequently built in an open hollow, crevice or stump. Although Dusky Woodswallows have large home ranges, individuals may spend most of their time in about a 2 ha range and defend an area about 50 m around the nest. Dusky Woodswallows prefer larger remnants over smaller remnants.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Dasyornis brachypterus	Eastern Bristlebird	E	E	Species or species' habitat may occur within 10km (DEE 2017a)	Occurs in three disjunct areas of south-eastern Australia: southern Queensland/northern NSW, the Illawarra Region and in the vicinity of the NSW/Victorian border. Habitat characterised by dense, low vegetation including heath and open woodland with a heathy understorey. The fire history of habitat is important, and the Illawarra and southern populations reach maximum densities in habitat that have not been burnt for over 15 years.	Nil. No suitable habitat present. Outside known distribution.	Nil.
Petroica phoenicea	Flame Robin	V		105 records within 10km (OEH 2016a)	Breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. Migrates in winter to more open lowland habitats such as grassland with scattered trees and open woodland on the inland slopes and plains. Forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris. Fallen logs and coarse woody debris are important habitat components. Open cup nest of plant fibres and cobweb is often built near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Callocephalon fimbriatum	Gang-gang Cockatoo	V		83 records within 10km (OEH 2016a)	Restricted to the south-eastern coast and highlands, from the lower Hunter and northern Blue Mountains to the South-western Slopes, south to and contiguous with the Victorian population. Inhabits eucalypt open forests and woodlands with an acacia understorey. In summer it lives in moist highland forest types, and in winter it moves to more open types at lower elevations. The Gang-Gang Cockatoo nests in hollows in the trunks, limbs or dead spouts of tall living trees, especially eucalypts, often near water. The Gang-gang Cockatoo feeds on seeds obtained in trees and shrubs, mostly from eucalypts and wattles.	Possible. May forage on occasion in the Project area. No suitable hollows present. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		13 records within 10km (OEH 2016a)	Widespread but uncommon from coast to southern tablelands and central western plains. Feeds almost exclusively on the seeds of Allocasuarina species. Prefers woodland and open forests, rarely away from Allocasuarina. Roost in leafy canopy trees, preferably eucalypts, usually <1km from feeding site. Nests in large (approx. 20cm) hollows in trees, stumps or limbs, usually in Eucalypts (Higgins 1999).	Nil. No breeding or foraging habitat present.	Nil
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V		5 records within 10km (OEH 2016a)	Considered a sedentary species, but local seasonal movements are possible. Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Occurrence is positively associated with patch size, and with components of habitat complexity including canopy cover, shrub cover, ground cover, logs, fallen branches and litter. Nests on low, live or dead forks or branches of trees or stumps, or occasionally on fallen trees or limbs.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Hieraaetus morphnoides	Little Eagle	V		1 record within 10km , last recorded 2006 (OEH 2016a)	Occurs throughout NSW except most densely forested parts of the Dividing Range escarpment. Occupies habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Glossopsitta pusilla	Little Lorikeet	V		1 record within 10km (OEH 2016a)	Occurs from coast to western slopes of the Great Dividing Range. Inhabits dry, open eucalypt forests and woodlands. Occurrence is positively associated with patch size, and with components of habitat complexity including canopy cover, shrub cover, ground cover, logs, fallen branches and litter. Feed primarily on profusely-flowering eucalypts and a variety of other species including melaleucas and mistletoes. Mostly nests in small (opening approx. 3cm) hollows in living, smooth-barked eucalypts. Most breeding records are from the western slopes.	Possible. May forage on occasion in the Project area. No suitable hollows present. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Tyto novaehollandiae	Masked Owl	V		1 record within 10km (OEH 2016a)	Occurs across NSW except NW corner. Most common on the coast. Inhabits dry eucalypt woodlands from sea level to 1100 m. Roosts and breeds in large (>40cm) hollows and sometime caves in moist eucalypt forested gullies. Hunts along the edges of forests and roadsides. Home range between 500 ha and 1000 ha. Prey mostly terrestrial mammals but arboreal species may also be taken.	Possible. May forage on occasion in the Project area. No suitable hollows present. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Grantiella picta	Painted Honeyeater	V	V	Species or species' habitat may occur within 10km (DEE 2017a)	Nomadic, occurring in low densities across most of NSW. Highest concentrations and almost all breeding occur on inland slopes of the Great Dividing Range. Inhabits Boree, Brigalow and Box Gum woodlands and Box-Ironbark forests. Specialist forager on the fruits of mistletoes, preferably of the Amyema genus. Nests in outer tree canopy.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Ninox strenua	Powerful Owl	V		10 records within 10km (OEH 2016a)	Occurs from the coast to the western slopes. Solitary and sedentary species. Inhabits a range of habitats from woodland and open sclerophyll forest to tall open wet forest and rainforest. Prefers large tracts of vegetation. Nests in large tree hollows (> 0.5 m deep), in large eucalypts (dbh 80-240 cm) that are at least 150 years old. Pairs have high fidelity to a small number of hollow-bearing nest trees and defend a large home range of 400 - 1,450 ha. Forages within open and closed woodlands as well as open areas.	Possible. May forage on occasion in the Project area. No suitable hollows present. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Anthochaera phrygia	Regent Honeyeater	CE	CE	Foraging, feeding or related behaviour likely to occur within 10km (DEE 2017a)	In NSW confined to two known breeding areas: the Capertee Valley and Bundarra-Barraba region. Non-breeding flocks occasionally seen in coastal areas foraging in flowering Spotted Gum and Swamp Mahogany forests, presumably in response to drought. Inhabits dry open forest and woodlands, particularly Box-Ironbark woodland and riparian forests of River Sheoak, with an abundance of mature trees, high canopy cover and abundance of mistletoes.	Nil. No breeding or foraging habitat present.	Nil.
Petroica boodang	Scarlet Robin	V		131 records within 10km (OEH 2016a)	In NSW occurs from coast to inland slopes. Breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within open understorey of shrubs and grasses and sometimes in open areas. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. Abundant logs and coarse woody debris are important habitat components.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Chthonicola sagittata	Speckled Warbler	V		1 record within 10km (OEH 2016a)	Within NSW most frequently reported from the hills and tablelands of the Great Dividing Range, rarely from the coast. Inhabits a wide range of Eucalyptus-dominated communities with a grassy understorey, a sparse shrub layer, often on rocky ridges or in gullies. Sedentary and requires large, relatively undisturbed remnants to persist in an area. Forages on the ground for seeds and insects, and nests in a slight hollow in the ground or at the base of a low dense plant.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Lophoictinia isura	Square-tailed Kite	V		1 record within 10km (OEH 2016a)	Occurs across NSW, resident in North, northeast and along west-flowing rivers. Summer breeding migrant to southeast of state. Inhabits a variety of habitats including woodlands and open forests, with preference for timbered watercourses. Favours productive forests on the coastal plain, box-ironbark-gum woodlands on the inland slopes, and Coolibah/River Red Gum on the inland plains. In Sydney area nests in mature living trees within 100m of ephemeral/permanent watercourse. Large home range > 100 km^2.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Lathamus discolor	Swift Parrot	E	CE	Species or species' habitat may occur within 10km (DEE 2017a)	Migratory, travelling to the mainland from March to October. Breeds in Tasmania from September to January. On the mainland, it mostly occurs in the southeast foraging on winter flowering eucalypts and lerps, with records of the species between Adelaide and Brisbane. Principal over-winter habitat is box-ironbark communities on the inland slopes and plains.	Nil. No breeding or foraging habitat present.	Nil.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Neophema pulchella	Turquoise Parrot	V		2 records within 10km (OEH 2016a)	Occurs from coast to inland slopes. In coastal area, most common between Hunter and Northern Rivers, and further south in S Coast. Inhabits open eucalypt woodlands and forests, typically with a grassy understorey. Favours edges of woodlands adjoining grasslands or timbered creek lines and ridges. Feeds on the seeds of native and introduced grasses and other herbs. Grasslands and open areas provide important foraging habitat for this species while woodlands provide important roosting and breeding habitat. Nests in tree hollows, logs or posts from August to December.	Possible. May forage on occasion in the Project area. No suitable hollows present. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Daphoenositta chrysoptera	Varied Sittella	V		14 records within 10km (OEH 2016a)	Sedentary, occurs across NSW from the coast to the far west. Inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Sensitive to habitat isolation and loss of structural complexity, and adversely affected by dominance of Noisy Miners. Cleared agricultural land is potentially a barrier to movement. Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
MAMMALS							
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Species or species' habitat likely to occur within 10km (DEE 2017a)	Occurs from the Shoalhaven north to the Queensland border. Now mostly extinct west of the Great Dividing Range. Occurs on rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Diet consists of vegetation in adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.	Nil. No suitable habitat present.	Nil.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V		2 records within 10km (OEH 2016a)	Generally occurs east of the Great Dividing Range along NSW coast (Churchill 2008). Inhabits various habitats from open grasslands to woodlands, wet and dry sclerophyll forests and rainforest. Essentially a cave bat but may also roost in road culverts, stormwater tunnels and other man-made structures. Only 4 known maternity caves in NSW, near Wee Jasper, Bungonia, Kempsey and Texas. Females may travel hundreds of kilometres to the nearest maternal colony (Churchill 2008).	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park. No roosting habitat present.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Cercartetus nanus	Eastern Pygmy-possum	V		12 records within 10km (OEH 2016a)	Occurs along the east coast of NSW, and inland to the Pillaga, Dubbo, Parkes and Wagga Wagga. Inhabits range of habitats from coastal heath and woodland though open and closed forests, subalpine heath and rainforest. Inhabits rainforest, sclerophyll forests and heath. Banksia spp. and myrtaceous shrubs and trees are favoured food sources and nesting subject sites in drier habitats. Diet mostly pollen and nectar from Banksia spp., Eucalyptus spp., Callistemon spp. and insects. Nests in hollows in trees, under the bark of Eucalypts, forks of tea-trees, abandoned bird nests and Xanthorrhoea bases.	Possible. May forage on occasion in the Project area. Unlikely to breed in the Project area given the high level of disturbance. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Petauroides volans	Greater Glider		V	131 records within 10km (OEH 2016a); Species or species' habitat known to occur within 10km (DEE 2017a)	The greater glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria (Wombat State Forest), with an elevational range from sea level to 1200 m above sea level. It prefers taller montane, moist eucalypt forest with relatively old trees and abundant hollows.	Possible. May forage on occasion in the Project area. No suitable hollows present. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Foraging, feeding or related behaviour known to occur within 10km (DEE 2017a)	Roosts in camps within 20 km of a regular food source, typically in gullies, close to water and in vegetation with a dense canopy. Forages in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths, swamps and street trees, particularly in eucalypts, melaleucas and banksias. Highly mobile with movements largely determined by food availability. Will also forage in urban gardens and cultivated fruit crops.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park. No roosting habitat present.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Phascolarctos cinereus	Koala	V	V	1 record within 10km , last recorded 1997 (OEH 2016a); Species or species' habitat known to occur within 10km (DEE 2017a)	Occurs from coast to inland slopes and plains. Restricted to areas of preferred feed trees in eucalypt woodlands and forests. Home range varies depending on habitat quality, from < 2 to several hundred hectares.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	1 record within 10km (OEH 2016a); Species or species' habitat likely to occur within 10km (DEE 2017a)	Occurs from the coast to the western slopes of the divide. Largest numbers of records from sandstone escarpment country in the Sydney Basin and Hunter Valley (Hoye and Schulz 2008). Roosts in caves and mines and most commonly recorded from dry sclerophyll forests and woodlands. An insectivorous species that flies over the canopy or along creek beds (Churchill 2008). In southern Sydney appears to be largely restricted to the interface between sandstone escarpments and fertile valleys.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park. No roosting habitat present.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Pseudomys novaehollandiae	New Holland Mouse		V	1 record within 10km (OEH 2016a); Species or species' habitat known to occur within 10km (DEE 2017a)	Occurs in disjunct, coastal populations from Tasmania to Queensland. In NSW inhabits a variety of coastal habitats including heathland, woodland, dry sclerophyll forest with a dense shrub layer and vegetated sand dunes. Populations may recolonise/ increase in size in regenerating native vegetation after wildfire, clearing and sandmining. Presence strongly correlated with understorey vegetation density, and high floristic diversity in regenerating heath.	Nil. No suitable habtiat present.	Nil.
Isoodon obesulus obesulus	Southern Brown Bandicoot	E	E	Species or species' habitat likely to occur within 10km (DEE 2017a)	Occurs mainly in two areas: Ku-ring-gai Chase and Garigal National Parks N of Sydney, and far SE NSW, but also occurs between these areas. Inhabits scrubby vegetation, including heath, shrubland, and heathy forest and woodland. Often associated with well-drained soils and dry heathland communities, and prefers periodically burnt areas as this increases insect abundance.	Nil. Outside known distribution.	Nil.
Dasyurus maculatus	Spotted-tailed Quoll	V	E	15 records within 10km (OEH 2016a); Species or species' habitat known to occur within 10km (DEE 2017a)	Inhabits a range of environments including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces. Females occupy home ranges of up to 750 ha and males up to 3,500 ha, usually traversed along densely vegetated creek lines.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park. No denning habitat present.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Petaurus norfolcensis	Squirrel Glider	V		4 records within 10km (OEH 2016a)	Occurs along the drier inland slopes as well as coastal habitats. Inhabits woodland and open forest with a Eucalyptus, Corymbia or Angophora overstorey and a shrubby understorey of Acacia or Banksia. Key habitat components include reliable winter and early-spring flowering Eucalypts, Banksia or other nectar sources, and hollow-bearing trees for roost and nest sites, with social groups moving between multiple hollows. Social groups include one or two adult males and females with offspring, and have home ranges of 5-10ha within NSW.	Possible. May forage on occasion in the Project area. No suitable hollows present. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Petaurus australis	Yellow-bellied Glider	V		2 records within 10km , last recorded 1999 (OEH 2016a)	Occurs along the east coast to the western slopes of the Great Dividing Range. Inhabits a variety of forest types but prefers tall mature eucalypt forest with high rainfall and rich soils. Relies on large hollow-bearing trees for shelter and nesting, with family groups of 2-6 typically denning together. In southern NSW its preferred habitat at low altitudes is moist gullies and creek flats in mature coastal forests. Mostly feeds on sap, nectar and honeydew.	Possible. May forage on occasion in the Project area. No suitable hollows present. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V		1 record within 10km (OEH 2016a)	Migrates from tropics to south-east Australia in summer. Forages across a range of habitats including those with and without trees, from wet and dry sclerophyll forest, open woodland, Acacia shrubland, mallee, grasslands and desert. Roosts communally in large tree hollows and.	Possible. May forage on occasion in the Project area. Few hollows present. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
REPTILES							

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Eulamprus leuraensis	Blue Mountains Water skink	E	E	17 records within 10km (OEH 2016a); Species or species' habitat known to occur within 10km (DEE 2017a)	This species of semi-aquatic lizard grows to 200 mm and inhabits permanently wet sedge and shrub swamps that have boggy soils at altitudes above 560 m in the Blue Mountains of NSW from Hazelbrook to the Newnes Plateau. It is active on warm sunny days between September - April. Its diet is known to consist of grasshoppers, flies, moths, weevils, wasps, and small fruits. The species is believe to shelter and breed in grass tussocks and in holes below the ground. Breeding occurs in December with the female giving birth to live young.	Likely. Suitable habitat present in the swamp downstream of the study area.	Low. Proposal has the potential to impact water quality and flows along the drainage line and in the swamp.
Hoplocephalus bungaroides	Broad-headed Snake	E	V	1 record within 10km (OEH 2016a); Species or species' habitat known to occur within 10km (DEE 2017a)	Nocturnal, sheltering in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter, and spring, moving to shelters in hollows of large trees within 200m of escarpments in summer. Feeds mostly on geckos and small skinks, and occasionally on frogs and small mammals.	Nil. No suitable habitat present.	Nil.
FROGS							
Litoria booroolongensis	Booroolong Frog	E	E	Species or species' habitat may occur within 10km (DEE 2017a)	Restricted to western slopes and tablelands, mainly in western-flowing streams and their headwaters on the Great Dividing Range. Has disappeared from the Northern Tablelands and rare throughout the rest of its range. Occurs along permanent streams with some fringing vegetation cover, ranging from slow-flowing creeks to large rivers, in both forested/ open pasture areas. Found on or near cobble banks and other rock structures within stream margins and shelter under rocks or amongst vegetation near the ground on the stream edge.	Nil. Outside known distribution. No suitable rocky stream habitat present.	Nil.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Heleioporus australiacus	Giant Burrowing Frog	V	V	1 record within 10km (OEH 2016a); Species or species' habitat known to occur within 10km (DEE 2017a)	Occurs along the coast and eastern slopes of the Great Dividing Range south from Wollemi National Park. Appears to exist as two populations with a 100km gap in records between Jervis Bay and Eden. Northern population occurs on sandy soils supporting heath, woodland or open forest. Breeds in ephemeral to intermittent streams with persistent pools. Only infrequently moves to breeding sites, most commonly found on ridges away from creeks, several hundred metres from water.	Likely. May breed along drainage line or swamp downstream of the study area. Could forage or shelter in the Project area on occasion.	Low. Proposal has the potential to impact water quality and flows along the drainage line.
Litoria littlejohni	Littlejohn's Tree Frog	V	V	Species or species' habitat may occur within 10km (DEE 2017a)	Occurs on plateaus and eastern slopes of the Great Dividing Range south from Watagan State Forest. Occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops, hunting either in shrubs or on the ground.	Possible. May occur along the drainage line and Wollangambe River downstream of the Project area.	Moderate. Proposal has the potential to impact water quality and flows along the drainage line.
Pseudophryne australis	Red-crowned Toadlet	V		1 record within 10km , last recorded 2003 (OEH 2016a)	Restricted to Sydney Basin, from Nowra to Pokolbin and west to Mt Victoria. Inhabits heathland and open woodland on Hawkesbury and Narrabeen Sandstones, within 100m of ridgelines. Breeds in ephemeral feeder creeks or flooded depressions, requiring unpolluted water between 5.5 and 6.5 pH. Shelters under rocks, amongst masses of dense vegetation or leaf litter. Populations restricted to immediate vicinity of breeding areas.	Likely. May breed and shelter in soaks and ephemeral drainage lines downstream of the study area.	Low. Proposal has the potential to impact water quality and flows along the drainage line.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Mixophyes balbus	Stuttering Frog	E	V	Species or species' habitat may occur within 10km (DEE 2017a)	Occurs along the east coast of Australia. Has undergone a massive range reduction particularly in the south of its range: within the Sydney Basin, White (2008a) located only three populations south of Sydney. Inhabits rainforest and wet, tall, open forest. Shelters in deep leaf litter and thick understorey vegetation on the forest floor. Feeds on insects and smaller frogs, breeding in streams during summer after heavy rain. The species does not occur in areas where the riparian vegetation has been disturbed or where there have been significant upstream human impacts. There is a chance that the Stuttering Frog is now extinct in south-west Wollemi and north-west Blue Mountains NPs, with targeted searches in 1999 and 2009 failing to locate it.	Unlikely. Potential habitat present downstream of the Project area however thought to be extinct in the area.	Nil.
INVERTEBRATES							
Petalura gigantea	Giant Dragonfly	E		27 records within 10km (OEH 2016a)	The Giant Dragonfly is found along the east coast of NSW from the Victorian border to northern NSW. There are known occurrences in the Blue Mountains and Southern Highlands. They live in permanent swamps and bogs with some free water and open vegetation. Adults spend most of their time settled on low vegetation on or adjacent to the swamp hunting for flying insects. Females lay eggs into moss or other soft vegetation bordering swamps. Larvae dig long branching burrows under the swamp leaving their burrows at night to feed on insects and other invertebrates on the surface and also use underwater entrances to hunt for food in the aquatic vegetation.	Likely. Suitable habitat present in the swamp downstream of the study area.	Low. Proposal has the potential to impact water quality and flows along the drainage line and in the swamp.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Paralucia spinifera	Purple Copper Butterfly	E	V	18 records within 10km (OEH 2016a); Species or species' habitat likely to occur within 10km (DEE 2017a)	Occurs on the Central Tablelands of NSW in an area approximately bounded by Oberon, Hartley and Bathurst. The butterfly is found at 35 locations, all with a west to north-west aspect, usually where direct sunlight reaches the habitat, and with extremes of cold such as regular winter snowfalls or heavy frosts. Its lifecycle relies on a mutualistic relationship with the ant, *Anonychomyra itinerans*, and on the presence of Blackthorn *Bursaria spinosa* subsp. *lasiophylla* which is used as the larval food plant. The butterflies emerge between August (later at higher altitude sites) and November, with a two-week peak of activity in September.	Nil. Outside known distribution. No blackthorn habitat present.	Nil.
FISH							
Prototroctes maraena	Australian Grayling		V	Species or species' habitat likely to occur within 10km (DEE 2017a)	Occurs in coastal rivers and streams south from the Shoalhaven River. Inhabits estuarine waters and coastal seas as larvae/juveniles, and freshwater rivers and streams as adults. Most of their lives are spent in freshwater rivers and streams in cool, clear waters with a gravel substrate and alternating pool and riffle zones, however can also occur in turbid water. The species can penetrate well inland, being recorded over 100 km inland from the sea.	Nil. Outside known distribution.	Nil.
Macquaria australasica	Macquarie Perch	V	E	Species or species' habitat known to occur within 10km (DEE 2017a)	Occurs in the upper reaches of the Lachlan, Murrumbidgee and Murray Rivers, and in parts of the Hawkesbury and Shoalhaven catchment areas. Known to occur in the lower reaches of the Wollangambe River. Inhabits river and lake habitats, especially the upper reaches of rivers and their tributaries. Requires clear water with deep, rocky holes and abundant cover (including aquatic vegetation, woody debris, large boulders and overhanging banks). Spawning occurs in spring and summer in shallow upland streams or flowing sections of river systems.	Nil. Project area about 50km upstream of mapped distribution.	Nil.

Key: CE – critically endangered, E – endangered, V - vulnerable

Migratory fauna species

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Hirundapus caudacutus	White-throated Needletail		C, J, K	6 records within 10km (OEH 2016a); Species or species' habitat known to occur within 10km (DEE 2017a)	Recorded along NSW coast to the western slopes and occasionally from the inland plains. Breeds in northern hemisphere. Almost exclusively aerial while in Australia. Occur above most habitat types, but are more frequently recorded above more densely vegetated habitats (rainforest, open forest and heathland) than over woodland or treeless areas.	Possible. May forage high above the Project area on occasion.	Nil.
Monarcha melanopsis	Black-faced Monarch		M	Species or species' habitat known to occur within 10km (DEE 2017a)	Found along the coast of eastern Australia, becoming less common further south. Found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating. Resident in the north of its range, but is a summer breeding migrant to coastal south-eastern Australia, arriving in September and returning northwards in March. It may also migrate to Papua New Guinea in autumn and winter.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Motacilla flava	Yellow Wagtail		C, J, K	Species or species' habitat may occur within 10km (DEE 2017a)	This species breeds in temperate Europe and Asia. They occur within Australia in open country habitat with disturbed ground and some water. Recorded in short grass and bare ground, swamp margins, sewage ponds, saltmarshes, playing fields, airfields, ploughed land and town lawns.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.
Myiagra cyanoleuca	Satin Flycatcher		M	Species or species' habitat known to occur within 10km (DEE 2017a)	In NSW widespread on and east of the Great Divide, sparsely scattered on the western slopes, very occasional records on the western plains. Inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, often near wetlands and watercourses. On migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. Generally not in rainforests.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Rhipidura rufifrons	Rufous Fantail		M	Species or species' habitat known to occur within 10km (DEE 2017a)	Found along NSW coast and ranges. Inhabits rainforest, dense wet forests, swamp woodlands and mangroves. During migration, it may be found in more open habitats or urban areas.	Possible. May forage on occasion in the Project area. Extensive areas of better quality habitat present in the adjacent national park.	Low. Small area of low quality foraging habitat would be removed. Revegetation would improve habitat in the long term.

Key: C, J, K – listed under international migratory bird agreements (China, Japan, Korea), M – migratory terrestrial.

Appendix B – Survey results

Plot/transect data

Vegetation Zone	Veg Type ID	Plot ID	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Over storey regeneration	Total length of fallen logs	Easting	Northing	Zone	Bearing
1	HN5600	Benchmark	41	20-30	33-53	1-10	7.2-15.2	13.6-21.6	0	> = 1	1	> = 50				
	Medium	1	44	16.5	20.5	8	10	14	0	0	1	46.5	244974	6292565.8	56	334
2	HN600	Benchmark	41	20-30	33-53	1-10	7.2-15.2	13.6-21.6	0	> = 1	1	> = 50				
	Poor	2	52	0	46	44	8	30	0	0	0	73	244923.7	6292724.5	56	278
		3	30	0	11	4	26	2	1	0	0	0	244902.8	6292522.8	56	n/a
4	Formerly HN600	Benchmark		3-37	15-68	19-55	0-20	10-30	0	> = 0	1	> = 0				
	Cleared	4	14	0	0	6	0	0	62	0	0.25	0	244896.6	6292411.7	56	284

Flora species recorded within the Bell Quarry study area

Family	Scientific Name	Common Name	Exotic	Plot 1 Cover	Plot 1 Abundance	Plot 2 Cover	Plot 2 Abundance	Plot 3 Cover	Plot 3 Abundance	Plot 4 Cover	Plot 4 Abundance	Area search 1 Cover	Area search 1 Abundance	Area search 2 Cover	Area search 2 Abundance
Acanthaceae	*Brunoniella australis*	Blue Trumpet		1	20										
Apiaceae	*Daucus glochidiatus*	Native Carrot				1	1								
Apiaceae	*Platysace linearifolia*														
Apiaceae	*Xanthosia pilosa*	Woolly Xanthosia		1	20										
Araliaceae	*Polyscias sambucifolia*	Elderberry Panax		1	10	1	1								
Asteraceae	*Arrhenechthites mixta*	Purple Fireweed		1	10										
Asteraceae	*Cassinia aculeata*	Dolly Bush				1	5	1	10	1	1				
Asteraceae	*Coronidium scorpioides*	Button Everlasting				1	20								
Asteraceae	*Euchiton sphaericus*	Star Cudweed								1	1				
Asteraceae	*Hypochaeris radicata*	Catsear	*	1	20	1	20	1	20	1	20				
Asteraceae	*Ozothamnus diosmifolius*	White Dogwood		1	10	1	10								
Campanulaceae	*Wahlenbergia gracilis*	Sprawling Bluebell													
Campanulaceae	*Wahlenbergia* sp.	Bluebell						1	1						
Casuarinaceae	*Allocasuarina nana*	Dwarf She-oak						1	2						
Colchicaceae	*Burchardia umbellata*	Milkmaids		1	3										
Cyperaceae	*Gahnia microstachya*					1	20								
Cyperaceae	*Gahnia sieberiana*	Red-fruit Saw-sedge		2	10	10	20							2	

Family	Scientific Name	Common Name	Exotic	Plot 1 Cover	Plot 1 Abundance	Plot 2 Cover	Plot 2 Abundance	Plot 3 Cover	Plot 3 Abundance	Plot 4 Cover	Plot 4 Abundance	Area search 1 Cover	Area search 1 Abundance	Area search 2 Cover	Area search 2 Abundance
Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge		1	10	1	10	1	3						
Cyperaceae	*Lepidosperma limicola*											4			
Cyperaceae	*Schoenus* sp.											2			
Dennstaedtiaceae	*Pteridium esculentum*	Bracken		1	20									1	
Droseraceae	*Drosera peltata*	A Sundew										2			
Ericaceae	*Epacris microphylla*	Coral Heath				1	5					1			
Ericaceae	*Leucopogon* sp.	Woronora Beard-heath						1	3			1			
Ericaceae	*Leucopogon lanceolatus*													2	
Ericaceae	*Monotoca scoparia*			1	10	1	10								
Euphorbiaceae	*Amperea xiphoclada*			1	50	1	20	1	1						
Fabaceae (Faboideae)	*Cytisus scoparius subsp. scoparius*	English Broom	*			1	20								
Fabaceae (Faboideae)	*Daviesia latifolia*	Bitter-pea		2	20	1	3	1	10						
Fabaceae (Faboideae)	*Podolobium scandens*	Netted Shaggy Pea													
Fabaceae (Faboideae)	*Trifolium subterraneum*	Subterranean Clover	*							60	500				
Fabaceae (Mimosoideae)	*Acacia baileyana*	Cootamundra Wattle				1	1								
Fabaceae (Mimosoideae)	*Acacia longifolia*			1	10	25	50	5	20	1	7				
Fabaceae (Mimosoideae)	*Acacia* sp.	Wattle										1			

Family	Scientific Name	Common Name	Exotic	Plot 1 Cover	Plot 1 Abundance	Plot 2 Cover	Plot 2 Abundance	Plot 3 Cover	Plot 3 Abundance	Plot 4 Cover	Plot 4 Abundance	Area search 1 Cover	Area search 1 Abundance	Area search 2 Cover	Area search 2 Abundance
Fabaceae (Mimosoideae)	*Acacia terminalis*	Sunshine Wattle		1	5	1	1	2	20						
Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses		1	1			1	5						
Gentianaceae	*Centaurium erythraea*	Common Centaury	*							1	1				
Gleicheniaceae	*Gleichenia dicarpa*	Pouched Coral Fern				1	1					1			
Goodeniaceae	*Dampiera stricta*											1		2	
Goodeniaceae	*Goodenia paniculata*					1	50								
Haemodoraceae	*Haemodorum planifolium*														
Haloragaceae	*Gonocarpus tetragynus*	Poverty Raspwort				1	20								
Iridaceae	*Patersonia sericea*	Silky Purple-Flag		1	20	1	10							2	
Juncaceae	*Juncus* sp.	A Rush								1	5	4			
Juncaceae	*Juncus usitatus*					1	20								
Lomandraceae	*Lomandra filiformis* subsp. *filiformis*			1	20	1	10								
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush		1	5	1	20	1	3	1	8			2	
Lomandraceae	*Lomandra multiflora subsp. multiflora*	Many-flowered Mat-rush				1	5								
Myrtaceae	*Baeckea linifolia*	Weeping Baeckea										2			
Myrtaceae	*Eucalyptus globoidea*	White Stringybark		2	1										

Family	Scientific Name	Common Name	Exotic	Plot 1 Cover	Plot 1 Abundance	Plot 2 Cover	Plot 2 Abundance	Plot 3 Cover	Plot 3 Abundance	Plot 4 Cover	Plot 4 Abundance	Area search 1 Cover	Area search 1 Abundance	Area search 2 Cover	Area search 2 Abundance
Myrtaceae	*Eucalyptus oreades*	Blue Mountains Ash				1	1	2	10						
Myrtaceae	*Eucalyptus piperita*	Sydney Peppermint		40	20	1	1			1	3			4	
Myrtaceae	*Eucalyptus sclerophylla*	Hard-leaved Scribbly Gum						1	5					2	
Myrtaceae	*Eucalyptus sieberi*	Silvertop Ash		3	1									4	
Myrtaceae	*Leptospermum continentale*	Prickly Teatree										3			
Myrtaceae	*Leptospermum grandifolium*	Woolly Teatree		1	5	1	5	1	10			3			
Myrtaceae	*Leptospermum macrocarpum*					1	5	1	5						
Myrtaceae	*Leptospermum polygalifolium*	Tantoon				1	3					2			
Myrtaceae	*Leptospermum rotundifolium*							1	20	1	3				
Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree		1	10	2	10							2	
Orchidaceae	*Microtis* sp.					1	1								
Orchidaceae	*Prasophyllum* sp.					1	1								
Orchidaceae	*Thelymitra* sp.							1	3						
Phormiaceae	*Dianella revoluta var. revoluta*	A Blue Flax Lily		1	10	1	1								
Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge				1	5								

Family	Scientific Name	Common Name	Exotic	Plot 1 Cover	Plot 1 Abundance	Plot 2 Cover	Plot 2 Abundance	Plot 3 Cover	Plot 3 Abundance	Plot 4 Cover	Plot 4 Abundance	Area search 1 Cover	Area search 1 Abundance	Area search 2 Cover	Area search 2 Abundance
Phyllanthaceae	*Poranthera microphylla*	Small Poranthera		1	10	1	10								
Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues	*											2	
Poaceae	*Austrostipa rudis subsp. nervosa*	A Speargrass		1	20	2	50	1	10						
Poaceae	*Billardiera scandens*	Hairy Apple Berry													
Poaceae	*Cortaderia selloana*	Pampas Grass	*			1	1	1	5	1	3				
Poaceae	*Elymus scaber*	Common Wheatgrass								5	100				
Poaceae	*Entolasia stricta*	Wiry Panic		1	50	2	100	1	20					1	
Poaceae	*Eragrostis curvula*	African Lovegrass	*					1	5						
Poaceae	*Microlaena stipoides*	Weeping Grass		1	10	1	20								
Poaceae	*Poa sieberiana*	Snowgrass		1	1	10	50								
Poaceae	*Rytidosperma* sp.			1	10										
Poaceae	*Rytidosperma tenuius*	A Wallaby Grass				5	100	1	20	1	20				
Polygalaceae	*Comesperma ericinum*	Pyramid Flower				1	1								
Proteaceae	*Banksia serrata*	Old-man Banksia													
Proteaceae	*Banksia spinulosa*	Hairpin Banksia						1	1			2			
Proteaceae	*Grevillea laurifolia*	Laurel-leaf Grevillea		1	10	5	5							3	
Proteaceae	*Hakea dactyloides*	Finger Hakea										1			
Proteaceae	*Hakea laurina*		*			1	5	1	10						

Family	Scientific Name	Common Name	Exotic	Plot 1 Cover	Plot 1 Abundance	Plot 2 Cover	Plot 2 Abundance	Plot 3 Cover	Plot 3 Abundance	Plot 4 Cover	Plot 4 Abundance	Area search 1 Cover	Area search 1 Abundance	Area search 2 Cover	Area search 2 Abundance
Proteaceae	*Hakea sericea*	Needlebush						1	3			1			
Proteaceae	*Isopogon anemonifolius*	Broad-leaf Drumsticks						1	10						
Proteaceae	*Lomatia silaifolia*	Crinkle Bush		1	10	1	1								
Proteaceae	*Persoonia lanceolata*	Lance Leaf Geebung		1	5	1	5								
Proteaceae	*Persoonia levis*	Broad-leaved Geebung		1	3	1	3							2	
Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung												2	
Proteaceae	*Petrophile pulchella*	Conesticks				1	1	1	50						
Proteaceae	*Telopea speciosissima*	Waratah		1	5									2	
Restionaceae	*Baloskion australe*											3			
Restionaceae	*Baloskion gracile*			1	5	2	20								
Restionaceae	*Empodisma minus*											3			
Restionaceae	*Eurychorda complanata*											2			
Restionaceae	*Lepyrodia scariosa*					1	10	1	5			3			
Rhamnaceae	*Pomaderris andromedifolia f. 'andromedifolia'*			1	20	1	10	1	10						
Rubiaceae	*Opercularia varia*	Variable Stinkweed		1	20										
Rubiaceae	*Pomax umbellata*	Pomax		1	1										

Family	Scientific Name	Common Name	Exotic	Plot 1 Cover	Plot 1 Abundance	Plot 2 Cover	Plot 2 Abundance	Plot 3 Cover	Plot 3 Abundance	Plot 4 Cover	Plot 4 Abundance	Area search 1 Cover	Area search 1 Abundance	Area search 2 Cover	Area search 2 Abundance
Rutaceae	*Boronia microphylla*	Small-leaved Boronia		1	5										
Solanaceae	*Solanum* sp.		*	1	1										
Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia		1	10										
Violaceae	*Hybanthus vernonii*			1	5										
Xyridaceae	*Xyris ustulata*	Yellow Flag										1			

Notes: Cover – visual estimate of foliage Projective cover within the plot, recorded from 1–5% and then to the nearest 5%.

Abundance - relative number of individuals or shoots of a species within the plot. Based on the following intervals: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 50, 100, 500, 1000. Counts above 20 are estimates only

Fauna species recorded

Common Name	Scientific Name	Site	Study area
Birds			
Australasian Grebe	*Tachybaptus novaehollandiae*	O	
Australian Magpie	*Cracticus tibicen*	W	O
Australian Wood Duck	*Chenonetta jubata*	O	
Brown Gerygone	*Gerygone mouki*		W
Brown Thornbill	*Acanthiza pusilla*	O	
Crimson Rosella	*Platycercus elegans*	W	OW
Eastern Spinebill	*Acanthorhynchus tenuirostris*	O	W
Grey Fantail	*Rhipidura albiscapa*		O
Grey Shrike-thrush	*Colluricincla harmonica*		W
Laughing Kookaburra	*Dacelo novaeguineae*		OW
Little Black Cormorant	*Phalacrocorax sulcirostris*	O	
Little Raven	*Corvus mellori*	OW	
Masked Lapwing	*Vanellus miles*	W	
New Holland Honeyeater	*Phylidonyris novaehollandiae*	O	O
Pacific Black Duck	*Anas superciliosa*	O	
Red Wattlebird	*Anthochaera carunculata*	O	
Rufous Whistler	*Pachycephala rufiventris*	W	W
Spotted Pardalote	*Pardalotus punctatus*		W
Striated Thornbill	*Acanthiza lineata*	O	
Superb Fairy-wren	*Malurus cyaneus*	O	
Superb Lyrebird	*Menura novaehollandiae*		W
Tree Martin	*Petrochelidon nigricans*	O	
Wedge-tailed Eagle	*Aquila audax*		O
Welcome Swallow	*Hirundo neoxena*	O	
White-browed Scrubwren	*Sericornis frontalis*	O	O
White-throated Treecreeper	*Cormobates leucophaea*		W
Yellow-faced Honeyeater	*Lichenostomus chrysops*	O	W
Yellow-tailed Black-cockatoo	*Calyptorhynchus funereus*	O	O
Mammals			
Common Wombat	*Vombatus ursinus*	F	F
Eastern Grey Kangaroo	*Macropus giganteus*		O
Red-necked Wallaby	*Macropus rufogriseus*		O
Swamp Wallaby	*Wallabia bicolor*	O	O
Eastern Bentwing Bat	*Miniopterus schreibersii oceanensis*	Po	
Gould's Wattled Bat	*Chalinolobus gouldii*	D	
Large Forest Bat	*Vespadelus darlingtoni*	D	
Southern Forest Bat	*Vespadelus regulus*	Po	
White-striped Freetail-Bat	*Tadarida australis*	D	W
Reptiles			
Black-bellied Swamp Snake	*Hemiaspis signata*		O
Dark-flecked Garden Sunskink	*Lampropholis delicata*	O	

Common Name	Scientific Name	Site	Study area
Eastern Water Dragon	*Intellagama lesueurii*		O
Jacky Lizard	*Amphibolurus muricatus*	O	
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*		O
Southern Forest Cool-skink	*Niveoscincus coventryi*	O	
unidentified grass skink	*Lampropholis* sp.		O
Yellow-bellied Water-skink	*Eulamprus heatwolei*	O	O
Frogs			
Common Eastern Froglet	*Crinia signifera*		W
Eastern Banjo Frog	*Limnodynastes dumerilii*	OW	
Peron's Tree Frog	*Litoria peronii*	W	
Smooth Toadlet	*Uperoleia laevigata*	OW	W
Tyler's Tree Frog	*Litoria tyleri*	O	
Verreaux's Frog	*Litoria verreauxii*	W	
Dragonflies and Damselflies			
Blue Skimmer	*Orthetrum caledonicum*		O
Eastern Pygmyfly	*Nannophya dalei*		O
Red and Blue Damsel	*Xanthagrion erythroneurum*		O
Slender Ringtail	*Austrolestes analis*		O
Wandering Ringtail	*Austrolestes leda*		O
Tau Emerald	*Hemicordulia tau*		O

Notes: O=observed, W=heard, OW=Observed and heard, Po= possible call from anabat analysis, D=definite call from anabat analysis, F= tracks and scratchings

Appendix C – Assessments of significance

Assessments of Significance have been prepared pursuant to s5A of the EP&A Act for threatened species and communities recorded or likely to occur in the study area and be impacted by the incident. Where possible, assessments have been grouped for species with similar habitat requirements. Assessments are provided for the following:

- Threatened ecological communities:
  - Newnes Plateau Shrub Swamp
- Threatened flora species:
  - *Boronia deanei*
  - *Persoonia hindii*
  - *Veronica blakelyi*
- Threatened fauna species:
  - Red-crowned Toadlet
  - Littlejohns Tree Frog
  - Giant Burrowing Frog
  - Blue Mountains Water Skink
  - Giant Dragonfly

In addition, an assessment of significance has been prepared pursuant to the EPBC Act significant impact guidelines for the Greater Blue Mountains World Heritage Area.

Newnes Plateau Shrub Swamp

There is an approximately 1.5 hectare occurrence of Newnes Plateau Shrub Swamp downstream and around 200 metres to the northeast of the Project area. This ecological community is dominated by moisture-dependant shrubs and sedges and in narrow, elongated swamps formed in low-slope headwaters of the Newnes Plateau, in predominantly sandstone catchments of Triassic Narrabeen Group geology, at approximately 900-1200 m elevation on deep sandy organic sediments that are permanently to periodically waterlogged (OEH 2016b). The occurrence of the ecological community in the study area is associated with alluvial flats along an unnamed first order drainage line that drains the pit void and flows to the northeast.

This community may provide habitat for the threatened plant *Boronia deanii* and a number of threatened fauna species including the Giant Dragonfly and Blue Mountains Water Skink.

Assessment of Significance for Newnes Plateau Shrub Swamp (Endangered Ecological Community)
a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,
Not applicable to this EEC.
b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,
Not applicable to this EEC.
c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
The Project would not clear any vegetation within an occurrence of this community or otherwise directly reduce the extent of the community. The Project includes measures to control weeds, suppress dust generation and to manage erosion and is unlikely to result in tangible impacts on habitat outside the Project area through any of these indirect effects. The ecological community is composed of moisture-dependant plant species and is associated with periodically to permanently inundated environments. Alterations to surface or groundwater flow regimes are recognised as a key threat to the community (OEH 2016b). The Project would modify the hydrology of the catchment for the ecological community through progressive dewatering of voids in the former quarry and emplacement and consolidation of clean fill material within the existing quarry voids to closely represent the pre-quarry landform. A water management system will be implemented to control surface water discharges throughout the rehabilitation program and from the final landform. A water resources assessment has been completed to determine the effect of the Project on downstream flow regimes and the effect on water quality through flow proportions of different types of water (GHD 2017). The Project would alter flow regimes temporarily, including less frequent low flows and more frequent higher flows, at various stages during the life of the Project. The existing voids will be progressively dewatered at moderate flow rates of between 1 and 2 ML/Day. This is considerably less than the current site discharges associated with storm flows during wet weather events of up to 10 ML/day and are unlikely to substantially alter local geomorphology or otherwise have a significant negative effect on the community. After completion of the Project and establishment of the final rehabilitated landform, flows will generally be restored to natural conditions and will be significantly closer to natural conditions than is currently the case (GHD 2017). The post rehabilitation conditions would include increased frequency and duration of low flow events which would be expected to have a positive effect on the moisture-dependant plant species that characterise this community. The Project would not

Assessment of Significance for Newnes Plateau Shrub Swamp (Endangered Ecological Community)
substantially or permanently reduce flows to the extent that the ecological community would be reduced in extent. Downstream reaches, including the occurrence of the ecological community, are expected to have a relatively high resistance to geomorphologic change. The temporary increase in frequency of higher flows during Project stages that include more substantial pit dewatering has some potential to result in scouring and modification to downstream creek formations. Proposed mitigation measures including regular fluctuation of discharge regimes would greatly reduce this impact. With implementation of these mitigation measures the Project is not expected to result in significant impacts on downstream waterway formation and geomorphic conditions (GHD 2017). Subject to confirmation of the source of the fill material, the Project could have a minor impact on downstream water quality. Minor exceedances of upland rivers guideline values for Electrical Conductivity and Zinc have been modelled for the final stages of the Project based on a conservative assessment of the poorest permissible fill material. During active filling and rehabilitation, the site discharge would be monitored monthly for water quality parameters (GHD 2017). The quality standards for fill material will be set so as to ensure that there are no exceedances of water quality guidelines. The Project would not result in any impacts on water quality that would reduce the extent of the ecological community.
(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,
The Project would not clear any vegetation within an occurrence of this community, remove any plants or animals or otherwise directly modify the species composition of the community. As described in part (i) above, the Project would modify surface and groundwater flows within the catchment of the ecological community and potentially affect water quality. These changes would be relatively minor and temporary. The post-rehabilitation hydrological regime is expected to more closely match natural conditions than the current situation (GHD 2017). Changes to environmental conditions as a result of the Project are likely to be within the range of conditions tolerated by species within the ecological community and are unlikely to modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.
d) in relation to the habitat of a threatened species, population or ecological community:
(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
The Project would not clear or otherwise directly remove or modify any habitat for the ecological community. The Project area is over 200 metres from the ecological community and would be separated from it by intact native vegetation as well as an existing detention pond and proposed surface water and sediment control devices designed to avoid downstream impacts. Construction impacts such as noise, vibration, light and dust generation would have a very minor effect on habitat for the ecological community. As described in part (i) above, the Project would modify surface and groundwater flows within the catchment of the ecological community and potentially affect water quality. These changes would be relatively minor and temporary. The post-rehabilitation hydrological regime is expected to more closely match natural conditions than the current situation (GHD 2017). Changes to environmental conditions as a result of the Project would comprise a minor effect on habitat for the ecological community.
(**ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
The Project would not clear any Newnes Plateau Shrub swamp vegetation or otherwise directly fragment or isolate any habitat for the ecological community.
(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,
The Project may result in minor indirect impacts to a 1.5 ha occurrence of Newnes Plateau Shrub Swamp. Vegetation mapping of the entire range of Newnes Plateau Shrub Swamp indicates that it

Assessment of Significance for Newnes Plateau Shrub Swamp (Endangered Ecological Community)
covers less than 650 ha in total with an average swamp size of less than 6 ha (OEH 2011). Patches of the ecological community are separated by drier ground at higher local elevations which would limit the potential for recruitment and regeneration in the event of impacts. In this context even a 1.5 ha area of habitat would have considerable importance to the long-term survival of the ecological community in the locality.
e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),
There is no critical habitat listed for this ecological community (OEH 2015d).
f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,
There is no recovery plan for this ecological community. OEH identifies a number of priority actions intended to abate threats to this ecological community and ensure its long term conservation (OEH, 2012). These priority actions are mainly related to research, assisted regeneration and communication and would not be directly affected by the Project. The Project would not involve any clearing or other direct impacts to the ecological community and potential indirect impacts are likely to be minor. The Project would not substantially interfere with the recovery of the ecological community.
g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.
The Project would include the operation of the KTP 'alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands' through the dewatering of pit voids and emplacement of fill material in the catchment of the ecological community. As described above the Project would have a relatively minor effect on water flows and post rehabilitation is likely to result in a more natural flow regime than the current situation. The Project would increase the operation of the KTP 'clearing of native vegetation' through the temporary removal of 2.61 ha of native vegetation, the majority of which is sub-mature planted native vegetation on a highly modified landform. Around 0.13 ha of remnant native vegetation with natural soil profiles would be removed. None of this vegetation is within the local occurrence of the ecological community but it would include populations of species representative of the community and their habitat. Extensive areas of intact native vegetation are present in the locality including many thousands of hectares conserved in National Parks. This temporary reduction in extent is highly unlikely to affect the viability of remnant vegetation in the study area or locality or reduce the extent of habitat below a minimum size required for any native species. The Project also has the potential to result in the following KTPs that may affect plants or animals within the ecological community: • Infection of native plants by *Phytophthora cinnamomi* • Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae • Infection of frogs by amphibian chytrid causing the disease chytridiomycosis. Appropriate hygiene protocols are recommended to prevent introduction or spread of these diseases.
Conclusion of Assessment of Significance
Based on the consideration of the above factors the Project is not likely to have a significant negative effect on the local occurrence of Newnes Plateau Shrub Swamp, as: • There would be no clearing of the ecological community and no habitat would be removed as a result of the Project • Impacts to surface and groundwater flows and water quality within the catchment of the ecological community would be relatively minor and temporary

Assessment of Significance for Newnes Plateau Shrub Swamp (Endangered Ecological Community)
• The post-rehabilitation hydrological regime is expected to more closely match natural conditions than the current situation.

Threatened Flora Species

Deanes Boronia (*Boronia deanii*) grows on the margins of high altitude swamps, in wet heath on sandstone, and in drier open forest (OEH 2016b). There are relatively abundant populations of this species associated with Newnes Plateau Shrub Swamp communities similar to the occurrence in the study area throughout the locality of Bell, Clarence and the Newnes Plateau. There is potential habitat for this species in native vegetation throughout the study area, though the most likely habitat is around the margins of the Newnes Plateau Shrub Swamp downstream of the Project area.

Persoonia hindii is restricted to the Newnes Plateau region and mostly occurs as discrete populations of clonal, suckering populations (OEH 2016b). Within this range it is frequently associated with Sydney Peppermint - Silvertop Ash heathy open forest on sandstone-derived soils equivalent to that within the study area.

Veronica blakelyi is restricted to the western Blue Mountains, and occurs as patchy and generally small populations. It occurs in eucalypt forest, often in moist and sheltered areas (OEH 2016b). There is potential habitat for this species in native vegetation throughout the study area, though the most likely habitat is associated with Sydney Peppermint - Silvertop Ash heathy open forest on more sheltered aspects such as lower slopes adjoin the unnamed drainage line that flows northeast from the Project area.

Assessment of significance	Deanes Boronia (*Boronia deanii*), *Persoonia hindii, Veronica blakelyi*
a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.	
None of these threatened plant species were observed in the Project area or are likely to occur given the highly modified nature of the site and the survey effort employed within the 0.13 ha of native vegetation with natural soil profiles. The Project would remove 0.13 ha of potential habitat for these species in the Project area and may affect habitat downstream of the site through factors such as changes to surface or groundwater flow regimes or through mobilisation of sediments. As described in part (c) these impacts could be mitigated through are the proposed soil and water management framework for the Project and would not substantially degrade any habitat for these threatened plants. Each of these threatened plant species occur as relatively abundant and secure local populations within the Blue Mountains National Park in vegetation that is continuous with the study area. The Project would affect few (if any) individuals of these plant species and is highly unlikely to affect an ecologically significant proportion of any local populations. Given the limited scale and duration of the Project it is unlikely to interfere with any ecological processes important to the life cycles of these threatened plant species. The post revegetation landform at the Project area would more closely resemble the natural environment and is likely to comprise potential habitat for these species.	

Assessment of significance	Deanes Boronia (*Boronia deanii*), *Persoonia hindii, Veronica blakelyi*

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable to threatened species.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed…

Not applicable to threatened species.

d) In relation to the habitat of a threatened species, population or ecological community:

(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

None of these threatened plant species were observed in the Project area or are likely to occur given the highly modified nature of the site and the survey effort employed within the 0.13 ha of native vegetation with natural soil profiles. The Project would remove 0.13 ha of potential habitat for these species in the Project area and may affect habitat downstream of the site through factors such as changes to surface or groundwater flow regimes or through mobilisation of sediments. The Project includes measures to control weeds, suppress dust generation and to manage erosion and is unlikely to result in tangible impacts on habitat outside the Project area through any of these indirect effects.

The Project would modify the hydrology of a catchment containing potential habitat for these threatened plants through progressive dewatering of voids in the former quarry and emplacement and consolidation of clean fill material within the existing quarry voids to closely represent the pre-quarry landform. A water management system will be implemented to control surface water discharges throughout the rehabilitation program and from the final landform.

A water resources assessment has been completed to determine the effect of the Project on downstream flow regimes and the effect on water quality through flow proportions of different types of water (GHD 2017). The Project would alter flow regimes temporarily, including less frequent low flows and more frequent higher flows, during the life of the Project. After completion of the Project and establishment of the final rehabilitated landform, flows will generally be restored to natural conditions and will be significantly closer to natural conditions than is currently the case (GHD 2017). The Project would not substantially or permanently reduce flows to the extent that it would degrade habitat for *Boronia deanii* around the margins of the Newnes Plateau Shrub Swamp downstream of the Project area. These changes would be minor and restricted to the immediate vicinity of the drainage line and would not affect habitat for *Persoonia hindii* or *Veronica blakelyi.*

The catchment downstream of the Project area, including habitat for these threatened plants, is expected to have a relatively high resistance to geomorphologic change. The temporary increase in frequency of moderate flows during Project stages that include more substantial pit dewatering has some potential to result in scouring and modification to downstream creek formations. Proposed mitigation measures including regular fluctuation of discharge regimes would greatly reduce this impact. With implementation of these mitigation measures the Project is not expected to result in significant impacts on downstream habitats (GHD 2017).

(ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The Project area has been substantially cleared and modified by previous quarrying activities and already comprises a gap in habitat for these threatened plants. The Project would slightly increase the degree of fragmentation of habitat in the locality through the removal of 0.13 ha of intact native vegetation and a further 2.48 ha of sub-mature planted native vegetation. This impact would be temporary as the Project area would be progressively filled and revegetated. Continuous native vegetation cover would be maintained around the disturbance area. The post-Project environment would more closely resemble natural conditions and in the longer term would improve the extent and connectivity of habitat in the locality.

(iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The 0.13 ha of potential habitat for these species that would be removed in the Project area would have very little importance to long-term survival of the species in the locality given its limited extent, its context on the edge of cleared disturbed land and the fact that no known populations of these plants currently occupy this habitat.

The potential habitat for these species that may be modified through indirect impacts downstream of the Project area would have moderate value given its extent and condition.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

There is no recommended or declared critical habitat of relevance to this assessment (OEH, 2015d).

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

No recovery plan has been prepared for *Boronia deanii, Persoonia hindii* or *Veronica blakelyi*. Targeted strategies for managing these species have been developed under the Saving our Species program. Each species is in the ‘site managed species’ stream, meaning that OEH has concluded that are protected by conserving them at specific sites and managing threats weeding, controlling erosion or revegetation, and monitoring the results (OEH, 2017b).

The Project may remove or modify potential habitat for these species and as such is not consistent with these strategies. As described in part c) the Project would have a minor and localised effect on habitat with moderate value and is unlikely to cause the extinction of a local population or otherwise substantially interfere with the recovery of these species.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The Project would increase the operation of the KTP ‘clearing of native vegetation’ through the temporary removal of 2.61 ha of native vegetation, the majority of which is sub-mature planted native vegetation on a highly modified landform. Around 0.13 ha of remnant native vegetation with natural soil profiles would be removed. This vegetation does not contain any known populations of these threatened plant species. Extensive areas of intact native vegetation are present in the locality including many thousands of hectares conserved in National Parks. This temporary reduction in extent is highly unlikely to affect the viability of remnant vegetation in the study area or locality or reduce the extent of habitat below a minimum size required to maintain populations of these threatened plants.

The Project also has the potential to result in the following KTPs that may affect plants or animals within the ecological community:

- Infection of native plants by *Phytophthora cinnamomi*
- Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae.

Appropriate hygiene protocols are recommended to prevent introduction or spread of these diseases.

Assessment of significance	Deanes Boronia (*Boronia deanii*), *Persoonia hindii, Veronica blakelyi*
Conclusion of Assessment of Significance	

Based on the consideration of the above factors the Project is not likely to have a significant negative effect on local populations of *Boronia deanii, Persoonia hindii* or *Veronica blakelyi*, should they occur, as:

- No individual plants or known occupied habitat would be removed as a result of the Project
- The Project would have a minor and localised effect on habitat with moderate value and is unlikely to cause the extinction of a local population or otherwise substantially interfere with the recovery of these species.
- The post-Project environment would more closely resemble natural conditions and in the longer term would improve the extent and connectivity of habitat in the locality.

Threatened Fauna Species

Stream-breeding frogs

The Red-crowned Toadlet is a habitat specialist occurring only on sandstone formations of the Sydney Basin, generally within 100 m of ridgetops. The species prefers ephemeral ‘feeder creeks’, permanently moist soaks and seepage zones (Thumm and Mahony 1999). It may occur in soaks and drainage lines surrounding the Project area.

Littlejohn’s Tree Frog could occur along the drainage line downstream of the Project area. It was not recorded during targeted surveys for the Wollangambe and Upper Wolgan area (DECC 2009), but is known to occur on the Newnes Plateau (OEH 2015a). This species is notoriously difficult to detect and is one of the least recorded frogs in NSW for this reason (Lemckert 2005, in DECC 2009).

Assessment of significance	Red-crowned Toadlet (*Pseudophryne australis*) Littlejohn’s Tree frog (*Litoria littlejohnii*)
a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.	
The Red-crowned Toadlet could occur in small drainage lines and soaks adjacent to the Project area. Littlejohn’s Tree Frog is a stream-breeding frogs, and could potentially occur downstream of the Project area. No habitat for these species is present within the Project area. Sedimentation of breeding habitat could occur during the dewatering process as a result of scour. pH levels are likely to remain within a suitable range. During the rehabilitation process flow magnitudes along the drainage line will vary, with high flows occurring in early stages, which could result in flushing of tadpoles, eggs or frogs further downstream, and also mortality of individuals. In the long-term, the Project is likely to improve potential breeding habitat in the drainage line downstream of the Project area, with flows returning to natural conditions (improved from current conditions). Red-crowned Toadlets are likely to occur in small soaks and other drainage lines near the Project area which would not be impacted by the Project. Littlejohns Tree Frog could occur in various creeks in the area. Large areas of habitat for these species occur in the national park. During the long periods of low flows, the local population would be dependent on rain events to create pools suitable for breeding. Outside the breeding season, individuals would continue to forage and shelter away from the drainage line. Adults may disperse to other areas of more suitable habitat during periods of low flow, however tadpoles and eggs could potentially die if a breeding event occurred prior to an extended period of low flows. Given that the Project would impact one drainage line, and that conditions will improve in the long term, and large areas of habitat are present in the national park, the Project is unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.	
b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.	
Not applicable to threatened species.	
c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed…	

Assessment of significance	Red-crowned Toadlet (*Pseudophryne australis*) Littlejohn's Tree frog (*Litoria littlejohnii*)
Not applicable to threatened species.	
d) In relation to the habitat of a threatened species, population or ecological community: **(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	
No habitat for these species would be cleared or removed with in the Project area. Potential habitat is present in drainage lines and soaks around the Project area. During the rehabilitation process flow magnitudes along one drainage line will vary, with moderate flows occurring in early stages, which could result in flushing of tadpoles, eggs or frogs further downstream, and also mortality of individuals, and periods of low flow that could potentially result in mortality of tadpoles and eggs. Adults are mobile and are likely to be able to move to areas of more suitable habitat. In the long-term, the Project is likely to improve potential breeding habitat in this drainage line downstream of the Project area, with flows returning to natural conditions.	
(ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	
No area of habitat is likely to have become fragmented or isolated as a result of the Project.	
(iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.	
The Project will impact one drainage line that runs from the Project area in to the national park. Numerous drainage lines and soaks in the national park are present that are potential habitat for this species. As such, the small drainage line running from the Project area is not important to the long-term survival of the species in the locality.	
e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)	
There is no recommended or declared critical habitat of relevance to this assessment (OEH, 2015d).	
f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.	
There is no recovery plan for the Red-crowned Toadlet. Targeted strategies for managing this species have been developed under the Saving our Species program (OEH, 2017b). Actions for the Red-crowned Toadlet include implementing water-sensitive design, minimising impacts on hydrology and habitat, and avoiding additional damage to ground layer vegetation and soil structure wherever possible. There is no recovery plan for Littlejohn's Tree Frog. Targeted strategies for managing this species have been developed under the Saving our Species program (OEH, 2017b). Relevant strategies include encouraging landholders to enter land management agreements (particularly in-perpetuity covenants) that promote the protection and maintenance of key areas of upland swamp or high-altitude stream habitat, particularly in areas likely to be targeted for mining or other degrading land-uses. The Project may impact potential habitat for this species, as such is not consistent with these strategies. The Project has the potential to impact single drainage line existing the Project area. The water management system for the Project has been designed so that in the long-term (following rehabilitation of the site), flows are returned to natural conditions (improved from current conditions). As such the Project is unlikely to cause the extinction of a local population, and is unlikely to interfere with the recovery of these species.	
g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process	

Assessment of significance	Red-crowned Toadlet (*Pseudophryne australis*) Littlejohn's Tree frog (*Litoria littlejohnii*)
The Project would include the operation of the KTP 'alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands' through the dewatering of pit voids and emplacement of fill material in the catchment for a natural drainage line. As described above the Project would have a relatively minor effect on water flows and post rehabilitation is likely to result in a more natural flow regime than the current situation. The Project also has the potential to result in the following KTPs: • Infection of native plants by *Phytophthora cinnamomi* • Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae • Infection of frogs by amphibian chytrid causing the disease chytridiomycosis. Appropriate hygiene protocols are recommended to prevent introduction or spread of these diseases.	
Conclusion of Assessment of Significance	
Based on the consideration of the above factors the Project is not likely to have a significant negative effect on the local population of this threatened frog species, should it occur, as: • No breeding or shelter habitat for these species would be removed as a result of the Project • Large areas of potential habitat for these species are present in the locality. • The water management system for the Project has been designed so that in the long-term (following rehabilitation of the site), flows are returned to natural conditions (improved from current conditions).	

Swamp-breeding species

The Giant Burrowing Frog is known to occur in the locality (OEH 2015a, DECC 2009). It may breed in hanging swamps in the study area, and could use the surrounding forest for shelter outside the breeding season. The Blue Mountains Water Skink has been recorded near Clarence at a number of locations (OEH 2015a). This species may occur in the hanging swamp located downstream of the Project area. The Giant Dragonfly (*Petalura gigantea*) may occur in the hanging swamp located downstream of the Project area.

Assessment of significance	Giant Burrowing Frog (*Heleioporus australiacus*) Blue Mountains Water Skink (*Eulamprus leuraensis*) Giant Dragonfly (*Petalura gigantea*)
a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.	
The Giant Burrowing Frog is likely to shelter in deep leaf litter in the national park adjacent to the Project area, but is not likely to shelter in the Project area given the lack of suitable habitat present. The swamp downstream of the Project area may represent breeding habitat for this species. The Blue Mountains Water Skink and Giant Dragonfly may breed and forage at the swamp downstream of the Project area. During the rehabilitation process flow magnitudes will vary, with moderate flows occurring in early stages and long periods of low flows in the middle stages. During these low flow periods, these species would be more dependent on rain events creating suitable conditions. In the long-term, the Project is likely to improve potential breeding habitat in the swamp downstream of the Project area, with flows returning to natural conditions. This is likely to result in areas of permanent water that create more suitable breeding habitat for these species.	

Assessment of significance	Giant Burrowing Frog (*Heleioporus australiacus*) Blue Mountains Water Skink (*Eulamprus leuraensis*) Giant Dragonfly (*Petalura gigantea*)
Given that the Project would impact one drainage line, and that conditions will improve in the long term, and large areas of habitat are present in the national park, the Project is unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.	
b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.	
Not applicable to threatened species.	
c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed…	
Not applicable to threatened species.	
d) In relation to the habitat of a threatened species, population or ecological community: **(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	
No breeding or shelter habitat for these species would be cleared or removed with in the Project area. Potential breeding habitat is present in the swamp downstream of the Project area. During the rehabilitation process flow magnitudes along one drainage line will vary, with high flows occurring in early stages and long periods of low flows in the middle stages. During these low flow periods, these species would be more dependent on rain events creating suitable conditions. In the long-term, the Project is likely to improve potential breeding habitat in the swamp downstream of the Project area, with flows returning to natural conditions.	
(ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	
No area of habitat is likely to become fragmented or isolated as a result of the Project. Revegetation of the final landform will improve connectivity in the area.	
(iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.	
The Project will impact one drainage line that runs from the Project area and the swamp located downstream of the site. Numerous upland swamps are located in the national park and many are potential habitat for these species. As such, the single swamp located downstream of the Project area is not important to the long-term survival of these species in the locality.	
e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)	
There is no recommended or declared critical habitat of relevance to this assessment.	
f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.	
There is no recovery plan for the Giant Burrowing Frog. Targeted strategies for managing this species have been developed under the Saving our Species program (OEH, 2015b). Of particular relevance are actions including water sensitive design that minimises run-off containing pollutants into known populations or habitat, and agreements to promote the retention of vegetation and minimise disturbance within 300 m of streams. The Project has the potential to impact a small area of potential breeding habitat for this species. The swamp is very small in size, and many other swamps are present in the area which may also provide potential habitat for the species. In the long-term, the Project is likely to improve potential breeding habitat in the swamp downstream of the Project area. The water management system for the Project has been designed so that in the long-term (following rehabilitation of the site), flows are returned to natural conditions (improved from	

Assessment of significance	Giant Burrowing Frog (*Heleioporus australiacus*) Blue Mountains Water Skink (*Eulamprus leuraensis*) Giant Dragonfly (*Petalura gigantea*)
current conditions). Based on these points, the Project is unlikely to cause the extinction of a local population, and is unlikely to interfere with the recovery of the species. Revegetation of the Project area would increase potential shelter habitat in the future. A recovery plan has been prepared for the Blue Mountains Water Skink (NPWS 2001a). Recovery objectives include monitoring known populations and identifying threats and management actions at key sites. The Project has the potential to impact a small area of potential breeding habitat for this species. The swamp is very small in size, and many other swamps are present in the area which may also provide potential habitat for the species. The water management system for the Project has been designed so that in the long-term (following rehabilitation of the site), flows are returned to natural conditions (improved from current conditions). Based on these points, the Project is unlikely to cause the extinction of a local population, and is unlikely to interfere with the recovery of the species. There is no recovery plan for the Giant Dragonfly. Targeted strategies for managing this species have been developed under the Saving our Species program (OEH, 2015b). Actions of particular relevance include water sensitive design to prevent runoff, maintenance of native vegetation buffers around swamps, undertake rehabilitation works on swamp habitat where required to repair damage. The Project has the potential to impact a small area of potential breeding habitat for this species. The swamp is very small in size, and many other swamps are present in the area which may also provide potential habitat for the species. In the long-term, the Project is likely to improve potential breeding habitat in the swamp downstream of the Project area. The water management system for the Project has been designed so that in the long-term (following rehabilitation of the site), flows are returned to natural conditions (improved from current conditions). Based on these points, the Project is unlikely to cause the extinction of a local population, and is unlikely to interfere with the recovery of the species.	
g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process	
The Project has the potential to result in the following KTPs: • Infection of native plants by *Phytophthora cinnamomi* • Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae • Infection of frogs by amphibian chytrid causing the disease chytridiomycosis. Appropriate hygiene protocols are recommended to prevent introduction or spread of these diseases.	
Conclusion of Assessment of Significance	
The Project is not likely to have a significant negative effect on the local population of these threatened species, should they occur, as: • No breeding or shelter habitat for these species would be removed as a result of the Project • Large areas of potential habitat for these species are present in the locality. • The water management system for the Project has been designed so that in the long-term (following rehabilitation of the site), flows are returned to natural conditions (improved from current conditions).	

Greater Blue Mountains World Heritage Area

The eastern boundary of the Project area abuts the Greater Blue Mountains World Heritage Area (GBMWHA). An assessment of significance is provided below with a focus on impacts on the biodiversity values of the GBMWHA.

Greater Blue Mountains World Heritage Area
The World Heritage values for which the GBMWHA was listed include: • Outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals. • Important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation. It is noted for the diversity of eucalypts associated with its wide range of habitats as well as significant numbers of rare or threatened species, including endemic and evolutionary relict species.
According to the significant impact guidelines (DEWHA 2013), an action is likely to have a significant impact on the World Heritage values of a declared World Heritage property (or the National Heritage values of a National Heritage place) if there is a real chance or possibility that it will cause: • ***one or more of the World Heritage/National Heritage values to be lost*** • ***one or more of the World Heritage/National Heritage values to be degraded or damaged, or*** • ***one or more of the World Heritage/National Heritage values to be notably altered, modified, obscured or diminished***
The GBMWHA covers a vast area, and the impacted area would be a negligible proportion of habitat present in the GBMWHA. No native vegetation would be removed from within the GBMWHA. Revegetation of the Project area is likely to improve conditions in the adjacent national park by minimising edge effects, dust and spread of weeds. The water management system for the Project has been designed so that in the long-term (following rehabilitation of the site), flows along the drainage line will be returned to natural conditions (improved from current conditions). The Project is not likely to result in the loss or degradation of one or more of the World Heritage values..
With respect to the specific biological and ecological values an action is likely to have a significant impact on a World Heritage property or National Heritage Place if there is a real chance or possibility that the action will:
• **modify or inhibit ecological processes in a National Heritage place** • **reduce the diversity or modify the composition of plant and animal species in all or part of a World Heritage property/National Heritage place** • **cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a World Heritage property/National Heritage place,**
No native vegetation would be removed from within the GBMWHA. Revegetation of the Project area is likely to improve conditions in the adjacent national park by minimising edge effects, dust and spread of weeds. The water management system for the Project has been designed so that in the long-term (following rehabilitation of the site), flows along the drainage line will be returned to natural conditions (improved from current conditions). Conditions for

Greater Blue Mountains World Heritage Area
endemic flora and fauna are likely to improve in the long-term as a result of the rehabilitation activies.
• **fragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in a World Heritage property/National Heritage place.**
No areas of habitat for rare, endemic or unique animal populations or species would be fragmented, isolated or substantially damaged. Rehabilitation of the quarry will improve connectivity in the area in the long term.
• **involve construction of buildings, roads, or other structures, vegetation clearance, or other actions with substantial, long-term or permanent impacts on relevant values, and**
No construction or vegetation clearing will occur in the GBMWHA. During the earlier phases of the Project there will be generally larger volume of flows along one small drainage line within the GBMWHA due to dewatering requirements and an overall larger catchment area. The water management system for the Project has been designed so that in the long-term (following rehabilitation of the site), flows along the drainage line will be returned to natural conditions (improved from current conditions). Revegetation of the Project area is likely to improve conditions in the adjacent national park by minimising edge effects, dust and spread of weeds.
• **introduce noise, odours, pollutants or other intrusive elements with substantial, long-term or permanent impacts on relevant values.**
GHD (2017) has predicted ENM soil water quality in order to assess potential impacts on water quality downstream of the site. The pH is predicted to remain slightly acidic, but could range up to pH 8 depending on the material present. No exceedances of the ANZECC (2000) guideline values for metals are predicted for any phase for the Project. There would be noise impacts during the construction phase as a result of the movement of vehicles and operation of plant during importation of fill and reprofiling activities. The Project footprint previously operated as a quarry and surrounding land was subject to noise from quarrying activities. Currently, noise is generated by vehicle movement along the nearby road, the rail line and operation of the Clarence Colliery. Following rehabilitation activities, noise at the site would substantially reduce.
Conclusion
The Project is not likely to have a significant impact on the biodiversity values of the GBMWHA given: • There would be no clearing of vegetation within the GBMWHA • The water management system for the Project has been designed so that in the long-term (following rehabilitation of the site), flows are returned to natural conditions (improved from current conditions). • Following rehabilitation, vegetation condition at the Project area and adjacent areas of the national park will improve. • Weed management measures would prevent the spread of weeds into the GBMWHA.

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	K. Crosby B. Harrington	J. Tipping		K. Rosen		29/08/2018

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Appendix E

Traffic Assessment

Bell Quarry Rehabilitation Project Pty Ltd

Bell Quarry Rehabilitation Project - Traffic Impact Assessment

July 2018

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Appendices

1. Introduction

1.1 Overview

A traffic, transport and access impact assessment has been prepared by GHD as required to inform the preparation of the Environmental Impact Statement (EIS) for the Bell Quarry Rehabilitation Project.

The former Bell Quarry has been purchased and Bell Quarry Rehabilitation Project Pty Ltd (BQRP), who are seeking to rehabilitate the site through the importation of virgin excavated natural material (VENM) and excavated natural material (ENM) sourced from earthworks projects across Sydney and the local regional area (the Project).

The rehabilitation process will involve:

- Importation of approximately 1.2 million cubic metres of VENM and ENM
- Vehicle haulage at a rate of up to 140,000 tonnes per annum (tpa)
- Emplacement and compaction of soil material within the existing quarry voids
- Shaping of fill to closely represent the pre-quarry landform and to allow surface water drainage across the final landform
- A water management system to control surface water discharges throughout the rehabilitation program and from the final landform
- Revegetation of the site with locally endemic species to provide effective integration with the surrounding landscape.

Extraction activities commenced at the site in 1967 and had a maximum approved extraction rate of 142,800 tonnes per annum (tpa). At peak production, the quarry operations generated and average of 37 and a maximum of around 54 truck movements per day and accessed the site via Sandham Road. Active quarry operations at the site have now ceased and the EPL No. 3218 for the operation of the quarry was surrendered to the EPA on the 24th October, 2014.

The project involves importation of spoil using truck and trailer combinations of up to 42.5 tonne capacity at a maximum rate of 140,000 tpa, to ensure the haulage for the rehabilitation works are equivalent in scale to the former quarry operations. The emplacement material will be transported to site from construction projects throughout the Sydney basin and the local region. Transport routes to the site will depend upon the origin of the emplacement material and be via either the Great Western Highway and Darling Causeway or the Bells Line of Road / Chifley Road and enter the site via Sandham Road. There will be no heavy vehicle haulage of material on Sandham Road through Newnes Village to the north of the site.

The project is defined as a resource management facility and constitutes designated development. This assessment forms part of the EIS to accompany the development application for the project, to determine traffic impacts to the local road network, and any mitigation measures required to maintain safety at the site.

1.2 Scope and limitations

This report has been based on the following assumptions:

- The report is based on information provided by BQRP in relation to the proposed traffic generation assumptions. (see section 4.2)
- Data collection has been limited to traffic count surveys provided by Matrix Traffic and Data Solutions on Wednesday, 30th November 2016 and automatic loop count survey between 1 December 2016 to 7 December 2016.
- Traffic distribution estimates have been based on high level assumptions on heavy vehicle routes.
- Background traffic growth has been based on historical traffic volume data on Bells Line of Road obtained from RMS traffic volume viewer.

This study has been limited by the following:

- The analysis is a desktop study and no site visits have been undertaken.
- The conditions of the surrounding network are based on information either supplied by the traffic surveys and Google Maps / Streetview.

1.3 Disclaimer

*This report: has been prepared by GHD for BQRP*and *may only be used and relied on by Remedial Civil Solutions Pty Ltd for the purpose agreed between GHD and the Remedial Civil Solutions Pty Ltd as set out in section 2 of this report.*

GHD otherwise disclaims responsibility to any person other than Remedial Civil Solutions Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.2 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

2. Method of analysis

This Traffic Impact Assessment (TIA) has been undertaken with reference to *Guide to Traffic Generating Development* (Roads and Maritimes Services 2002). While not mandatory, the guideline suggests a process and method to undertake the TIA. The traffic operation assessment process outlined in the guidelines stipulates that the operating characteristics need to be compared with agreed performance criteria.

The assessment criteria adopted for this report is outlined in the following sections:

This Traffic Impact Assessment report discusses the following:

- Existing conditions – a review of existing road features, traffic volumes and crash data;
- Proposed traffic – a review of additional traffic generated by the site for an average traffic operation scenario case and a worst case traffic operation scenario; and
- Operational traffic impact – assessment of the performance of the existing intersections and future case scenarios with and without the operation of the site.

3. Existing conditions

The existing Bell Quarry is located at Newnes Junction approximately 10 kilometres south east of Lithgow in New South Wales. .

Currently, access to the quarry via the Sandham Road from Bells Line of Road as shown on. Figure 3.1. Sandham Road passes through the village of Bell and runs parallel to arterial road Chifley Road on the western side of the Main Western Railway Line and follows a north-western alignment to the access point to the quarry.

3.1 Existing road network characteristics

This section provides an understanding of the existing road network surrounding the site.

3.1.1 Functional road hierarchy

Roads within NSW are categorised in following two ways:

- By Classification (ownership)
- By the function that they perform.

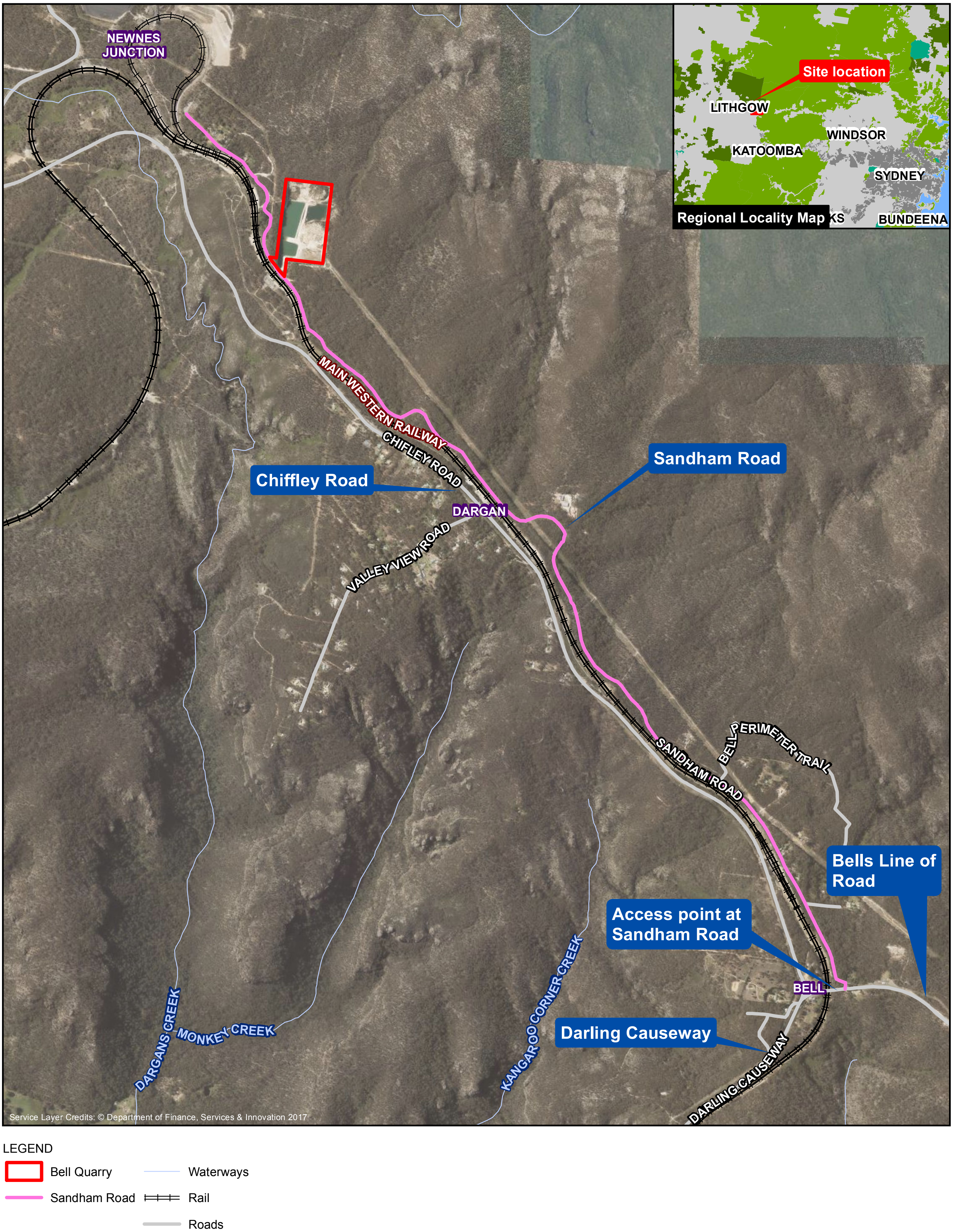
Road Classification

Roads are classified (as defined by the *Roads Act 1993*) based on their importance to the movement of people and goods within NSW (as a primary means of communication).

The classification of a road allows Roads and Maritime Services (Roads and Maritime) to exercise authority of all or part of the road. Classified roads include Main Roads, State Highways, Tourist Roads, Secondary Roads, Tollways, Freeways and Transitways.

For management purposes, Roads and Maritime has three administrative classes of roads. These are:

- **State Roads –** Major arterial links through NSW and within major urban areas. They are the principle traffic carrying roads and fully controlled by Roads and Maritime with maintenance fully funded by Roads and Maritime. State Roads include all Tollways, Freeways and Transitways; and all or part of a Main Road, Tourist Road or State Highway.
- **Regional Roads** – Roads of secondary importance between State Roads and Local Roads which, with State Roads provide the main connections to and between smaller towns and perform a sub arterial function in major urban areas. Regional roads are the responsibility of councils for maintenance funding, though Roads and Maritime funds some maintenance based on traffic and infrastructure. Traffic management on Regional Roads is controlled under the delegations to local government from Roads and Maritime. Regional Roads may or all part of all or part of a Main Road, Secondary Road, Tourist Road or State Highway; or other roads as determined by Roads and Maritime.
- **Local Roads** – The remainder of the council controlled roads. Local Roads are the responsibility of councils for maintenance funding. Roads and Maritime may fund some maintenance and improvements based on specific programs (e.g. urban bus routes, road safety programs). Traffic management on Local Roads is controlled under the delegations to local government from Roads and Maritime.



Paper Size A4

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Remedial Civil Solutions Pty Ltd
Traffic Impact Assessment

Study Area

Job Number 21-25774
Revision A
Date 29 May 2018

Figure 2-1

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Data source: Aerial imagery - sixmaps 2016, Inset map - Geoscience Australia, General topo - NSW LPI DTDB 2012, Mining Titles: Geology Survey NSW. Created by:afoddy

Functional Hierarchy

Functional road classification involves the relative balance of the mobility and access functions. Roads and Maritime define four levels in a typical functional road hierarchy, ranking from high mobility and low accessibility, to high accessibility and low mobility. These road classes are:

- **Arterial Roads** – generally controlled by Roads and Maritime, typically no limit in flow and designed to carry vehicles long distance between regional centres.
- **Sub-Arterial Roads** – can be managed by either Roads and Maritime or local council. Typically, their operating capacity ranges between 10,000 and 20,000 vehicles per day, and their aim is to carry through traffic between specific areas in a sub region, or provide connectivity from arterial road routes (regional links).
- **Collector Roads** – provide connectivity between local roads and the-arterial road network and typically carry between 2,000 and 10,000 vehicles per day.
- **Local Roads** – provide direct access to properties and the collector road system and typically carry between 500 and 4,000 vehicles per day.

3.1.2 Bells Line of Road / Chifley Road

Bells Line of Road is a collector road which provides an alternate route through the Blue Mountains between Richmond in the east and Bell, and joins with Chifley Road west in the Blue Mountains. Bells Line of Road has the following key features within proximity of the site:

- Generally a two lane two-way divided carriageway with overtaking lanes;
- Sealed road with shoulders and road line markings;
- typically carries about 3,200 vehicles per day (RMS Traffic Volume Viewer – Station ID T0384); and
- It operates at 60 km/h in the vicinity of Sandham Road and Darling Causeway
- Automatic Tube Count Survey (ATC) shows that 85 percentile speed is 74 km/h westbound and 72 km/h eastbound (see Road Safety Section 4.4)

Figure 3-2 Bells Line of Road facing west at Sandham Road

Source: Google maps Streetview

3.1.3 Sandham Road

Sandham Road is a local road that intersects on the northern side of Bells Line of Road, located about 150 m east of Darling Causeway. Sandham Road runs parallel to Chifley Road and provides access to the Bell Quarry. Sandham Road has the following key features:

- Two - way carriageway (one lane each way) of approximately seven metres in width;
- Combination of sealed and unsealed road surface;
- Posted speed limit of 50 km/h ; and
- No road line markings.
- Automatic Tube Count Survey (ATC) shows that average speed is approximately 52 km/h.

Figure 3-3 Sandham Road at Bells Line of Road intersection

Source: Google maps Streetview

3.1.4 Darling Causeway

Darling Causeway is an arterial road that links Bell in the north at Bells Line of Road, with Mount Victoria in the south at the Great Western Highway. It is an alternate road route to Bells Line of Road for vehicles to travel between Sydney and towns of Bell and Lithgow. The road has the following key features.

- Two - way carriageway (one lane each way) of approximately seven metres in width;
- Sealed road with shoulders and road line markings; and
- Posted speed limit of 80 km/h.

Figure 3-4 Darling Causeway facing north at Bells Line of Road intersection

Source: Google maps Streetview

3.1.5 Great Western Highway

Great Western Highway (route A32) is a state road that is approximately 200 kilometres long. The highway is a major road route that links Sydney to Bathurst. The Great Western Highway links with Darling Causeway at Mount Victoria, which provides an alternate road route to the site access at Bell. The Great Western Highway has the following key features:

- Two - way carriageway (one lane each way) of approximately seven metres in width
- Sealed road with shoulders and road line markings;
- Posted speed limit of 60 km/h; and
- Typically carries about 11,350 vehicles per day near Mount Victoria (RMS Traffic Volume Viewer – Station ID 6188).

Figure 3-5 Great Western Highway facing west at Station Street / Darling Causeway intersection

3.2 Crash statistics

Crash statistics within the vicinity of the site was taken from the NSW Centre for Road Safety website. Crashes for a five year period were reviewed (2011 – 2016). A total of seven crashes occurred within proximity to the local road network.

A summary of crashes are as follows:

- One fatal crash caused by a vehicle leaving left off the carriageway and hitting an object at the Darling Causeway / Chiefly Road intersection
- Two serious injury crashes caused by:
  - A vehicle coming off the road on a left bend on Sandham Road, about 3 km north west of the Sandham Road / Bells Line of Road intersection. (not shown in Figure 3-6).
  - A vehicle leaving left off the carriageway and hitting an object at the southern approach of Darling Causeway / Chiefly Road intersection.
- Two moderate injury crashes caused by:
  - An animal strike on Bells Line of Road east of Sandham Road.
  - U-turn at the north approach to Bells Line of Road / Darling Causeway intersection.
- Two minor injury crashes caused by:
  - a vehicle leaving left off the carriageway and hitting an object on Bells Line of Road east of Sandham Road

– a head on collision at the Bells Line of Road / Darling Causeway intersection

The location of the crashes are shown in Figure 3-6.

Figure 3-6 Crashes map

Source: NSW Centre for Road Safety

3.3 Existing peak hour volumes

Traffic surveys were undertaken by Matrix Traffic and Data Solutions on Wednesday 30 November 2016 at the following intersections:

- Bells Line of Road / Chifley Road / Darling Causeway; and
- Bells Line of Road / Sandham Road

The survey results identified the weekday AM peak hour occurred between 8:00 am to 9:00 am with the PM peak hour occurred between 4:00 pm to 5:00 pm. A summary of peak hour survey is shown in Table 3-1 and Table 3-2 respectively.

A copy of the traffic count data is provided in Appendix A.

Table 3-1 2016 peak hour traffic volumes Bells Line of Road / Chifley Road / Darling Causeway

Location	8:00 to 9:00 AM		4:00 to 5:00 PM	
	Light Vehicles (veh/h)	Heavy Vehicles (veh/h)	Light vehicles (veh/h)	Heavy Vehicles (veh/h)
Bells Line of Road – Eastbound	70	8	78	10
Bells Line of Road – Westbound	77	8	71	6
Darling Causeway – Northbound	27	9	40	6
Darling Causeway – Southbound	26	11	42	6
Chifley Road – Northbound	77	8	86	7

Chifley Road – Southbound	75	11	77	11

Table 3-2 2016 peak hour traffic volumes Sandham Road / Bells Line of Road

Location	8:00 to 9:00 AM		4:00 to 5:00 PM	
	Light Vehicles (veh/h)	Heavy Vehicles (veh/h)	Light Vehicles (veh/h)	Heavy Vehicles (veh/h)
Sandham Road – Northbound	3	0	5	1
Sandham Road – Southbound	4	0	1	2
Bells Line of Road – Eastbound	68	8	76	9
Bells Line of Road – Westbound	74	8	69	4

As shown in Table 3-1 and Table 3-2, the existing weekday traffic volumes show that traffic is generally higher on Bells Line of Road, while AM and PM peak flows are generally similar.

A seven-day tube data count was also undertaken from 1 December 2016 to 7 December 2016 on Bells Line of Road (east of Sandham Road) and on Sandham Road. Traffic volumes over a 24 hour period on Bells Line of Road for eastbound and westbound directions are shown in Figure 3-7 and Figure 3-8 respectively. The graphs show that Sunday traffic volumes travelling eastbound on Bells Line of Road are significantly higher, with peak volumes of approximately 330 vehicles per hour at 2:00 pm, when compared to weekday five day average volumes, which peak at approximately 110 vehicles per hour.at 3:00 pm. Westbound tube counts on Bells Line of Road tend to be lower in comparison to the eastbound direction, with peak volumes at approximately 190 vehicles per hour at 12:00 pm on Saturday and 100 vehicles per hour at 3:00 pm on an average weekday.

Figure 3-7 Eastbound tube count Bells Line of Road (east of Sandham Road)

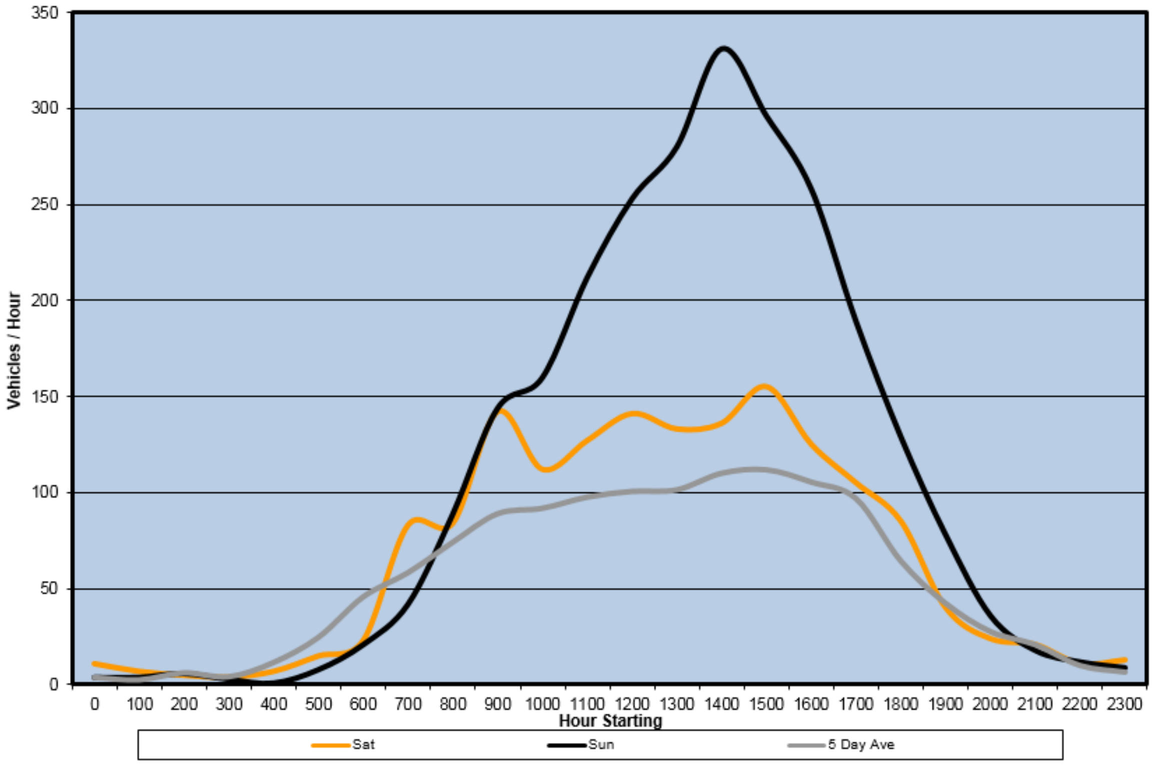


Figure 3-8 Westbound tube count Bells Line of Road (east of Sandham Road

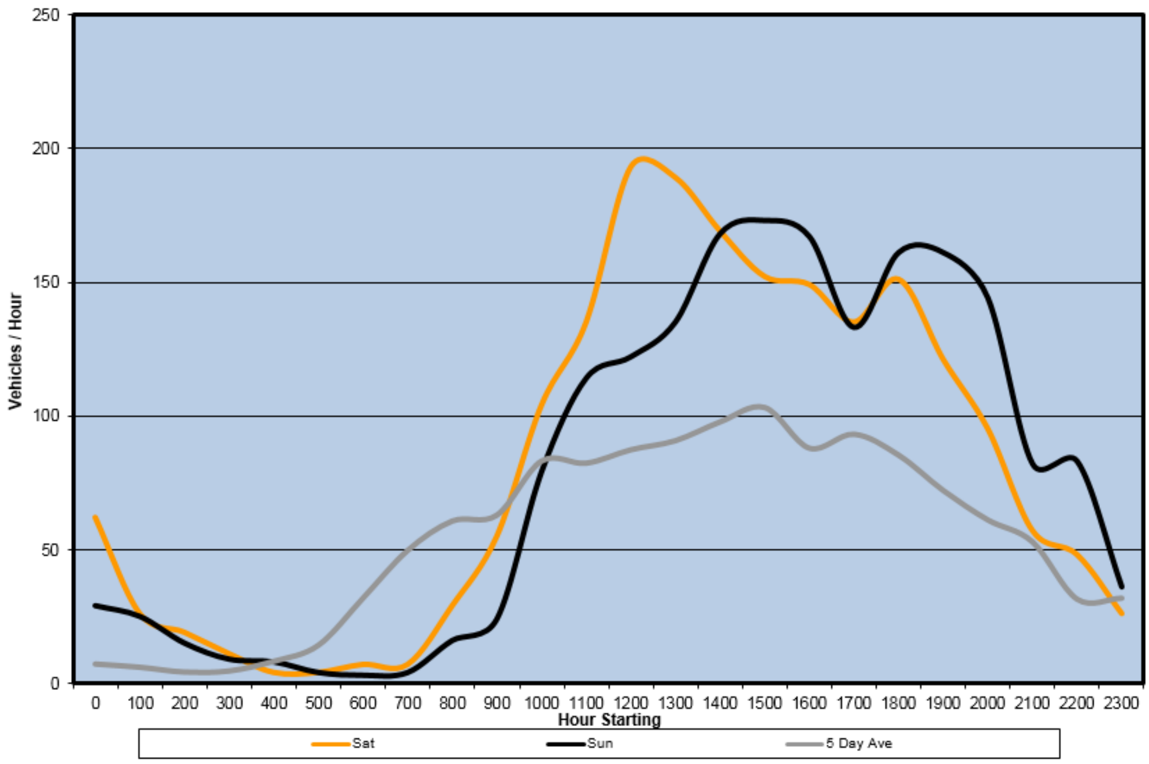


Figure 3-9 and Figure 3-10 shows the daily traffic count profile on Sandham Road for the northbound and southbound directions respectively. The graphs show that daily volumes on Sandham Road are low for both Saturday and the 5 day weekday average traffic counts. Peak periods for the weekday generally occur between 7:00 am – 8:00 am and 4:00 pm – 5:00 pm. The Saturday traffic count shows that traffic volumes have multiple peaks and troughs throughout the day for the northbound and southbound directions.

Figure 3-9 Northbound tubecount Sandham Road

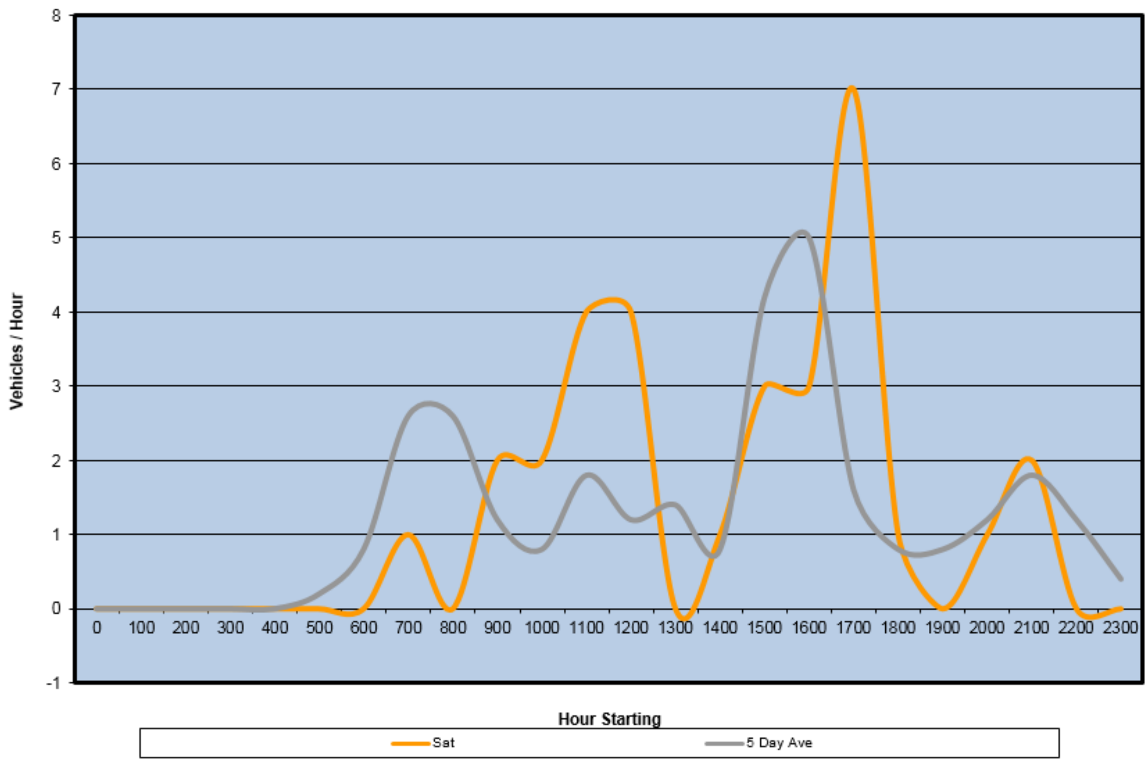
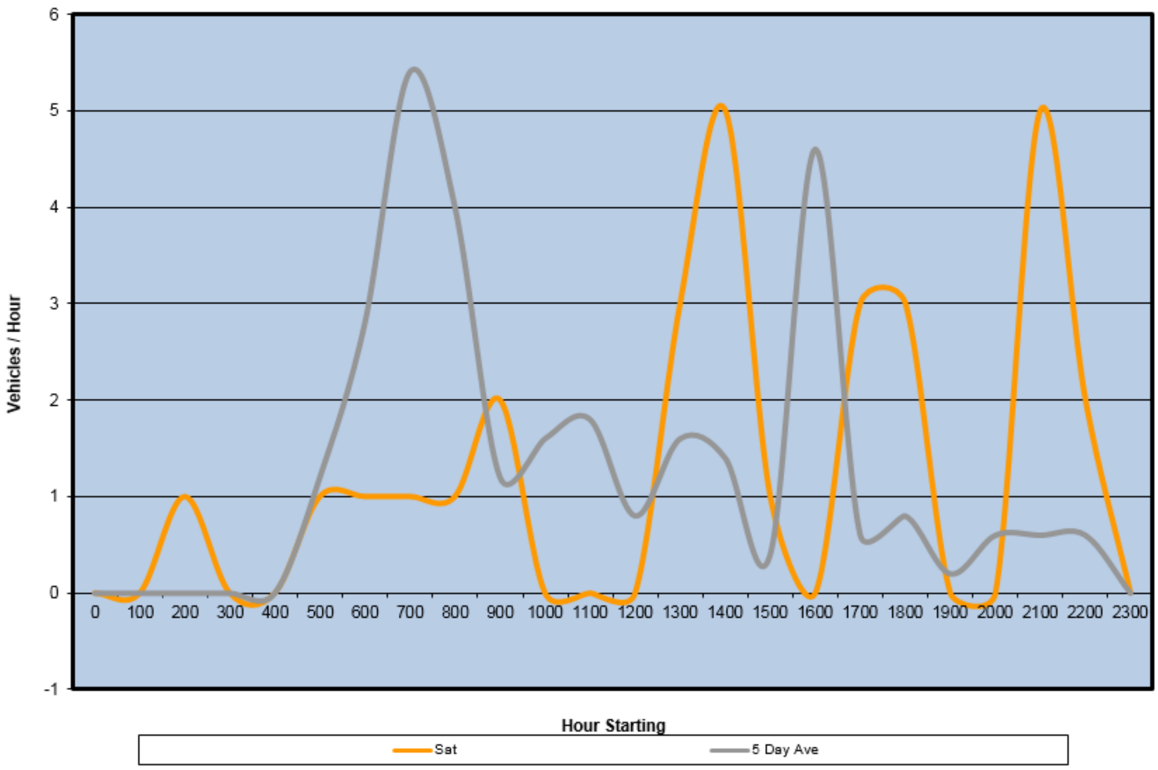


Figure 3-10 Southbound tubecount Sandham Road



A review of the vehicle classification was also undertaken to identify vehicle types on Bells Line of Road east of Sandham Road. Table 3-3 outlines the percentage of vehicle types and shows that the majority of vehicles during the weekday are vehicle type C1 (light vehicles) at 85 percent and vehicle type C2 (car and trailer) at five percent of the total volume of vehicles along Bells Line of Road. Vehicle type C3 (two axle truck or bus) account for four percent, while vehicle type C4 (three axle truck or bus) account for one percent of the vehicle volumes.

A graphical representation of vehicle classes is shown in Appendix D

Table 3-3 Weekday average classification summary - Bells Line of Road east of Sandham Road

Vehicle Type	Vehicle Class	Combined %	Eastbound %	Westbound%
Light	C1	85	85	85
	C2	5	5	5
Medium	C3	4	4	3
	C4	1	2	1
	C5	0	0	0
Heavy	C6	0	0	0
	C7	0	0	0
	C8	0	0	0
	C9	2	2	3
	C10	1	1	2
	C11	0	0	0
	C12	0	0	0

3.4 Existing intersection performance

The performance of the existing road network is largely dependent on the operating performance of key intersections, which are critical capacity control points on the road network. SIDRA intersection modelling software was used to assess the proposed peak hour operating performance of intersections on the surrounding road network at key intersections within proximity of the site. The criteria for evaluating the operational performance of intersections is provided by the *Guide to Traffic Generating Developments (Roads and Maritime Services 2002)* and reproduced in Table 4. The criteria for evaluating the operational performance of intersections is based on a qualitative measure (i.e. Level of Service), which is applied to each band of average vehicle delay.

Table 3-4 Level of service criteria for intersections

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabouts	Give Way & Stop Signs
A	< 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays & spare capacity	Acceptable delays & spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity & accident study required
E	57 to 70	At capacity; at signals, incidents will cause excessive delays Roundabouts require other control modes	At capacity, requires other control mode
F	> 70	Over Capacity Unstable operation	Over Capacity Unstable operation

Source: Guide to Traffic Generating Developments (Roads and Maritime 2002)

Notes:

1. *The average delay for priority-controlled intersections is selected from the movement on the approach with the highest average delay.*
2. *The level of service for priority-controlled intersections is based on the highest average delay per vehicle for the most critical movement.*
3. *The degree of saturation is defined as the ratio of the arrival flow (demand) to the capacity of each approach.*

The 2016 traffic flows were analysed using SIDRA Intersection 7 modelling software to obtain the current operation of the intersections near the site access. The results of the SIDRA assessment are summarised in Table 3-5, with detailed SIDRA outputs are provided in Appendix B. Table 3-5 indicates that both the intersections at Darling Causeway / Bells Line of Road / Chifley Road and Sandham Road / Bells Line of Road were operating at satisfactory level with spare capacity in both the AM and PM peak periods.

Table 3-5 Existing Intersection Performance Modelling Results (2016)

Intersection	Priority Type	AM peak				PM peak			
		LoS	Ave. Delay (s)	Queue (m)	Deg of Sat.	LoS	Ave. Delay (s)	Queue (m)	Deg of Sat.
Darling Causeway / Bells Line of Road	Give-way	A	6.7	1 (S)	0.038	A	6.4	1 (N)	0.04
Sandham Road / Bells Line of Road	Give-way	A	9.0	1 (N)	0.047	A	9.3	1 (N)	0.04

Notes:

1. *The average delay (Ave. Delay) for priority-controlled intersections is selected from the movement on the approach with the highest average delay, given in seconds per vehicle.*
2. *The level of service (LoS) for priority-controlled intersections is based on the highest average delay per vehicle for the most critical movement.*
3. *The degree of saturation (Deg of Sat) is defined as the ratio of the arrival flow (demand) to the capacity of each approach.*

4. Traffic impact assessment

This section assesses the operational impacts of the traffic generated by the proposed Bell Quarry Rehabilitation Site.

4.1 Background traffic growth

Roads and Maritime Services Traffic Volume viewer was used to determine traffic growth trends on Bells Line of Road (Traffic counter ID T0384). Table 4-1 shows that the Average Annual Daily Traffic volumes (AADT) have increased by 160 vehicles per day over the last three years. This equates to a background traffic growth rate of approximately two percent per year.

This growth rate has been applied to the existing traffic volumes on the local road network to calculate the opening year and future year horizon background traffic volumes.

Table 4-1 Bells Line of Road traffic growth trend (AADT)

	2015	2016	2017
Daily Traffic Volumes (vpd)	3,002	3,083	3,162

4.2 Projected traffic generation

The project involves importation of approximately 1.2 million cubic metres of clean fill over a period of approximately 15 years with a maximum haulage rate of 140,000 tpa. The emplacement material will be sourced from major construction projects throughout the Sydney basin and the local region and will be transported to site using truck and trailers of up to 42.5 tonne capacity.

It is estimated that haulage will occur for around 250 days per year accounting for wet days and reduced haulage on weekends with an average transport capacity of 30 tonne. The resulting traffic generated based on this assumption is an average of 37 heavy vehicle movements per day (19 truck deliveries), which is equivalent to the previous quarry operations

It is likely that at some stages, haulage to site may occur in campaigns corresponding to generation of excess VENM and ENM from major construction projects throughout the region. This has potentially double the haulage movements for a restricted period of time and generate up to 74 heavy vehicle movements per day (38 truck deliveries). Any temporary increase in haulage during campaign operations would be followed by a period of reduced haulage to maintain the capacity of the site to accept 140,000 tpa.

In addition to heavy vehicle movements, it has been assumed that there will be 2 light vehicles operated by staff that travel in and out from the site during peak periods.

To ensure a conservative assessment, two traffic generation scenarios have been considered:

- An average haulage – 37 heavy vehicle movements per day; and
- A worst case haulage – double average haulage (74 heavy vehicle movements per day).

It has been assumed that ten percent of the daily heavy vehicle movements in the average and worst case scenarios account for the peak hour traffic (morning and afternoon) as shown in Table 4-2.

Table 4-2 Peak hour traffic generation

Traffic Scenario	Light Vehicles (veh/h)		Heavy Vehicles (veh/h)		Total vehicles (veh/h)	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
Average Haulage	2	2	2	2	4	4
Double Average Haulage	2	2	4	4	6	6

The proposed heavy vehicle traffic generated by the site that access / egress Sandham Road / Bells Line of Road intersection have been modelled as being distributed to the local road network according to the following assumptions:

- 45 percent of inbound and outbound heavy vehicle movements use Bells Line of Road to access / egress Sandham Road.
- 45 percent of inbound and outbound heavy vehicle movements use Darlings Causeway to access / egress Sandham Road.
- Ten percent of inbound and outbound heavy vehicle movements use Chifley Road to access / egress Sandham Road.

A diagram of traffic distribution and future projected traffic volumes is shown in Appendix C.

Vehicle movements generated by the project will increase the volume of traffic along key roads and intersections on the haulage route. The predicted increase in traffic on key roads on the haulage route is shown in Table 4-3.

Table 4-3 Predicted traffic increases

Road	Existing Traffic (vpd)	Average haulage (vpd)	Percent Increase	Maximum haulage (vpd)	Percent Increase
Sandham Road	30	37	123	74	247
Bells Line of Road (east of Sandham Road)	1310	17	1.3	34	2.6
Bells Line of Road (west of Sandham Road)	1310	21	1.6	42	3.2
Darling Causeway	500[1]	17	3.4	34	6.8
Chifley Road	1830[1]	4	0.2	8	0.4

Notes:

1 * *the daily traffic volume for these roads has been estimated based on assumption that the peak hour traffic flow is approximately 10% of these daily traffic volume.*

2. ** *(vpd) = vehicles per day*

Sandham Road currently experiences low volumes of traffic and primarily services rural residential properties in Bell following the cessation of the quarry operations. The additional haulage traffic for the rehabilitation activities will therefore represent a relatively large proportional increase to existing background conditions based upon the vehicle counts undertaken following the completion of active extraction operations. The project proposes to limit haulage to within the maximum extraction volumes during the operation of the quarry and the heavy vehicle movements will therefore be representative of the number of movements during the previous quarry operations.

The haulage traffic represents a relatively small proportional increase to background traffic on the wider regional road network. The minor increases to traffic are not considered to impact upon the safety or capacity of the road network.

4.3 Intersection performance

4.3.1 Project commencement

Table 4-4 shows the intersection performance at Darling Causeway / Bells Line of Road and Sandham Road / Bells Line of Road for the year of opening (2018) with background traffic growth.

Table 4-4 Intersection performance with background traffic growth 2018

Intersection	Priority Type	AM peak				PM peak			
		LoS	Ave. Delay (s)	Queue (m)	Deg of Sat.	LoS	Ave. Delay (s)	Queue (m)	Deg of Sat.
Darling Causeway / Bells Line of Road	Give-way	A	6.7	1 (S)	0.04	A	6.6	1 (N)	0.04
Sandham Road / Bells Line of Road	Give-way	A	8.8	1 (N)	0.05	A	10.6	1 (N)	0.04

Notes:

1. *The average delay (Ave. Delay) for priority-controlled intersections is selected from the movement on the approach with the highest average delay, given in seconds per vehicle.*
2. *The level of service (LoS) for priority-controlled intersections is based on the highest average delay per vehicle for the most critical movement.*
3. *The degree of saturation (Deg of Sat) is defined as the ratio of the arrival flow (demand) to the capacity of each approach.*

Table 4-4 indicates that both Darling Causeway / Bells Line of Road and Sandham Road / Bells Line of Road currently operate at a satisfactory performance with spare capacity in both AM and PM peak periods. Detailed SIDRA results of the intersections are provided in Appendix B.

4.3.2 Future scenarios

The life of the quarry rehabilitation project is anticipated to take approximately 15 years. Therefore a future 2033 scenario was also review for intersection performance. These future year scenarios were tested in SIDRA intersection to determine the likely performance with 2% per year background traffic applied.

Table 4-5 shows the SIDRA results summary at Darling Causeway / Bells Line of Road for future year scenarios with and without the operation of the site.

Table 4-5 Darling Causeway / Bells Line of Road SIDRA summary results

Intersection	AM Peak		PM Peak	
	Delay (s)	LOS	Delay (s)	LOS
2018 Base	6.7	A	6.6	A
2018 Average Haulage	6.8	A	6.7	A
2018 Double Average Haulage	6.9	A	6.7	A
Future Base (2033)	7.0	A	6.7	A
Future Average Haulage (2033)	7.1	A	6.8	A
Future Double Average Haulage (2033)	7.1	A	6.9	A

Table 4-5 shows that for all scenarios tested in 2033, the intersections perform satisfactorily with spare capacity. There are negligible changes in traffic performance between the base and traffic operation scenarios for both the AM and PM peak periods. Given the expected low increase in heavy vehicle movements associated with each scenario, it is likely that traffic generation would result in minimal traffic impacts to the operation of the local road network. This small increase in traffic is expected to fall within typical daily traffic variations for the roads surrounding the site.

Table 4-6 shows the SIDRA results summary at Sandham Road / Bells Line of Road intersection.

Table 4-6 Sandham Road / Bells Line of Road SIDRA results summary

Intersection	AM Peak		PM Peak	
	Delay (s)	LOS	Delay (s)	LOS
2018 Average Haulage	9.7	A	10.9	A
2018 Double Average Haulage	10.5	A	11.1	A
Future Base (2033)	8.9	A	10.8	A
Future Average Haulage (2033)	9.8	A	11.1	A
Future Double Average Haulage (2033)	10.6	A	11.3	A

Similar to Darling Causeway / Bells Line of Road intersection, Table 4-6 also shows that Sandham Road / Bells Line of Road has satisfactory performance for all scenarios in 2033. The small increase in traffic is expected to fall within typical daily traffic variations for the roads surrounding the site.

4.4 Road safety

The automatic tube count survey undertaken on Bells Line of Road recorded that the 85th percentile speed was 74 km/h in the westbound direction and 72 km/h eastbound in the eastbound direction. This is higher than the posted speed limit of 60 km/h, however the review of crash data indicates that no accidents have occurred at the Sandham Road / Bells Line of Road intersection in the last five year recorded period (2011-2016). It is assumed therefore the intersection of the quarry access road operates safely.

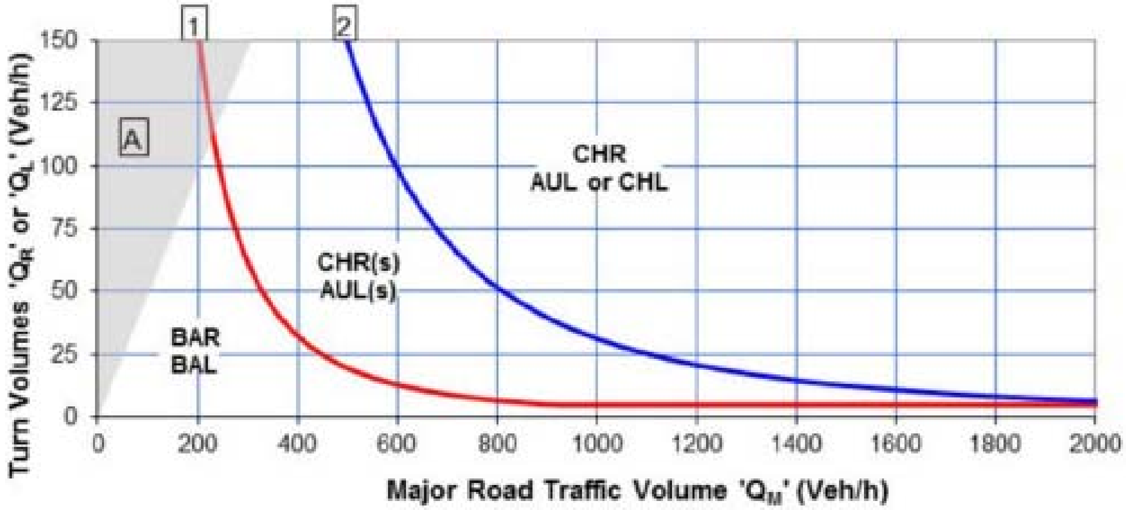
A desktop sight distance review utilising google streetview images was undertaken at the existing intersection of Sandham Road / Bells Line of Road in reference to the recorded 85th percentile speed. The Austroads Guide to Road Design Part 3: Geometric Design (Table 5.5: Truck stopping sight distances) specifies that (accounting for a reaction time of two seconds) speeds of up to 80 km/h, a minimum sight distance of 130 metres should be provided. The desktop review indicates that that this sight distance is currently achieved from Sandham Road.

4.4.1 Intersection treatment warrant criteria

The Austroads warrants for intersection treatments provides guidance on the preferred intersection design based on traffic volumes. Figure 4-1 has been sourced from the Austroads *Guide to Traffic Management – Part 6: Intersections, interchanges and crossings - Figure 2.26*. This figure contains three graphs for the selection of turn treatments on roads with design speed.

For the purpose of this assessment the graph for a speed of less than 70 km/h has been used, which is appropriate for the intersection assessed, as shown in Figure 4-1.

Figure 4-1 Warrants for turn treatments with design speed < 70km/hr

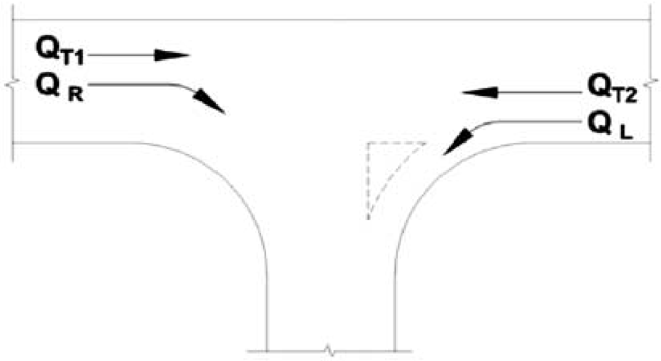


Source: Austroads Guide to Traffic Management – Part 6: Intersections, interchanges and crossings - Figure 2.26 (2017, page 49)

Curve 1 represents the boundary between a BA (Basic) turn treatment and a CH (Channelized) turn treatment, whereas curve 2 represents the boundary between CH and AU (Auxiliary) turn treatments.

A desktop review of the intersection geometry at the Sandham Road / Bells Line of Road intersection shows that there are currently no channelised right or left turns. The calculation of peak traffic volumes at the intersection, for the purpose of this assessment, was based on a two-lane two-way road type, as shown in Figure 4-2

Figure 4-2 Calculation of major road traffic volumes (Q_M)



Road type	Turn type	Splitter island	Q_M (veh/h)
Two-lane two-way	Right	No	$= Q_{T1} + Q_{T2} + Q_L$
		Yes	$= Q_{T1} + Q_{T2}$
	Left	Yes or no	$= Q_{T2}$

Source: Austroads Guide to Traffic Management – Part 6: Intersections, interchanges and crossings - Figure 2.26 (2017)

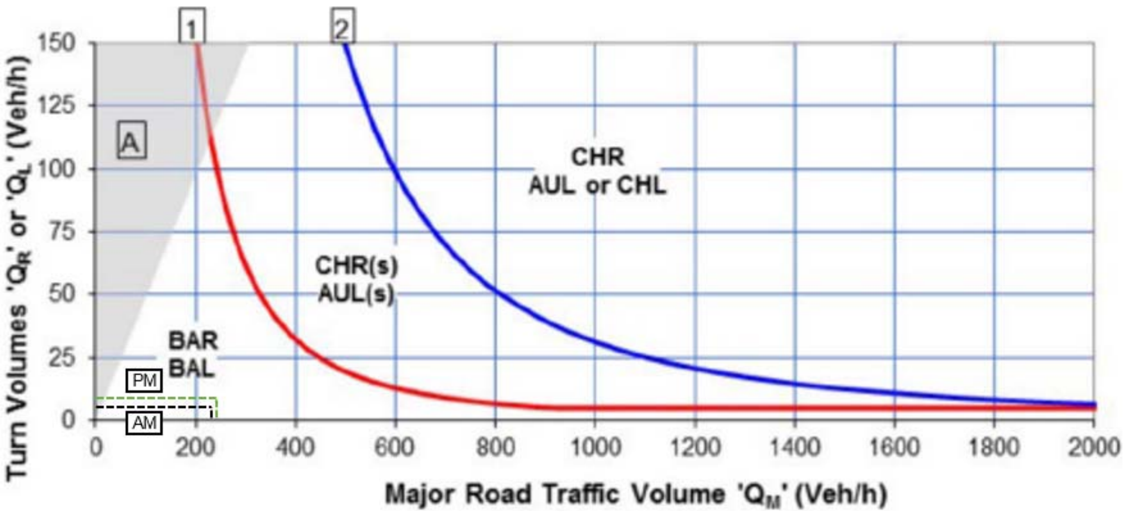
Future Double Average Haulage (2033) Scenario Right Turn– AM Peak

The projected traffic generation indicates that the peak traffic volume of four vehicles will turn right from Bells Line of Road into Sandham Road in the AM peak. Based on the existing highest peak hour on Sandham Road of 215 vehicles per hour, the proposed treatment at the intersection would be a BAR, as shown in Figure 4-3.

Future Double Average Haulage (2033) Scenario Right Turn– PM Peak

The projected traffic generation indicates that the peak traffic volume of seven vehicles will turn right from Bells Line of Road into Sandham Road in the PM peak. Based on the existing highest peak hour on Sandham Road of 217 vehicles per hour, the proposed treatment at the intersection would be a BAR, as shown in Figure 4-3.

Figure 4-3 Warrants for right turn AM and PM peaks



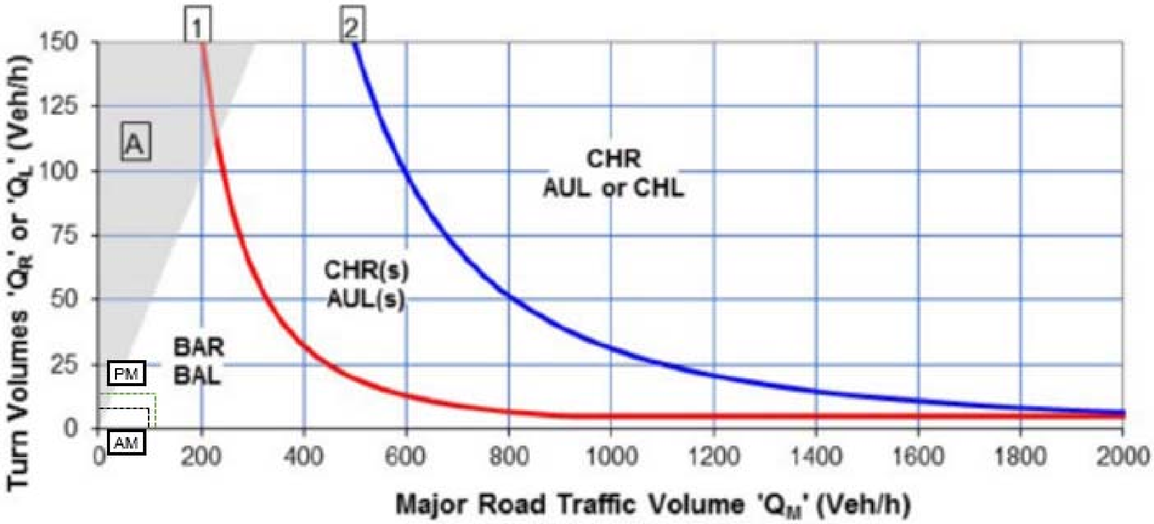
Future Double Average Haulage (2033) Scenario Left Turn– AM Peak

The projected traffic generation indicates that the peak traffic volume of eight vehicles will turn left from Bells Line of Road into Sandham Road in the AM peak. Based on the existing highest peak hour on Sandham Road of 99 vehicles per hour, the proposed treatment at the intersection would be a BAR, as shown in Figure 4-4.

Future Double Average Haulage (2033) Scenario Left Turn – PM Peak

The projected traffic generation indicates that the peak traffic volume of 13 vehicles will turn left from Bells Line of Road into Sandham Road in the PM peak. Based on the existing highest peak hour on Sandham Road of 111 vehicles per hour, the proposed treatment at the intersection would be a BAR, as shown in Figure 4-4.

Figure 4-4 Warrants for left turn AM and PM peaks



The existing Bells Line of Road / Sandham Road intersection is shown at Figure 4-5, which indicates that a BAR / BAL treatment is already provided at the intersection. Given that the number of heavy vehicles generated by the site during peak periods is low, this does not warrant turn treatments and no further upgrade would be required to accommodate the additional traffic. There are sealed shoulders at the intersection that may provide an informal area for a through vehicle to pass a vehicle turning into Sandham Road.

Figure 4-5 Images of Bells Line of Road / Sandham Road intersection

Bells Line of Road, viewed eastwards towards the intersection with Sandham Road

Bells Line of Road and Sandham Road Intersection – aerial view

Source: Google Maps (2017)

5. Summary and conclusion

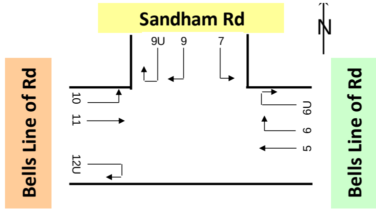
Based on the traffic assessment undertaken, the estimated average haulage case and worst case haulage generated by the project of 19 and 37 heavy vehicle deliveries per day respectively. The intersection analysis shows that this traffic generation will have minimal impact on the performance of the local road network and intersections in 2018 and 2033 scenarios. The projected traffic generation as a result of the quarry is low and would typically fall within typical daily traffic variations on regional road network.

In terms of road safety, the current intersection geometry at Sandham Road / Bells Line of Road shows that there are no channelised right or left turns for heavy vehicles. Given that the number of heavy vehicles generated by the site during peak periods is low, this does not warrant channelised turn treatments and no further upgrade would be required to accommodate the additional traffic. There are sealed shoulders at the intersection that may provide an informal area for a through vehicle to pass a vehicle turning into Sandham Road.

Appendices

Appendix A – (Traffic Count Data)

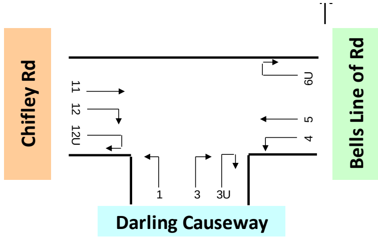
Job No.	: N2883
Client	: GHD
Suburb	: Bell
Location	: 1. Bells Line of Rd / Sandham Rd
Day/Date	: Wed, 30th Nov 2016
Weather	: Fine
Description	: Classified Intersection Count
	: Hourly Summary



Approach	Bells Line of Rd								
Direction	Direction 5 (Through)			Direction 6 (Right Turn)			Direction 6U (U Turn)		
Time Period	Lights	Heavies	Total	Lights	Heavies	Total	Lights	Heavies	Total
7:00 to 8:00	64	13	**77**	0	0	**0**	0	0	**0**
7:15 to 8:15	63	13	**76**	0	0	**0**	0	0	**0**
7:30 to 8:30	64	11	**75**	0	0	**0**	0	0	**0**
7:45 to 8:45	66	8	**74**	0	0	**0**	0	0	**0**
8:00 to 9:00	74	8	**82**	0	0	**0**	0	0	**0**
AM Totals	**138**	**21**	**159**	**0**	**0**	**0**	**0**	**0**	**0**
16:00 to 17:00	68	4	**72**	1	0	**1**	0	0	**0**
16:15 to 17:15	59	4	**63**	1	0	**1**	0	0	**0**
16:30 to 17:30	58	3	**61**	0	0	**0**	0	0	**0**
16:45 to 17:45	64	3	**67**	0	0	**0**	0	0	**0**
17:00 to 18:00	66	3	**69**	0	0	**0**	0	0	**0**
PM Totals	**134**	**7**	**141**	**1**	**0**	**1**	**0**	**0**	**0**

Approach	Sandham Rd									Bells Line of Rd								
Direction	Direction 7 (Left Turn)			Direction 9 (Right Turn)			Direction 9U (U Turn)			Direction 10 (Left Turn)			Direction 11 (Through)			Direction 12U (U Turn)		
Time Period	Lights	Heavies	Total	Lights	Heavies	Total	Lights	Heavies	Total	Lights	Heavies	Total	Lights	Heavies	Total	Lights	Heavies	Total
7:00 to 8:00	0	0	**0**	5	1	**6**	0	0	**0**	1	1	**2**	46	4	**50**	0	0	**0**
7:15 to 8:15	0	0	**0**	6	1	**7**	0	0	**0**	3	1	**4**	47	2	**49**	0	0	**0**
7:30 to 8:30	0	0	**0**	7	1	**8**	0	0	**0**	3	0	**3**	47	1	**48**	0	0	**0**
7:45 to 8:45	1	0	**1**	6	1	**7**	0	0	**0**	3	0	**3**	64	4	**68**	0	0	**0**
8:00 to 9:00	1	0	**1**	3	0	**3**	0	0	**0**	3	0	**3**	67	8	**75**	0	0	**0**
AM Totals	**1**	**0**	**1**	**8**	**1**	**9**	**0**	**0**	**0**	**4**	**1**	**5**	**113**	**12**	**125**	**0**	**0**	**0**
16:00 to 17:00	0	0	**0**	1	2	**3**	0	0	**0**	4	1	**5**	76	9	**85**	0	0	**0**
16:15 to 17:15	0	0	**0**	2	2	**4**	0	0	**0**	3	0	**3**	72	5	**77**	0	0	**0**
16:30 to 17:30	0	0	**0**	2	1	**3**	0	0	**0**	3	0	**3**	81	5	**86**	0	0	**0**
16:45 to 17:45	0	0	**0**	3	1	**4**	0	0	**0**	4	0	**4**	76	4	**80**	0	0	**0**
17:00 to 18:00	0	0	**0**	2	0	**2**	0	0	**0**	1	0	**1**	79	4	**83**	0	0	**0**
PM Totals	**0**	**0**	**0**	**3**	**2**	**5**	**0**	**0**	**0**	**5**	**1**	**6**	**155**	**13**	**168**	**0**	**0**	**0**

Job No.	: N2883
Client	: GHD
Suburb	: Bell
Location	: 2. Darling Causeway / Chifley Rd / Bells Line of Rd
Day/Date	: Wed, 30th Nov 2016
Weather	: Fine
Description	: Classified Intersection Count
	: Hourly Summary



MATRIX Traffic and Transport Data

Approach	**Darling Causeway**									**Bells Line of Rd**								
Direction	**Direction 1 (Left Turn)**			**Direction 3 (Right Turn)**			**Direction 3U (U Turn)**			**Direction 4 (Left Turn)**			**Direction 5 (Through)**			**Direction 6U (U Turn)**		
Time Period	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Total**
7:00 to 8:00	6	0	**6**	13	2	**15**	0	0	**0**	14	3	**17**	56	11	**67**	0	0	**0**
7:15 to 8:15	10	2	**12**	12	1	**13**	0	0	**0**	16	4	**20**	53	10	**63**	0	0	**0**
7:30 to 8:30	14	3	**17**	11	0	**11**	0	0	**0**	12	4	**16**	60	9	**69**	0	0	**0**
7:45 to 8:45	15	4	**19**	11	1	**12**	0	0	**0**	13	5	**18**	60	4	**64**	0	0	**0**
8:00 to 9:00	17	5	**22**	10	4	**14**	0	0	**0**	11	4	**15**	66	3	**69**	0	0	**0**
AM Totals	**23**	**5**	**28**	**23**	**6**	**29**	**0**	**0**	**0**	**25**	**7**	**32**	**122**	**14**	**136**	**0**	**0**	**0**
16:00 to 17:00	25	3	**28**	15	3	**18**	0	0	**0**	19	2	**21**	52	4	**56**	0	0	**0**
16:15 to 17:15	16	2	**18**	17	3	**20**	0	0	**0**	17	2	**19**	43	4	**47**	0	0	**0**
16:30 to 17:30	15	0	**15**	16	2	**18**	0	0	**0**	15	2	**17**	48	2	**50**	0	0	**0**
16:45 to 17:45	12	1	**13**	19	1	**20**	0	0	**0**	17	1	**18**	52	3	**55**	0	0	**0**
17:00 to 18:00	12	1	**13**	16	2	**18**	0	0	**0**	14	0	**14**	54	3	**57**	0	0	**0**
PM Totals	**37**	**4**	**41**	**31**	**5**	**36**	**0**	**0**	**0**	**33**	**2**	**35**	**106**	**7**	**113**	**0**	**0**	**0**

Approach	**Chifley Rd**								
Direction	**Direction 11 (Through)**			**Direction 12 (Right Turn)**			**Direction 12U (U Turn)**		
Time Period	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Total**
7:00 to 8:00	35	3	**38**	19	10	**29**	0	0	**0**
7:15 to 8:15	39	2	**41**	22	6	**28**	0	0	**0**
7:30 to 8:30	41	1	**42**	17	10	**27**	0	0	**0**
7:45 to 8:45	57	3	**60**	12	8	**20**	0	0	**0**
8:00 to 9:00	60	4	**64**	15	7	**22**	0	0	**0**
AM Totals	**95**	**7**	**102**	**34**	**17**	**51**	**0**	**0**	**0**
16:00 to 17:00	63	7	**70**	23	4	**27**	0	0	**0**
16:15 to 17:15	58	2	**60**	16	3	**19**	0	0	**0**
16:30 to 17:30	69	3	**72**	18	3	**21**	0	0	**0**
16:45 to 17:45	61	3	**64**	15	2	**17**	0	0	**0**
17:00 to 18:00	64	2	**66**	12	1	**13**	0	0	**0**
PM Totals	**127**	**9**	**136**	**35**	**5**	**40**	**0**	**0**	**0**

Appendix B – (Detailed SIDRA Output)

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_AM]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	23	22.7	0.029	6.3	LOS A	0.1	1.1	0.21	0.47	53.4
3	R2	15	28.6	0.029	6.7	LOS A	0.1	1.1	0.21	0.47	51.7
Approach		38	25.0	0.029	6.4	NA	0.1	1.1	0.21	0.47	52.7
East: Old Bells Line of Road											
4	L2	16	26.7	0.010	5.9	LOS A	0.0	0.0	0.00	0.51	54.0
5	T1	73	4.3	0.038	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		88	8.3	0.038	1.1	NA	0.0	0.0	0.00	0.09	58.8
West: Old Bells Line of Road											
11	T1	67	6.3	0.036	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	23	31.8	0.012	6.1	LOS A	0.1	0.8	0.19	0.53	51.5
Approach		91	12.8	0.036	1.6	NA	0.1	0.8	0.05	0.14	57.6
All Vehicles		217	13.1	0.038	2.2	NA	0.1	1.1	0.06	0.18	57.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_AM - 2018 base]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	23	22.7	0.029	6.3	LOS A	0.1	1.1	0.21	0.47	53.4
3	R2	15	28.6	0.029	6.7	LOS A	0.1	1.1	0.21	0.47	51.7
Approach		38	25.0	0.029	6.5	NA	0.1	1.1	0.21	0.47	52.7
East: Old Bells Line of Road											
4	L2	16	26.7	0.010	5.9	LOS A	0.0	0.0	0.00	0.51	54.0
5	T1	74	4.3	0.039	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		89	8.2	0.039	1.0	NA	0.0	0.0	0.00	0.09	58.8
West: Old Bells Line of Road											
11	T1	68	6.2	0.036	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	23	31.8	0.012	6.1	LOS A	0.1	0.8	0.19	0.53	51.5
Approach		92	12.6	0.036	1.5	NA	0.1	0.8	0.05	0.13	57.6
All Vehicles		219	13.0	0.039	2.2	NA	0.1	1.1	0.06	0.17	57.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_AM - 2018 Ave Dev]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	25	25.0	0.035	6.4	LOS A	0.1	1.4	0.23	0.46	53.2
3	R2	18	35.3	0.035	6.9	LOS A	0.1	1.4	0.23	0.46	51.4
Approach		43	29.3	0.035	6.6	NA	0.1	1.4	0.23	0.46	52.4
East: Old Bells Line of Road											
4	L2	19	33.3	0.013	6.0	LOS A	0.0	0.0	0.00	0.51	53.8
5	T1	76	5.6	0.040	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		95	11.1	0.040	1.2	NA	0.0	0.0	0.00	0.10	58.6
West: Old Bells Line of Road											
11	T1	71	7.5	0.038	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	25	33.3	0.013	6.1	LOS A	0.1	0.9	0.19	0.53	51.4
Approach		96	14.3	0.038	1.6	NA	0.1	0.9	0.05	0.14	57.5
All Vehicles		234	15.8	0.040	2.4	NA	0.1	1.4	0.06	0.18	56.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_AM - 2018 2X Ave Dev]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	25	25.0	0.038	6.5	LOS A	0.1	1.7	0.24	0.46	53.2
3	R2	20	42.1	0.038	7.0	LOS A	0.1	1.7	0.24	0.46	51.0
Approach		45	32.6	0.038	6.7	NA	0.1	1.7	0.24	0.46	52.2
East: Old Bells Line of Road											
4	L2	21	40.0	0.015	6.0	LOS A	0.0	0.0	0.00	0.51	53.5
5	T1	76	5.6	0.040	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		97	13.0	0.040	1.3	NA	0.0	0.0	0.00	0.11	58.4
West: Old Bells Line of Road											
11	T1	71	7.5	0.038	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	25	33.3	0.013	6.1	LOS A	0.1	0.9	0.19	0.53	51.4
Approach		96	14.3	0.038	1.6	NA	0.1	0.9	0.05	0.14	57.5
All Vehicles		238	17.3	0.040	2.5	NA	0.1	1.7	0.07	0.19	56.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_AM - Future Base]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	32	23.3	0.042	6.5	LOS A	0.1	1.6	0.25	0.46	53.2
3	R2	20	31.6	0.042	7.0	LOS A	0.1	1.6	0.25	0.46	51.4
Approach		52	26.5	0.042	6.7	NA	0.1	1.6	0.25	0.46	52.5
East: Old Bells Line of Road											
4	L2	22	28.6	0.014	5.9	LOS A	0.0	0.0	0.00	0.51	53.9
5	T1	95	4.4	0.050	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		117	9.0	0.050	1.1	NA	0.0	0.0	0.00	0.10	58.7
West: Old Bells Line of Road											
11	T1	88	7.1	0.047	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	32	33.3	0.017	6.2	LOS A	0.1	1.1	0.22	0.53	51.3
Approach		120	14.0	0.047	1.6	NA	0.1	1.1	0.06	0.14	57.4
All Vehicles		288	14.2	0.050	2.3	NA	0.1	1.6	0.07	0.18	57.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_AM - Future Ave. Dev]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	32	23.3	0.043	6.6	LOS A	0.2	1.8	0.26	0.46	53.2
3	R2	21	35.0	0.043	7.1	LOS A	0.2	1.8	0.26	0.46	51.3
Approach		53	28.0	0.043	6.8	NA	0.2	1.8	0.26	0.46	52.4
East: Old Bells Line of Road											
4	L2	23	31.8	0.015	5.9	LOS A	0.0	0.0	0.00	0.51	53.8
5	T1	96	5.5	0.051	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		119	10.6	0.051	1.2	NA	0.0	0.0	0.00	0.10	58.7
West: Old Bells Line of Road											
11	T1	88	7.1	0.047	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	32	33.3	0.017	6.2	LOS A	0.1	1.1	0.22	0.53	51.3
Approach		120	14.0	0.047	1.6	NA	0.1	1.1	0.06	0.14	57.4
All Vehicles		292	15.2	0.051	2.4	NA	0.2	1.8	0.07	0.18	56.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_AM - Future 2X Ave. Dev]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	32	23.3	0.047	6.7	LOS A	0.2	2.1	0.27	0.45	53.1
3	R2	23	40.9	0.047	7.3	LOS A	0.2	2.1	0.27	0.45	51.0
Approach		55	30.8	0.047	6.9	NA	0.2	2.1	0.27	0.45	52.2
East: Old Bells Line of Road											
4	L2	25	37.5	0.017	6.0	LOS A	0.0	0.0	0.00	0.51	53.6
5	T1	96	5.5	0.051	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		121	12.2	0.051	1.3	NA	0.0	0.0	0.00	0.11	58.5
West: Old Bells Line of Road											
11	T1	88	7.1	0.047	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	32	33.3	0.017	6.2	LOS A	0.1	1.1	0.22	0.53	51.3
Approach		120	14.0	0.047	1.6	NA	0.1	1.1	0.06	0.14	57.4
All Vehicles		296	16.4	0.051	2.5	NA	0.2	2.1	0.07	0.18	56.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_AM - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	86	9.8	0.047	0.0	LOS A	0.0	0.0	0.01	0.01	59.9
6	R2	1	0.0	0.047	5.7	LOS A	0.0	0.0	0.01	0.01	58.1
Approach		87	9.6	0.047	0.1	NA	0.0	0.0	0.01	0.01	59.9
North: Sandham Road											
7	L2	1	0.0	0.004	8.2	LOS A	0.0	0.1	0.17	0.93	52.0
9	R2	4	25.0	0.004	9.0	LOS A	0.0	0.1	0.17	0.93	50.5
Approach		5	20.0	0.004	8.8	LOS A	0.0	0.1	0.17	0.93	50.8
West: Bells Line of Road											
10	L2	3	0.0	0.044	5.5	LOS A	0.0	0.0	0.00	0.02	58.1
11	T1	79	10.7	0.044	0.0	LOS A	0.0	0.0	0.00	0.02	59.8
Approach		82	10.3	0.044	0.2	NA	0.0	0.0	0.00	0.02	59.7
All Vehicles		175	10.2	0.047	0.4	NA	0.0	0.1	0.01	0.04	59.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_AM - 2018 Base - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	89	10.6	0.049	0.0	LOS A	0.0	0.1	0.01	0.01	59.9
6	R2	1	0.0	0.049	5.7	LOS A	0.0	0.1	0.01	0.01	58.1
Approach		91	10.5	0.049	0.1	NA	0.0	0.1	0.01	0.01	59.9
North: Sandham Road											
7	L2	2	0.0	0.006	8.2	LOS A	0.0	0.2	0.17	0.92	51.9
9	R2	5	20.0	0.006	8.8	LOS A	0.0	0.2	0.17	0.92	50.7
Approach		7	14.3	0.006	8.6	LOS A	0.0	0.2	0.17	0.92	51.0
West: Bells Line of Road											
10	L2	4	0.0	0.046	5.5	LOS A	0.0	0.0	0.00	0.03	58.1
11	T1	82	11.5	0.046	0.0	LOS A	0.0	0.0	0.00	0.03	59.7
Approach		86	11.0	0.046	0.3	NA	0.0	0.0	0.00	0.03	59.6
All Vehicles		184	10.9	0.049	0.5	NA	0.0	0.2	0.01	0.05	59.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_AM - 2018 Ave. Dev - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	89	10.6	0.051	0.0	LOS A	0.0	0.2	0.02	0.02	59.8
6	R2	3	66.7	0.051	6.7	LOS A	0.0	0.2	0.02	0.02	54.8
Approach		93	12.5	0.051	0.2	NA	0.0	0.2	0.02	0.02	59.7
North: Sandham Road											
7	L2	4	50.0	0.011	10.5	LOS A	0.0	0.4	0.19	0.96	49.9
9	R2	7	42.9	0.011	9.8	LOS A	0.0	0.4	0.19	0.96	49.7
Approach		12	45.5	0.011	10.1	LOS A	0.0	0.4	0.19	0.96	49.8
West: Bells Line of Road											
10	L2	7	42.9	0.049	6.0	LOS A	0.0	0.0	0.00	0.05	56.0
11	T1	82	11.5	0.049	0.0	LOS A	0.0	0.0	0.00	0.05	59.7
Approach		89	14.1	0.049	0.5	NA	0.0	0.0	0.00	0.05	59.4
All Vehicles		194	15.2	0.051	1.0	NA	0.0	0.4	0.02	0.09	58.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_AM - 2018 2X Ave. Dev - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	89	10.6	0.053	0.0	LOS A	0.0	0.4	0.04	0.03	59.8
6	R2	5	80.0	0.053	6.9	LOS A	0.0	0.4	0.04	0.03	54.1
Approach		95	14.4	0.053	0.4	NA	0.0	0.4	0.04	0.03	59.4
North: Sandham Road											
7	L2	6	66.7	0.014	11.2	LOS A	0.0	0.7	0.19	0.97	49.3
9	R2	8	50.0	0.014	10.2	LOS A	0.0	0.7	0.19	0.97	49.4
Approach		15	57.1	0.014	10.6	LOS A	0.0	0.7	0.19	0.97	49.4
West: Bells Line of Road											
10	L2	8	50.0	0.050	6.1	LOS A	0.0	0.0	0.00	0.05	55.6
11	T1	82	11.5	0.050	0.0	LOS A	0.0	0.0	0.00	0.05	59.7
Approach		91	15.1	0.050	0.6	NA	0.0	0.0	0.00	0.05	59.3
All Vehicles		200	17.9	0.053	1.2	NA	0.0	0.7	0.03	0.11	58.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_AM - Future Base - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	114	10.2	0.062	0.0	LOS A	0.0	0.1	0.00	0.01	59.9
6	R2	1	0.0	0.062	5.8	LOS A	0.0	0.1	0.00	0.01	58.1
Approach		115	10.1	0.062	0.1	NA	0.0	0.1	0.00	0.01	59.9
North: Sandham Road											
7	L2	2	0.0	0.006	8.3	LOS A	0.0	0.2	0.20	0.91	51.9
9	R2	5	20.0	0.006	8.9	LOS A	0.0	0.2	0.20	0.91	50.6
Approach		7	14.3	0.006	8.7	LOS A	0.0	0.2	0.20	0.91	51.0
West: Bells Line of Road											
10	L2	4	0.0	0.058	5.5	LOS A	0.0	0.0	0.00	0.02	58.1
11	T1	104	11.1	0.058	0.0	LOS A	0.0	0.0	0.00	0.02	59.8
Approach		108	10.7	0.058	0.2	NA	0.0	0.0	0.00	0.02	59.7
All Vehicles		231	10.5	0.062	0.4	NA	0.0	0.2	0.01	0.04	59.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_AM - Future Ave. Dev - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	114	10.2	0.064	0.0	LOS A	0.0	0.2	0.02	0.02	59.9
6	R2	3	66.7	0.064	6.8	LOS A	0.0	0.2	0.02	0.02	54.8
Approach		117	11.7	0.064	0.2	NA	0.0	0.2	0.02	0.02	59.7
North: Sandham Road											
7	L2	4	50.0	0.011	10.6	LOS A	0.0	0.5	0.22	0.95	49.9
9	R2	7	42.9	0.011	10.0	LOS A	0.0	0.5	0.22	0.95	49.6
Approach		12	45.5	0.011	10.2	LOS A	0.0	0.5	0.22	0.95	49.7
West: Bells Line of Road											
10	L2	7	42.9	0.061	6.0	LOS A	0.0	0.0	0.00	0.04	56.0
11	T1	104	11.1	0.061	0.0	LOS A	0.0	0.0	0.00	0.04	59.8
Approach		112	13.2	0.061	0.4	NA	0.0	0.0	0.00	0.04	59.5
All Vehicles		240	14.0	0.064	0.8	NA	0.0	0.5	0.02	0.07	59.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_AM - Future 2X Ave. Dev - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	114	10.2	0.067	0.0	LOS A	0.1	0.4	0.03	0.02	59.8
6	R2	5	80.0	0.067	7.0	LOS A	0.1	0.4	0.03	0.02	54.1
Approach		119	13.3	0.067	0.3	NA	0.1	0.4	0.03	0.02	59.5
North: Sandham Road											
7	L2	6	66.7	0.014	11.4	LOS A	0.0	0.7	0.22	0.96	49.2
9	R2	8	50.0	0.014	10.3	LOS A	0.0	0.7	0.22	0.96	49.3
Approach		15	57.1	0.014	10.8	LOS A	0.0	0.7	0.22	0.96	49.3
West: Bells Line of Road											
10	L2	8	50.0	0.062	6.1	LOS A	0.0	0.0	0.00	0.04	55.7
11	T1	104	11.1	0.062	0.0	LOS A	0.0	0.0	0.00	0.04	59.8
Approach		113	14.0	0.062	0.5	NA	0.0	0.0	0.00	0.04	59.4
All Vehicles		246	16.2	0.067	1.0	NA	0.1	0.7	0.03	0.09	58.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_PM]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	29	10.7	0.035	6.2	LOS A	0.1	1.1	0.20	0.47	53.8
3	R2	19	16.7	0.035	6.4	LOS A	0.1	1.1	0.20	0.47	52.2
Approach		48	13.0	0.035	6.3	NA	0.1	1.1	0.20	0.47	53.2
East: Old Bells Line of Road											
4	L2	22	9.5	0.013	5.7	LOS A	0.0	0.0	0.00	0.52	54.6
5	T1	59	7.1	0.032	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		81	7.8	0.032	1.6	NA	0.0	0.0	0.00	0.14	58.4
West: Old Bells Line of Road											
11	T1	74	10.0	0.040	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	28	14.8	0.013	5.8	LOS A	0.1	0.7	0.16	0.53	52.3
Approach		102	11.3	0.040	1.6	NA	0.1	0.7	0.04	0.15	57.6
All Vehicles		232	10.5	0.040	2.6	NA	0.1	1.1	0.06	0.21	56.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_PM - 2018 Base]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	32	13.3	0.039	6.2	LOS A	0.1	1.3	0.22	0.47	53.7
3	R2	21	20.0	0.039	6.6	LOS A	0.1	1.3	0.22	0.47	52.0
Approach		53	16.0	0.039	6.4	NA	0.1	1.3	0.22	0.47	53.0
East: Old Bells Line of Road											
4	L2	24	13.0	0.014	5.7	LOS A	0.0	0.0	0.00	0.52	54.5
5	T1	62	8.5	0.034	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		86	9.8	0.034	1.6	NA	0.0	0.0	0.00	0.15	58.3
West: Old Bells Line of Road											
11	T1	77	11.0	0.042	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	31	17.2	0.015	5.9	LOS A	0.1	0.8	0.17	0.53	52.2
Approach		107	12.7	0.042	1.7	NA	0.1	0.8	0.05	0.15	57.5
All Vehicles		246	12.4	0.042	2.7	NA	0.1	1.3	0.07	0.22	56.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_PM - 2018 Ave. Dev]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	32	13.3	0.044	6.4	LOS A	0.2	1.7	0.24	0.46	53.6
3	R2	24	30.4	0.044	6.8	LOS A	0.2	1.7	0.24	0.46	51.5
Approach		56	20.8	0.044	6.6	NA	0.2	1.7	0.24	0.46	52.7
East: Old Bells Line of Road											
4	L2	27	23.1	0.017	5.8	LOS A	0.0	0.0	0.00	0.52	54.1
5	T1	63	10.0	0.034	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		91	14.0	0.034	1.8	NA	0.0	0.0	0.00	0.16	58.1
West: Old Bells Line of Road											
11	T1	78	12.2	0.043	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	31	17.2	0.015	5.9	LOS A	0.1	0.8	0.17	0.53	52.2
Approach		108	13.6	0.043	1.7	NA	0.1	0.8	0.05	0.15	57.6
All Vehicles		255	15.3	0.044	2.8	NA	0.2	1.7	0.07	0.22	56.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_PM - 2018 2X Ave. Dev]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	32	13.3	0.048	6.4	LOS A	0.2	1.9	0.25	0.46	53.5
3	R2	26	36.0	0.048	6.9	LOS A	0.2	1.9	0.25	0.46	51.2
Approach		58	23.6	0.048	6.7	NA	0.2	1.9	0.25	0.46	52.5
East: Old Bells Line of Road											
4	L2	29	28.6	0.019	5.9	LOS A	0.0	0.0	0.00	0.51	53.9
5	T1	63	10.0	0.034	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		93	15.9	0.034	1.9	NA	0.0	0.0	0.00	0.16	57.9
West: Old Bells Line of Road											
11	T1	78	12.2	0.043	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	31	17.2	0.015	5.9	LOS A	0.1	0.8	0.17	0.53	52.2
Approach		108	13.6	0.043	1.7	NA	0.1	0.8	0.05	0.15	57.6
All Vehicles		259	16.7	0.048	2.9	NA	0.2	1.9	0.08	0.22	56.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_PM - Future Base]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	39	10.8	0.048	6.3	LOS A	0.2	1.5	0.24	0.47	53.6
3	R2	25	16.7	0.048	6.7	LOS A	0.2	1.5	0.24	0.47	52.1
Approach		64	13.1	0.048	6.5	NA	0.2	1.5	0.24	0.47	53.0
East: Old Bells Line of Road											
4	L2	29	10.7	0.017	5.7	LOS A	0.0	0.0	0.00	0.52	54.6
5	T1	78	8.1	0.042	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		107	8.8	0.042	1.6	NA	0.0	0.0	0.00	0.14	58.4
West: Old Bells Line of Road											
11	T1	97	10.9	0.053	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	38	16.7	0.018	5.9	LOS A	0.1	0.9	0.19	0.53	52.1
Approach		135	12.5	0.053	1.7	NA	0.1	0.9	0.05	0.15	57.5
All Vehicles		306	11.3	0.053	2.6	NA	0.2	1.5	0.07	0.21	56.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_PM - Future Ave. Dev]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	39	10.8	0.053	6.5	LOS A	0.2	1.9	0.26	0.46	53.6
3	R2	28	25.9	0.053	7.0	LOS A	0.2	1.9	0.26	0.46	51.6
Approach		67	17.2	0.053	6.7	NA	0.2	1.9	0.26	0.46	52.7
East: Old Bells Line of Road											
4	L2	32	16.7	0.019	5.8	LOS A	0.0	0.0	0.00	0.52	54.4
5	T1	78	8.1	0.042	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		109	10.6	0.042	1.7	NA	0.0	0.0	0.00	0.15	58.2
West: Old Bells Line of Road											
11	T1	97	10.9	0.053	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	38	16.7	0.018	5.9	LOS A	0.1	0.9	0.19	0.53	52.1
Approach		135	12.5	0.053	1.7	NA	0.1	0.9	0.05	0.15	57.5
All Vehicles		312	12.8	0.053	2.7	NA	0.2	1.9	0.08	0.22	56.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Darling Causeway / Bells Line of Road - Conversion_PM - Future 2X Ave. Dev]

Bells Line of Road / Darling Causeway
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Darling Causeway											
1	L2	39	10.8	0.057	6.6	LOS A	0.2	2.2	0.28	0.46	53.5
3	R2	31	31.0	0.057	7.1	LOS A	0.2	2.2	0.28	0.46	51.4
Approach		69	19.7	0.057	6.8	NA	0.2	2.2	0.28	0.46	52.5
East: Old Bells Line of Road											
4	L2	35	24.2	0.022	5.9	LOS A	0.0	0.0	0.00	0.51	54.1
5	T1	79	9.3	0.043	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		114	13.9	0.043	1.8	NA	0.0	0.0	0.00	0.16	58.0
West: Old Bells Line of Road											
11	T1	98	11.8	0.054	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
12	R2	38	16.7	0.018	5.9	LOS A	0.1	0.9	0.19	0.53	52.1
Approach		136	13.2	0.054	1.6	NA	0.1	0.9	0.05	0.15	57.6
All Vehicles		319	14.9	0.057	2.8	NA	0.2	2.2	0.08	0.22	56.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_PM - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	76	5.6	0.040	0.0	LOS A	0.0	0.0	0.01	0.01	59.9
6	R2	1	0.0	0.040	5.7	LOS A	0.0	0.0	0.01	0.01	58.1
Approach		77	5.5	0.040	0.1	NA	0.0	0.0	0.01	0.01	59.9
North: Sandham Road											
7	L2	1	0.0	0.004	8.3	LOS A	0.0	0.1	0.18	0.93	51.9
9	R2	3	33.3	0.004	9.3	LOS A	0.0	0.1	0.18	0.93	50.1
Approach		4	25.0	0.004	9.1	LOS A	0.0	0.1	0.18	0.93	50.6
West: Bells Line of Road											
10	L2	5	20.0	0.051	5.8	LOS A	0.0	0.0	0.00	0.03	57.1
11	T1	89	10.6	0.051	0.0	LOS A	0.0	0.0	0.00	0.03	59.7
Approach		95	11.1	0.051	0.3	NA	0.0	0.0	0.00	0.03	59.6
All Vehicles		176	9.0	0.051	0.4	NA	0.0	0.1	0.01	0.04	59.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_PM - 2018 Base - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	79	6.7	0.043	0.0	LOS A	0.0	0.1	0.01	0.02	59.8
6	R2	2	0.0	0.043	5.8	LOS A	0.0	0.1	0.01	0.02	58.0
Approach		81	6.5	0.043	0.2	NA	0.0	0.1	0.01	0.02	59.7
North: Sandham Road											
7	L2	1	0.0	0.006	8.3	LOS A	0.0	0.2	0.19	0.96	51.9
9	R2	5	60.0	0.006	10.6	LOS A	0.0	0.2	0.19	0.96	49.0
Approach		6	50.0	0.006	10.2	LOS A	0.0	0.2	0.19	0.96	49.4
West: Bells Line of Road											
10	L2	7	28.6	0.054	5.9	LOS A	0.0	0.0	0.00	0.04	56.6
11	T1	93	11.4	0.054	0.0	LOS A	0.0	0.0	0.00	0.04	59.7
Approach		100	12.6	0.054	0.4	NA	0.0	0.0	0.00	0.04	59.4
All Vehicles		187	11.2	0.054	0.6	NA	0.0	0.2	0.01	0.06	59.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_PM - 2018 Ave. Dev - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	79	6.7	0.046	0.0	LOS A	0.0	0.4	0.04	0.04	59.7
6	R2	5	60.0	0.046	6.6	LOS A	0.0	0.4	0.04	0.04	54.9
Approach		84	10.0	0.046	0.5	NA	0.0	0.4	0.04	0.04	59.4
North: Sandham Road											
7	L2	3	100.0	0.013	10.7	LOS A	0.0	0.7	0.22	0.96	49.8
9	R2	8	75.0	0.013	11.3	LOS A	0.0	0.7	0.22	0.96	48.3
Approach		12	81.8	0.013	11.1	LOS A	0.0	0.7	0.22	0.96	48.7
West: Bells Line of Road											
10	L2	11	50.0	0.057	6.1	LOS A	0.0	0.0	0.00	0.06	55.6
11	T1	93	11.4	0.057	0.0	LOS A	0.0	0.0	0.00	0.06	59.7
Approach		103	15.3	0.057	0.6	NA	0.0	0.0	0.00	0.06	59.2
All Vehicles		199	16.9	0.057	1.2	NA	0.0	0.7	0.03	0.10	58.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_PM - 2018 2x Ave. Dev - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	79	6.7	0.048	0.1	LOS A	0.1	0.6	0.06	0.05	59.6
6	R2	7	71.4	0.048	6.8	LOS A	0.1	0.6	0.06	0.05	54.3
Approach		86	12.2	0.048	0.6	NA	0.1	0.6	0.06	0.05	59.1
North: Sandham Road											
7	L2	5	100.0	0.019	10.7	LOS A	0.1	1.1	0.22	0.96	49.7
9	R2	12	81.8	0.019	11.7	LOS A	0.1	1.1	0.22	0.96	48.0
Approach		17	87.5	0.019	11.2	LOS A	0.1	1.1	0.22	0.96	48.5
West: Bells Line of Road											
10	L2	14	61.5	0.060	6.3	LOS A	0.0	0.0	0.00	0.07	55.1
11	T1	93	11.4	0.060	0.0	LOS A	0.0	0.0	0.00	0.07	59.7
Approach		106	17.8	0.060	0.8	NA	0.0	0.0	0.00	0.07	59.0
All Vehicles		209	21.1	0.060	1.6	NA	0.1	1.1	0.04	0.13	58.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_PM - Future Base - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	100	6.3	0.054	0.0	LOS A	0.0	0.1	0.01	0.01	59.8
6	R2	2	0.0	0.054	5.8	LOS A	0.0	0.1	0.01	0.01	58.0
Approach		102	6.2	0.054	0.1	NA	0.0	0.1	0.01	0.01	59.8
North: Sandham Road											
7	L2	1	0.0	0.007	8.3	LOS A	0.0	0.2	0.22	0.95	51.8
9	R2	5	60.0	0.007	10.8	LOS A	0.0	0.2	0.22	0.95	48.9
Approach		6	50.0	0.007	10.4	LOS A	0.0	0.2	0.22	0.95	49.4
West: Bells Line of Road											
10	L2	8	25.0	0.068	5.8	LOS A	0.0	0.0	0.00	0.04	56.8
11	T1	117	10.8	0.068	0.0	LOS A	0.0	0.0	0.00	0.04	59.7
Approach		125	11.8	0.068	0.4	NA	0.0	0.0	0.00	0.04	59.5
All Vehicles		234	10.4	0.068	0.5	NA	0.0	0.2	0.01	0.05	59.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_PM - Future Ave. Dev - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	100	6.3	0.057	0.0	LOS A	0.0	0.4	0.04	0.03	59.7
6	R2	5	60.0	0.057	6.8	LOS A	0.0	0.4	0.04	0.03	55.0
Approach		105	9.0	0.057	0.4	NA	0.0	0.4	0.04	0.03	59.5
North: Sandham Road											
7	L2	3	100.0	0.013	10.9	LOS A	0.0	0.7	0.25	0.95	49.7
9	R2	8	75.0	0.013	11.5	LOS A	0.0	0.7	0.25	0.95	48.2
Approach		12	81.8	0.013	11.3	LOS A	0.0	0.7	0.25	0.95	48.6
West: Bells Line of Road											
10	L2	12	45.5	0.071	6.1	LOS A	0.0	0.0	0.00	0.05	55.8
11	T1	117	10.8	0.071	0.0	LOS A	0.0	0.0	0.00	0.05	59.7
Approach		128	13.9	0.071	0.6	NA	0.0	0.0	0.00	0.05	59.3
All Vehicles		245	15.0	0.071	1.0	NA	0.0	0.7	0.03	0.08	58.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Sandham Road / Bells Line of Road_PM - Future 2X Ave. Dev - Conversion]

Sandham Road / Bells Line of Road
Stop (Two-Way)

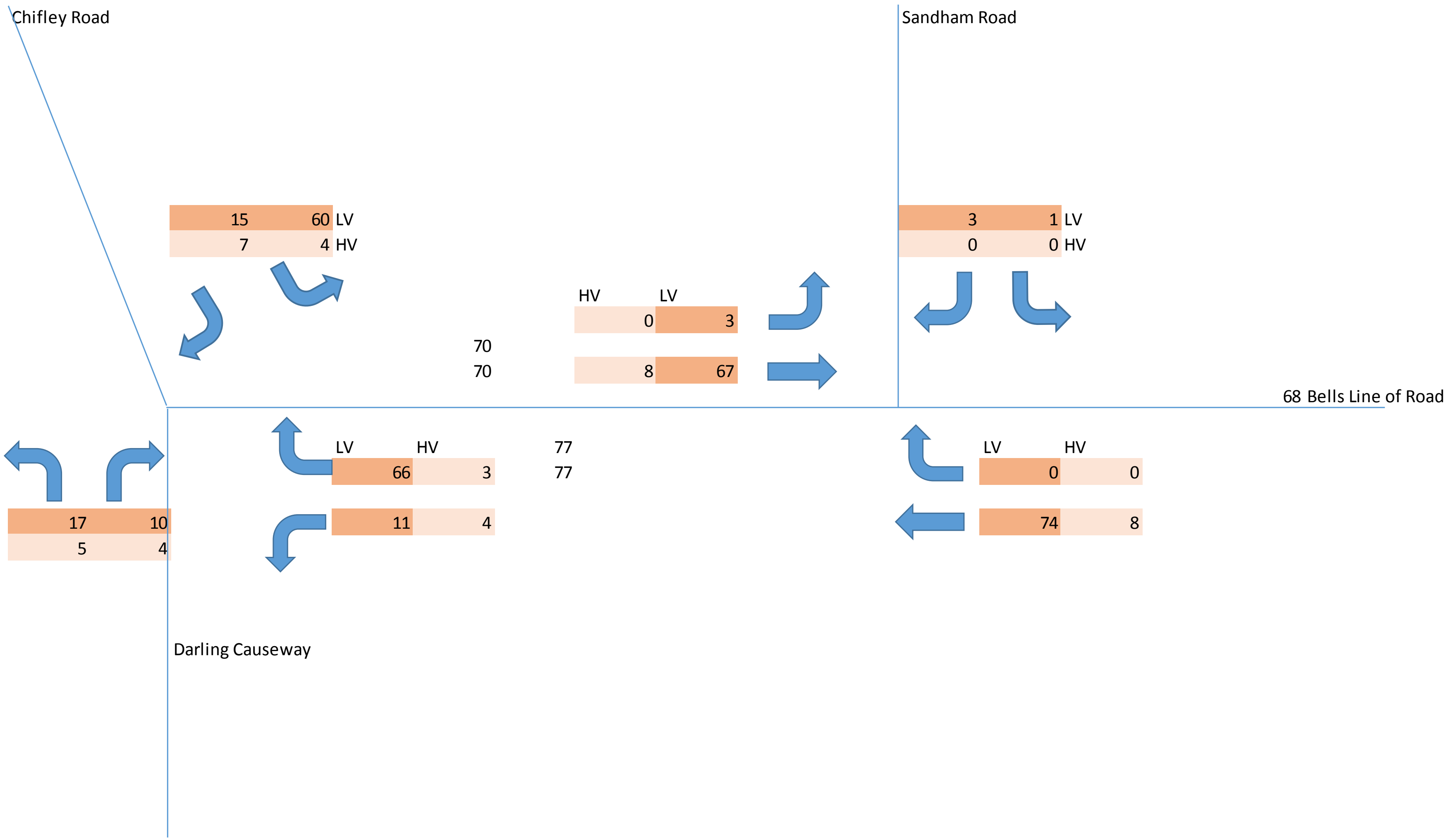
Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Bells Line of Road											
5	T1	100	6.3	0.060	0.1	LOS A	0.1	0.6	0.05	0.04	59.6
6	R2	7	71.4	0.060	7.0	LOS A	0.1	0.6	0.05	0.04	54.4
Approach		107	10.8	0.060	0.5	NA	0.1	0.6	0.05	0.04	59.3
North: Sandham Road											
7	L2	5	100.0	0.020	10.9	LOS A	0.1	1.2	0.25	0.95	49.6
9	R2	12	81.8	0.020	11.9	LOS A	0.1	1.2	0.25	0.95	47.9
Approach		17	87.5	0.020	11.5	LOS A	0.1	1.2	0.25	0.95	48.4
West: Bells Line of Road											
10	L2	14	53.8	0.072	6.2	LOS A	0.0	0.0	0.00	0.06	55.4
11	T1	117	10.8	0.072	0.0	LOS A	0.0	0.0	0.00	0.06	59.7
Approach		131	15.3	0.072	0.7	NA	0.0	0.0	0.00	0.06	59.2
All Vehicles		255	18.2	0.072	1.3	NA	0.1	1.2	0.04	0.11	58.4

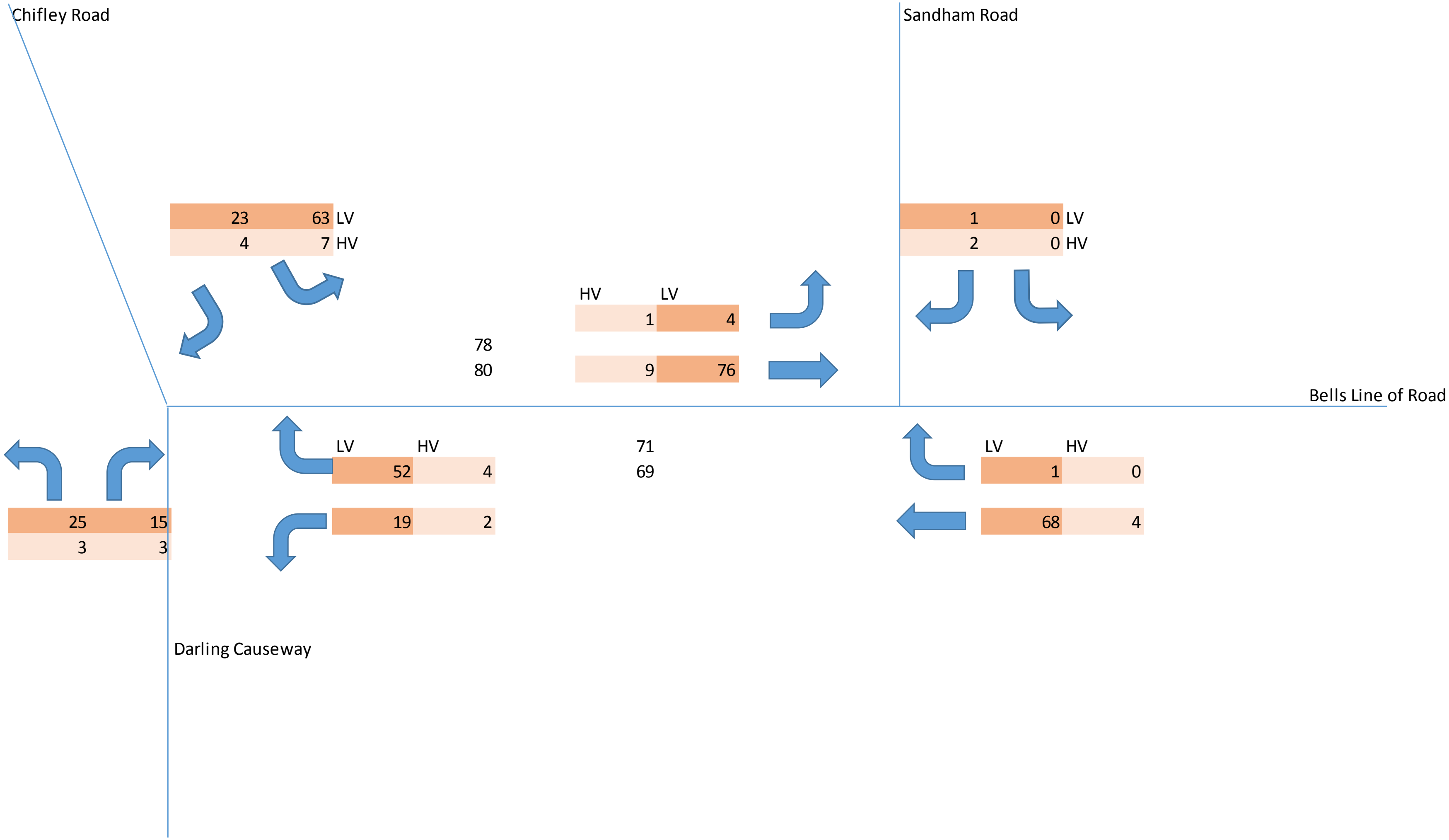
Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Appendix C – (Projected traffic distribution and volumes)

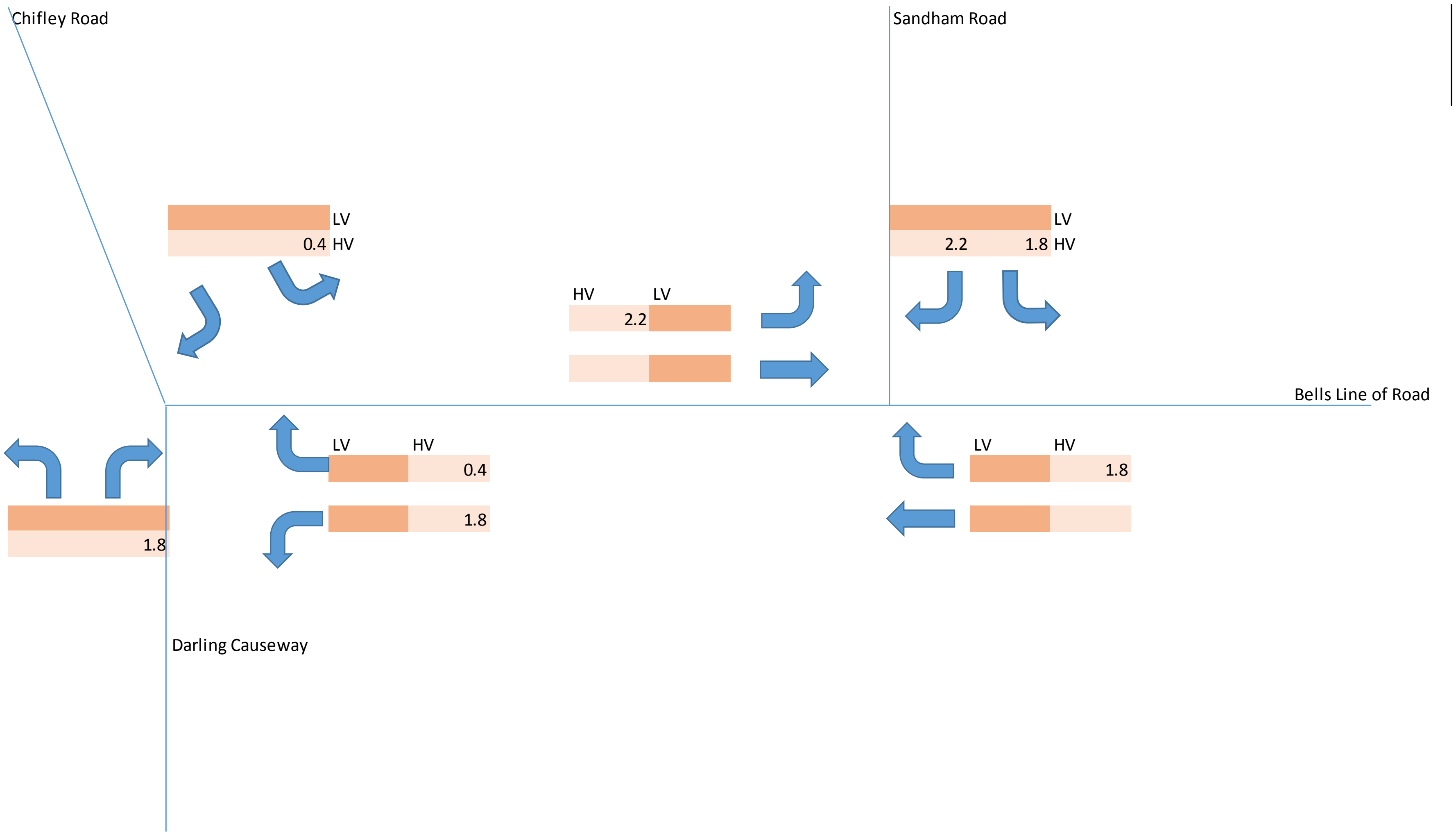
Existing AM Peak



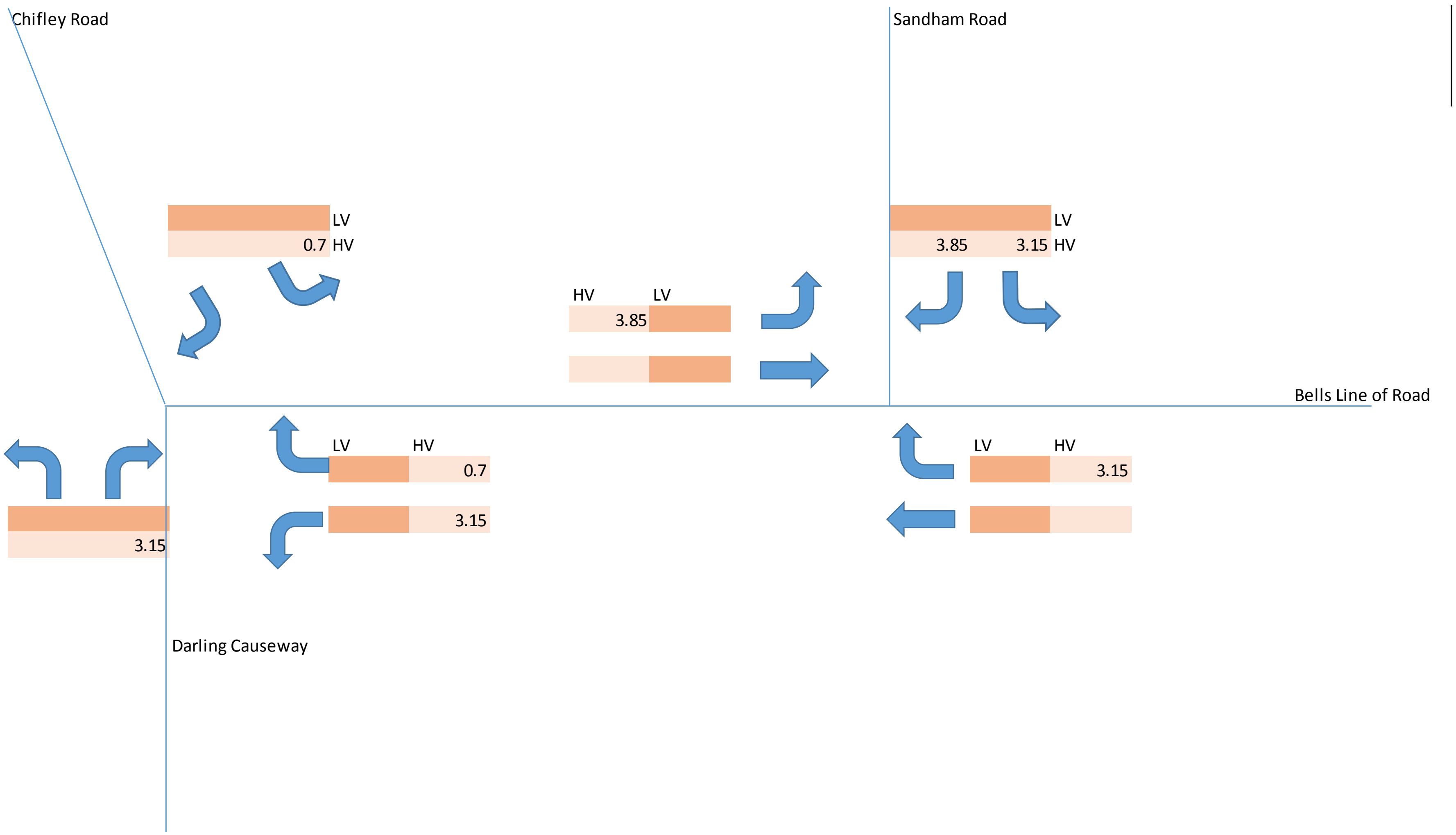
Existing PM Peak



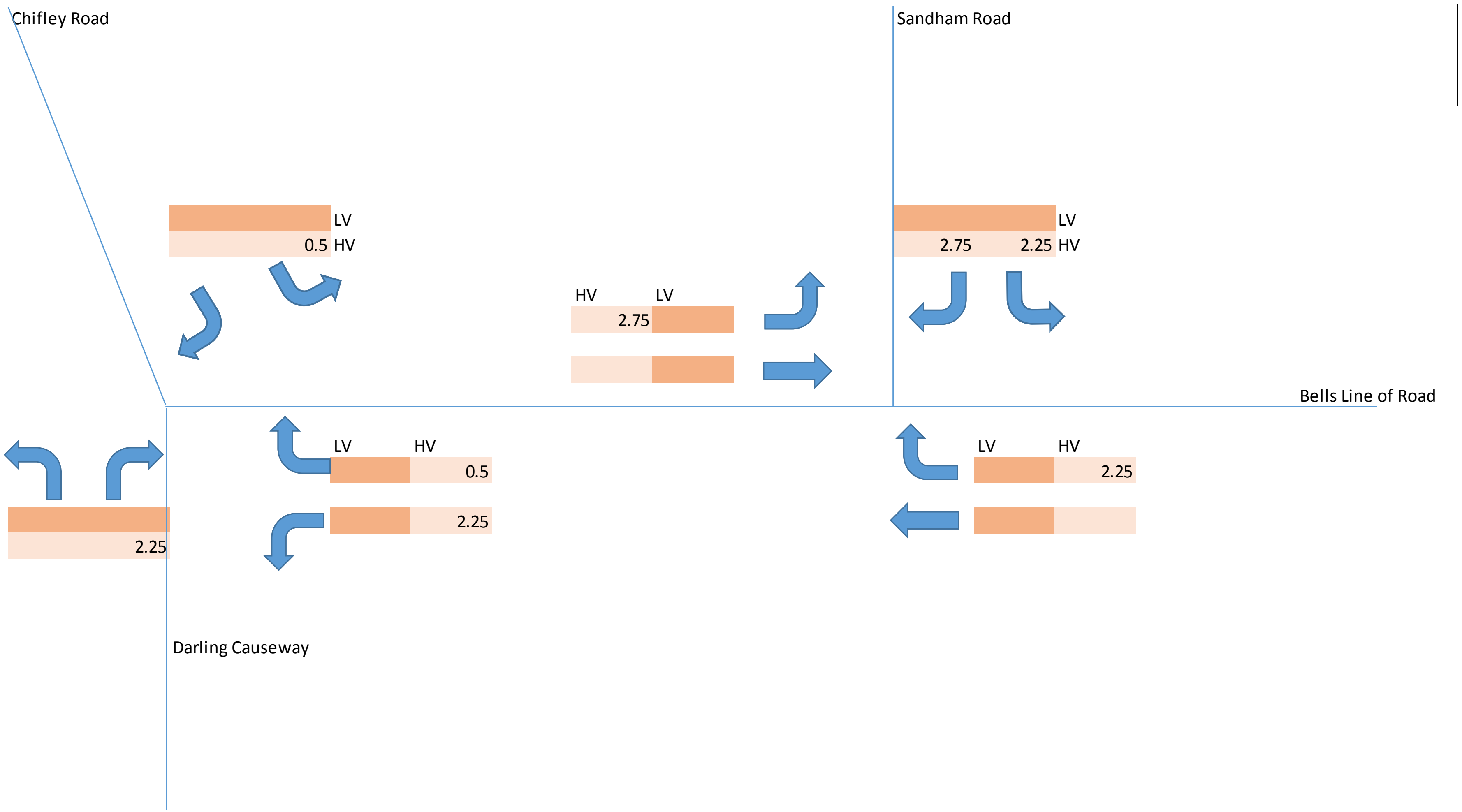
Average Haulage Traffic Generation AM Peak



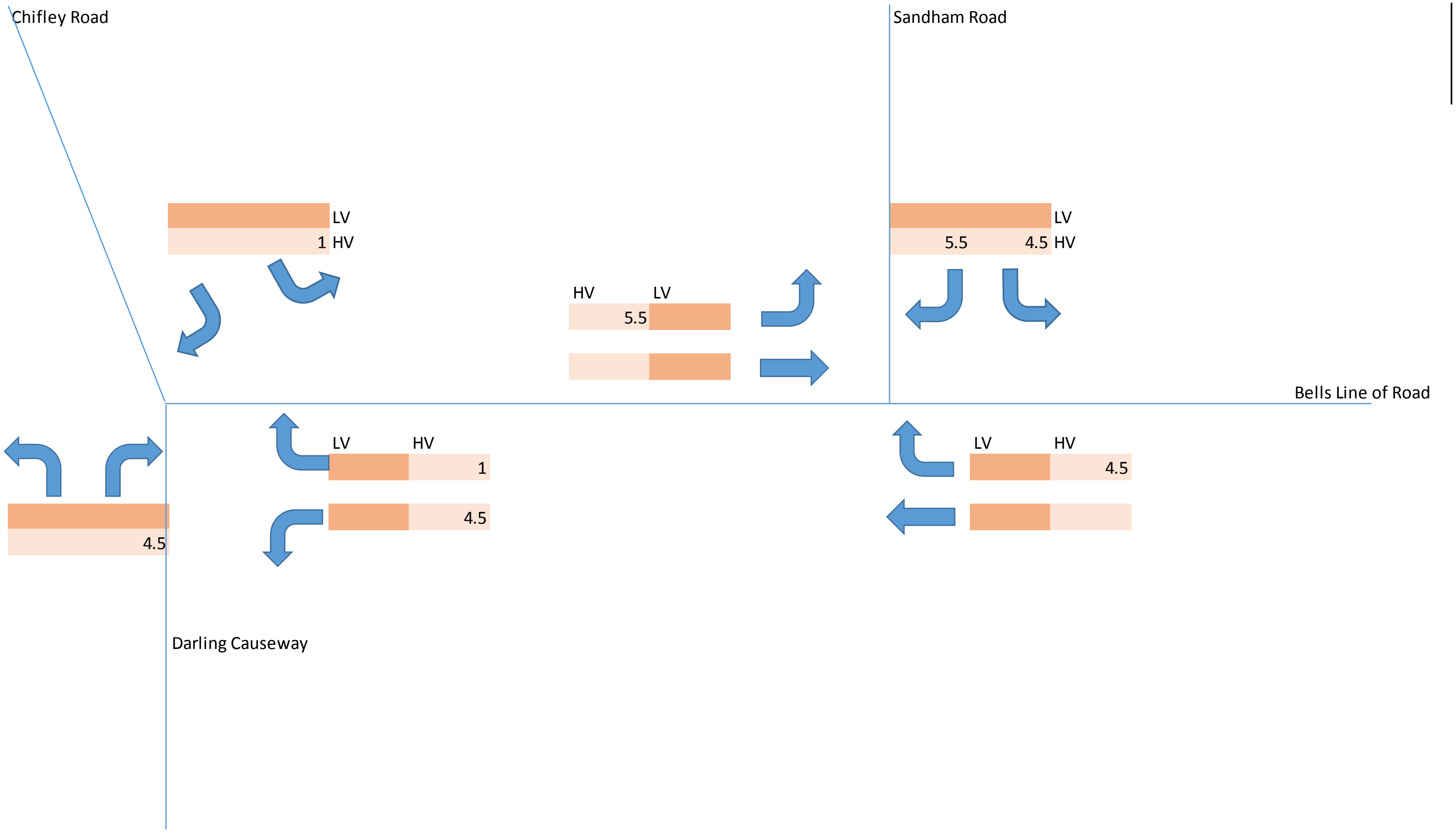
2 X Average Haulage Traffic Generation AM Peak



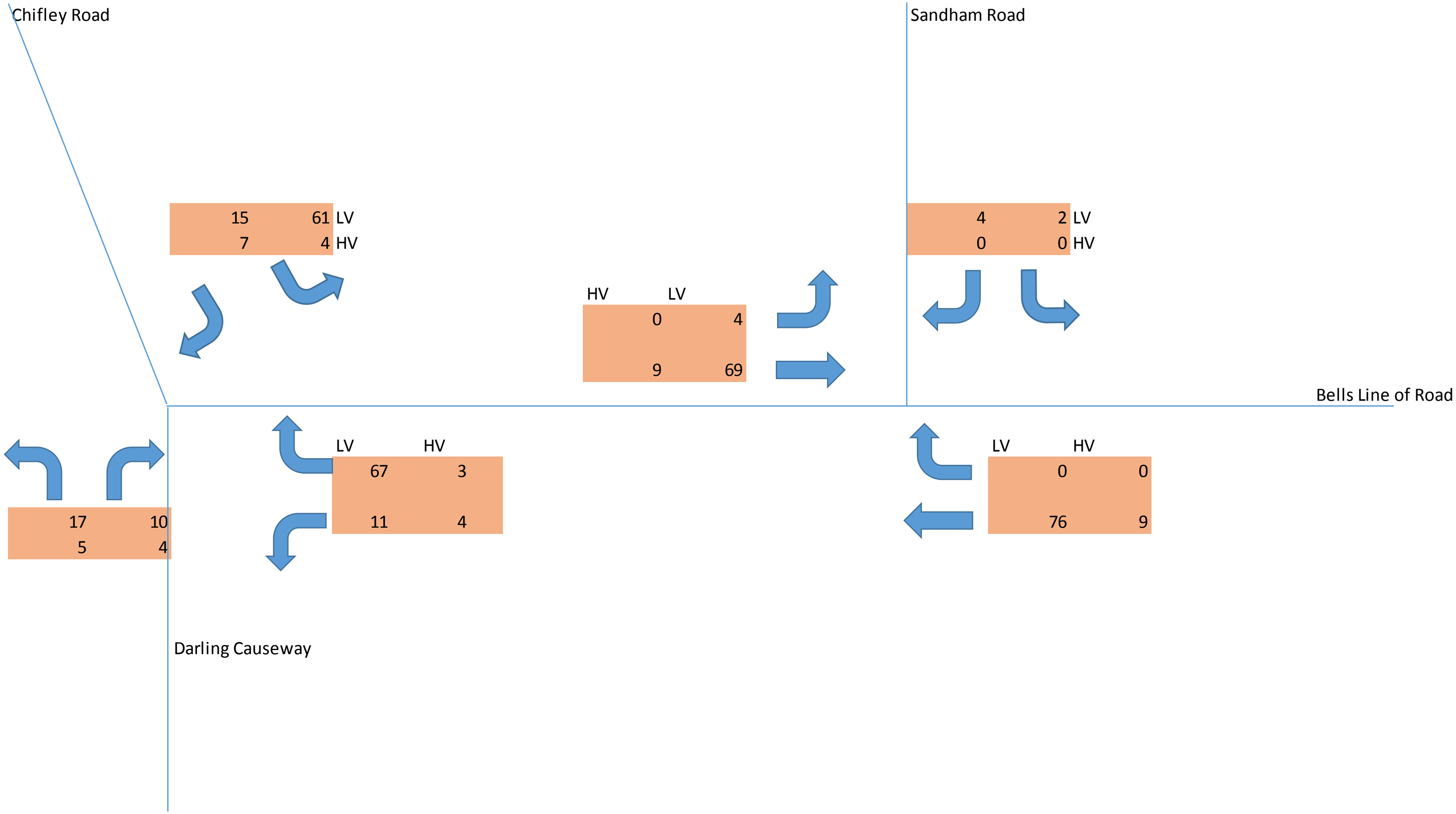
Average Haulage Traffic Generation PM Peak



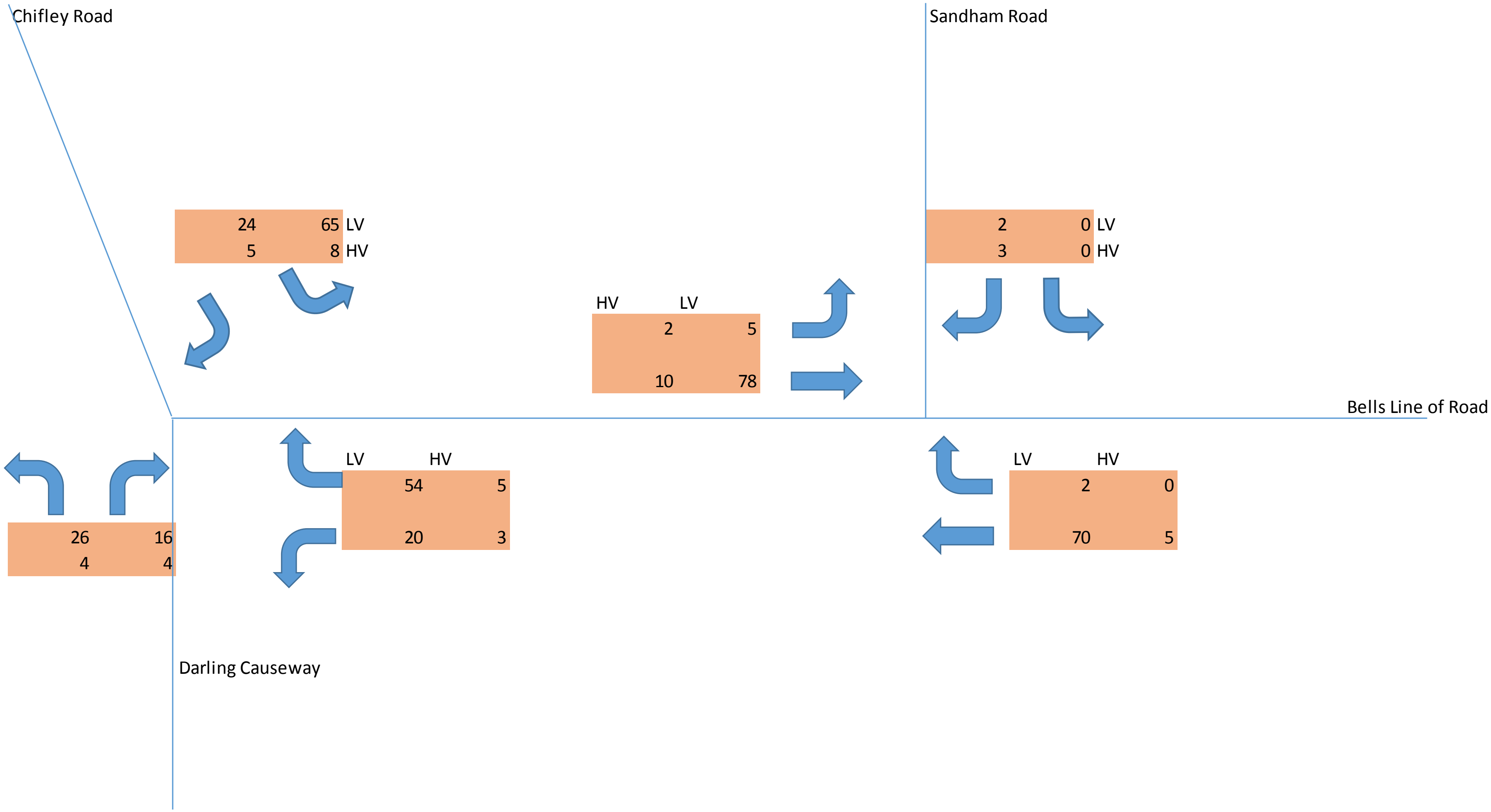
2 X Average Haulage Traffic Generation PM Peak



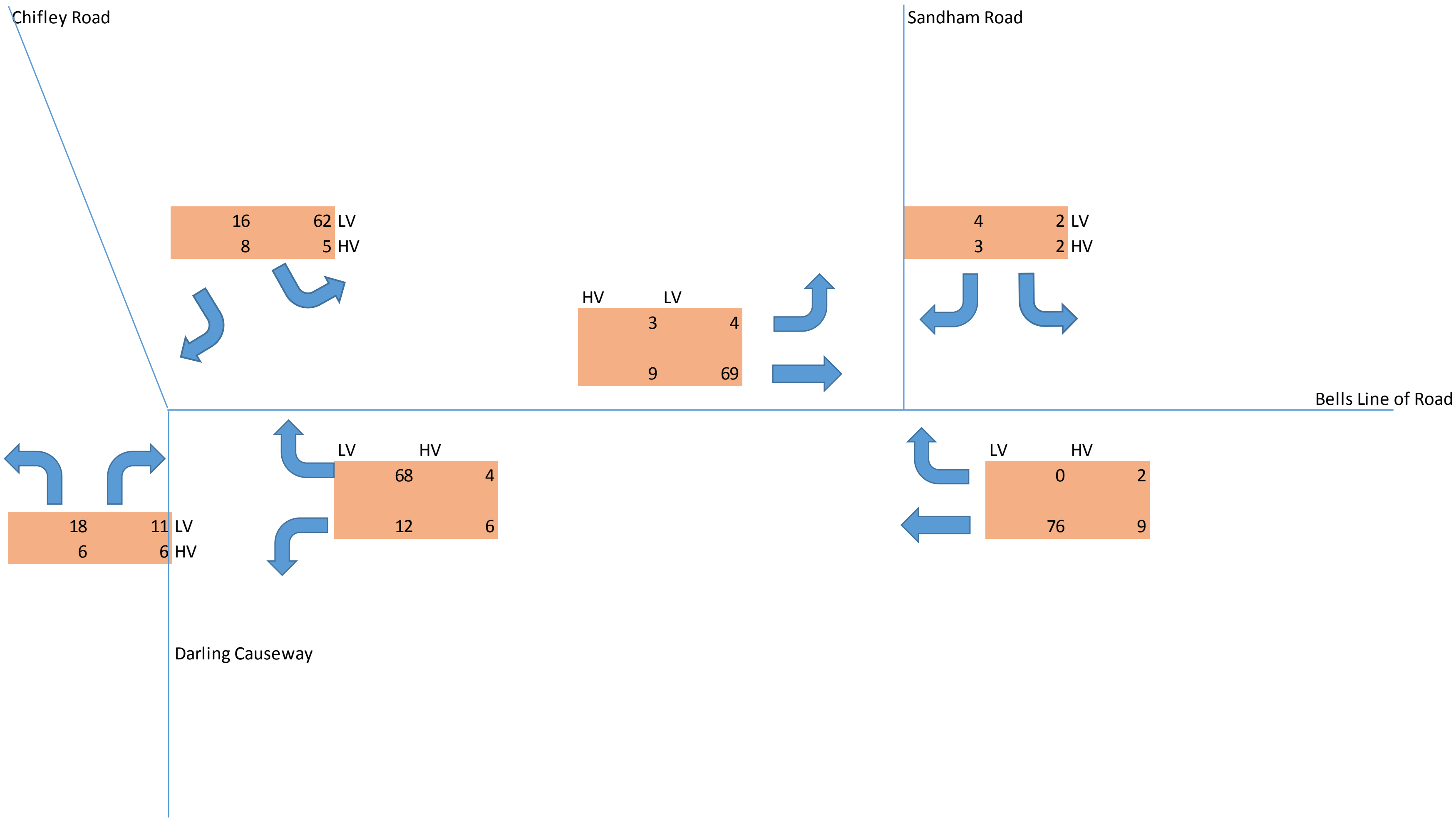
2018 AM Peak Base



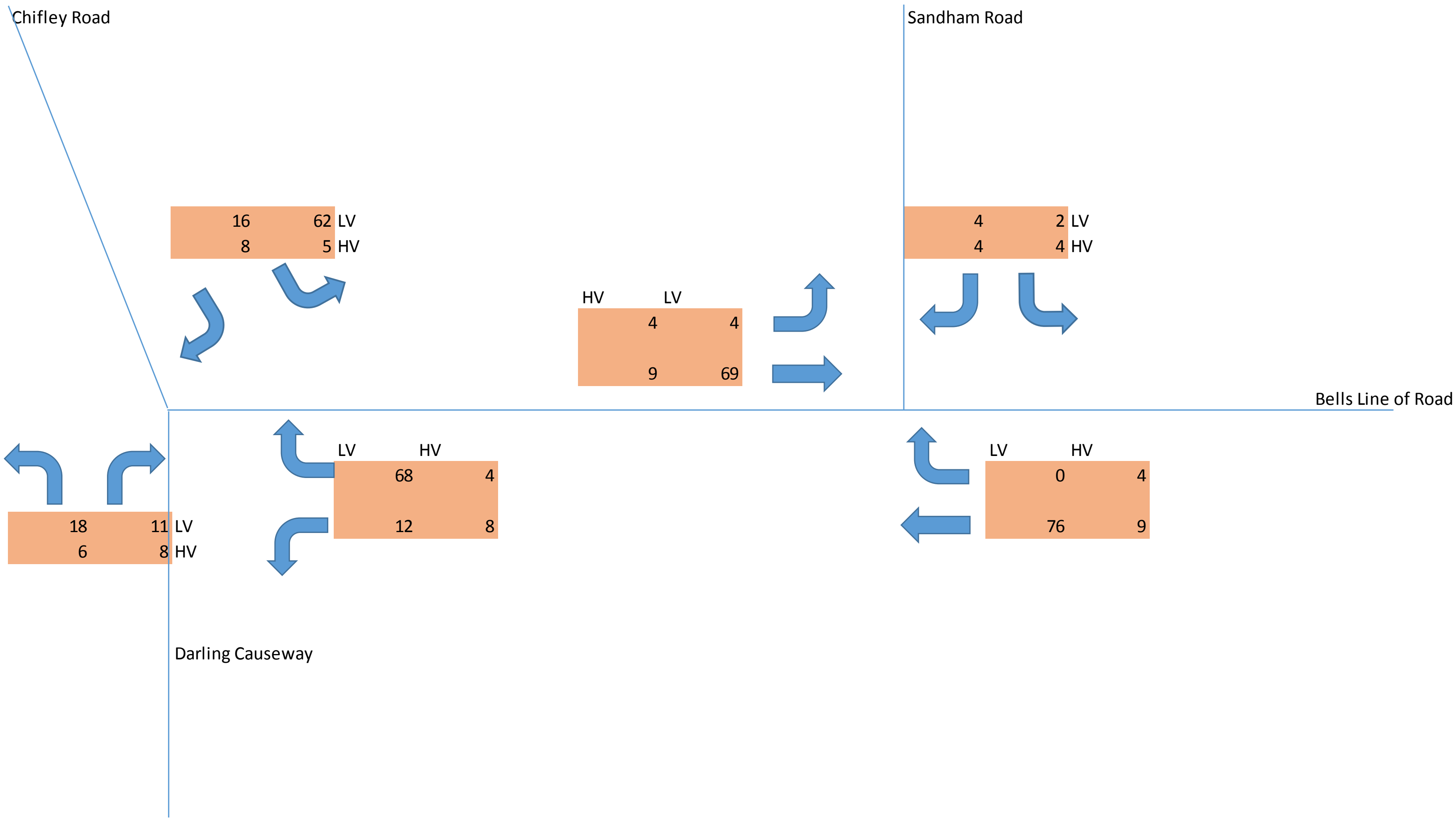
2018 PM Peak Base



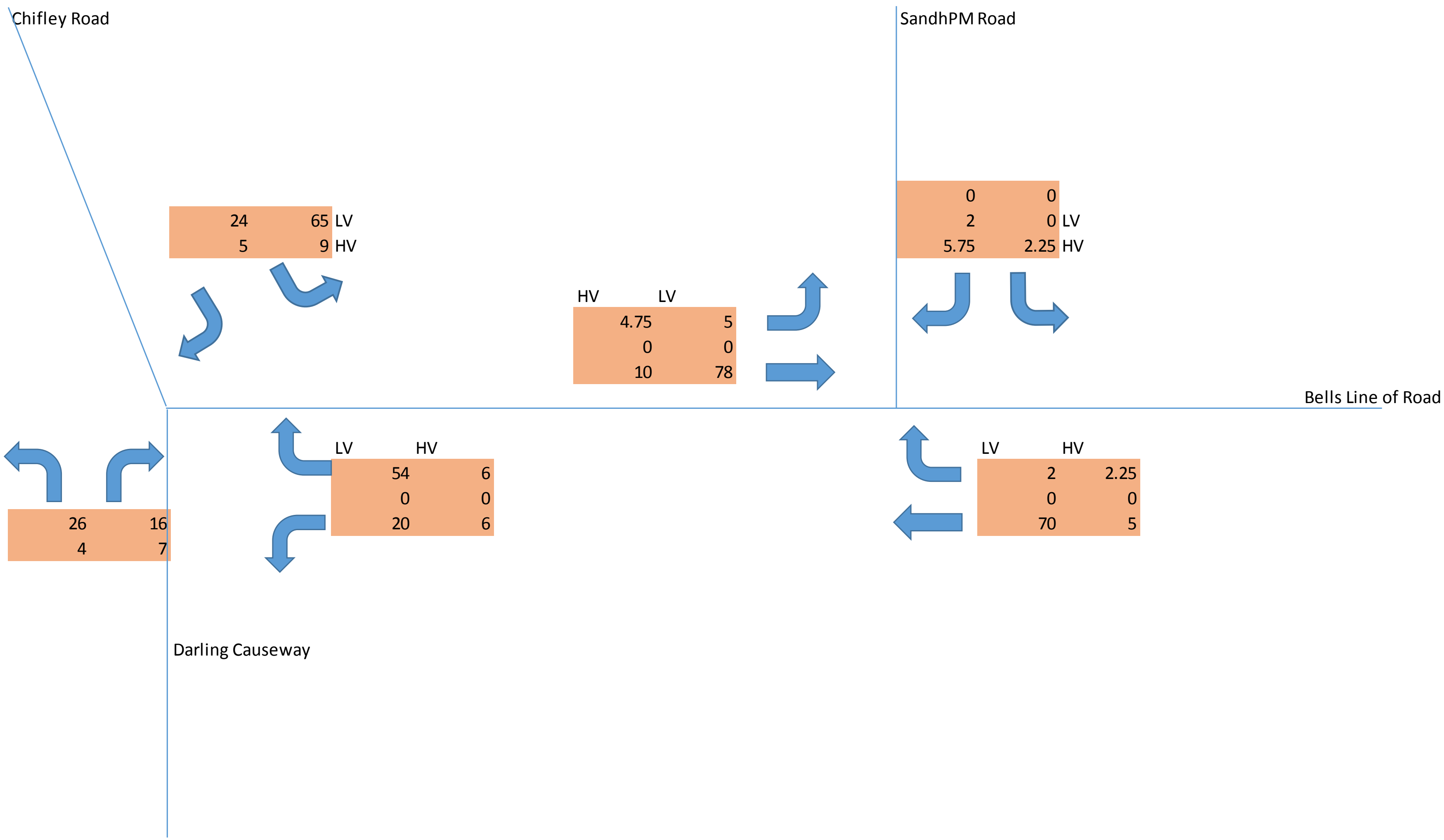
2018 AM Peak with Average Haulage



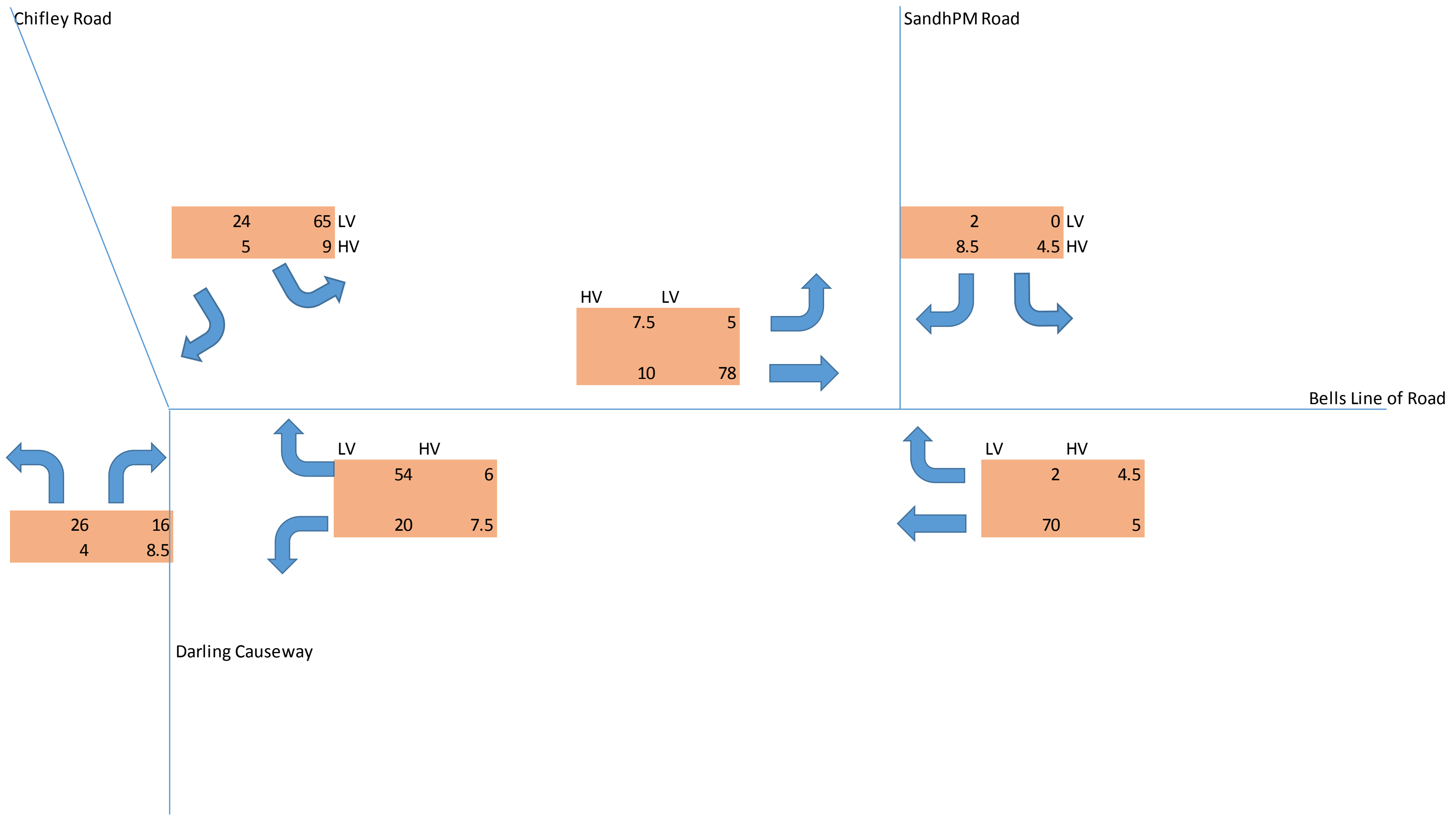
2018 AM Peak with 2 X Average Haulage



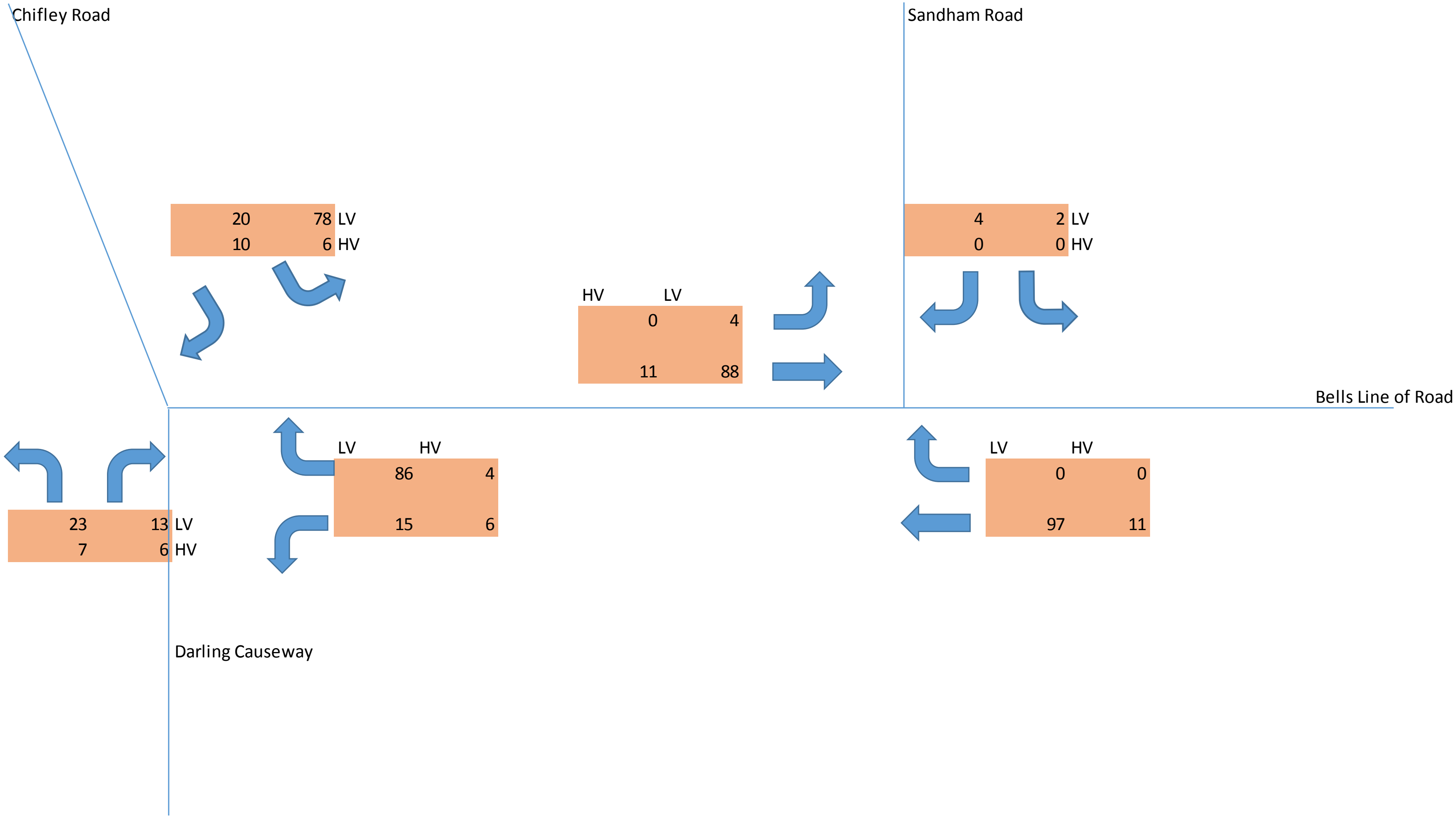
2018 PM Peak with Average Haulage



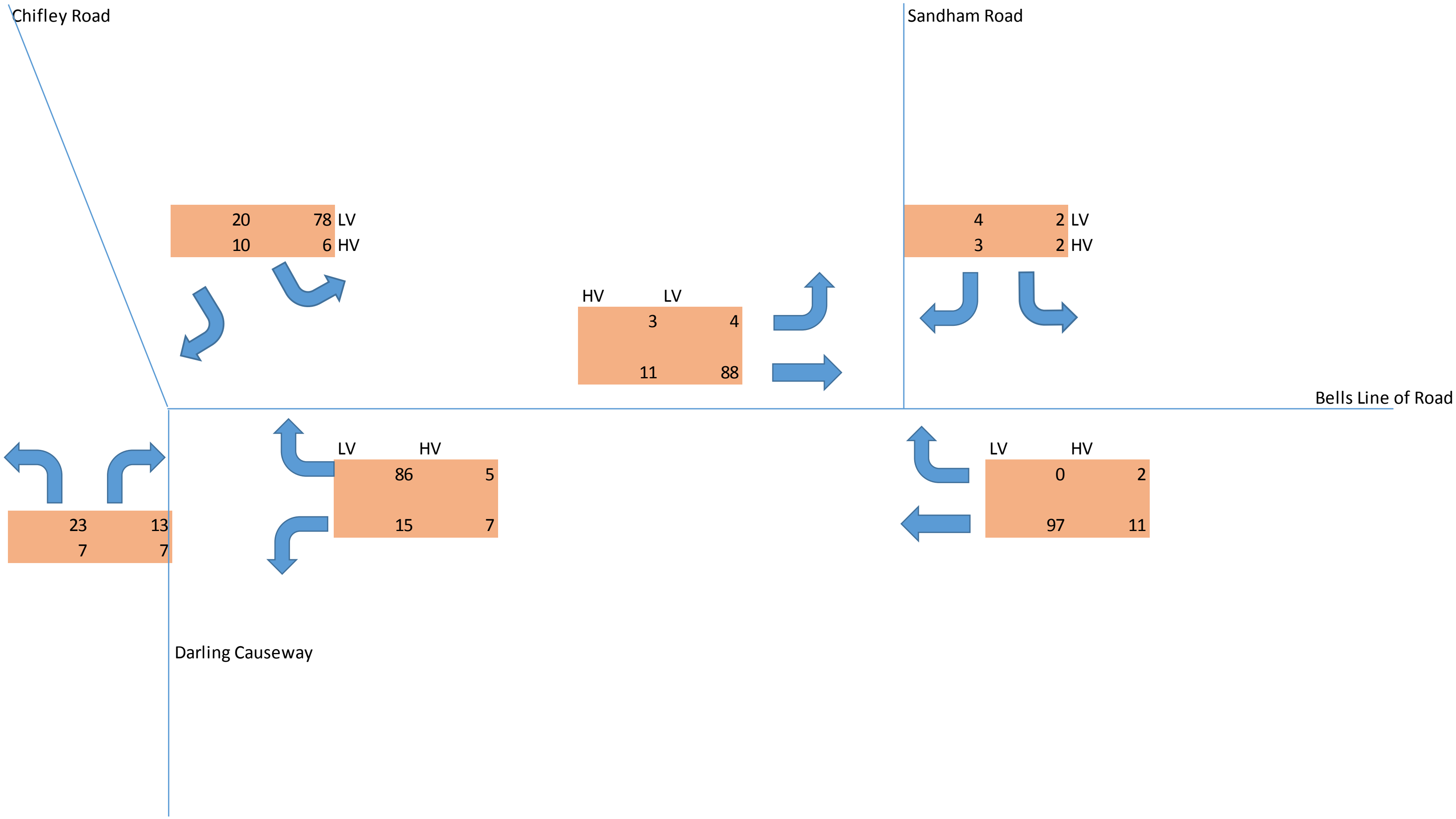
2018 PM Peak with 2 X Average Haulage



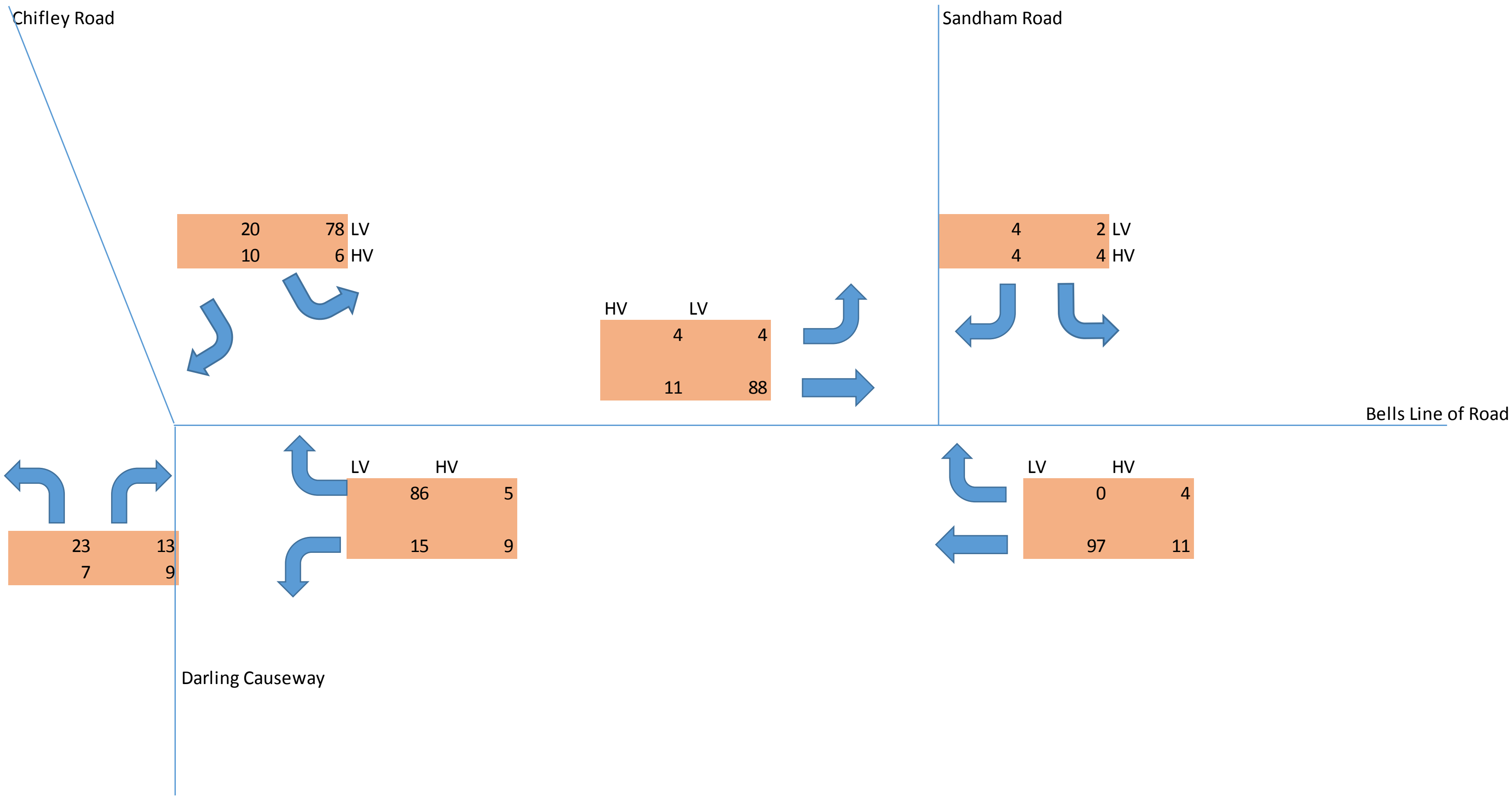
Future Base AM Peak (2032)



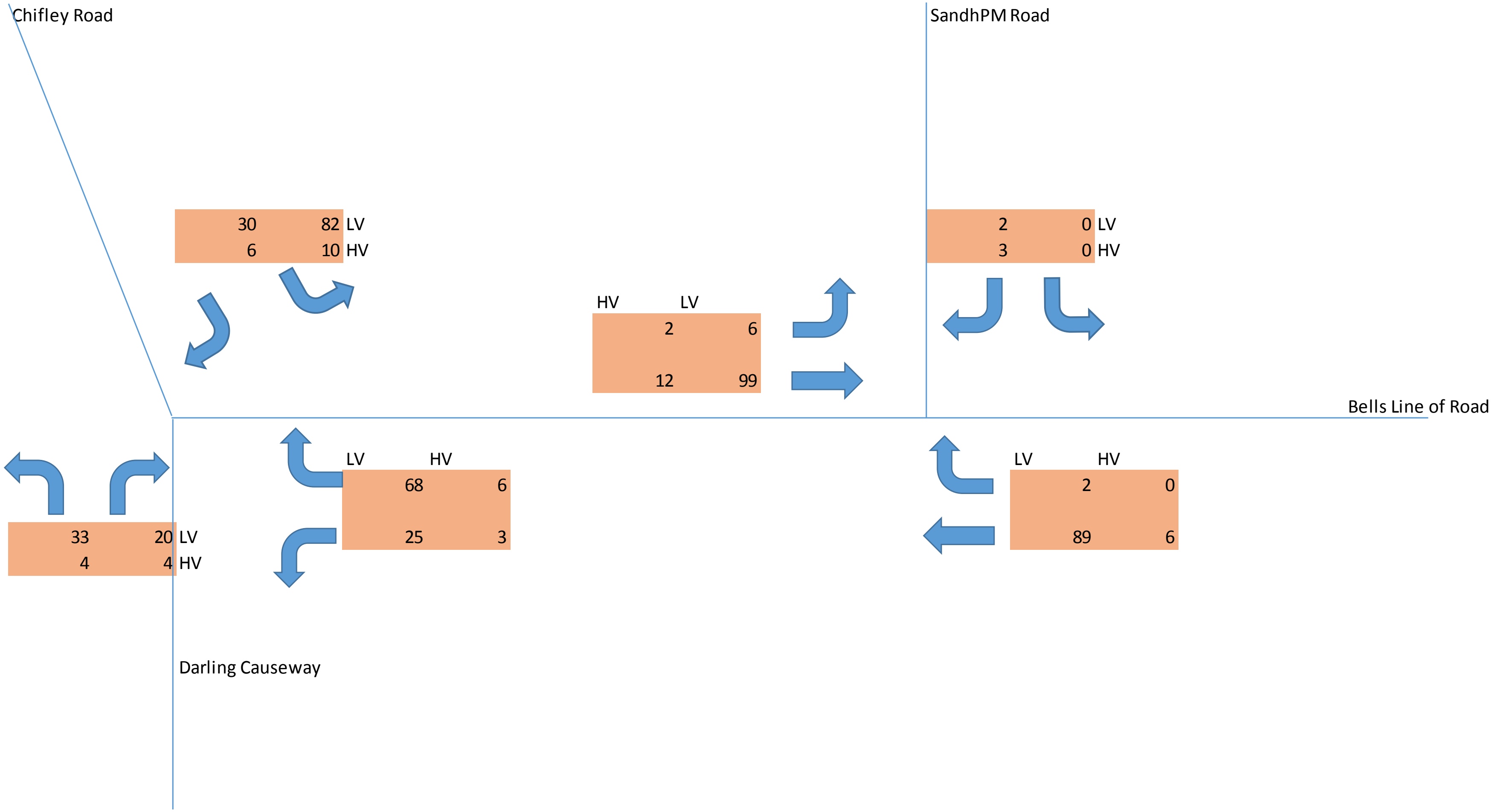
Future with average haulage AM Peak (2032)



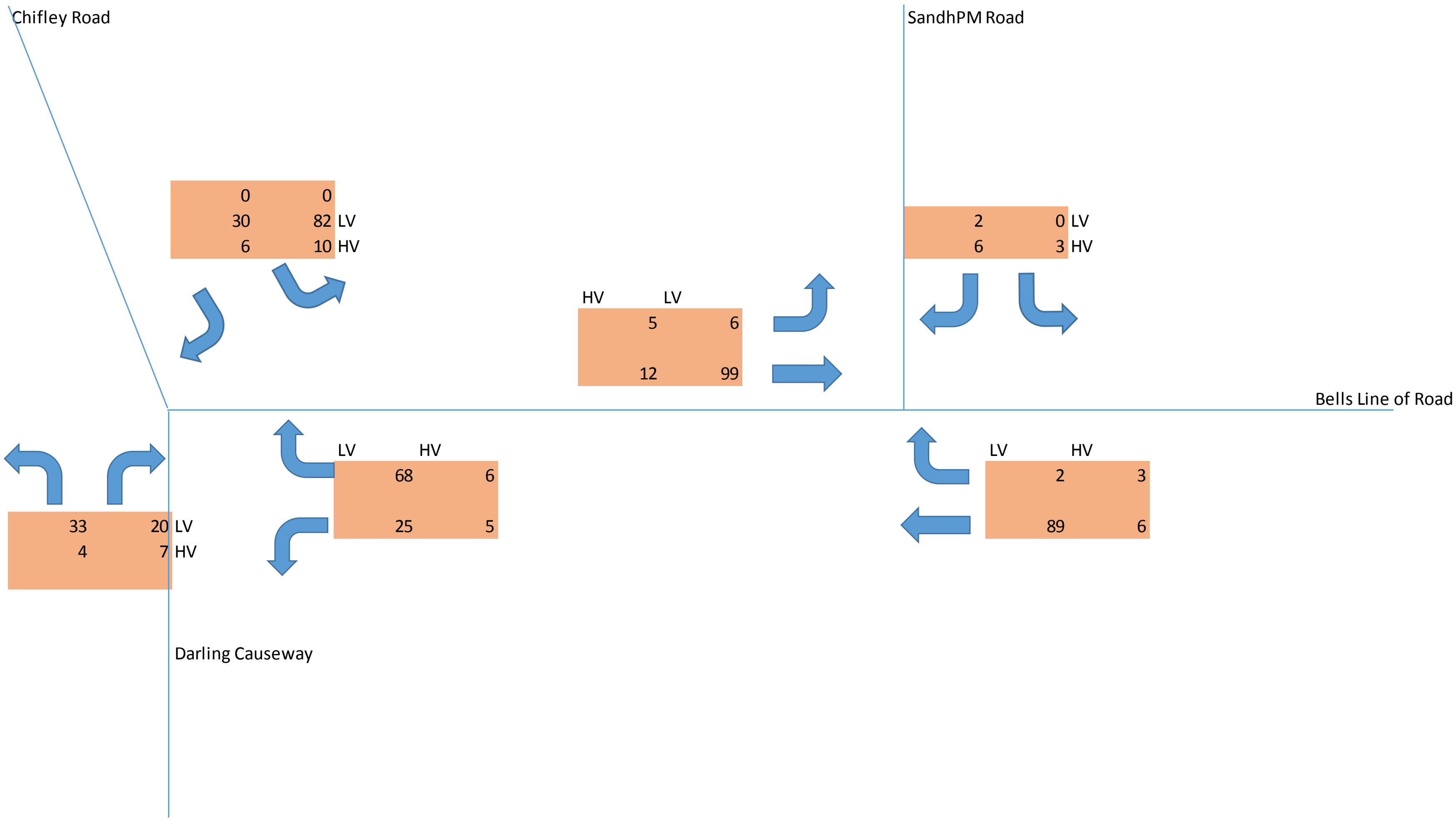
Future with 2 x Average Haulage AM Peak (2032)



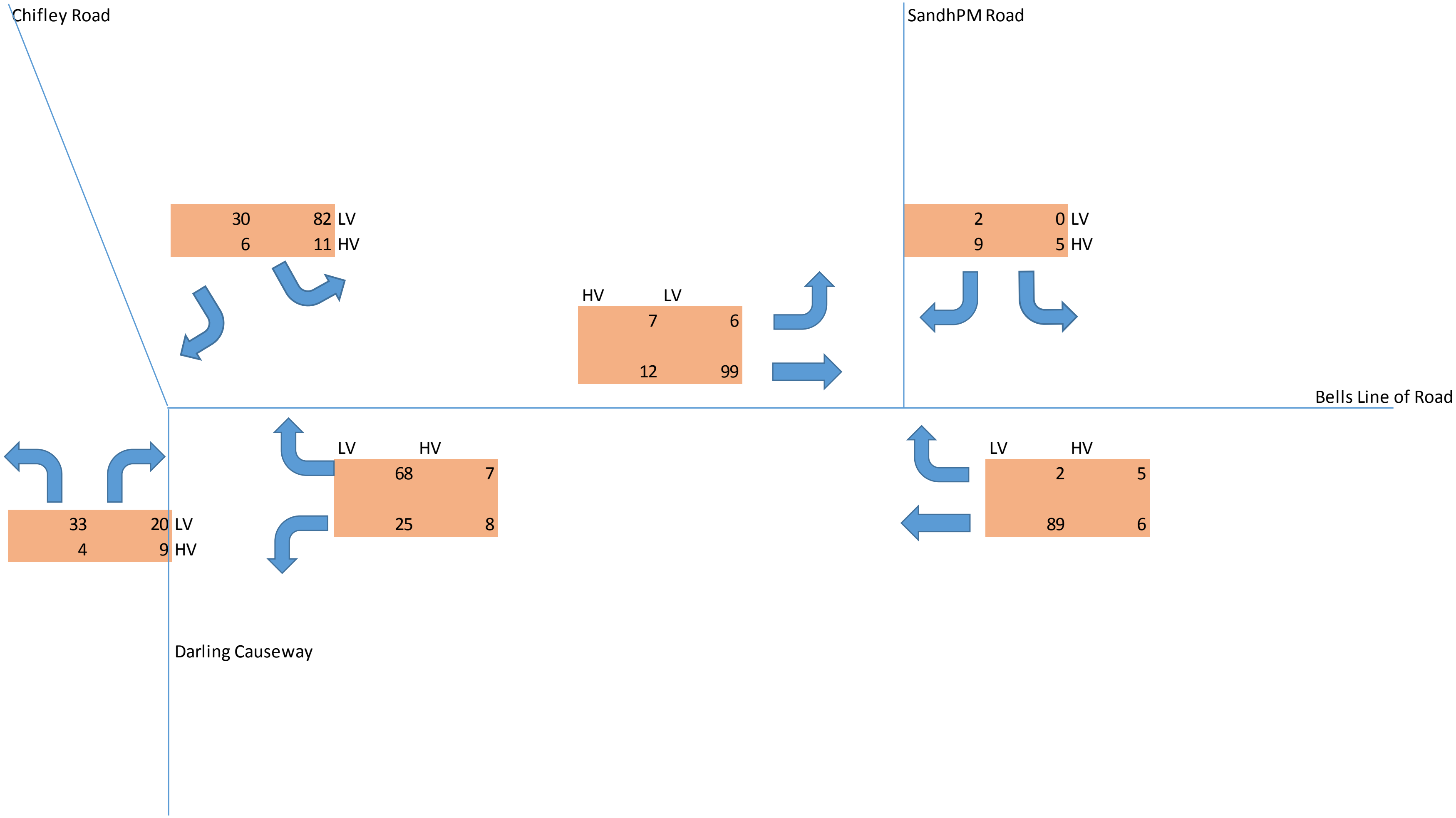
Future Base PM Peak (2032)



Future with Average Haulage PM Peak (2032)

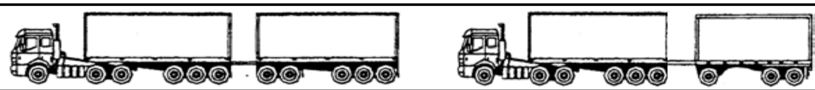
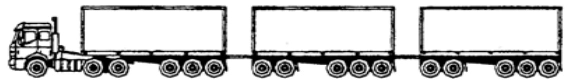


Future with 2 x Average Haulage PM Peak (2032)



Appendix D – (AUSTROADS Vehicle Classification System)

AUSTROADS Vehicle Classification System

Level 1	Level 2		Level 3			
Length (indicative)	**Axles and Axle Groups**		**Vehicle Type**	**AUSTROADS Classification**		
Type	**Axles**	**Groups**	**Typical Description**	**Class**	**Parameters**	**Typical Configuration**
	LIGHT VEHICLES					
Short up to 5.5m		1 or 2	**Short** Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc	**1**	d(1) ≤ 3.2m and axles = 2	
Medium 5.5m to 14.5m	3, 4 or 5	3	**Short - Towing** Trailer, Caravan, Boat, etc	**2**	groups = 3 d(1) ≥ 2.1m, d(1) ≤ 3.2m, d(2) ≥ 2.1m and axles = 3, 4 or 5	
	HEAVY VEHICLES					
	2	2	**Two Axle Truck or Bus**	**3**	d(1) > 3.2m and axles = 2	
	3	2	**Three Axle Truck or Bus**	**4**	axles = 3 and groups = 2	
	> 3	2	**Four Axle Truck**	**5**	axles > 3 and groups = 2	
Long 11.5m to 19.0m	3	3	**Three Axle Articulated** Three axle articulated vehicle, or Rigid vehicle and trailer	**6**	d(1) > 3.2m, axles = 3 and groups = 3	
	4	> 2	**Four Axle Articulated** Four axle articulated vehicle, or Rigid vehicle and trailer	**7**	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 4 and groups > 2	
	5	> 2	**Five Axle Articulated** Five axle articulated vehicle, or Rigid vehicle and trailer	**8**	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 5 and groups > 2	
	≥ 6	> 2	**Six Axle Articulated** Six axle articulated vehicle, or Rigid vehicle and trailer	**9**	axles = 6 and groups > 2 or axles > 6 and groups = 3	
Medium Combination 17.5m to 36.5m	> 6	4	**B Double** B Double, or Heavy truck and trailer	**10**	groups = 4 and axles > 6	
	> 6	5 or 6	**Double Road Train** Double road train, or Medium articulated vehicle and one dog trailer (M.A.D.)	**11**	groups = 5 or 6 and axles > 6	
Large Combination Over 33.0m	> 6	> 6	**Triple Road Train** Triple road train, or Heavy truck and three trailers	**12**	groups > 6 and axles > 6	

Definitions:
Group: Axle group, where adjacent axles are less than 2.1m apart
Groups: Number of axle groups
Axles: Number of axles (maximum axle spacing of 10.0m)

d(1): Distance between first and second axle
d(2): Distance between second and third axle

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2125774-10280/https://projects.ghd.com/oc/Sydney/bellquarryrehabilita/Delivery/Documents/2125774_Traffic Impact Assessment Bells Quarry RevA.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	Shane Quinn	Sean Clarke	On File	Karl Rosen		29/08/2018

www.ghd.com

Appendix F

Air Quality

Bell Quarry Rehabilitation Project Pty Ltd

Bell Quarry Rehabilitation Project
Air Quality Impact Assessment

July 2018

WATER | ENERGY & RESOURCES | ENVIRONMENT | PROPERTY & BUILDINGS | TRANSPORTATION

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Appendices

1. Introduction

1.1 Overview

The former Bell Quarry has been purchased and Bell Quarry Rehabilitation Project Pty Ltd (BQRP) are seeking to rehabilitate the site through the importation of virgin excavated natural material (VENM), excavated natural material (ENM) and other clean fill material sourced from earthworks projects across Sydney and the local regional area (the Project).

Rehabilitation of the site will involve emplacement of clean fill within the existing footprint to enable the site to be returned to a condition more closely representing the original landform and that of the adjoining Blue Mountains National Park. It is estimated that approximately 1.2 million cubic metres of fill material would be required to fill the site and return it to be representative of the original landform characteristics.

This Air Quality Impact Assessment (AQIA) has been prepared to assess the potential air quality impacts associated with the Project to accompany the Environmental Impact Statement for the proposal.

1.2 Purpose of this report

This report describes the procedures and results of the assessment of air quality impacts resulting from operation of the BQRP. The purpose of this report is to determine if the proposal would result in air quality impacts within the criteria at sensitive receivers and, if necessary, provide recommendations and mitigation strategies to ensure that these criteria are not exceeded.

1.3 Scope of this report

The scope of work undertaken by GHD for the assessment of air emissions from the BQRP is outlined below:

- Desktop review of site plans, aerial photographs and topographic maps to gain an understanding of the existing environment in terms of local terrain, proposed operations and sensitive receivers within the study area.
- Review of available ambient air quality monitoring data, to gain an understanding of existing air quality in the vicinity of the site. Ambient dust levels were sourced from data recorded from the Office of Environment and Heritage (OEH) ambient monitoring station located in Richmond.
- Outline the applicable air quality criteria with consideration to the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2016) (the Approved Methods').
- Undertake meteorological modelling to gain an understanding of the local wind climate and use as model input for conducting atmospheric dispersion modelling.
- Derive an emission inventory for the proposed operations with which to identify significant sources of dust emission and estimate the emissions rates. Emission rates were characterised using emission factors published in the National Pollutant Inventory (NPI) *Emission Estimation Technique Manual* (EETM) *for Mining (V 3.1* January 2012). The focus of this air quality impact assessment would be on potential impact from particulate (dust) emissions, in particular: total suspended particulates (TSP); fine particulates less than 10 and 2.5 micrometres in equivalent aerodynamic diameter (PM_{10} and $PM_{2.5}$); and dust deposition.

- Undertake a disperion modelling scenario using the regulatory atmospheric dispersion model CALPUFF based on proposed worst-case operations.
- Recommended in principle mitigation and management measures to reduce dust impacts and, if warranted, recommend air quality monitoring programmes.

1.4 Secretary's Environmental Assessment Requirements (SEAR) 1105

The following air quality key issues are to be addressed in accordance with the SEARs 1105:

- A description of all potential sources of air and odour emissions;
- An air quality impact assessment in accordance with relevant Environment Protection Authority Guidelines; and
- A description and appraisal of air quality impact mitigation and monitoring measures.

The EIS should include a detailed air quality impact assessment (AQIA). The AQIA should:

1. Identify all potential discharges of fugitive and point source emissions of pollutants including dust for all stages of the proposal and assess the risk associated with those emissions. All processes that could result in air emissions must be identified and described. Sufficient detail to accurately communicate the characteristics and quantity of all emissions must be provided. Assessment of risk relates to environmental harm, risk to human health and amenity.
2. Justify the level of assessment undertaken on the basis of risk factors, including but not limited to:
   a. Proposal location;
   b. Characteristic of the receiving environment; and
   c. Type and quantity of pollutants emitted.
3. Describe the receiving environment in detail. The proposal must be contextualised within the receiving environment (local, regional and inter-regional as appropriate). The description must include but need not be limited to:
   a. Meteorology and climate;
   b. Topography; and
   c. Surrounding land-use; receptors; and
   d. Ambient air quality.
4. Include a consideration of 'worst case' emission scenarios and impacts at proposed emission limits.
5. Account for cumulative impacts associated with existing emission sources as well as any currently approved developments linked to the receiving environment.
6. Include air dispersion modelling where there is a risk of adverse air quality impacts, or where there is uncertaintly to warrant a rigorous numerical impact assessment. Air dispersion modelling must be conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (2005) http://www.environment.nsw.gov.au/resources/air/ammodelling05361.pdf.

Demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations (POEO) Act (1997) POEO (Clean Air) Regulations (2010).*

Detail emission control techniques/practices that will be employed by the proposal.

1.5 Limitations

This report: has been prepared by GHD for Bell Quarry Rehabilitation Project Pty Ltd and may only be used and relied on by Bell Quarry Rehabilitation Project Pty Ltd for the purpose agreed between GHD and the Bell Quarry Rehabilitation Project Pty Ltd as set out in section 0 of this report.

GHD otherwise disclaims responsibility to any person other than Bell Quarry Rehabilitation Project Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Bell Quarry Rehabilitation Project Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Existing environment

2.1 Site location and sensitive receivers

The site is located within the Lithgow Local Government Area, approximately 10 kilometres east of Lithgow and approximately 250 metres south-east of Newnes Junction. Road access to the site is via Sandham Road from the south.

The nearest identified sensitive receivers located in the vicinity of the site are detailed in Table 2-1 and shown in Figure 2-1 below. Distances are stated from the receiver to the nearest point at the site boundary.

Table 2-1 Identified air quality sensitive receivers (from site operations)

Receiver	Receiver type	Address	Distance from site activity (m)	Direction from site
R1	Residential	Sandham Road, Dargan	184	North-west
R2	Residential	567 Sandham Road	360	North-west
R3	Residential	576 Sandham Road	378	North-west
R4	Residential	399 Chifley Road	700	South
R5	Residential	371 Chifley Road	918	South
R6	Residential	363 Chifley Road	964	South

Sensitive receivers were also identified along Sandham Road, which will be used to access the quarry. Sandham Road is considered as a potential source of particulates in the unpaved sections only, so receivers adjacent to the paved road have not been included in the results table. These are detailed in Table 2-2 and Figure 2-1 below. Distances are stated from Sandham Road to 1.5 m from the nearest residential dwelling on the subject property.

Table 2-2 Identified air quality sensitive receivers (from Sandham Road)

Receiver	Receiver type	Address	Distance from Sandham Road (m)
R4	Residential	399 Chifley Road	198
R5	Residential	371 Chifley Road	180
R6	Residential	363 Chifley Road	156
R7	Residential	361 Chifley Road	197
R8	Residential	357 Chifley Road	214
R9	Residential	347 Chifley Road	178
R10	Residential	345 Chifley Road	168
R11	Residential	339 Chifley Road	175
R12	Residential	333 Chifley Road	230
R13	Residential	329 Chifley Road	184
R14	Residential	327 Chifley Road	239
R15	Residential	291 Chifley Road	196
R16	Residential	289 Chifley Road	163
R17	Residential	287 Chifley Road	245
R18	Residential	310 Sandham Road	90
R19	Residential	275 Chifley Road	263
R20	Residential	267 Chifley Road	139
R21	Residential	225 Chifley Road	141
R22	Residential	221 Chifley Road	165
R23	Residential	215 Chifley Road	267

Receiver	Receiver type	Address	Distance from Sandham Road (m)
R24	Residential	213 Chifley Road	128
R28	Residential	32 Sandham Road	80
R29	Residential	30 Sandham Road	142

2.1 Relevant pollutants

Air quality may be impacted by a number of pollutants, each of which has different emission sources and effects on human health and the environment. The air quality assessment of the proposal is focused on the highest-risk impacts which have the potential to occur during operation of the proposal. There is the potential for impacts as a result of emissions of total suspended particulate matter in the form of airborne particulate matter (less than 10 microns in size – that is, PM_{10}) and dust deposition. $PM_{2.5}$ has also been assessed.

Fine particle emissions associated with exhausts from mobile plant and stationary engines used during construction activities are accounted for in the emission factors for earthmoving and handling used in the air quality assessment. Engine emission sources during operation are expected to be discontinuous, transient and mobile.

LEGEND

- Residential buildings
- Bell Quarry
- Reserves and State Forests
- Waterways
- Rail
- Roads

Paper Size A4

0 200 400 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Remedial Civil Solutions Pty Ltd
Air Quality Assessment

Job Number	21-25774
Revision	A
Date	11 Jul 2018

Air quality sensitive receivers near site and Sandham Road

Figure 2-1

G:\21\25774\GIS\Maps\Deliverables\21_25774_Z0010_AirLocation.mxd

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: Aerial imagery - sixmaps 2016, Inset map - Geoscience Australia, General topo - NSW LPI DTDB 2012, Mining Titles: Geology Survey NSW. Created by:afoddy

2.2 Ambient air quality

The NSW Office of Environment and Heritage (OEH) operates ambient air quality monitoring stations in selected areas around NSW. The nearest stations to the site are Richmond which is approximately 50 km to the east and Bathurst which is 60 km to the west. Richmond has air quality sampling data for fine particles including both PM_{10} and $PM_{2.5}$, and has a higher yearly average PM_{10} concentration than Bathurst and has therefore been conservatively used in the assessment. A summary of the data set from Richmond in 2014 is shown in Figure 2-2. The figure shows no exceedances of the PM_{10} and $PM_{2.5}$ criteria in 2014.

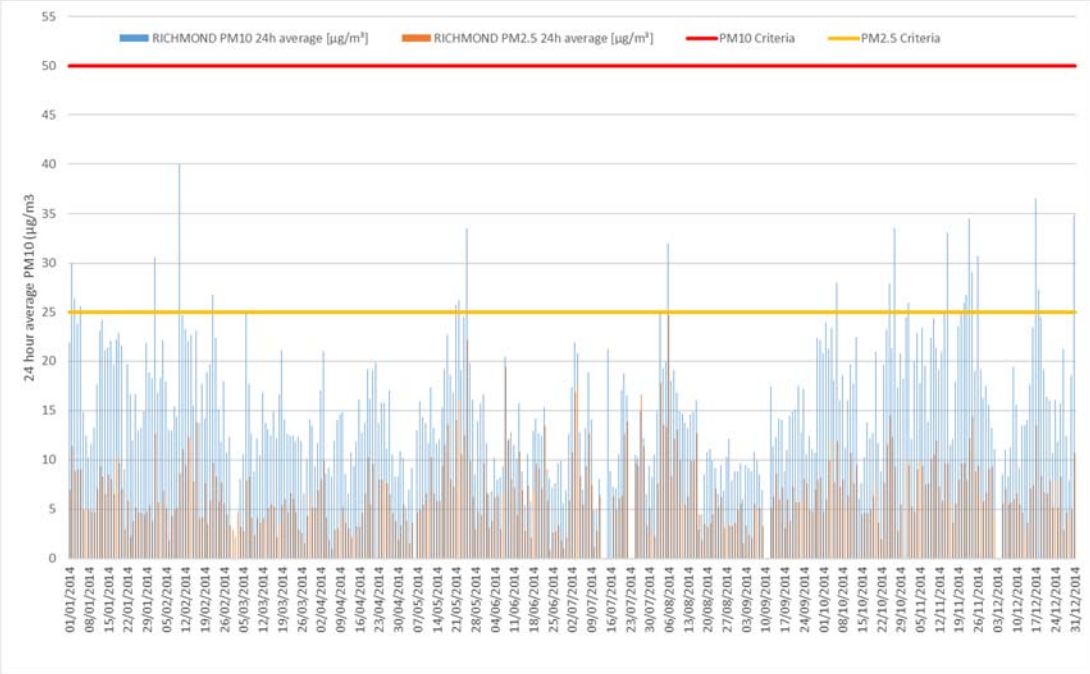


Figure 2-2 24 hour average PM_{10} Data monitored at Richmond 2014

2.2.1 Particulates from Clarence Colliery

The Clarence Colliery Air Quality Assessment (SLR, 2013) has been reviewed in order to identify whether cumulative air quality impacts are likely. The nearest receivers to both projects are identified as Receivers R1, R2 and R3, which are located between the Bell Quarry site and other potential sources of particulates that are the Clarence Colliery and Hansen Quarry.

Receivers R1, R2 and R3 are located between the main sources of dust in the local area, so it is unlikely that maximum cumulative impacts would occur where the particulate levels are at maximum at these receivers from each source on the same day. For example if there was a northwesterly wind, particulate from Clarence Colliery and Hansen Quarry may be dispersed in the direction of Receivers R1, R2 and R3, however particulate from Bell Quarry site would disperse away from receivers R1, R2 and R3 towards the south east.

Receiver 1 in the SLR study, is also labelled Receiver 1 in this study (refer Section 2.1). The SLR study predicts the 100^{th} percentile PM_{10} and $PM_{2.5}$ concentrations at R1, however the modelling year was 2010 which is not the same at this study, meaning the levels cannot be directed added together for worst-case cumulative impacts. The year modelled in this study (2014) is discussed in more detail in Section 5.1. The maximum predicted 24 hour PM_{10} and $PM_{2.5}$ project increment from Clarence Colliery at R1 was 7.2 µg/m3 and 2.1 µg/m3 respectively.

As discussed above the maximum particulate increment from the various projects would not likely occur at Receiver R1, R2 and R3 on the same day as the maximum increment from Bell Quarry.

3. Air Quality Criteria

3.1 Legislative and policy context to the assessment

The Protection of the Environment Operations (POEO) Act 1997 provides the statutory framework for managing pollution in NSW, including the procedures for issuing licences for environmental protection on aspects such as waste, air, water and noise pollution control. Companies and property owners are legally bound to control emissions (including particulates and deposited dust) from construction sites under the POEO Act. Activities undertaken onsite must not contribute to environmental degradation, and pollution and air emissions must not exceed the standards. Where an environment protection licence applies, air quality requirements (including criteria) may be specified by the licence.

The *Protection of the Environment Operations (Clean Air) Regulation 2010* (the Clean Air Regulation) provides regulatory measures to control emissions from motor vehicles, fuels, and industry. The proposal would be operated to ensure it complies with the Clean Air Regulation.

Air quality impact assessment criteria are prescribed by the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2016) (known as 'the Approved Methods').

The National Environment Protection Council of Environmental Ministers, now the National Environment Protection Council (NEPC), set uniform national standards for ambient air quality in February 2016. These are known as the *National Environment Protection (Ambient Air Quality) Measure* ('the Air NEPM'). The Air NEPM sets non-binding standards and ten-year goals (for 2026). The goal for the Air NEPM is a PM_{10} of 50 micrograms per cubic metre ($\mu g/m^3$) as a 24-hour average (no exceedances per year) and a $PM_{2.5}$ goal of 25 $\mu g/m^3$ as a 24-hour average.

The Air NEPM standards apply to regional air quality as it affects the general population. The standards do not apply in areas impacted by localised air emissions, such as industrial sources, construction activity, and heavily trafficked streets and roads.

Background concentrations of air pollutants are ideally obtained from ambient monitoring data collected at a proposal site in accordance with the Approved Methods. The Approved Methods recognises that this data is rare, and that data is typically obtained from monitoring sites as close as possible to a proposal site, where sources of air pollution resemble the existing sources at the proposal site.

The Approved Methods lists the statutory methods for modelling and assessing emissions of air pollutants from stationary sources in NSW. The assessment criteria for pollutants is applied at the nearest existing or likely future off-site sensitive receptor.

3.2 Project impact assessment criteria

The criteria for particulate matter (PM_{10} and $PM_{2.5}$) and total suspended particles (TSP) are prescribed by the Air NEPM and the Approved Methods respectively. PM_{10}, which has a 24-hour assessment criteria, is most relevant for assessing construction impacts. Dust deposition criteria are mainly used to assess the potential for amenity impacts. These criteria should be met at existing or future off-site sensitive receptors. Particulate and dust deposition levels are provided as cumulative impacts, where the predicted impact of the proposal is added to the adopted background levels.

To ensure that dust environmental outcomes are achieved, emissions from the proposal must be assessed against the assessment criteria shown in Table 3-1.

Table 3-1 Impact assessment criteria

Pollutant	Averaging period	Concentration (µg/m^3)
Total suspended particulates (TSP)	Annual	90
PM_{10}	24 hours	50
	Annual	25
$PM_{2.5}$	24 hours	25
	Annual	8
Dust deposition	Annual	2 g/m^2/month*

** Maximum Increment. Maximum cumulative impact of 4 g/m^2/month.*

The above criteria are provided as cumulative (incremental plus background) concentration levels.

4. Emissions from the proposal

4.1 Emissions overview

The air quality assessment focuses on dust, particulate matter being the primary emission to air from the quarry rehabilitation with potential for off-site impact. The fractions of interest assessed in this report are airborne concentrations of TSP and fine particulate matter as well as total deposited dust. Weather conditions that cause maximum dust impact are generally consistent winds in the direction of the nearest sensitive receivers throughout the daytime period outside of rain events.

The rehabilitation processes that may generate significant amounts of particulate matter (dust) were identified to be:

- Importation of up to 1.2 million cubic metres of clean fill consisting of VENM and ENM
- Vehicle haulage of clean fill material at a rate of up to 140,000 tpa
- Emplacement and consolidation of clean fill material within the existing quarry voids to closely represent the pre-quarry landform.

Emission rates from naturally wind-borne dust and mechanically induced dust were characterised using Emission Factors (EFs) provided in the National Pollutant Inventory (NPI) Emission Estimation Technique Manual (EETM) for Mining[1]. The techniques used to estimate emissions from mining operations are based primarily on activity rate (e.g. tonnes per hour).

Other air emissions such as combustion products (e.g. vehicle exhaust) will also be present within the quarry site, however due to the small number of vehicles, the potential for impact from these emissions is negligible. Therefore, vehicle exhaust emissions have not been considered further in this assessment.

4.2 Proposal site activities

It is understood that the quarry is to have a maximum material throughput of up to 1,110 tonnes per day, which equates, on average, to 111 tonnes per hour (TPH) over an 10 hour day (assume 1 hour of breaks in total), 6 days per week. Although it is not expected that the quarry will operate at 111 TPH consistently, this production rate has been chosen to represent a worst-case scenario to derive emission rates.

Table 4-1 provides a summary of the quarry equipment considered in this assessment.

Table 4-1 – On-site Equipment Summary

Equipment Type	Number of Units
Grader	1
Tipper truck (at any time)	1
Roller	1
Bulldozer	1
Wheeled loader	2
Water truck	1
Haul trucks – Daily movements on site (worst case)	74

[1] National Pollutant Inventory (NP)I Emission Estimation Technique Manual for Mining, Version 3.1 January 2012.

The following assumptions were made in calculating the dust emission rates for quarry activities.

- Where there was more than one item of the same equipment, the total throughput was split between each item. For example, if there were two loaders operating at once, it was assumed that each loader would have a throughput of 55.5 tonnes per hour.
- The use of a water truck and roller has been assumed not to generate dust emissions, as its use will act to suppress emissions. Therefore, the water truck and roller are not included in the emissions inventory.
- GHD has assumed that the existing quarry pit area will be rehabilitated (i.e the project) or used for water storage, and wind erosion will be minimal.

Observations made on similar sites compare well with the rank of primary dust emission sources as detailed in Table 4-2, which identifies vehicle movements and bulldozers to be the primary contributors to site dust emissions.

Table 4-2 Air quality emissions inventory

Equipment	Default TSP Emission Factor	Default PM_{10} Emission Factor	Default $PM_{2.5}$ Emission Factor	Unit	Application	TSP Emission Rate (kg/hr)	PM_{10} Emission Rate (kg/hr)	$PM_{2.5}$ Emission Rate (kg/hr)
Trucks within site to drop-off and back	4.23	1.25	0.19	kg/VKT	37 trucks in and out per day. Drop off area approximately 270 m from site entry.	4.2	1.2	0.2
Front end loaders	0.025	0.012	0.0018	kg/t	2 loaders, 55.5 tonnes per hour for each loader over a 10 hour day	2.8	1.3	0.2
Grader	0.19	0.085	0.01275	kg/VKT	1 grader, travelling 40 km per day onsite	0.8	0.3	0.1
Dump Truck - dumping	0.012	0.0043	0.00065	kg/t	Dumping 111 tonnes per hour	1.3	0.5	0.1
Bulldozer	17	4.1	0.615	kg/hr	1 bulldozer operating for 10 hours in the day. Assumed level 2 watering on days with high dust potential	4.3	1.0	0.2
Incoming spoil stockpile	0.4	0.2	0.03	kg/ha/hr	40 m^2, 2 m high incoming spoil stockpile based on two days of spoil stockpiled at any one time	0.0064	0.0032	0.00048

4.3 Sandham Road

Sandham Road is an unpaved road that leads from Bells Line Road to the site. The project involves importation of approximately 1.2 million cubic metres of clean fill over a period of approximately 15 years with a maximum haulage rate of 140,000 tpa using trucks with an average capacity of 30 tonnes.

It is estimated that haulage will occur for around 250 days per year accounting for wet days and reduced haulage on weekends. The resulting traffic generated based on this assumption is around 18 trucks travelling to the site resulting in an average of 37 heavy vehicle movements per day along Sandham Road.

It is also likely that at some stages, haulage to site may occur in campaigns corresponding to generation of excess VENM and ENM from construction projects throughout the region. This has potentially double the haulage movements for a restricted period of time and generate up to 74 heavy vehicle movements per day along Sandham Road. Any temporary increase in haulage during campaign operations would be followed by a period of reduced haulage to maintain the capacity of the site to accept 140,000 tpa.

To ensure a conservative assessment the worst case truck movement scenario has been assessed to determine dust emissions to sensitive receivers along Sandham Road. The site is open for 11 hours Monday to Friday (7 am to 6 pm) however to be conservative it has been assumed that trucks will be limited to travel 10 hours a day when determining an average per hour.

The unpaved section is approximately 3.7 km to the site entry. Particulate emissions ($PM_{2.5}$ and PM_{10}) have been assessed using the following assumptions in Table 4-3.

Table 4-3 Sandham Road particulate emissions

Truck movement detail	Assumption
Truck deliveries per day	37
Total truck numbers on Sandham Road	74
Trucks per hour	7.4
Truck frequency (minutes)	8.1
Unpaved section of Sandham Road	3.7 km
Total vehicle km per hour	27.4 km
TSP (4.23 kg/VKT)	115.9 kg/hr for entire unpaved road
PM_{10} (1.25 kg/VKT)	34.2 kg/hr for entire unpaved road
$PM_{2.5}$ (0.1875 kg/VKT)	5.13 kg/hr for entire unpaved road

Emissions from the road can be modelled as a number of volume sources spaced evenly along the road alignment, or by modelling representative sections of road.

5. Assessment methodology

5.1 Selection of a representative year of meteorology

An analysis of meteorology from the years from 2012 to 2016 was conducted to select a period considered to be most representative of 'normal' conditions.

A comprehensive analysis of the meteorological data has been undertaken that covers five years from the BoM site at Mount Boyce AWS, ID 063292. The analysis included five consecutive years of meteorological data as per guidance in the Approved Methods (EPA, 2016).

The analysis shows that the year 2014 is the most representative year based on a review of temperature, humidity, wind speed and wind direction. This year was also identified as not being excessively wet or dry.

Probability density function graphs of the wind speed and direction over the five years are provided in Appendix A.

5.2 Meteorological modelling

The TAPM prognostic model was run to obtain a coarse meteorological 3D gridded dataset for the site for the selected year. This dataset is based on synoptic observations, local terrain and land use information with a resolution of 1000 m. The TAPM model parameters are summarised in Table 5-1.

Table 5-1 Selected TAPM model settings

Parameter	Value
Modelled Year	January 2014 – December 2014
Domain centre	Latitude = S -33.47 Longitude = E 150.25
Site location	244846 m E; 6292544 m N
Number of vertical levels	30
Number of Easting Grid Points	41
Number of Northing Grid Points	41
Outer Grid Spacing Number of Grids (nests)	30,000 m x 30,000 m 4
Grid Resolution	Level 1 – 30,000 m Level 2 – 10,000 m Level 3 – 3,000 m Level 4 – 1,000 m

GHD has found from previous studies that TAPM does not predict light wind conditions as well as CALMET. It is these meteorological conditions which give rise to the upper percentile impacts, (i.e. top 0.1 per cent) when poor dispersion can occur.

Upon completion of the broad scale TAPM modelling runs, a CALMET simulation was set up to run for the modelled year, combining the three dimensional gridded data output from the TAPM model and using the CALTAPM conversion utility available with CALMET. This approach is consistent with NSW OEH (2011) guidance documentation.

5.2.1 CALMET diagnostic meteorological pre-processor

The US EPA approved version of CALMET (Version 5.8) was used to resolve the wind field around the project area to a 400 m spatial resolution. The application of CALMET is an approved modelling approach in Approved Methods, with model guidance documentation provided (OEH, 2011).

All model settings were selected based on the OEH (2012) guidance and as per the CALPUFF modelling guidelines (OEH, 2011, p. 5). CALMET was run using the OBS mode with the TAPM data provided as an initial guess field.

All CALMET settings were selected as per the CALPUFF guidance document OEH (2011), except for the following.

- O'Brien adjustment for vertical velocity smoothing (IOBR = 1)

The terrain of the site is shown in Figure 5-1, where Lakes Calpuff View was used to generate the geo file containing topography and land use data to the resolution required for the CALMET run. This file was modified manually to produce the results with the site location in the centre. The meteorology of the region is also influenced by the local terrain and vegetation meaning that the resulting winds in the local area are different to those experienced at the BOM Mount Boyce site approximately 20 km away.

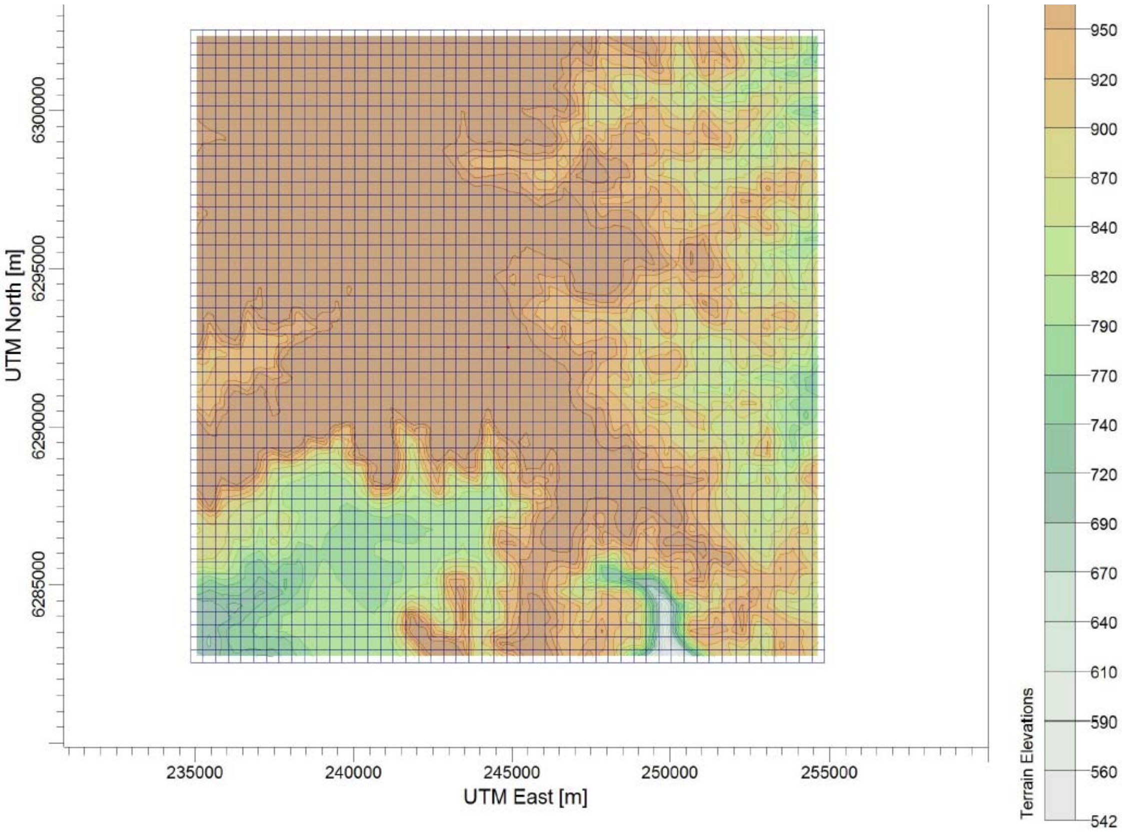


Figure 5-1 CALMET terrain data

The TERRAD variable was set to a value of 3 km based on an inspection of the terrain elevations in the immediate vicinity of the site, based on OEH (2011) guidance. The CALMET model parameters are summarised in Table 5-2.

Table 5-2 Selected CALMET model settings

Parameter	Value
Mode	No obs mode
UTM Zone	56
Domain Origin (SW corner)	Easting: 234.846 km Northing: 6282.544 km
Grid Resolution	60 x 60 at 0.4 km resolution (24 km x 24 km)
Number of Vertical Levels	11
Vertical Levels (m)	20,40,60,90,120,180,250,500, 750, 1000, 2000, 3000
CALMET Settings for No-Obs mode (OEH, 2011)	TERRAD = 3 km O'Brien Vertical Velocity Adjustments

5.3 Site specific meteorology

5.3.1 Wind

The local meteorology largely determines the pattern of off-site air quality impact on receptors. The effect of wind on dispersion patterns can be examined using the wind and stability class distributions at the site. The winds at a site are most readily displayed by means of wind rose and stability distribution plots.

The features of particular interest in this assessment are: (i) the dominant wind directions and (ii) the relative incidence of stable light wind conditions that yield minimal mixing.

Figure 5-2 shows the annual average wind rose for the site for the period 1 January 2014 to 31 December 2014, and the following features can be seen:

- Annual average wind speed of 3.01 m/s
- Winds are most prevalent from the western sectors
- Winds are least prevalent for the south and eastern sectors
- Light winds (< 1.5 m/s) are more prevalent from the southeast and northwest
- The observed wind speed distribution indicates that the largest proportion of high wind speeds (> 6 m/s) are from the west, with a small portion of high wind speeds (> 6 m/s) from the north, east and south.

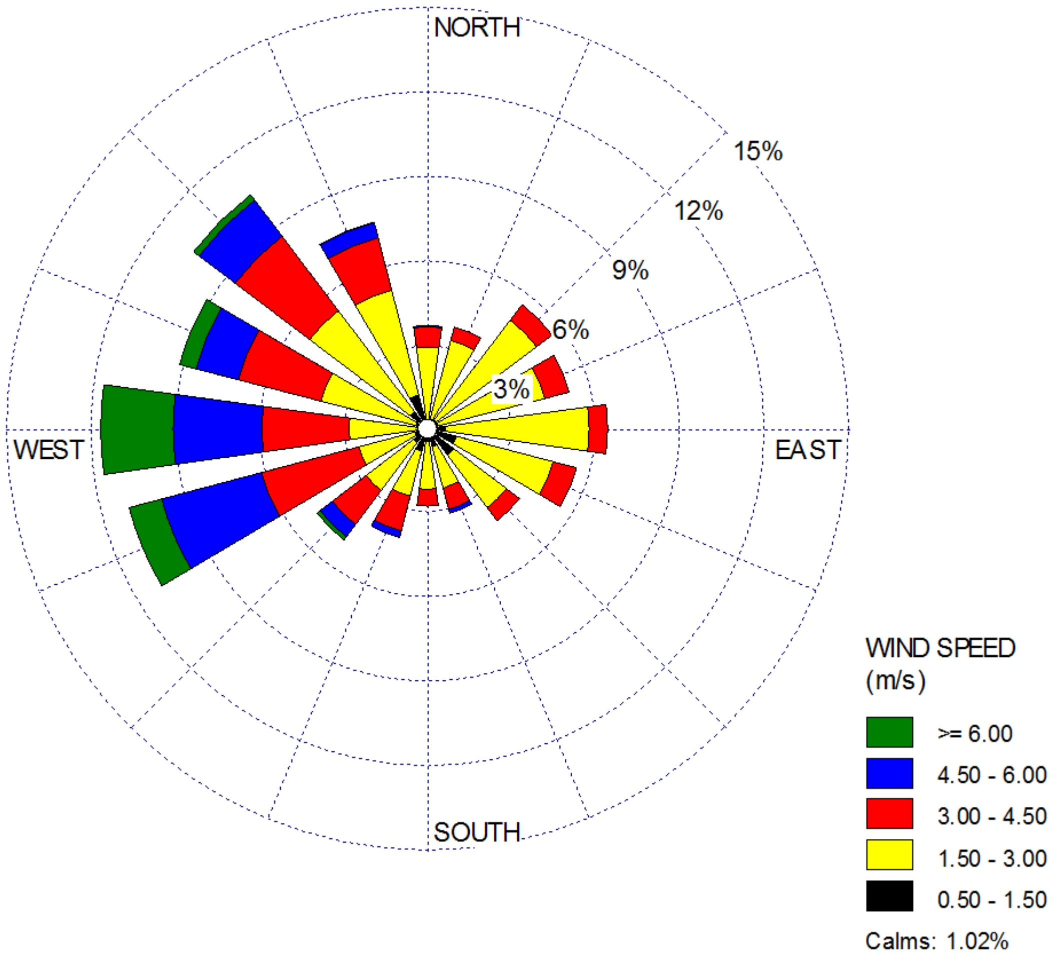


Figure 5-2 CALMET wind rose at proposal site (average wind speed = 3 m/s)

5.3.2 Atmospheric Stability

Atmospheric stability substantially affects the capacity of a pollutant such as gas, particulate matter or odour to disperse into the surrounding atmosphere upon discharge and is a measure of the amount of turbulent energy in the atmosphere.

There are six Pasquill–Gifford classes (A-F) used to describe atmospheric stability, and these classes are grouped into three stability categories; stable (classes E-F), neutral (class D), and unstable (classes A-C). The climate parameters of wind speed, cloud cover and insolation are used to define the stability category as shown in Table 5-3, and as these parameters vary diurnally, there is a corresponding variation in the occurrence of each stability category. Stability is most readily displayed by means of stability rose plots, giving the frequency of winds from different directions for various stability classes A to F.

Table 5-3 Stability category relationship to wind speed, and stability characteristics

Stability Category	Wind Speed Range (m/s) [a]	Stability Characteristics
A	0 – 2.8	Extremely unstable atmospheric conditions, occurring near the middle of day, with very light winds, no significant cloud
B	2.9 – 4.8	Moderately unstable atmospheric conditions occurring during mid-morning/mid-afternoon with light winds or very light winds with significant cloud
C	4.9 – 5.9	Slightly unstable atmospheric conditions occurring during early morning/late afternoon with moderate winds or lighter winds with significant cloud
D	≥6	Neutral atmospheric conditions. Occur during the day or night with stronger winds or during periods of total cloud cover, or during the twilight period
E	3.4 – 5.4 [b]	Slightly stable atmospheric conditions occurring during the night-time with significant cloud and/or moderate winds
F	0 – 3.3 [b]	Moderately stable atmospheric conditions occurring during the night-time with no significant cloud and light winds

a. Data sourced from the Turner's Key to the P-G stability Categories, assuming a Net Radiation Index of +4 for daytime conditions (between 10:00 am and 6:00 pm) and –2 for night-time conditions (between 6:00 pm and 10:00 am)

b. Assumed to only occur at night, during Net Radiation Index categories of –2.

The incidence of stable conditions can be viewed by means of a stability distribution plot.

Figure 5-3 shows the frequency distribution of stability classes for the entire data period (one year). The figure shows that stable atmospheres (E and F) occur for 43% of the total time period. Unstable atmospheres (A, B and C) occur 35% of the total time period while neutral conditions (D) occur 21% of the total time period. The dominant state of the atmosphere is stable or neutral (D, E and F).

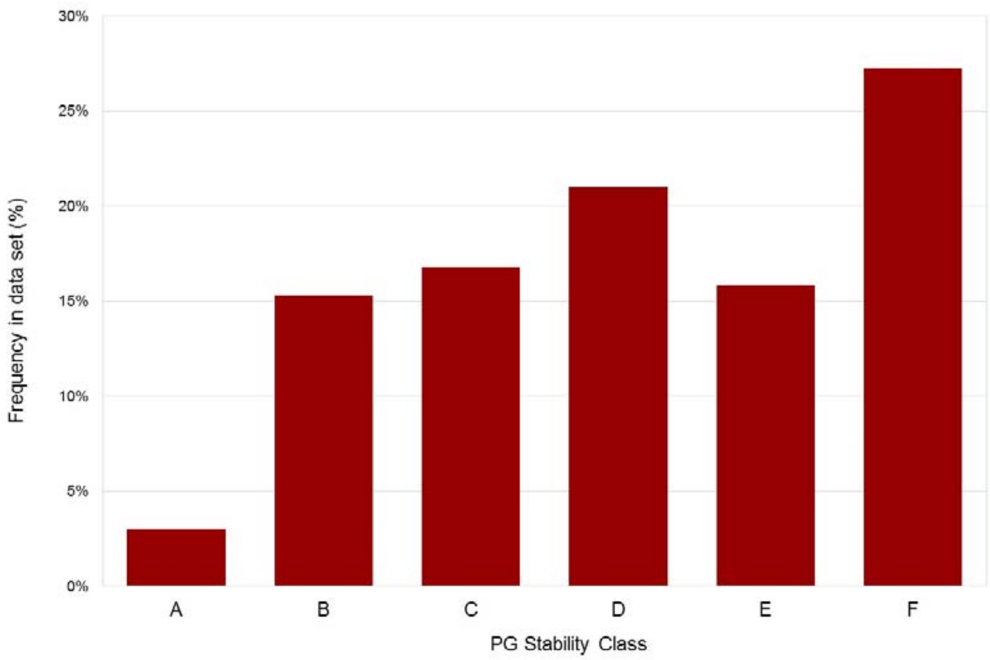


Figure 5-3 CALMET atmospheric stability class distribution at site

5.4 Dispersion modelling

Atmospheric dispersion modelling was carried out using the CALPUFF dispersion model. CALPUFF is a non-steady-state, Lagrangian puff dispersion model. It is accepted for use by the Office of Environment and Heritage and NSW Environment Protection Authority for application in environments where wind patterns and plume dispersion is strongly influenced by complex terrain, the land-sea interface or where there is a high frequency of stable calm night-time conditions.

The local terrain surrounding the site is relatively complex, and surrounding receivers are all at a higher elevation that the Bell Quarry site. This makes CALPUFF the most appropriate dispersion model for this assessment.

For this assessment, the CALPUFF dispersion model was used to predict ground-level concentrations of modelled pollutants downwind of the proposal. The grid size used in the CALPUFF model was equivalent to the CALMET domain. A grid resolution of 200 m was used in CALPUFF.

The following assumptions have also been applied in the assessment:

- Stage 1 of the proposal is closest to nearby receivers that can be exposed to particulate emission and is considered worst-case. This area is also elevated compared to other areas of site which may mean particulates will disperse easier towards receivers to the north west
- During Stage 1 it is anticipated that excess water currently in the quarry will be available for dust suppression. Level 2 watering has been assumed to occur in areas where the bulldozer is operating on days of excessive winds or dust lift off in the direction of nearby receivers
- Site works are between 7 am and 6 pm, and a 1 hour break has been assumed to occur i.e. emissions for each piece of equipment have been assumed to operate for 10 full hours and is considered conservative.

6. Predicted impacts

6.1 Bell Quarry site

A summary of the predicted particulate concentrations are presented in Table 6-1 to

Table 6-3. These tables include the top four ranked days at the nearest six sensitive receivers and show that the levels drop considerably after the two highest predicted days at the nearest two receivers. The values in these tables are the incremental impact only and do not include the background.

Table 6-1 Top ranked incremental 24 hour PM_{10} impact (µg/m^3)

Receptor	Rank 1	Rank 2	Rank 3	Rank 4
R1	27.6	25.0	16.5	15.4
R2	20.4	18.1	10.2	10.1
R3	22.8	17.2	9.9	9.6
R4	4.4	4.2	3.7	3.3
R5	2.7	2.7	2.2	1.9
R6	2.5	2.4	2.3	2.1

Table 6-2 Top ranked incremental 24 hour $PM_{2.5}$ impact (µg/m^3)

Receptor	Rank 1	Rank 2	Rank 3	Rank 4
R1	9.3	9.1	8.5	7.2
R2	5.8	5.7	5.6	4.8
R3	6.6	5.8	5.8	5.0
R4	1.9	1.5	1.3	1.2
R5	1.2	1.1	1.0	0.8
R6	1.2	1.0	1.0	0.9

Table 6-3 Predicted annual concentration (µg/m^3)

Receptor	TSP	PM_{10}	$PM_{2.5}$	Deposited Dust (g/m^2/month)
R1	19.5	1.4	0.7	0.59
R2	11.0	0.8	0.4	0.25
R3	11.1	0.8	0.5	0.23
R4	3.6	0.2	0.1	0.06
R5	2.9	0.1	0.1	0.04
R6	2.6	0.1	0.1	0.04

The following dispersion modelling plots are provided in Appendix C:

- Predicted PM_{10} 24-hour Average Concentration $\mu g/m^3$
- Predicted PM_{10} Annual Average Concentration $\mu g/m^3$
- Predicted $PM_{2.5}$ 24-hour Average Concentration $\mu g/m^3$
- Predicted $PM_{2.5}$ Annual Average Concentration $\mu g/m^3$
- Predicted TSP Annual Average Concentration $\mu g/m^3$.

A contemporaneous assessment has been undertaken at the nearest receiver in accordance with the Approved Methods to predict PM_{10} and $PM_{2.5}$ levels from the proposal site. The maximum measured background, site increment and total for PM_{10} and $PM_{2.5}$ is shown in Table 6-4 and Table 6-5 below. Results show compliance with the criteria of 50 $\mu g/m^3$ and 25 $\mu g/m^3$ for both PM_{10} and $PM_{2.5}$. It should be noted that the background and incremental levels will not sum up to the provided total levels as the maximum background, incremental and total impacts occur on different days.

Table 6-4 Summary of highest measured and predicted PM_{10} $\mu g/m^3$ levels (R1)

Date	PM_{10} background	Date	PM_{10} increment	Date	PM_{10} Total
10/02/2014	40	23/03/2014	27.6	23/03/2014	40.1
17/12/2014	36.6	20/08/2014	25.0	10/02/2014	40.0
31/12/2014	34.9	10/06/2014	16.5	26/11/2014	38.0
23/11/2014	34.5	25/08/2014	15.4	17/12/2014	36.6
27/10/2014	33.6	12/08/2014	14.6	20/08/2014	35.8
25/05/2014	33.5	05/09/2014	14.1	31/12/2014	34.9
15/11/2014	33.1	09/06/2014	12.9	23/11/2014	34.5
06/08/2014	32	11/05/2014	11.2	27/10/2014	33.6
26/11/2014	30.7	21/01/2014	11.0	25/05/2014	33.5
01/02/2014	30.6	14/04/2014	10.6	15/11/2014	33.1

Table 6-5 Summary of highest measured and predicted $PM_{2.5}$ $\mu g/m^3$ levels (R1)

Date	PM2.5 background	Date	PM2.5 increment	Date	PM2.5 Total
06/08/2014	24.7	31/12/2014	9.3	06/08/2014	24.7
25/05/2014	22.1	20/09/2014	9.3	25/05/2014	22.1
08/06/2014	19.4	10/06/2014	9.1	31/12/2014	20.0
03/08/2014	17.8	02/04/2014	8.5	08/06/2014	19.6
04/07/2014	17.6	21/02/2014	7.2	03/08/2014	17.9
03/07/2014	16.8	20/08/2014	7.0	04/07/2014	17.6
27/07/2014	16.6	03/04/2014	6.9	22/07/2014	17.4
22/05/2014	16.1	30/03/2014	6.8	10/06/2014	17.1
25/10/2014	14.5	20/07/2014	6.6	03/07/2014	16.8
24/11/2014	14.4	23/03/2014	6.4	03/04/2014	16.8

6.2 Sandham Road

Worst case (100th percentile) PM_{10} emissions have been modelled in order to gain an understanding of potential dust impacts. Three scenarios have been assessed:

- Worst case predicted 24 hour PM_{10} concentration with no mitigation
- Worst case predicted 24 hour PM_{10} concentration with level 1 watering (2 litres/m^2/hr)
- Worst case predicted 24 hour PM_{10} concentration with level 2 watering (>2 litres/m^2/hr).

Results in Figure 6-1 show that on the worst case day of the year, PM_{10} emission would exceed the criteria up to a distance of 120 m from the road (the nearest house is approximately 80 m from Sandham Road). As identified in Section 2.1, receivers R18 and R28 are within this distance. Dust mitigation would be needed on these worst-case days as the predicted increment from the road is above the 24 hour criteria of 50 µg/m^3 (i.e. Mitigation is needed when visible dust plumes are observed to be blowing in the direction of affected receivers).

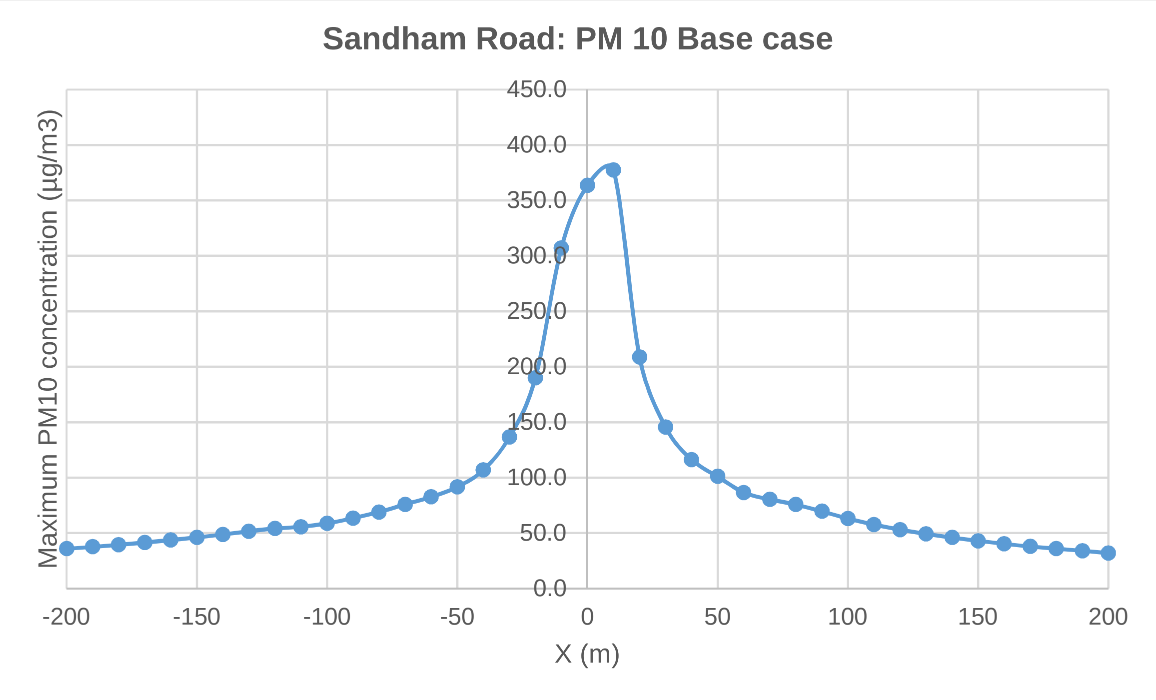


Figure 6-1 Predicted 100th percentile PM10 emissions from Sandham Road, no mitigation

Modelling assuming level 1 watering applied to Sandham Road when visible dust plumes are observed to be dispersing in the direction of nearby receivers has been undertaken with a worst-case cross section of PM_{10} levels from Sandham Road presented in Figure 6-2. Results show that PM_{10} emission would exceed the criteria up to a distance of 60 m from the road.

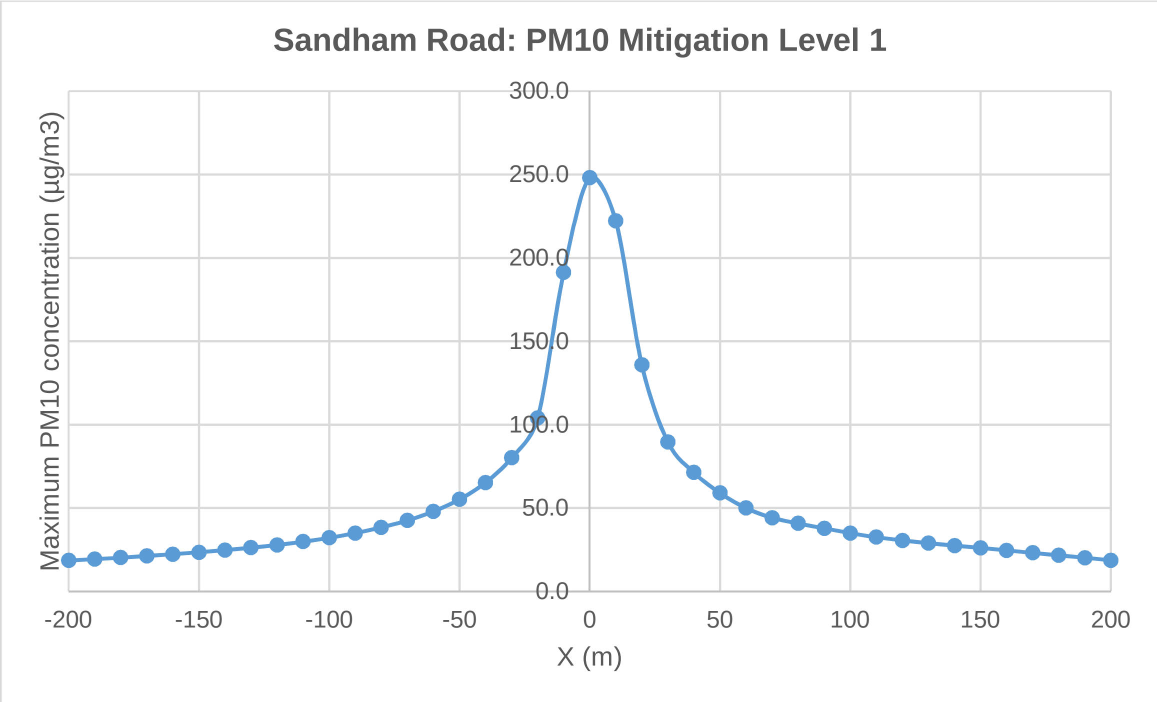


Figure 6-2 Predicted 100th percentile PM10 emissions from Sandham Road, with level 1 mitigation

Modelling assuming level 2 watering applied to Sandham Road when visible dust plumes are observed to be dispersing in the direction of nearby receivers has been undertaken with a worst-case cross section of PM_{10} levels from Sandham Road presented in Figure 6-2. Results show that PM_{10} emission would exceed the criteria up to a distance of 30 m from the road.

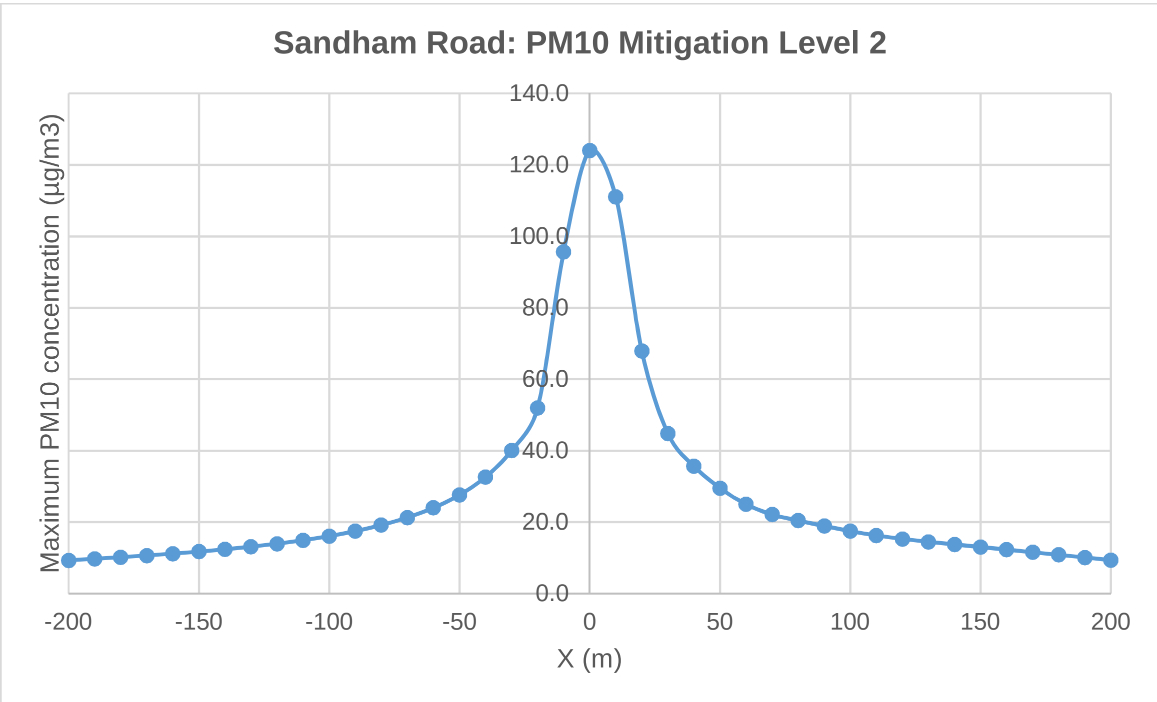


Figure 6-3 Predicted 100th percentile PM_{10} emissions from Sandham Road, with level 2 mitigation

A contemporaneous assessment in accordance with the Approved Methods has been undertaken at the nearest receiver to predict the highest PM_{10} impacts from Sandham Road for both dust mitigation scenarios. The contemporaneous assessment for Mitigation 1 in Table 6-6 shows one day in the year where predicted PM_{10} levels marginally exceed the 24 hour criteria of 50 µg/m^3. This is at the nearest receiver only (R28) and it not expected at any other receivers.

Table 6-6 Summary of highest measured and predicted PM_{10} levels at nearest receiver (R28) to Sandham Road (Mitigation 1)

Date	PM_{10} background	Date	PM_{10} increment	Date	PM_{10} Total
10/02/2014	40	18/06/2014	39.1	**18/06/2014**	**52.0**
17/12/2014	36.6	14/08/2014	30.5	10/02/2014	49.9
31/12/2014	34.9	11/06/2014	23.7	14/08/2014	45.1
23/11/2014	34.5	05/06/2014	23.0	17/12/2014	42.9
27/10/2014	33.6	22/07/2014	21.6	21/05/2014	42.3
25/05/2014	33.5	21/09/2014	18.7	06/08/2014	41.8
15/11/2014	33.1	08/06/2014	16.6	25/05/2014	40.0
06/08/2014	32	22/06/2014	16.6	31/12/2014	39.3
26/11/2014	30.7	21/05/2014	16.5	15/11/2014	38.2
01/02/2014	30.6	31/08/2014	14.9	22/07/2014	38.1

Level 2 watering of applying greater than 2L/m2/hr, to the portion of Sandham Road directly adjacent to R28 when visible dust plumes are observed to be dispersing in that direction was therefore considered. Results are shown in Table 6-7 and show compliance with the 24 hour criteria of 50 µg/m^3.

Table 6-7 Summary of highest measured and predicted PM_{10} levels at nearest receiver (R28) to Sandham Road (Mitigation 2)

Date	PM_{10} background	Date	PM_{10} increment	Date	PM_{10} Total
10/02/2014	40	18/06/2014	19.6	10/02/2014	45.0
17/12/2014	36.6	14/08/2014	15.2	17/12/2014	39.7
31/12/2014	34.9	11/06/2014	11.8	31/12/2014	37.1
23/11/2014	34.5	05/06/2014	11.5	06/08/2014	36.9
27/10/2014	33.6	22/07/2014	10.8	25/05/2014	36.7
25/05/2014	33.5	21/09/2014	9.4	15/11/2014	35.7
15/11/2014	33.1	08/06/2014	8.3	23/11/2014	34.8
06/08/2014	32	22/06/2014	8.3	27/10/2014	34.3
26/11/2014	30.7	21/05/2014	8.2	21/05/2014	34.0
01/02/2014	30.6	31/08/2014	7.5	18/06/2014	32.5

7. Mitigation measures

7.1 Sandham Road

Dust dispersion modelling identified haul trucks operating on unsealed surfaces are a significant source of dust. In order to control potential dust impacts from Sandham Road, and to meet the project criteria, Level 1 (2L/m^2/hr) water spraying should be undertaken on Sandham Road whenever visible plumes of dust are observed to be blowing towards nearby receivers (specifically R18 and R28). This should be undertaken during daytime weather conditions that assist dust dispersion (dry and windy).

Level 2 watering (>2L/m^2/hr) should be undertaken directly adjacent to R28 when visible dust plumes are observed to be dispersing in that direction.

7.2 General dust mitigation measures

While general quarry rehabilitation operations are not expected to exceed air quality goals at nearby private receptors, the following mitigation measures are recommended.

- Water material prior to it being loaded for on-site haulage, where appropriate
- Aim to minimise the size of storage piles where possible
- Limit cleared areas of land and clear only when necessary to reduce fugitive dust emissions
- Control on-site traffic by designating specific routes for haulage and access and limiting vehicle speeds to below 25 km/hr
- All trucks hauling material should be covered on the way to the site and should maintain a reasonable amount of vertical space between the top of the load and top of the trailer
- Operations conducted in areas of low moisture content material should be suspended during high wind speed events or water sprays should be used
- These measures will assist in reducing impact on all areas off-site.

8. Conclusion

GHD was commissioned by Bell Quarry Rehabilitation Project Pty Ltd to undertake an air quality assessment of proposed operations at the Bell Quarry site. The air quality assessment was undertaken to assess potential impacts on surrounding sensitive receivers during operation of the site. Particulate emissions ($PM_{2.5}$, PM_{10} and TSP) were estimated based on the project description and expected equipment to be used during operation. The assessment was undertaken of Stage 1 of the proposal as this is considered worst-case in terms of potential dust impacts on receivers.

Weather conditions that cause maximum dust impact are generally consistent winds in the direction of the nearest sensitive receivers throughout the daytime period outside of rain events

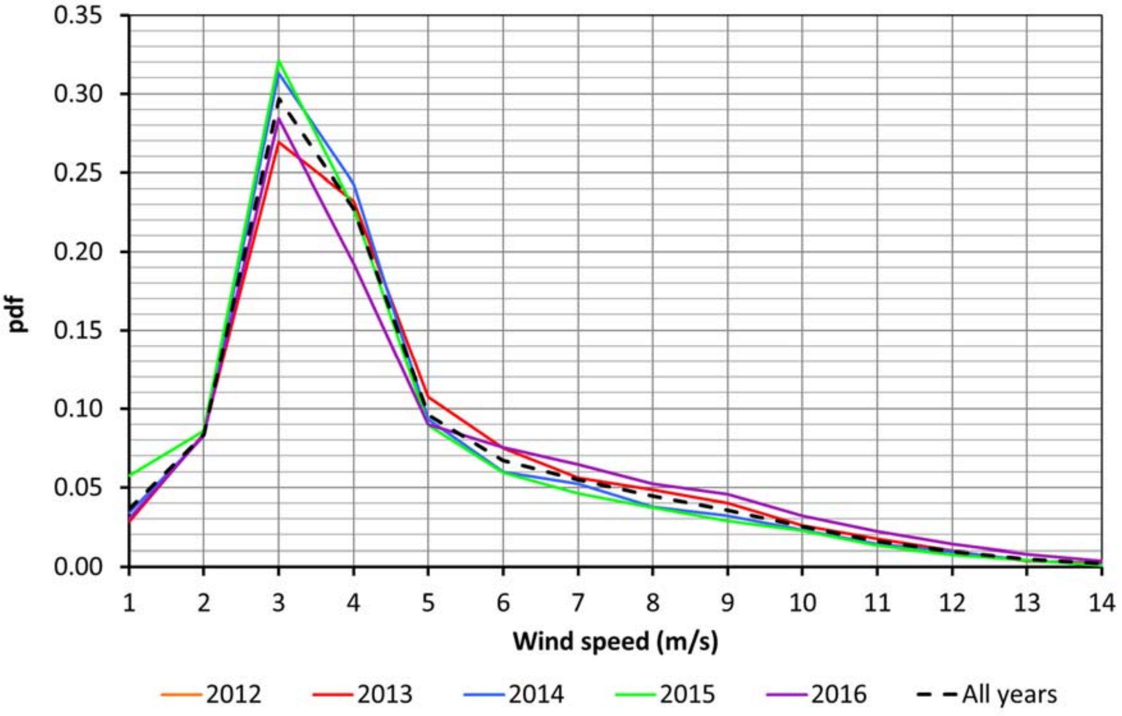
Based on assumptions in the assessment, predicted $PM_{2.5}$, PM_{10} and TSP emissions from the proposed site are expected to comply with the relevant criteria when assessed in accordance with the Approved Methods. The application of standard dust mitigation measures will also assist to minimise potential impacts from general site operations.

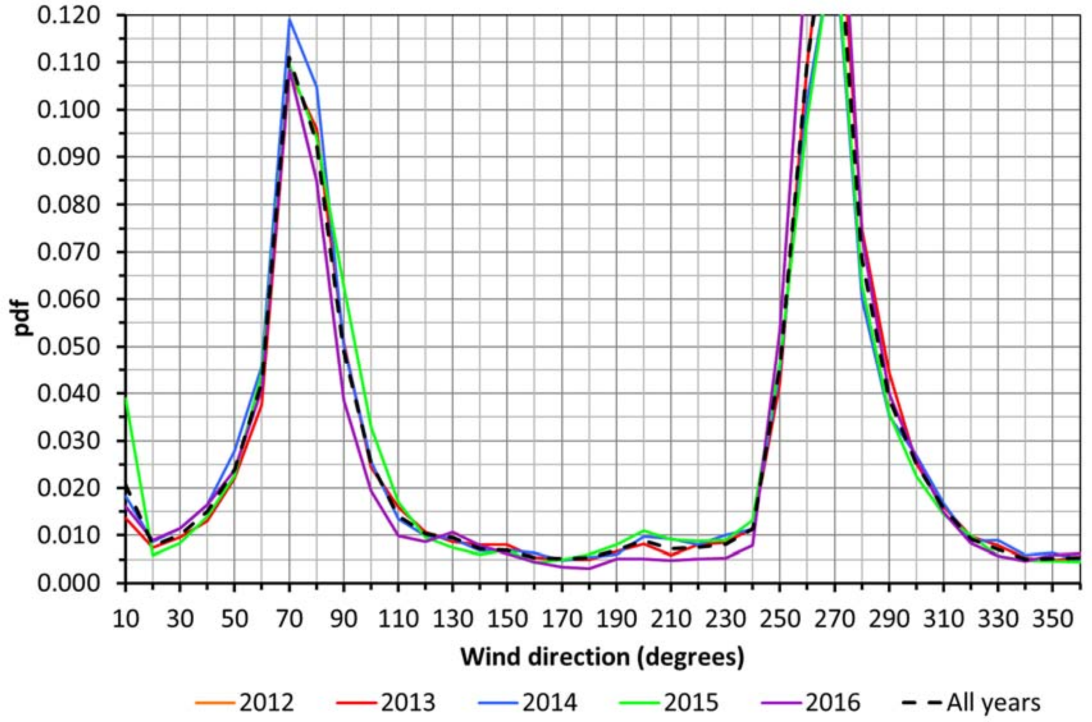
An assessment was undertaken of potential PM_{10} impacts from trucks using the unpaved Sandham Road. The assessment found that the maximum predicted 24 hour PM_{10} level may exceed the 50 µg/m^3 criteria. Dust mitigation options were considered which include different levels of watering. The assessment found that Level 1 (2L/m^2/hr) water spraying should be undertaken on Sandham Road during dry windy conditions whenever visible plumes of dust are observed to be blowing towards nearby receivers (specifically R18 and R28). Level 2 watering (>2L/m^2/hr) should be undertaken directly adjacent to R28 when visible dust plumes are observed to be dispersing in that direction.

The proposal should be acceptable from an air quality perspective provided the relevant mitigation measures are implemented.

Appendices

Appendix A – Selection of a representative year





Appendix B – Sample Calpuff input file

```
BellQuarry - Dust


---------------- Run title (3 lines) ------------------------------------------

                    CALPUFF MODEL CONTROL FILE
                    --------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names

--------------
Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    * METDAT = *
    or
ISCMET.DAT    input    * ISCDAT = *
    or
PLMMET.DAT    input    * PLMDAT = *
    or
PROFILE.DAT   input    * PRFDAT = *
SURFACE.DAT   input    * SFCDAT = *
RESTARTB.DAT  input    * RSTARTB = *
--------------------------------------------------------------------------------
CALPUFF.LST   output   ! PUFLST = CALPUFF.LST !
CONC.DAT      output   ! CONDAT = CONC.DAT !
DFLX.DAT      output   ! DFDAT = DFLX.DAT !
WFLX.DAT      output   ! WFDAT = WFLX.DAT !

VISB.DAT      output   * VISDAT = *
RHO2D.DAT     output   * RHODAT = *
RESTARTE.DAT  output   * RSTARTE = *
--------------------------------------------------------------------------------
Emission Files
--------------
PTEMARB.DAT   input    * PTDAT = *
VOLEMARB.DAT  input    * VOLDAT = *
BAEMARB.DAT   input    * ARDAT = *
LNEMARB.DAT   input    * LNDAT = *
--------------------------------------------------------------------------------
Other Files
-----------
OZONE.DAT     input    * OZDAT = *
VD.DAT        input    * VDDAT = *
CHEM.DAT      input    * CHEMDAT = *
H2O2.DAT      input    * H2O2DAT = *
HILL.DAT      input    * HILDAT = *
HILLRCT.DAT   input    * RCTDAT = *
COASTLN.DAT   input    * CSTDAT = *
FLUXBDY.DAT   input    * BDYDAT = *
BCON.DAT      input    * BCNDAT = *
DEBUG.DAT     output   * DEBUG = *
MASSFLX.DAT   output   * FLXDAT = *
MASSBAL.DAT   output   * BALDAT = *
FOG.DAT       output   * FOGDAT = *
--------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case      ! LCFILES = F !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 70 characters in length


Provision for multiple input files
----------------------------------

     Number of CALMET.DAT files for run (NMETDAT)
                                      Default: 1       ! NMETDAT = 8 !

     Number of PTEMARB.DAT files for run (NPTDAT)
                                      Default: 0       ! NPTDAT = 0 !

     Number of BAEMARB.DAT files for run (NARDAT)
                                      Default: 0       ! NARDAT = 0 !

     Number of VOLEMARB.DAT files for run (NVOLDAT)
                                      Default: 0       ! NVOLDAT = 0 !

!END!

-------------
Subgroup (0a)
-------------

  The following CALMET.DAT filenames are processed in sequence if NMETDAT>1
```



```
Default Name  Type          File Name
------------  ----          ---------
 none         input    ! METDAT=CALMET_2011-12-27-00-0000-2012-08-11-00-0000.DAT     !  !END!
 none         input    ! METDAT=CALMET_2012-08-11-00-0000-2013-03-27-00-0000.DAT     !  !END!
 none         input    ! METDAT=CALMET_2013-03-27-00-0000-2013-11-10-00-0000.DAT     !  !END!
 none         input    ! METDAT=CALMET_2013-11-10-00-0000-2014-06-26-00-0000.DAT     !  !END!
 none         input    ! METDAT=CALMET_2014-06-26-00-0000-2015-02-10-00-0000.DAT     !  !END!
 none         input    ! METDAT=CALMET_2015-02-10-00-0000-2015-09-26-00-0000.DAT     !  !END!
 none         input    ! METDAT=CALMET_2015-09-26-00-0000-2016-05-11-00-0000.DAT     !  !END!
 none         input    ! METDAT=CALMET_2016-05-11-00-0000-2016-12-25-00-0000.DAT     !  !END!


-------------
Subgroup (0b)
-------------

  The following PTEMARB.DAT filenames are processed in sequence if NPTDAT>0
  (Each file contains a subset of the sources, for the entire simulation)

Default Name  Type          File Name
------------  ----          ---------
* PTDATLIST = *


-------------
Subgroup (0c)
-------------

  The following BAEMARB.DAT filenames are processed in sequence if NARDAT>0
  (Each file contains a subset of the sources, for the entire simulation)

Default Name  Type          File Name
------------  ----          ---------
* ARDATLIST = *


-------------
Subgroup (0d)
-------------

  The following VOLEMARB.DAT filenames are processed in sequence if NARDAT>0
  (Each file contains a subset of the sources, for the entire simulation)

Default Name  Type          File Name
------------  ----          ---------
* VOLDATLIST = *

-------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

    Option to run all periods found
    in the met. file     (METRUN)   Default: 0       ! METRUN = 0 !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in met. file

     Starting date:   Year (IBYR) -- No default       ! IBYR = 2014 !
     (used only if   Month (IBMO) -- No default       ! IBMO = 1 !
      METRUN = 0)      Day (IBDY) -- No default       ! IBDY = 1 !
                      Hour (IBHR) -- No default       ! IBHR = 0 !

     Base time zone        (XBTZ) -- No default       ! XBTZ = -10 !
        PST = 8., MST = 7.
        CST = 6., EST = 5.

     Length of run (hours) (IRLG) -- No default       ! IRLG = 8760 !

     Number of chemical species (NSPEC)
                                     Default: 5       ! NSPEC = 3 !

     Number of chemical species
     to be emitted  (NSE)            Default: 3       ! NSE = 3 !

     Flag to stop run after
     SETUP phase (ITEST)             Default: 2       ! ITEST = 2 !
     (Used to allow checking
     of the model inputs, files, etc.)
           ITEST = 1 - STOPS program after SETUP phase
           ITEST = 2 - Continues with execution of program
                       after SETUP

     Restart Configuration:
```



```
        Control flag (MRESTART)      Default: 0       ! MRESTART = 0 !

           0 = Do not read or write a restart file
           1 = Read a restart file at the beginning of
               the run
           2 = Write a restart file during run
           3 = Read a restart file at beginning of run
               and write a restart file during run

        Number of periods in Restart
        output cycle (NRESPD)        Default: 0       ! NRESPD = 0 !

           0 = File written only at last period
          >0 = File updated every NRESPD periods

     Meteorological Data Format (METFM)
                                     Default: 1       ! METFM = 1 !

           METFM = 1 - CALMET binary file (CALMET.MET)
           METFM = 2 - ISC ASCII file (ISCMET.MET)
           METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
           METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)
           METFM = 5 - AERMET tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)

     Meteorological Profile Data Format (MPRFFM)
            (used only for METFM = 1, 2, 3)
                                     Default: 1       ! MPRFFM = 1 !

           MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
           MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

     PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
     Averaging Time (minutes) (AVET)
                                     Default: 60.0    ! AVET = 60 !
     PG Averaging Time (minutes) (PGTIME)
                                     Default: 60.0    ! PGTIME = 60 !


!END!


-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Technical options
--------------


     Vertical distribution used in the
     near field (MGAUSS)                   Default: 1     ! MGAUSS = 1 !
        0 = uniform
        1 = Gaussian

     Terrain adjustment method
     (MCTADJ)                              Default: 3     ! MCTADJ = 3 !
        0 = no adjustment
        1 = ISC-type of terrain adjustment
        2 = simple, CALPUFF-type of terrain
            adjustment
        3 = partial plume path adjustment

     Subgrid-scale complex terrain
     flag (MCTSG)                          Default: 0     ! MCTSG = 0 !
        0 = not modeled
        1 = modeled

     Near-field puffs modeled as
     elongated slugs? (MSLUG)              Default: 0     ! MSLUG = 0 !
        0 = no
        1 = yes (slug model used)

     Transitional plume rise modeled?
     (MTRANS)                              Default: 1     ! MTRANS = 1 !
        0 = no  (i.e., final rise only)
        1 = yes (i.e., transitional rise computed)

     Stack tip downwash? (MTIP)            Default: 1     ! MTIP = 1 !
        0 = no  (i.e., no stack tip downwash)
        1 = yes (i.e., use stack tip downwash)

     Method used to simulate building
     downwash? (MBDW)                      Default: 1     ! MBDW = 1 !
        1 = ISC method
        2 = PRIME method
```



```
     Vertical wind shear modeled above
     stack top? (MSHEAR)                   Default: 0     ! MSHEAR = 0 !
        0 = no  (i.e., vertical wind shear not modeled)
        1 = yes (i.e., vertical wind shear modeled)

     Puff splitting allowed? (MSPLIT)      Default: 0     ! MSPLIT = 0 !
        0 = no (i.e., puffs not split)
        1 = yes (i.e., puffs are split)

     Chemical mechanism flag (MCHEM)       Default: 1     ! MCHEM = 0 !
        0 = chemical transformation not
            modeled
        1 = transformation rates computed
            internally (MESOPUFF II scheme)
        2 = user-specified transformation
            rates used
        3 = transformation rates computed
            internally (RIVAD/ARM3 scheme)
        4 = secondary organic aerosol formation
            computed (MESOPUFF II scheme for OH)

     Aqueous phase transformation flag (MAQCHEM)
     (Used only if MCHEM = 1, or 3)        Default: 0     ! MAQCHEM = 0 !
        0 = aqueous phase transformation
            not modeled
        1 = transformation rates adjusted
            for aqueous phase reactions

     Wet removal modeled ? (MWET)          Default: 1     ! MWET = 1 !
        0 = no
        1 = yes

     Dry deposition modeled ? (MDRY)       Default: 1     ! MDRY = 1 !
        0 = no
        1 = yes
        (dry deposition method specified
         for each species in Input Group 3)


     Gravitational settling (plume tilt)
     modeled ? (MTILT)                     Default: 0     ! MTILT = 0 !
        0 = no
        1 = yes
        (puff center falls at the gravitational
         settling velocity for 1 particle species)

     Restrictions:
         - MDRY  = 1
         - NSPEC = 1  (must be particle species as well)
         - sg    = 0  GEOMETRIC STANDARD DEVIATION in Group 8 is
                      set to zero for a single particle diameter

     Method used to compute dispersion
     coefficients (MDISP)                  Default: 3     ! MDISP = 3 !

        1 = dispersion coefficients computed from measured values
            of turbulence, sigma v, sigma w
        2 = dispersion coefficients from internally calculated
            sigma v, sigma w using micrometeorological variables
            (u*, w*, L, etc.)
        3 = PG dispersion coefficients for RURAL areas (computed using
            the ISCST multi-segment approximation) and MP coefficients in
            urban areas
        4 = same as 3 except PG coefficients computed using
            the MESOPUFF II eqns.
        5 = CTDM sigmas used for stable and neutral conditions.
            For unstable conditions, sigmas are computed as in
            MDISP = 3, described above.  MDISP = 5 assumes that
            measured values are read

     Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
     (Used only if MDISP = 1 or 5)         Default: 3     ! MTURBVW = 3 !
        1 = use sigma-v or sigma-theta measurements
            from PROFILE.DAT to compute sigma-y
            (valid for METFM = 1, 2, 3, 4, 5)
        2 = use sigma-w measurements
            from PROFILE.DAT to compute sigma-z
            (valid for METFM = 1, 2, 3, 4, 5)
        3 = use both sigma-(v/theta) and sigma-w
            from PROFILE.DAT to compute sigma-y and sigma-z
            (valid for METFM = 1, 2, 3, 4, 5)
        4 = use sigma-theta measurements
            from PLMMET.DAT to compute sigma-y
            (valid only if METFM = 3)

     Back-up method used to compute dispersion
```

```
     when measured turbulence data are
     missing (MDISP2)                   Default: 3     ! MDISP2 = 3 !
     (used only if MDISP = 1 or 5)
        2 = dispersion coefficients from internally calculated
            sigma v, sigma w using micrometeorological variables
            (u*, w*, L, etc.)
        3 = PG dispersion coefficients for RURAL areas (computed using
            the ISCST multi-segment approximation) and MP coefficients in
            urban areas
        4 = same as 3 except PG coefficients computed using
            the MESOPUFF II eqns.

     [DIAGNOSTIC FEATURE]
     Method used for Lagrangian timescale for Sigma-y
     (used only if MDISP=1,2 or MDISP2=1,2)
     (MTAULY)                           Default: 0     ! MTAULY = 0 !
        0 = Draxler default 617.284 (s)
        1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
       10 <Direct user input (s)             -- e.g., 306.9

     [DIAGNOSTIC FEATURE]
     Method used for Advective-Decay timescale for Turbulence
     (used only if MDISP=2 or MDISP2=2)
     (MTAUADV)                          Default: 0     ! MTAUADV = 0 !
        0 = No turbulence advection
        1 = Computed (OPTION NOT IMPLEMENTED)
       10 <Direct user input (s)   -- e.g., 300

     Method used to compute turbulence sigma-v &
     sigma-w using micrometeorological variables
     (Used only if MDISP = 2 or MDISP2 = 2)
     (MCTURB)                           Default: 1     ! MCTURB = 1 !
        1 = Standard CALPUFF subroutines
        2 = AERMOD subroutines

     PG sigma-y,z adj. for roughness?      Default: 0     ! MROUGH = 0 !
     (MROUGH)
        0 = no
        1 = yes

     Partial plume penetration of          Default: 1     ! MPARTL = 1 !
     elevated inversion?
     (MPARTL)
        0 = no
        1 = yes

     Strength of temperature inversion     Default: 0     ! MTINV = 0 !
     provided in PROFILE.DAT extended records?
     (MTINV)
        0 = no (computed from measured/default gradients)
        1 = yes

     PDF used for dispersion under convective conditions?
                                        Default: 0     ! MPDF = 0 !
     (MPDF)
        0 = no
        1 = yes

     Sub-Grid TIBL module used for shore line?
                                        Default: 0     ! MSGTIBL = 0 !
     (MSGTIBL)
        0 = no
        1 = yes

     Boundary conditions (concentration) modeled?
                                        Default: 0     ! MBCON = 0 !
     (MBCON)
        0 = no
        1 = yes, using formatted BCON.DAT file
        2 = yes, using unformatted CONC.DAT file

     Note:  MBCON > 0 requires that the last species modeled
            be 'BCON'.  Mass is placed in species BCON when
            generating boundary condition puffs so that clean
            air entering the modeling domain can be simulated
            in the same way as polluted air.  Specify zero
            emission of species BCON for all regular sources.

     Individual source contributions saved?
                                        Default: 0     ! MSOURCE = 1 !
     (MSOURCE)
        0 = no
        1 = yes
```



```
     Analyses of fogging and icing impacts due to emissions from
     arrays of mechanically-forced cooling towers can be performed
     using CALPUFF in conjunction with a cooling tower emissions
     processor (CTEMISS) and its associated postprocessors.  Hourly
     emissions of water vapor and temperature from each cooling tower
     cell are computed for the current cell configuration and ambient
     conditions by CTEMISS. CALPUFF models the dispersion of these
     emissions and provides cloud information in a specialized format
     for further analysis. Output to FOG.DAT is provided in either
     'plume mode' or 'receptor mode' format.

     Configure for FOG Model output?
                                        Default: 0     ! MFOG = 0 !
     (MFOG)
        0 = no
        1 = yes  - report results in PLUME Mode format
        2 = yes  - report results in RECEPTOR Mode format


     Test options specified to see if
     they conform to regulatory
     values? (MREG)                     Default: 1     ! MREG = 0 !

        0 = NO checks are made
        1 = Technical options must conform to USEPA
            Long Range Transport (LRT) guidance
                       METFM    1 or 2
                       AVET     60. (min)
                       PGTIME   60. (min)
                       MGAUSS   1
                       MCTADJ   3
                       MTRANS   1
                       MTIP     1
                       MCHEM    1 or 3 (if modeling SOx, NOx)
                       MWET     1
                       MDRY     1
                       MDISP    2 or 3
                       MPDF     0 if MDISP=3
                                1 if MDISP=2
                       MROUGH   0
                       MPARTL   1
                       SYTDEP   550. (m)
                       MHFTSZ   0
                       SVMIN    0.5 (m/s)


!END!

-------------------------------------------------------------------------------

INPUT GROUP: 3a, 3b -- Species list
-------------------

------------
Subgroup (3a)
------------

  The following species are modeled:

! CSPEC =         PM10 !            !END!
! CSPEC =        PM2.5 !            !END!
! CSPEC =          TXS !            !END!

                                                        Dry                 OUTPUT GROUP
    SPECIES          MODELED          EMITTED        DEPOSITED                 NUMBER
     NAME          (0=NO, 1=YES)    (0=NO, 1=YES)    (0=NO,                  (0=NONE,
   (Limit: 12                                         1=COMPUTED-GAS         1=1st CGRUP,
    Characters                                        2=COMPUTED-PARTICLE   2=2nd CGRUP,
    in length)                                        3=USER-SPECIFIED)     3= etc.)

!         PM10  =          1,                1,            2,                  0   !
!        PM2.5  =          1,                1,            2,                  0   !
!          TXS  =          1,                1,            2,                  0   !

!END!

  Note:  The last species in (3a) must be 'BCON' when using the
         boundary condition option (MBCON > 0).  Species BCON should
         typically be modeled as inert (no chem transformation or
         removal).
```



```
-------------
Subgroup (3b)
-------------
  The following names are used for Species-Groups in which results
  for certain species are combined (added) prior to output.  The
  CGRUP name will be used as the species name in output files.
  Use this feature to model specific particle-size distributions
  by treating each size-range as a separate species.
  Order must be consistent with 3(a) above.


-------------------------------------------------------------------------------


INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------

     Map projection
     (PMAP)                     Default: UTM    ! PMAP = UTM  !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                    Default=0.0     ! FEAST  = 0.0 !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.0 !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN = 56 !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                   Default: N      ! UTMHEM = S !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                    No Default      ! RLAT0 = 0.00N !
     (RLON0)                    No Default      ! RLON0 = 0.00E !

         TTM :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of projection
                RLAT0 is REPLACED by 0.0N (Equator)
         LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
                RLAT0 identifies latitude of tangent-point of mapping plane

     Matching parallel(s) of latitude (decimal degrees) for projection
     (Used only if PMAP= LCC or PS)
     (XLAT1)                    No Default      ! XLAT1 = 30S !
     (XLAT2)                    No Default      ! XLAT2 = 60S !

         LCC :  Projection cone slices through Earth's surface at XLAT1 and XLAT2
         PS  :  Projection plane slices through Earth at XLAT1
                (XLAT2 is not used)

     ----------
     Note:  Latitudes and longitudes should be positive, and include a
            letter N,S,E, or W indicating north or south latitude, and
            east or west longitude.  For example,
            35.9  N Latitude  =  35.9N
            118.7 E Longitude = 118.7E


     Datum-region
     ------------

     The Datum-Region for the coordinates is identified by a character
     string.  Many mapping products currently available use the model of the
     Earth known as the World Geodetic System 1984 (WGS-84).  Other local
     models may be in use, and their selection in CALMET will make its output
```



```
     consistent with local mapping products.  The list of Datum-Regions with
     official transformation parameters is provided by the National Imagery and
     Mapping Agency (NIMA).

     NIMA Datum - Regions(Examples)
     ------------------------------------------------------------------------------
     WGS-84    WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
     NAS-C     NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
     NAR-C     NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
     NWS-84    NWS 6370KM Radius, Sphere
     ESR-S     ESRI REFERENCE 6371KM Radius, Sphere

     Datum-region for output coordinates
     (DATUM)                    Default: WGS-84    ! DATUM = WGS-84 !


METEOROLOGICAL Grid:

     Rectangular grid defined for projection PMAP,
     with X the Easting and Y the Northing coordinate

            No. X grid cells (NX)      No default     ! NX = 50 !
            No. Y grid cells (NY)      No default     ! NY = 50 !
         No. vertical layers (NZ)      No default     ! NZ = 12 !

           Grid spacing (DGRIDKM)      No default     ! DGRIDKM = 0.4 !
                                       Units: km

                Cell face heights
                    (ZFACE(nz+1))      No defaults
                                       Units: m
   ! ZFACE =  0.0, 20.0, 40.0, 60.0, 90.0, 120.0, 180.0, 250.0, 500.0, 750.0, 1000.0, 2000.0, 3000.0
!

             Reference Coordinates
           of SOUTHWEST corner of
                 grid cell(1, 1):

            X coordinate (XORIGKM)     No default     ! XORIGKM = 234.8460 !
            Y coordinate (YORIGKM)     No default     ! YORIGKM = 6282.5440 !
                                      Units: km


COMPUTATIONAL Grid:

     The computational grid is identical to or a subset of the MET. grid.
     The lower left (LL) corner of the computational grid is at grid point
     (IBCOMP, JBCOMP) of the MET. grid.  The upper right (UR) corner of the
     computational grid is at grid point (IECOMP, JECOMP) of the MET. grid.
     The grid spacing of the computational grid is the same as the MET. grid.

        X index of LL corner (IBCOMP)      No default     ! IBCOMP = 1 !
                  (1 <= IBCOMP <= NX)

        Y index of LL corner (JBCOMP)      No default     ! JBCOMP = 1 !
                  (1 <= JBCOMP <= NY)


        X index of UR corner (IECOMP)      No default     ! IECOMP = 50 !
                  (1 <= IECOMP <= NX)

        Y index of UR corner (JECOMP)      No default     ! JECOMP = 50 !
                  (1 <= JECOMP <= NY)


SAMPLING Grid (GRIDDED RECEPTORS):

     The lower left (LL) corner of the sampling grid is at grid point
     (IBSAMP, JBSAMP) of the MET. grid.  The upper right (UR) corner of the
     sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid.
     The sampling grid must be identical to or a subset of the computational
     grid.  It may be a nested grid inside the computational grid.
     The grid spacing of the sampling grid is DGRIDKM/MESHDN.

        Logical flag indicating if gridded
        receptors are used (LSAMP)          Default: T     ! LSAMP = T !
        (T=yes, F=no)

        X index of LL corner (IBSAMP)      No default     ! IBSAMP = 21 !
         (IBCOMP <= IBSAMP <= IECOMP)

        Y index of LL corner (JBSAMP)      No default     ! JBSAMP = 21 !
         (JBCOMP <= JBSAMP <= JECOMP)
```

```
        X index of UR corner (IESAMP)      No default     ! IESAMP = 29 !
         (IBCOMP <= IESAMP <= IECOMP)

        Y index of UR corner (JESAMP)      No default     ! JESAMP = 29 !
         (JBCOMP <= JESAMP <= JECOMP)


       Nesting factor of the sampling
        grid (MESHDN)                      Default: 1     ! MESHDN = 2 !
        (MESHDN is an integer >= 1)

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 5 -- Output Options
--------------
                                             *                            *
     FILE                       DEFAULT VALUE             VALUE THIS RUN
     ----                       -------------             --------------

   Concentrations (ICON)              1                   ! ICON = 1 !
   Dry Fluxes (IDRY)                  1                   ! IDRY = 1 !
   Wet Fluxes (IWET)                  1                   ! IWET = 1 !
   2D Temperature (IT2D)              0                   ! IT2D = 0 !
   2D Density (IRHO)                  0                   ! IRHO = 0 !
   Relative Humidity (IVIS)           1                   ! IVIS = 0 !
    (relative humidity file is
     required for visibility
     analysis)
   Use data compression option in output file?
   (LCOMPRS)                           Default: T         ! LCOMPRS = T !

   *
    0 = Do not create file, 1 = create file


    QA PLOT FILE OUTPUT OPTION:

       Create a standard series of output files (e.g.
       locations of sources, receptors, grids ...)
       suitable for plotting?
       (IQAPLOT)                       Default: 1         ! IQAPLOT = 1 !
         0 = no
         1 = yes

    DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

       Mass flux across specified boundaries
       for selected species reported hourly?
       (IMFLX)                         Default: 0         ! IMFLX = 0 !
         0 = no
         1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
                  are specified in Input Group 0)

       Mass balance for each species
       reported hourly?
       (IMBAL)                         Default: 0         ! IMBAL = 0 !
         0 = no
         1 = yes (MASSBAL.DAT filename is
              specified in Input Group 0)


    LINE PRINTER OUTPUT OPTIONS:

       Print concentrations (ICPRT)    Default: 0         ! ICPRT = 1 !
       Print dry fluxes (IDPRT)        Default: 0         ! IDPRT = 0 !
       Print wet fluxes (IWPRT)        Default: 0         ! IWPRT = 0 !
       (0 = Do not print, 1 = Print)

       Concentration print interval
       (ICFRQ) in hours                Default: 1         ! ICFRQ = 1 !
       Dry flux print interval
       (IDFRQ) in hours                Default: 1         ! IDFRQ = 1 !
       Wet flux print interval
       (IWFRQ) in hours                Default: 1         ! IWFRQ = 1 !

       Units for Line Printer Output
       (IPRTU)                         Default: 1         ! IPRTU = 3 !
                       for          for
                  Concentration    Deposition
           1 =       g/m**3         g/m**2/s
           2 =      mg/m**3        mg/m**2/s
           3 =      ug/m**3        ug/m**2/s
```



```
           4 =      ng/m**3        ng/m**2/s
           5 =     Odour Units

       Messages tracking progress of run
       written to the screen ?
       (IMESG)                         Default: 2         ! IMESG = 2 !
         0 = no
         1 = yes (advection step, puff ID)
         2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)


     SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

                ---- CONCENTRATIONS ----   ------ DRY FLUXES ------   ------ WET FLUXES ------   --
MASS FLUX --
   SPECIES
   /GROUP       PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?
SAVED ON DISK?
   -------      ------------------------   ------------------------   ------------------------
---------------
!        PM10 =     1,           1,           0,           1,           0,           1,           0
  !
!       PM2.5 =     1,           1,           0,           1,           0,           1,           0
  !
!         TXS =     1,           1,           1,           1,           1,           1,           0
  !

  Note:  Species BCON (for MBCON > 0) does not need to be saved on disk.


     OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

       Logical for debug output
       (LDEBUG)                                 Default: F     ! LDEBUG = F !

       First puff to track
       (IPFDEB)                                 Default: 1     ! IPFDEB = 1 !

       Number of puffs to track
       (NPFDEB)                                 Default: 1     ! NPFDEB = 1000 !

       Met. period to start output
       (NN1)                                    Default: 1     ! NN1 = 1 !

       Met. period to end output
       (NN2)                                    Default: 10    ! NN2 = 10 !

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
-------------------------

---------------
Subgroup (6a)
---------------
       Number of terrain features (NHILL)       Default: 0     ! NHILL = 0 !

       Number of special complex terrain
       receptors  (NCTREC)                      Default: 0     ! NCTREC = 0 !

       Terrain and CTSG Receptor data for
       CTSG hills input in CTDM format ?
       (MHILL)                                  No Default     ! MHILL = 2 !
       1 = Hill and Receptor data created
           by CTDM processors & read from
           HILL.DAT and HILLRCT.DAT files
       2 = Hill data created by OPTHILL &
           input below in Subgroup (6b);
           Receptor data in Subgroup (6c)

       Factor to convert horizontal dimensions  Default: 1.0   ! XHILL2M = 1.0 !
       to meters (MHILL=1)

       Factor to convert vertical dimensions    Default: 1.0   ! ZHILL2M = 1.0 !
       to meters (MHILL=1)

       X-origin of CTDM system relative to      No Default     ! XCTDMKM = 0.0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

       Y-origin of CTDM system relative to      No Default     ! YCTDMKM = 0.0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)
```



```
! END !

---------------
Subgroup (6b)
---------------

                      1 **
     HILL information


HILL           XC        YC       THETAH  ZGRID  RELIEF    EXPO 1    EXPO 2   SCALE 1    SCALE 2
AMAX1     AMAX2
 NO.          (km)      (km)      (deg.)   (m)     (m)       (m)       (m)       (m)        (m)
(m)       (m)
----          ----      ----      ------  -----  ------    ------    ------   -------    -------
-----     -----

---------------
Subgroup (6c)
---------------

    COMPLEX TERRAIN RECEPTOR INFORMATION

                      XRCT         YRCT        ZRCT          XHH
                      (km)         (km)         (m)
                     ------        -----      ------         ----


-------------------
1
     Description of Complex Terrain Variables:
          XC, YC  = Coordinates of center of hill
          THETAH  = Orientation of major axis of hill (clockwise from
                    North)
          ZGRID   = Height of the  0  of the grid above mean sea
                    level
          RELIEF  = Height of the crest of the hill above the grid elevation
          EXPO 1  = Hill-shape exponent for the major axis
          EXPO 2  = Hill-shape exponent for the major axis
          SCALE 1 = Horizontal length scale along the major axis
          SCALE 2 = Horizontal length scale along the minor axis
          AMAX    = Maximum allowed axis length for the major axis
          BMAX    = Maximum allowed axis length for the major axis

          XRCT, YRCT = Coordinates of the complex terrain receptors
          ZRCT    = Height of the ground (MSL) at the complex terrain
                    Receptor
          XHH     = Hill number associated with each complex terrain receptor
                    (NOTE: MUST BE ENTERED AS A REAL NUMBER)

   **
     NOTE: DATA for each hill and CTSG receptor are treated as a separate
           input subgroup and therefore must end with an input group terminator.

-------------------------------------------------------------------------------

INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases
--------------

      SPECIES     DIFFUSIVITY      ALPHA STAR      REACTIVITY    MESOPHYLL RESISTANCE     HENRY'S
LAW COEFFICIENT
       NAME        (cm**2/s)                                            (s/cm)
(dimensionless)
      -------     -----------      ----------      ----------    --------------------
-----------------------
* DRYGAS = *

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 8 -- Size parameters for dry deposition of particles
--------------

     For SINGLE SPECIES, the mean and standard deviation are used to
     compute a deposition velocity for NINT (see group 9) size-ranges,
     and these are then averaged to obtain a mean deposition velocity.

     For GROUPED SPECIES, the size distribution should be explicitly
     specified (by the 'species' in the group), and the standard deviation
     for each should be entered as 0.  The model will then use the
```



```
     deposition velocity for the stated mean diameter.

      SPECIES      GEOMETRIC MASS MEAN        GEOMETRIC STANDARD
       NAME             DIAMETER                   DEVIATION
                        (microns)                  (microns)
      -------      -------------------        ------------------
!        PM10 =            5,              1.24185787   !
!       PM2.5 =          1.25,             1.24185787   !
!         TXS =            20,              1.2418578   !

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
--------------

     Reference cuticle resistance (s/cm)
     (RCUTR)                          Default: 30    ! RCUTR = 30 !
     Reference ground resistance  (s/cm)
     (RGR)                            Default: 10    ! RGR = 10 !
     Reference pollutant reactivity
     (REACTR)                         Default: 8     ! REACTR = 8 !

     Number of particle-size intervals used to
     evaluate effective particle deposition velocity
     (NINT)                           Default: 9     ! NINT = 9 !

     Vegetation state in unirrigated areas
     (IVEG)                           Default: 1     ! IVEG = 1 !
        IVEG=1 for active and unstressed vegetation
        IVEG=2 for active and stressed vegetation
        IVEG=3 for inactive vegetation

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 10 -- Wet Deposition Parameters
---------------


                      Scavenging Coefficient -- Units: (sec)**(-1)

       Pollutant      Liquid Precip.       Frozen Precip.
       ---------      --------------       --------------
!        PM10 =         1.00E-04,            3.00E-05 !
!       PM2.5 =         1.00E-04,            3.00E-05 !
!         TXS =         1.00E-04,            3.00E-05 !

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 11 -- Chemistry Parameters
---------------

     Ozone data input option (MOZ)     Default: 1            ! MOZ = 1 !
     (Used only if MCHEM = 1, 3, or 4)
        0 = use a monthly background ozone value
        1 = read hourly ozone concentrations from
            the OZONE.DAT data file

     Monthly ozone concentrations
     (Used only if MCHEM = 1, 3, or 4 and
      MOZ = 0 or MOZ = 1 and all hourly O3 data missing)
     (BCKO3) in ppb                   Default: 12*80.
     ! BCKO3 = 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00 !

     Monthly ammonia concentrations
     (Used only if MCHEM = 1, or 3)
     (BCKNH3) in ppb                  Default: 12*10.
     ! BCKNH3 = 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00 !

     Nighttime SO2 loss rate (RNITE1)
     in percent/hour                  Default: 0.2           ! RNITE1 = 0.2 !

     Nighttime NOx loss rate (RNITE2)
     in percent/hour                  Default: 2.0           ! RNITE2 = 2 !
```

```
     Nighttime HNO3 formation rate (RNITE3)
     in percent/hour                     Default: 2.0          ! RNITE3 = 2 !

     H2O2 data input option (MH2O2)    Default: 1            ! MH2O2 = 1 !
     (Used only if MAQCHEM = 1)
        0 = use a monthly background H2O2 value
        1 = read hourly H2O2 concentrations from
            the H2O2.DAT data file

     Monthly H2O2 concentrations
     (Used only if MQACHEM = 1 and
      MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)
     (BCKH2O2) in ppb                    Default: 12*1.
     ! BCKH2O2 = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00 !


 --- Data for SECONDARY ORGANIC AEROSOL (SOA) Option
     (used only if MCHEM = 4)

     The SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3 (BCKPMF)
          Organic fraction of fine particulate     (OFRAC)
          VOC / NOX ratio (after reaction)         (VCNX)
     to characterize the air mass when computing
     the formation of SOA from VOC emissions.
     Typical values for several distinct air mass types are:

        Month    1    2    3    4    5    6    7    8    9   10   11   12
                Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

     Clean Continental
        BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
        OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20  .20  .20  .15
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Clean Marine (surface)
        BCKPMF  .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5
        OFRAC  .25  .25  .30  .30  .30  .30  .30  .30  .30  .30  .30  .25
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Urban - low biogenic (controls present)
        BCKPMF  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.
        OFRAC  .20  .20  .25  .25  .25  .25  .25  .25  .20  .20  .20  .20
        VCNX     4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.

     Urban - high biogenic (controls present)
        BCKPMF  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.
        OFRAC  .25  .25  .30  .30  .30  .55  .55  .55  .35  .35  .35  .25
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Regional Plume
        BCKPMF  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.
        OFRAC  .20  .20  .25  .35  .25  .40  .40  .40  .30  .30  .30  .20
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Urban - no controls present
        BCKPMF 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
        OFRAC  .30  .30  .35  .35  .35  .55  .55  .55  .35  .35  .35  .30
        VCNX     2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.

     Default: Clean Continental
     ! BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00 !
     ! OFRAC = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.15 !
     ! VCNX = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00 !


!END!


-------------------------------------------------------------------------------


INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
---------------

     Horizontal size of puff (m) beyond which
     time-dependent dispersion equations (Heffter)
     are used to determine sigma-y and
     sigma-z (SYTDEP)                           Default: 550.   ! SYTDEP = 550 !

     Switch for using Heffter equation for sigma z
     as above (0 = Not use Heffter; 1 = use Heffter
     (MHFTSZ)                                   Default: 0      ! MHFTSZ = 0 !

     Stability class used to determine plume
     growth rates for puffs above the boundary
```



```
     layer (JSUP)                                  Default: 5      ! JSUP = 5 !

     Vertical dispersion constant for stable
     conditions (k1 in Eqn. 2.7-3)  (CONK1)        Default: 0.01   ! CONK1 = 0.01 !

     Vertical dispersion constant for neutral/
     unstable conditions (k2 in Eqn. 2.7-4)
     (CONK2)                                       Default: 0.1    ! CONK2 = 0.1 !

     Factor for determining Transition-point from
     Schulman-Scire to Huber-Snyder Building Downwash
     scheme (SS used for Hs <Hb + TBD * HL)
     (TBD)                                         Default: 0.5    ! TBD = 0.5 !
        TBD <0   ==> always use Huber-Snyder
        TBD = 1.5 ==> always use Schulman-Scire
        TBD = 0.5 ==> ISC Transition-point

     Range of land use categories for which
     urban dispersion is assumed
     (IURB1, IURB2)                                Default: 10     ! IURB1 = 10 !
                                                            19     ! IURB2 = 19 !

     Site characterization parameters for single-point Met data files ---------
     (needed for METFM = 2,3,4,5)

        Land use category for modeling domain
        (ILANDUIN)                                 Default: 20     ! ILANDUIN = 20 !

        Roughness length (m) for modeling domain
        (Z0IN)                                     Default: 0.25   ! Z0IN = .25 !

        Leaf area index for modeling domain
        (XLAIIN)                                   Default: 3.0    ! XLAIIN = 3.0 !

        Elevation above sea level (m)
        (ELEVIN)                                   Default: 0.0    ! ELEVIN = .0 !

        Latitude (degrees) for met location
        (XLATIN)                                   Default: -999.  ! XLATIN = -999.0 !

        Longitude (degrees) for met location
        (XLONIN)                                   Default: -999.  ! XLONIN = -999.0 !

     Specialized information for interpreting single-point Met data files -----

        Anemometer height (m) (Used only if METFM = 2,3)
        (ANEMHT)                                   Default: 10.    ! ANEMHT = 10.0 !

        Form of lateral turbulance data in PROFILE.DAT file
        (Used only if METFM = 4,5 or MTURBVW = 1 or 3)
        (ISIGMAV)                                  Default: 1      ! ISIGMAV = 1 !
            0 = read sigma-theta
            1 = read sigma-v

        Choice of mixing heights (Used only if METFM = 4)
        (IMIXCTDM)                                 Default: 0      ! IMIXCTDM = 0 !
            0 = read PREDICTED mixing heights
            1 = read OBSERVED mixing heights

     Maximum length of a slug (met. grid units)
     (XMXLEN)                                      Default: 1.0    ! XMXLEN = 1 !

     Maximum travel distance of a puff/slug (in
     grid units) during one sampling step
     (XSAMLEN)                                     Default: 1.0    ! XSAMLEN = 1 !

     Maximum Number of slugs/puffs release from
     one source during one time step
     (MXNEW)                                       Default: 99     ! MXNEW = 99 !

     Maximum Number of sampling steps for
     one puff/slug during one time step
     (MXSAM)                                       Default: 99     ! MXSAM = 99 !

     Number of iterations used when computing
     the transport wind for a sampling step
     that includes gradual rise (for CALMET
     and PROFILE winds)
     (NCOUNT)                                      Default: 2      ! NCOUNT = 2 !

     Minimum sigma y for a new puff/slug (m)
     (SYMIN)                                       Default: 1.0    ! SYMIN = 1 !

     Minimum sigma z for a new puff/slug (m)
     (SZMIN)                                       Default: 1.0    ! SZMIN = 1 !
```



```
     Default minimum turbulence velocities sigma-v and sigma-w
     for each stability class over land and over water (m/s)
     (SVMIN(12) and SWMIN(12))

                     ----------  LAND  ----------       ---------  WATER  ----------
        Stab Class :  A    B    C    D    E    F         A    B    C    D    E    F
                     ---  ---  ---  ---  ---  ---       ---  ---  ---  ---  ---  ---
     Default SVMIN : .50, .50, .50, .50, .50, .50,      .37, .37, .37, .37, .37, .37
     Default SWMIN : .20, .12, .08, .06, .03, .016,     .20, .12, .08, .06, .03, .016

           ! SVMIN = 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.37, 0.37, 0.37, 0.37, 0.37, 0.37 !
           ! SWMIN = 0.2, 0.12, 0.08, 0.06, 0.03, 0.016, 0.2, 0.12, 0.08, 0.06, 0.03, 0.016 !

     Divergence criterion for dw/dz across puff
     used to initiate adjustment for horizontal
     convergence (1/s)
     Partial adjustment starts at CDIV(1), and
     full adjustment is reached at CDIV(2)
     (CDIV(2))                                  Default: 0.0,0.0  ! CDIV = 0, 0 !

     Minimum wind speed (m/s) allowed for
     non-calm conditions. Also used as minimum
     speed returned when using power-law
     extrapolation toward surface
     (WSCALM)                                   Default: 0.5    ! WSCALM = 0.5 !

     Maximum mixing height (m)
     (XMAXZI)                                   Default: 3000.  ! XMAXZI = 3000 !

     Minimum mixing height (m)
     (XMINZI)                                   Default: 50.    ! XMINZI = 50 !

     Default wind speed classes --
     5 upper bounds (m/s) are entered;
     the 6th class has no upper limit
     (WSCAT(5))                      Default   :
                                     ISC RURAL : 1.54, 3.09, 5.14, 8.23, 10.8 (10.8+)

                              Wind Speed Class :  1     2     3     4     5
                                                 ---   ---   ---   ---   ---
                                       ! WSCAT = 1.54, 3.09, 5.14, 8.23, 10.80 !

     Default wind speed profile power-law
     exponents for stabilities 1-6
     (PLX0(6))                       Default   : ISC RURAL values
                                     ISC RURAL : .07, .07, .10, .15, .35, .55
                                     ISC URBAN : .15, .15, .20, .25, .30, .30

                               Stability Class :  A     B     C     D     E     F
                                                 ---   ---   ---   ---   ---   ---
                                        ! PLX0 = 0.07, 0.07, 0.1, 0.15, 0.35, 0.55 !

     Default potential temperature gradient
     for stable classes E, F (degK/m)
     (PTG0(2))                       Default: 0.020, 0.035
                                        ! PTG0 = 0.02, 0.035 !

     Default plume path coefficients for
     each stability class (used when option
     for partial plume height terrain adjustment
     is selected -- MCTADJ=3)
     (PPC(6))                  Stability Class :  A     B     C     D     E     F
                                  Default  PPC : .50,  .50,  .50,  .50,  .35,  .35
                                                 ---   ---   ---   ---   ---   ---
                                         ! PPC = 0.5, 0.5, 0.5, 0.5, 0.35, 0.35 !

     Slug-to-puff transition criterion factor
     equal to sigma-y/length of slug
     (SL2PF)                              Default: 10.        ! SL2PF = 10 !

     Puff-splitting control variables ------------------------

       VERTICAL SPLIT
       --------------

       Number of puffs that result every time a puff
       is split - nsplit=2 means that 1 puff splits
       into 2
       (NSPLIT)                           Default:   3        ! NSPLIT = 3 !

       Time(s) of a day when split puffs are eligible to
       be split once again; this is typically set once
       per day, around sunset before nocturnal shear develops.
       24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
       0=do not re-split    1=eligible for re-split
       (IRESPLIT(24))                     Default:  Hour 17 = 1
```



```
       ! IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0 !

       Split is allowed only if last hour's mixing
       height (m) exceeds a minimum value
       (ZISPLIT)                          Default: 100.       ! ZISPLIT = 100 !

       Split is allowed only if ratio of last hour's
       mixing ht to the maximum mixing ht experienced
       by the puff is less than a maximum value (this
       postpones a split until a nocturnal layer develops)
       (ROLDMAX)                          Default: 0.25       ! ROLDMAX = 0.25 !


       HORIZONTAL SPLIT
       ----------------

       Number of puffs that result every time a puff
       is split - nsplith=5 means that 1 puff splits
       into 5
       (NSPLITH)                          Default:   5        ! NSPLITH = 5 !

       Minimum sigma-y (Grid Cells Units) of puff
       before it may be split
       (SYSPLITH)                         Default:  1.0       ! SYSPLITH = 1 !

       Minimum puff elongation rate (SYSPLITH/hr) due to
       wind shear, before it may be split
       (SHSPLITH)                         Default:  2.        ! SHSPLITH = 2 !

       Minimum concentration (g/m^3) of each
       species in puff before it may be split
       Enter array of NSPEC values; if a single value is
       entered, it will be used for ALL species
       (CNSPLITH)                         Default:  1.0E-07   ! CNSPLITH = 0 !

     Integration control variables ------------------------

       Fractional convergence criterion for numerical SLUG
       sampling integration
       (EPSSLUG)                          Default:   1.0e-04  ! EPSSLUG = 0.0001 !

       Fractional convergence criterion for numerical AREA
       source integration
       (EPSAREA)                          Default:   1.0e-06  ! EPSAREA = 1E-006 !

       Trajectory step-length (m) used for numerical rise
       integration
       (DSRISE)                           Default:   1.0      ! DSRISE = 1.0 !

       Boundary Condition (BC) Puff control variables ------------------------

       Minimum height (m) to which BC puffs are mixed as they are emitted
       (MBCON=2 ONLY).  Actual height is reset to the current mixing height
       at the release point if greater than this minimum.
       (HTMINBC)                          Default:   500.     ! HTMINBC = 500 !

       Search radius (km) about a receptor for sampling nearest BC puff.
       BC puffs are typically emitted with a spacing of one grid cell
       length, so the search radius should be greater than DGRIDKM.
       (RSAMPBC)                          Default:   10.      ! RSAMPBC = 10 !

       Near-Surface depletion adjustment to concentration profile used when
       sampling BC puffs?
       (MDEPBC)                           Default:   1        ! MDEPBC = 1 !
          0 = Concentration is NOT adjusted for depletion
          1 = Adjust Concentration for depletion

!END!


-------------------------------------------------------------------------------


INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
--------------------------------

---------------
Subgroup (13a)
---------------

     Number of point sources with
     parameters provided below      (NPT1)  No default  ! NPT1 = 0 !

     Units used for point source
     emissions below                (IPTU)  Default: 1  ! IPTU = 1 !
           1 =        g/s
```

```
          2 =      kg/hr
          3 =      lb/hr
          4 =     tons/yr
          5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
          6 =     Odour Unit * m**3/min
          7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (13d)        (NSPT1) Default: 0  ! NSPT1 = 0 !

     Number of point sources with
     variable emission parameters
     provided in external file      (NPT2)  No default  ! NPT2 = 0 !

     (If NPT2 > 0, these point
     source emissions are read from
     the file: PTEMARB.DAT)

!END!

---------------
Subgroup (13b)
---------------
                                         a
          POINT SOURCE: CONSTANT DATA
          -----------------------------
                                                                             b          c
 Source       X         Y       Stack    Base     Stack    Exit  Exit    Bldg.  Emission
  No.     Coordinate Coordinate Height Elevation Diameter  Vel.  Temp.   Dwash   Rates
             (km)       (km)      (m)      (m)       (m)  (m/s) (deg. K)
 ------   ---------- ---------- ------  ------   -------- ----- -------- ----- --------

--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

     SRCNAM  is a 12-character name for a source
             (No default)
     X       is an array holding the source data listed by the column headings
             (No default)
     SIGYZI  is an array holding the initial sigma-y and sigma-z (m)
             (Default: 0.,0.)
     ZPLTFM  is the platform height (m) for sources influenced by an isolated
             structure that has a significant open area between the surface
             and the bulk of the structure, such as an offshore oil platform.
             The Base Elevation is that of the surface (ground or ocean),
             and the Stack Height is the release height above the Base (not
             above the platform).  Building heights entered in Subgroup 13c
             must be those of the buildings on the platform, measured from
             the platform deck.  ZPLTFM is used only with MBDW=1 (ISC
             downwash method) for sources with building downwash.
             (Default: 0.0)
     FMFAC   is a vertical momentum flux factor (0. or 1.0) used to represent
             the effect of rain-caps or other physical configurations that
             reduce momentum rise associated with the actual exit velocity.
             (Default: 1.0  -- full momentum used)

    b
     0. = No building downwash modeled
     1. = Downwash modeled for buildings resting on the surface
     2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)
     NOTE: must be entered as a REAL number (i.e., with decimal point)

    c
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IPTU
     (e.g. 1 for g/s).

---------------
Subgroup (13c)
---------------

           BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
           -------------------------------------------------------
Source                                                                     a
 No.       Effective building height, width, length and X/Y offset (in meters)
           every 10 degrees.  LENGTH, XBADJ, and YBADJ are only needed for
           MBDW=2 (PRIME downwash option)
------     --------------------------------------------------------------------
```



```
--------

    a
     Building height, width, length, and X/Y offset from the source are treated
     as a separate input subgroup for each source and therefore must end with
     an input group terminator.  The X/Y offset is the position, relative to the
     stack, of the center of the upwind face of the projected building, with the
     x-axis pointing along the flow direction.


---------------
Subgroup (13d)
---------------
                                                   a
          POINT SOURCE: VARIABLE EMISSIONS DATA
          ---------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 13b.  Factors entered multiply the rates in 13b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                 Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)


--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------


INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters
--------------------------------

---------------
Subgroup (14a)
---------------

     Number of polygon area sources with
     parameters specified below (NAR1)       No default  ! NAR1 = 1 !

     Units used for area source
     emissions below               (IARU)       Default: 1  ! IARU = 2 !
           1 =        g/m**2/s
           2 =       kg/m**2/hr
           3 =       lb/m**2/hr
           4 =     tons/m**2/yr
           5 =     Odour Unit * m/s  (vol. flux/m**2 of odour compound)
           6 =     Odour Unit * m/min
           7 =     metric tons/m**2/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (14d)        (NSAR1) Default: 0  ! NSAR1 = 0 !

     Number of buoyant polygon area sources
     with variable location and emission
     parameters (NAR2)                      No default  ! NAR2 = 0 !
     (If NAR2 > 0, ALL parameter data for
     these sources are read from the file: BAEMARB.DAT)

!END!

---------------
Subgroup (14b)
---------------
```



```
                                        a
          AREA SOURCE: CONSTANT DATA
          ----------------------------
                                                             b
Source           Effect.    Base      Initial    Emission
 No.             Height   Elevation   Sigma z     Rates
                   (m)       (m)        (m)
-------          ------    ------     --------   ---------

   1 ! SRCNAM = STOCKPILE !
   1 ! X =         2.0,  1052.88,         1.0, 3.2E-06, 4.8E-07,  4E-005 !
!END!

--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IARU
     (e.g. 1 for g/m**2/s).

---------------
Subgroup (14c)
---------------

           COORDINATES (km) FOR EACH VERTEX(4) OF EACH POLYGON
           --------------------------------------------------------
Source                                                                 a
 No.       Ordered list of X followed by list of Y, grouped by source
------     ------------------------------------------------------------

   1 ! SRCNAM = STOCKPILE !
   1 ! XVERT =  244.87038, 244.86985, 244.90984, 244.91037 !
   1 ! YVERT = 6292.52433,6292.48406,6292.48353,6292.52351 !
!END!

--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.


---------------
Subgroup (14d)
---------------
                                                  a
          AREA SOURCE: VARIABLE EMISSIONS DATA
          --------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 14b.  Factors entered multiply the rates in 14b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                 Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)


--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters
---------------------------

---------------
```



```
Subgroup (15a)
---------------

     Number of buoyant line sources
     with variable location and emission
     parameters (NLN2)                             No default  ! NLN2 = 0 !

     (If NLN2 > 0, ALL parameter data for
      these sources are read from the file: LNEMARB.DAT)

     Number of buoyant line sources (NLINES)        No default   ! NLINES = 0 !

     Units used for line source
     emissions below                (ILNU)          Default: 1   ! ILNU = 1 !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (15c)        (NSLN1) Default: 0  ! NSLN1 = 0 !

     Maximum number of segments used to model
     each line (MXNSEG)                             Default: 7   ! MXNSEG = 7 !

     The following variables are required only if NLINES > 0.  They are
     used in the buoyant line source plume rise calculations.

        Number of distances at which                Default: 6   ! NLRISE = 6 !
        transitional rise is computed

        Average building length (XL)                No default   * XL = *
                                                    (in meters)

        Average building height (HBL)               No default   * HBL = *
                                                    (in meters)

        Average building width (WBL)                No default   * WBL = *
                                                    (in meters)

        Average line source width (WML)             No default   * WML = *
                                                    (in meters)

        Average separation between buildings (DXL)  No default   * DXL = *
                                                    (in meters)

        Average buoyancy parameter (FPRIMEL)        No default   * FPRIMEL = *
                                                    (in m**4/s**3)

!END!

---------------
Subgroup (15b)
---------------

          BUOYANT LINE SOURCE: CONSTANT DATA
          ----------------------------------
                                                                                       a
Source     Beg. X      Beg. Y      End. X    End. Y     Release    Base        Emission
 No.     Coordinate  Coordinate  Coordinate Coordinate  Height   Elevation      Rates
            (km)        (km)        (km)       (km)       (m)       (m)
------   ----------  ----------  ---------  ----------  -------  ---------    ---------

--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by ILNTU
     (e.g. 1 for g/s).

---------------
Subgroup (15c)
---------------
                                                        a
          BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------------
```

```
     Use this subgroup to describe temporal variations in the emission
     rates given in 15b.  Factors entered multiply the rates in 15b.
     Skip sources here that have constant emissions.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                              Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)


--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.

-------------------------------------------------------------------------------

INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
---------------------------

---------------
Subgroup (16a)
---------------

     Number of volume sources with
     parameters provided in 16b,c (NVL1)     No default  ! NVL1 = 20 !

     Units used for volume source
     emissions below in 16b       (IVLU)     Default: 1  ! IVLU = 2 !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (16c)      (NSVL1)    Default: 0  ! NSVL1 = 57 !

     Number of volume sources with
     variable location and emission
     parameters                   (NVL2)     No default  ! NVL2 = 0 !

     (If NVL2 > 0, ALL parameter data for
      these sources are read from the VOLEMARB.DAT file(s) )

!END!

---------------
Subgroup (16b)
---------------
                                          a
           VOLUME SOURCE: CONSTANT DATA
           ------------------------------
                                                                          b
          X            Y        Effect.    Base     Initial    Initial   Emission
     Coordinate   Coordinate   Height   Elevation  Sigma y    Sigma z     Rates
        (km)         (km)        (m)       (m)       (m)        (m)
     ----------   ----------   ------    ------   --------   --------   --------

   1 ! SRCNAM = TRUCK01 !
   1 ! X =  244.746, 6292.348,     2.0,   1068.7,       1.16,      2.33,    0.18,    0.03,     0.6 !
!END!
   2 ! SRCNAM = TRUCK02 !
   2 ! X =  244.749, 6292.380,     2.0,  1067.99,       1.16,      2.33,    0.18,    0.03,     0.6 !
!END!
   3 ! SRCNAM = TRUCK03 !
   3 ! X =  244.770, 6292.402,     2.0,  1065.82,       1.16,      2.33,    0.18,    0.03,     0.6 !
```



```
!END!
   4 ! SRCNAM = TRUCK04 !
   4 ! X =  244.804, 6292.405,     2.0,  1063.13,       1.16,      2.33,    0.18,    0.03,     0.6 !
!END!
   5 ! SRCNAM = TRUCK05 !
   5 ! X =  244.826, 6292.423,     2.0,  1061.02,       1.16,      2.33,    0.18,    0.03,     0.6 !
!END!
   6 ! SRCNAM = TRUCK06 !
   6 ! X =  244.829, 6292.452,     2.0,  1059.98,       1.16,      2.33,    0.18,    0.03,     0.6 !
!END!
   7 ! SRCNAM = TRUCK07 !
   7 ! X =  244.854, 6292.473,     2.0,  1058.38,       1.16,      2.33,    0.18,    0.03,     0.6 !
!END!
   8 ! SRCNAM = LOADER01 !
   8 ! X =  244.844, 6292.734,     2.0,  1051.17,       1.16,      2.33,    0.44,    0.07,    0.93 !
!END!
   9 ! SRCNAM = LOADER02 !
   9 ! X =  244.852, 6292.620,     2.0,  1050.44,       1.16,      2.33,    0.44,    0.07,    0.93 !
!END!
  10 ! SRCNAM = LOADER03 !
  10 ! X =  244.867, 6292.529,     2.0,   1053.2,       1.16,      2.33,    0.44,    0.07,    0.93 !
!END!
  11 ! SRCNAM = GRADER01 !
  11 ! X =  244.818, 6292.754,     2.0,  1052.27,       1.16,      2.33,   0.034,   0.005,   0.076 !
!END!
  12 ! SRCNAM = BULLDOZER01 !
  12 ! X =  244.787, 6292.707,     2.0,  1057.59,       1.16,      2.33,    0.15,    0.02,    0.61 !
!END!
  13 ! SRCNAM = BULLDOZER02 !
  13 ! X =  244.776, 6292.650,     2.0,   1058.2,       1.16,      2.33,    0.15,    0.02,    0.61 !
!END!
  14 ! SRCNAM = BULLDOZER03 !
  14 ! X =  244.866, 6292.652,     2.0,  1047.94,       1.16,      2.33,    0.15,    0.02,    0.61 !
!END!
  15 ! SRCNAM = BULLDOZER04 !
  15 ! X =  244.880, 6292.716,     2.0,  1044.17,       1.16,      2.33,    0.15,    0.02,    0.61 !
!END!
  16 ! SRCNAM = BULLDOZER05 !
  16 ! X =  244.804, 6292.785,     2.0,   1053.5,       1.16,      2.33,    0.15,    0.02,    0.61 !
!END!
  17 ! SRCNAM = BULLDOZER06 !
  17 ! X =  244.883, 6292.779,     2.0,  1042.48,       1.16,      2.33,    0.15,    0.02,    0.61 !
!END!
  18 ! SRCNAM = BULLDOZER07 !
  18 ! X =  244.857, 6292.568,     2.0,  1052.14,       1.16,      2.33,    0.15,    0.02,    0.61 !
!END!
  19 ! SRCNAM = TIPPER01 !
  19 ! X =  244.842, 6292.771,     2.0,  1048.88,       1.16,      2.33,    0.12,    0.02,    0.33 !
!END!
  20 ! SRCNAM = TIPPER02 !
  20 ! X =  244.893, 6292.528,     2.0,  1051.77,       1.16,      2.33,    0.12,    0.02,    0.33 !
!END!

--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IVLU
     (e.g. 1 for g/s).

---------------
Subgroup (16c)
---------------
                                                   a
           VOLUME SOURCE: VARIABLE EMISSIONS DATA
           ---------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 16b.  Factors entered multiply the rates in 16b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                              Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
```



```
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)


   1 ! SRCNAM = TRUCK01 !
   1 ! IVARY = 1 !    (24 Hours)
   1 ! PM10 = 0,0,0,0,0,0,
          1,1,1,1,1,0,
          1,1,1,1,1,0,
          0,0,0,0,0,0      !
!END!
   2 ! SRCNAM = TRUCK01 !
   2 ! IVARY = 1 !    (24 Hours)
   2 ! PM2.5 = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
   3 ! SRCNAM = TRUCK01 !
   3 ! IVARY = 1 !    (24 Hours)
   3 ! TXS = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
   4 ! SRCNAM = TRUCK02 !
   4 ! IVARY = 1 !    (24 Hours)
   4 ! PM10 = 0,0,0,0,0,0,
          1,1,1,1,1,0,
          1,1,1,1,1,0,
          0,0,0,0,0,0      !
!END!
   5 ! SRCNAM = TRUCK02 !
   5 ! IVARY = 1 !    (24 Hours)
   5 ! PM2.5 = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
   6 ! SRCNAM = TRUCK02 !
   6 ! IVARY = 1 !    (24 Hours)
   6 ! TXS = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
   7 ! SRCNAM = TRUCK03 !
   7 ! IVARY = 1 !    (24 Hours)
   7 ! PM10 = 0,0,0,0,0,0,
          1,1,1,1,1,0,
          1,1,1,1,1,0,
          0,0,0,0,0,0      !
!END!
   8 ! SRCNAM = TRUCK03 !
   8 ! IVARY = 1 !    (24 Hours)
   8 ! PM2.5 = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
   9 ! SRCNAM = TRUCK03 !
   9 ! IVARY = 1 !    (24 Hours)
   9 ! TXS = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
  10 ! SRCNAM = TRUCK04 !
  10 ! IVARY = 1 !    (24 Hours)
  10 ! PM10 = 0,0,0,0,0,0,
          1,1,1,1,1,0,
          1,1,1,1,1,0,
          0,0,0,0,0,0      !
!END!
  11 ! SRCNAM = TRUCK04 !
  11 ! IVARY = 1 !    (24 Hours)
  11 ! PM2.5 = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
  12 ! SRCNAM = TRUCK04 !
  12 ! IVARY = 1 !    (24 Hours)
```



```
  12 ! TXS = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
  13 ! SRCNAM = TRUCK05 !
  13 ! IVARY = 1 !    (24 Hours)
  13 ! PM10 = 0,0,0,0,0,0,
          1,1,1,1,1,0,
          1,1,1,1,1,0,
          0,0,0,0,0,0      !
!END!
  14 ! SRCNAM = TRUCK05 !
  14 ! IVARY = 1 !    (24 Hours)
  14 ! PM2.5 = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
  15 ! SRCNAM = TRUCK05 !
  15 ! IVARY = 1 !    (24 Hours)
  15 ! TXS = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
  16 ! SRCNAM = TRUCK06 !
  16 ! IVARY = 1 !    (24 Hours)
  16 ! PM10 = 0,0,0,0,0,0,
          1,1,1,1,1,0,
          1,1,1,1,1,0,
          0,0,0,0,0,0      !
!END!
  17 ! SRCNAM = TRUCK06 !
  17 ! IVARY = 1 !    (24 Hours)
  17 ! PM2.5 = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
  18 ! SRCNAM = TRUCK06 !
  18 ! IVARY = 1 !    (24 Hours)
  18 ! TXS = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
  19 ! SRCNAM = TRUCK07 !
  19 ! IVARY = 1 !    (24 Hours)
  19 ! PM10 = 0,0,0,0,0,0,
          1,1,1,1,1,0,
          1,1,1,1,1,0,
          0,0,0,0,0,0      !
!END!
  20 ! SRCNAM = TRUCK07 !
  20 ! IVARY = 1 !    (24 Hours)
  20 ! PM2.5 = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
  21 ! SRCNAM = TRUCK07 !
  21 ! IVARY = 1 !    (24 Hours)
  21 ! TXS = 0,0,0,0,0,0,
          1,1,1,1,1,1,
          1,1,1,1,0,0,
          0,0,0,0,0,0      !
!END!
  22 ! SRCNAM = LOADER01 !
  22 ! IVARY = 1 !    (24 Hours)
  22 ! PM10 = 0,0,0,0,0,0,
          1,1,1,1,1,0,
          1,1,1,1,1,0,
          0,0,0,0,0,0      !
!END!
  23 ! SRCNAM = LOADER01 !
  23 ! IVARY = 1 !    (24 Hours)
  23 ! PM2.5 = 0,0,0,0,0,0,
          0.3568,0.3568,0.3568,0.3568,0.3568,0.3568,
          0.3568,0.3568,0.3568,0.3568,0.3568,0,
          0,0,0,0,0,0      !
!END!
  24 ! SRCNAM = LOADER02 !
  24 ! IVARY = 1 !    (24 Hours)
  24 ! PM10 = 0,0,0,0,0,0,
          1,1,1,1,1,0,
```

```
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  25 ! SRCNAM = LOADER02 !
  25 ! IVARY = 1 !    (24 Hours)
  25 ! PM2.5 = 0,0,0,0,0,0,
         1,1,1,1,1,1,
         1,1,1,1,0,0,
         0,0,0,0,0,0      !
!END!
  26 ! SRCNAM = LOADER03 !
  26 ! IVARY = 1 !    (24 Hours)
  26 ! PM10 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  27 ! SRCNAM = LOADER03 !
  27 ! IVARY = 1 !    (24 Hours)
  27 ! PM2.5 = 0,0,0,0,0,0,
         0.3568,0.3568,0.3568,0.3568,0.3568,0.3568,
         0.3568,0.3568,0.3568,0.3568,0.3568,0,
         0,0,0,0,0,0      !
!END!
  28 ! SRCNAM = GRADER01 !
  28 ! IVARY = 1 !    (24 Hours)
  28 ! PM10 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  29 ! SRCNAM = GRADER01 !
  29 ! IVARY = 1 !    (24 Hours)
  29 ! PM2.5 = 0,0,0,0,0,0,
         0.3568,0.3568,0.3568,0.3568,0.3568,0.3568,
         0.3568,0.3568,0.3568,0.3568,0.3568,0,
         0,0,0,0,0,0      !
!END!
  30 ! SRCNAM = GRADER01 !
  30 ! IVARY = 1 !    (24 Hours)
  30 ! TXS = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  31 ! SRCNAM = BULLDOZER01 !
  31 ! IVARY = 1 !    (24 Hours)
  31 ! PM10 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  32 ! SRCNAM = BULLDOZER01 !
  32 ! IVARY = 1 !    (24 Hours)
  32 ! PM2.5 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  33 ! SRCNAM = BULLDOZER01 !
  33 ! IVARY = 1 !    (24 Hours)
  33 ! TXS = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  34 ! SRCNAM = BULLDOZER02 !
  34 ! IVARY = 1 !    (24 Hours)
  34 ! PM10 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  35 ! SRCNAM = BULLDOZER02 !
  35 ! IVARY = 1 !    (24 Hours)
  35 ! PM2.5 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  36 ! SRCNAM = BULLDOZER02 !
  36 ! IVARY = 1 !    (24 Hours)
  36 ! TXS = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
```



```
!END!
  37 ! SRCNAM = BULLDOZER03 !
  37 ! IVARY = 1 !    (24 Hours)
  37 ! PM10 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  38 ! SRCNAM = BULLDOZER03 !
  38 ! IVARY = 1 !    (24 Hours)
  38 ! PM2.5 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  39 ! SRCNAM = BULLDOZER03 !
  39 ! IVARY = 1 !    (24 Hours)
  39 ! TXS = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  40 ! SRCNAM = BULLDOZER04 !
  40 ! IVARY = 1 !    (24 Hours)
  40 ! PM10 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  41 ! SRCNAM = BULLDOZER04 !
  41 ! IVARY = 1 !    (24 Hours)
  41 ! PM2.5 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  42 ! SRCNAM = BULLDOZER04 !
  42 ! IVARY = 1 !    (24 Hours)
  42 ! TXS = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  43 ! SRCNAM = BULLDOZER05 !
  43 ! IVARY = 1 !    (24 Hours)
  43 ! PM10 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  44 ! SRCNAM = BULLDOZER05 !
  44 ! IVARY = 1 !    (24 Hours)
  44 ! PM2.5 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  45 ! SRCNAM = BULLDOZER05 !
  45 ! IVARY = 1 !    (24 Hours)
  45 ! TXS = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  46 ! SRCNAM = BULLDOZER06 !
  46 ! IVARY = 1 !    (24 Hours)
  46 ! PM10 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  47 ! SRCNAM = BULLDOZER06 !
  47 ! IVARY = 1 !    (24 Hours)
  47 ! PM2.5 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  48 ! SRCNAM = BULLDOZER06 !
  48 ! IVARY = 1 !    (24 Hours)
  48 ! TXS = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  49 ! SRCNAM = BULLDOZER07 !
```



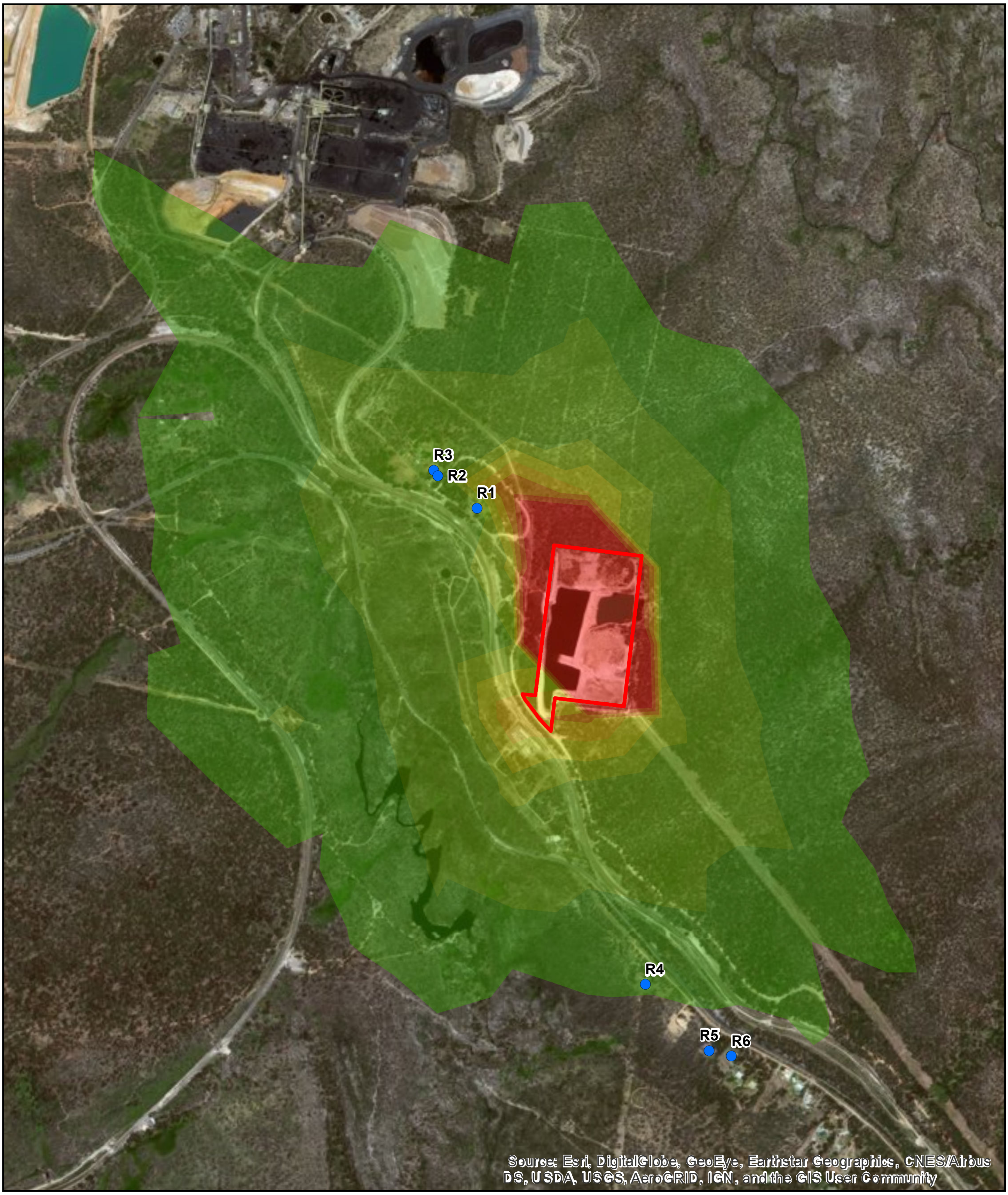
```
  49 ! IVARY = 1 !    (24 Hours)
  49 ! PM10 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  50 ! SRCNAM = BULLDOZER07 !
  50 ! IVARY = 1 !    (24 Hours)
  50 ! PM2.5 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  51 ! SRCNAM = BULLDOZER07 !
  51 ! IVARY = 1 !    (24 Hours)
  51 ! TXS = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  52 ! SRCNAM = TIPPER01 !
  52 ! IVARY = 1 !    (24 Hours)
  52 ! PM10 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  53 ! SRCNAM = TIPPER01 !
  53 ! IVARY = 1 !    (24 Hours)
  53 ! PM2.5 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  54 ! SRCNAM = TIPPER01 !
  54 ! IVARY = 1 !    (24 Hours)
  54 ! TXS = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  55 ! SRCNAM = TIPPER02 !
  55 ! IVARY = 1 !    (24 Hours)
  55 ! PM10 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  56 ! SRCNAM = TIPPER02 !
  56 ! IVARY = 1 !    (24 Hours)
  56 ! PM2.5 = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!
  57 ! SRCNAM = TIPPER02 !
  57 ! IVARY = 1 !    (24 Hours)
  57 ! TXS = 0,0,0,0,0,0,
         1,1,1,1,1,0,
         1,1,1,1,1,0,
         0,0,0,0,0,0      !
!END!

--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.

-------------------------------------------------------------------------------

INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information
----------------------

---------------
Subgroup (17a)
---------------

     Number of non-gridded receptors (NREC)  No default  ! NREC = 6 !

!END!

---------------
Subgroup (17b)
---------------
                                     a
```



```
          NON-GRIDDED (DISCRETE) RECEPTOR DATA
          ------------------------------------

                    X            Y          Ground       Height   b
Receptor       Coordinate   Coordinate    Elevation   Above Ground
  No.             (km)         (km)          (m)           (m)
--------       ----------   ----------    ---------   ------------


    1 ! X =     244.55221,   6292.90647,      1062.6,            0.0 !   !END!
    2 ! X =     244.44800,   6292.98900,      1067.3,            0.0 !   !END!
    3 ! X =     244.43500,   6292.99800,      1069.4,            0.0 !   !END!
    4 ! X =     244.99300,   6291.67300,      1074.3,            0.0 !   !END!
    5 ! X =     245.15900,   6291.51000,      1082.5,            0.0 !   !END!
    6 ! X =     245.21700,   6291.48500,      1083.9,            0.0 !   !END!

-------------
    a
     Data for each receptor are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     Receptor height above ground is optional.  If no value is entered,
     the receptor is placed on the ground.
```

Appendix C – Dispersion modelling plots

Predicted PM_{10} 24-hour Average Concentration $\mu g/m^3$ Predicted PM_{10} Annual Average Concentration $\mu g/m^3$ Predicted $PM_{2.5}$ 24-hour Average Concentration $\mu g/m^3$ Predicted $PM_{2.5}$ Annual Average Concentration $\mu g/m^3$ Predicted TSP Annual Average Concentration $\mu g/m^3$.



Legend

Residential buildings

Bell Quarry site

PM10 Concentration (μg/m3)

10, 30, 40, 50, 60, 80, 100, 482.02

Paper Size A4

0 100 200 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation

Job Number	21-25774
Revision	A
Date	29 May 2018

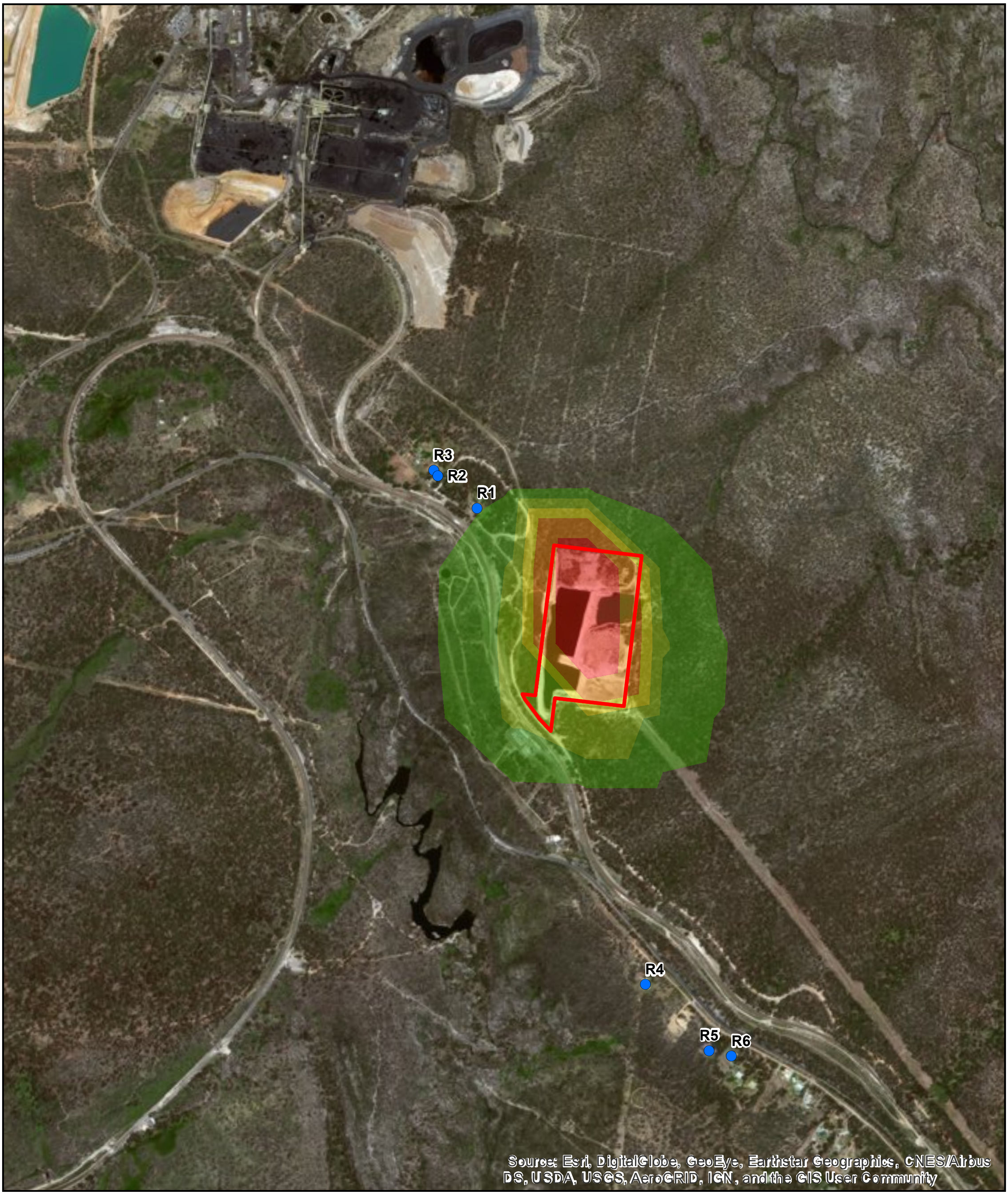
Predicted PM_{10} 24-hour Average Concentration

Figure A

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

G:\21\25774\GIS\Maps\Deliverables\21-25774_SMA_Air.mxd (SMA record: 1)

Data source: LPI, topographic base data, 2012. Created by:afoddy



Legend

Residential buildings
Bell Quarry site

PM10 Concentration (µg/m3)

5 10 15 25 39.735

Paper Size A4

0 100 200 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation

Job Number	21-25774
Revision	A
Date	29 May 2018

Predicted PM_{10} Annual Average Concentration

Figure B

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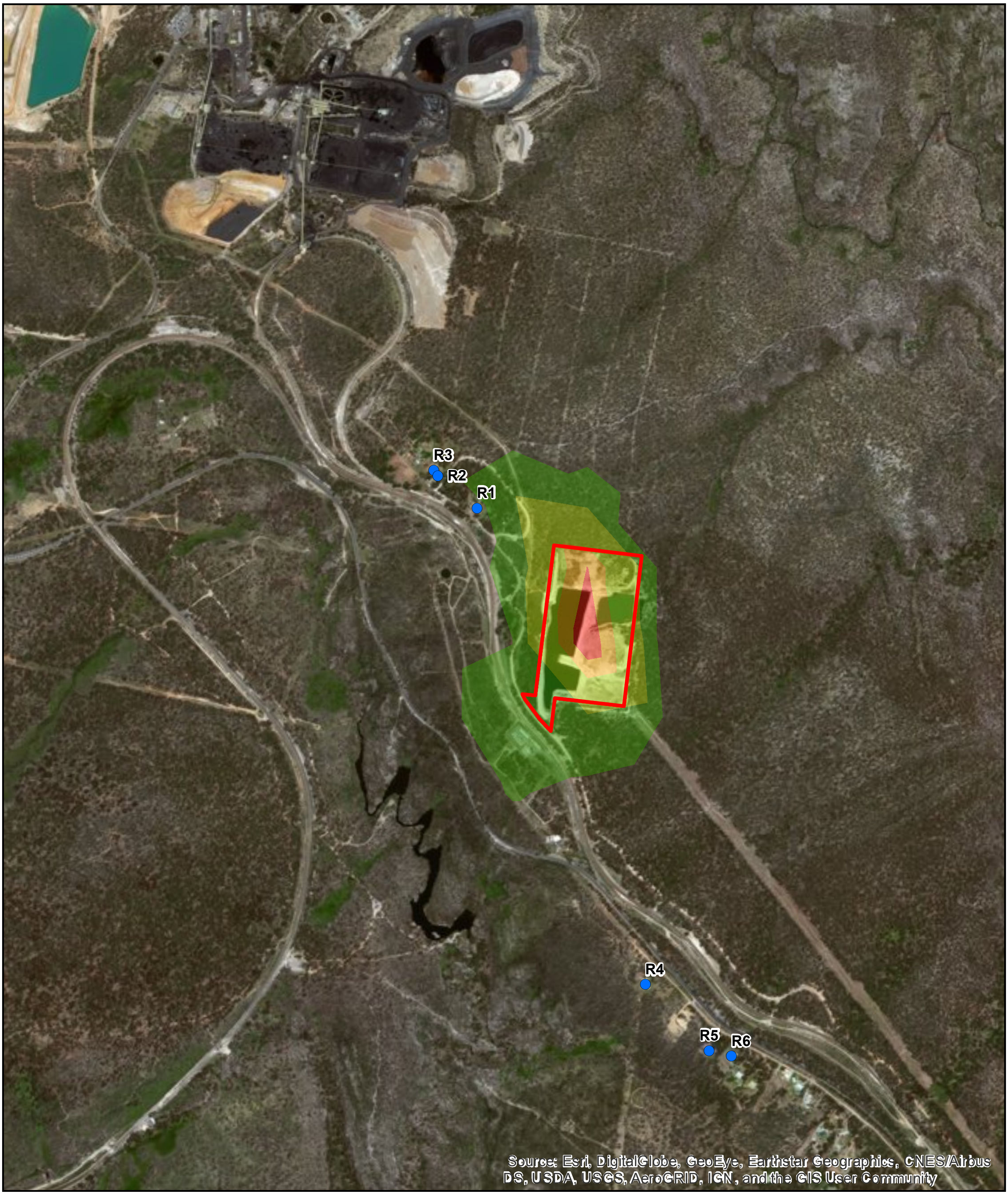
G:\21\25774\GIS\Maps\Deliverables\21-25774_SMA_Air.mxd (SMA record: 2)

Data source: LPI, topographic base data, 2012. Created by:afoddy



Legend

Residential buildings

Bell Quarry site

PM2.5 Concentration (µg/m3)

10 20 25 29.603

Paper Size A4

0 100 200 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation

Job Number	21-25774
Revision	A
Date	29 May 2018

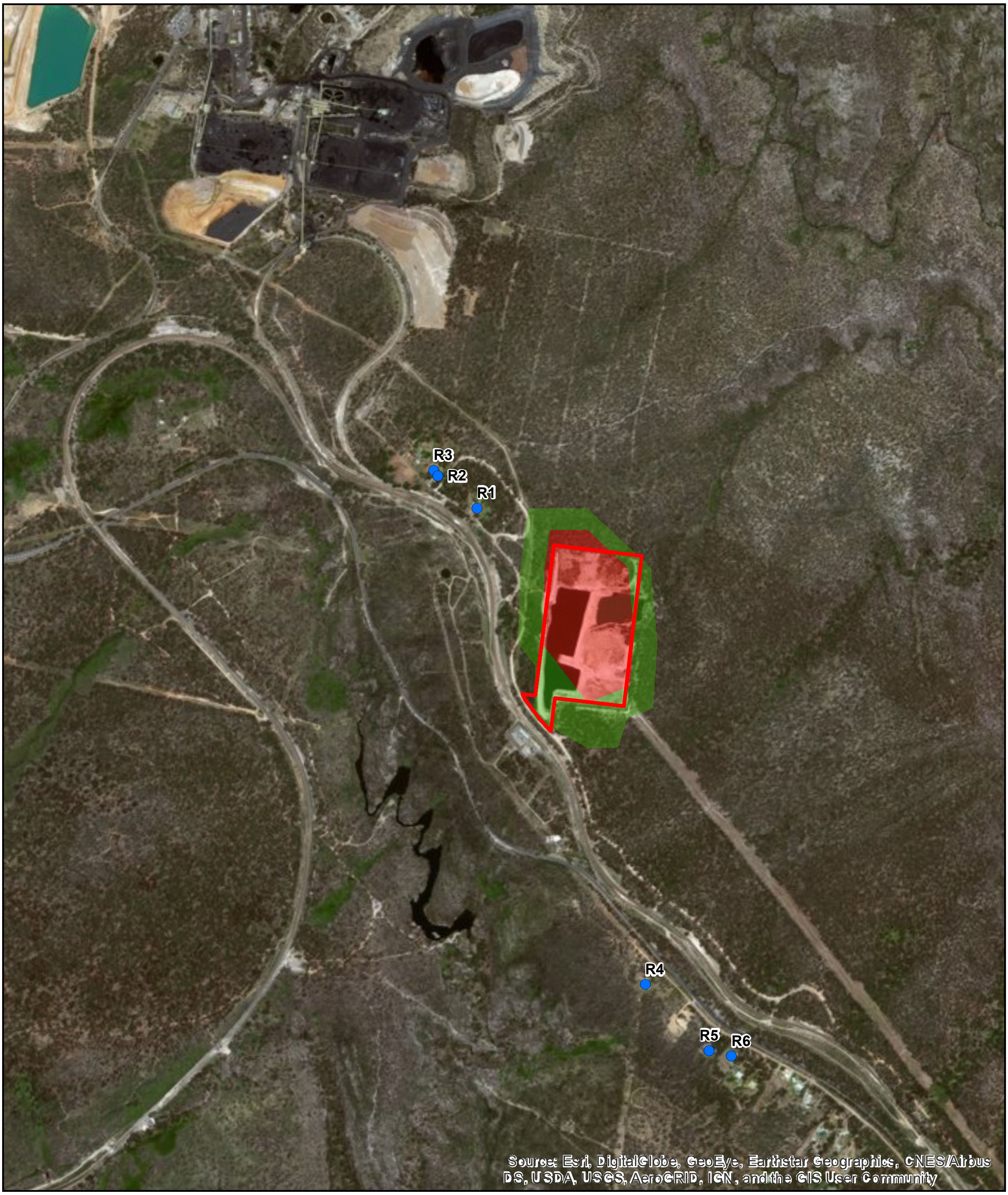
Predicted $PM_{2.5}$ 24-hour Average Concentration

Figure C

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

G:\21\25774\GIS\Maps\Deliverables\21-25774_SMA_Air.mxd (SMA record: 3)

Data source: LPI, topographic base data, 2012. Created by:afoddy



Legend

Residential buildings

Bell Quarry site

PM2.5 Concentration (µg/m3)

2 4

Paper Size A4

0 100 200 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation

Job Number	21-25774
Revision	A
Date	29 May 2018

Predicted $PM_{2.5}$ Annual Average Concentration

Figure D

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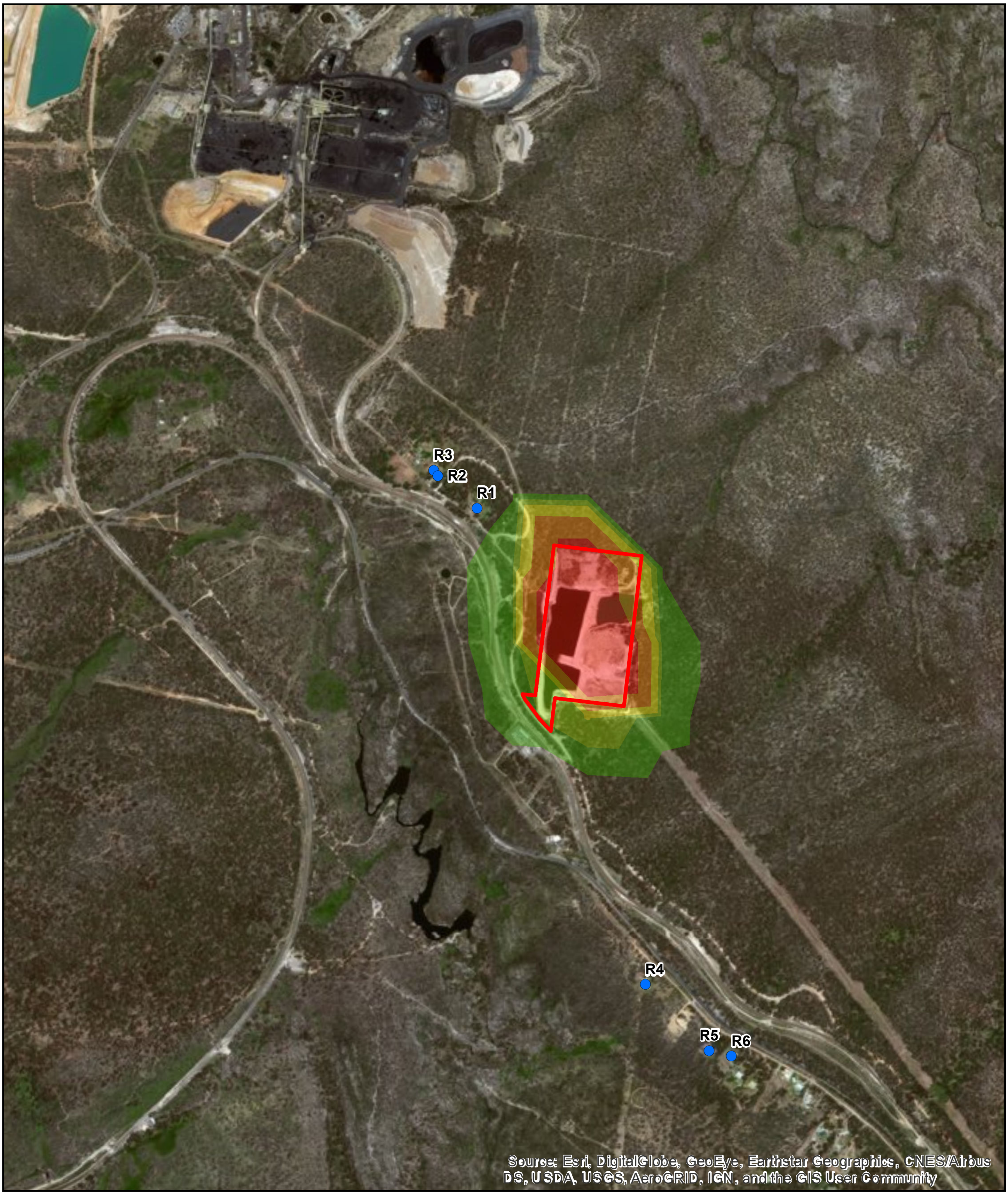
G:\21\25774\GIS\Maps\Deliverables\21-25774_SMA_Air.mxd (SMA record: 4)

Data source: LPI, topographic base data, 2012. Created by:afoddy



Legend

Residential buildings

Bell Quarry site

TSP Concentration (µg/m3)

20 30 50 90 241.02

Paper Size A4

0 100 200 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation

Job Number	21-25774
Revision	A
Date	29 May 2018

Predicted TSP Annual Average Concentration

Figure E

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G:\21\25774\GIS\Maps\Deliverables\21-25774_SMA_Air.mxd (SMA record: 5)

Data source: LPI, topographic base data, 2012. Created by:afoddy

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2125774-27610/https://projects.ghd.com/oc/Sydney/bellquarryrehabilita/Delivery/Documents/2125774_REP-A_Air Quality Assessment.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	P Pandey E Smith		On file	E Milton		26/10/17
B	P Pandey E Smith		On file	K.Rosen		29/08/18

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Appendix G

Noise Impact Assessment

Bell Quarry Rehabilitation Project Pty Ltd

Bell Quarry Rehabilitation

Noise impact assessment

August 2018

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Table index

Figure index

Appendices

1. Introduction

1.1 Overview

The former Bell Quarry has been purchased and Bell Quarry Rehabilitation Project Pty Ltd (BQRP) are seeking to rehabilitate the site through the importation of virgin excavated natural material (VENM), excavated natural material (ENM) and other clean fill material sourced from earthworks projects across Sydney and the local regional area (the Project). The rehabilitation process will involve:

- Importation of approximately 1.2 million cubic metres of VENM, ENM and other clean fill material
- Vehicle haulage at a rate of up to 140,000 tonnes per annum (tpa)
- Vehicle haulage to and from the site between 7:00 am and 6:00 pm on weekdays and between 7:00 am and 1:00 pm on Saturdays
- Plant and heavy vehicles within the quarry site between 7:00 am and 6:00 pm on weekdays and between 7:00 am and 1:00 pm on Saturdays
- The preparation of the ground on site for haul trucks between 6:00 am and 7:00 am on weekdays and Saturdays
- Emplacement and compaction of soil material within the existing quarry voids
- Shaping of fill to closely represent the pre-quarry landform and to allow surface water drainage across the final landform
- Development of a water management system to control surface water discharges throughout the rehabilitation program and from the final landform
- Revegetation of the site with locally endemic species to provide effective integration with the surrounding landscape.

A noise assessment is required to assess the potential noise impacts of emplacement activities at the site and the additional truck movements to and from the site. Up to thirty seven (37) inbound and thirty seven (37) outbound 40 tonne truck movements and four (4) light vehicles (staff) movements per day have been assessed as a worst case assessment, however the volumes of truck movements generated would typically be less.

1.2 Purpose of this report

This report describes the procedures and results of the assessment of noise impacts resulting from the emplacement activities at the site as described above. The purpose of this report is to determine if the project would result in noise impacts above the project noise trigger levels at sensitive receivers and, if necessary, provide recommendations and mitigation strategies to ensure that the project noise trigger levels are not exceeded.

1.3 Scope of this report

GHD conducted a noise impact assessment to assess the potential impacts of noise from machinery and equipment on-site and the light and heavy vehicle movements at sensitive receptors. The assessment involved the following tasks:

- Conduct an initial desk top review to identify environmental noise and vibration sensitive receivers from aerial photography and a site visit.

- Undertake background noise monitoring for one week at two noise receiver locations identified as being indicative of the local ambient noise environment.
- Establish project specific noise trigger levels and vibration criteria for the operation of the quarry with consideration to the guidelines and standards mentioned below.
- Identify the likely principal noise and vibration sources during the proposed operations.
- Undertake noise modelling to predict operational noise levels at the nearest identified noise receivers to the quarry.
- Calculate the noise level at the nearest receptors due to noise generating equipment and plant movements at the site during the early and later stages of the rehabilitation
- The scope of work above has been conducted with consideration to the following guidelines:
  - Noise Policy for Industry (NPI) (EPA, 2017).
  - Road Noise Policy RNP (DECCW 2011).
  - Assessing Vibration: A Technical Guideline (DEC 2006).
- Assessing noise impacts from the increase in traffic movements associated with material transport on Sandham Road. The potential noise impacts associated with the traffic movements were assessed with consideration of the *Road Noise Policy* (NSW DECCW, 2011).

1.4 Secretary's Environmental Assessment Requirements (SEAR) 1105

The following noise and vibration key issues are to be addressed in accordance with the SEAR 1105:

- A description of all potential noise and vibration sources during construction and operation, including road traffic noise
- A noise and vibration assessment in accordance with the relevant Environment Protection Authority Guidelines
- A description and appraisal of noise and vibration mitigation and monitoring measures

SEAR 1105 references the NSW *Industrial Noise Policy* (EPA, 2000). Note should be made that this policy has been superseded by the NSW *Noise Policy for Industry* (EPA, 2017). Further, the assessment of noise from the site has been assessed against the EPA Noise Policy for Industry (NPI) as the construction noise criteria from the Interim Construction Noise Guideline (ICNG) is less stringent than the noise goals of the NPI. The assessment of vibration emissions from the site have been assessed with guidance from the RMS Construction Noise and Vibration Guideline (CNVG).

1.5 Limitations

This report: has been prepared by GHD for Bell Quarry Rehabilitation Project Pty Ltd and may only be used and relied on by Bell Quarry Rehabilitation Project Pty Ltd for the purpose agreed as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Bell Quarry Rehabilitation Project Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Bell Quarry Rehabilitation Project Pty Ltd and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Existing environment

2.1 The site and sensitive receivers

The site is located within the Lithgow Local Government Area, approximately 10 kilometres east of the Lithgow and approximately 250 metres south-east of Newnes Junction. Road access to the site is via Sandham Road from the south.

The nearest identified sensitive receivers located in the vicinity of the site are detailed in Table 2-1 and shown in Figure 2-1 below. Distances are stated from the most affected point at or within the residential boundary of the nearest receivers (or at the most affected point within 30 metres of a dwelling) to the nearest point at the site boundary.

Table 2-1 Identified noise sensitive receivers (from site operations)

Receiver	Receiver type	Address	Distance from site boundary (metres)	Direction from site
R1	Residential	Sandham Road, Dargan	184	North-west
R2	Residential	567 Sandham Road	360	North-west
R3	Residential	576 Sandham Road	378	North-west
R4	Residential	399 Chifley Road	700	South
R5	Residential	371 Chifley Road	918	South
R6	Residential	363 Chifley Road	964	South

Sensitive receivers were also identified along Sandham Road, which will be used to access the quarry. These are detailed in Table 2-2 and Figure 2-2 below. Distances are stated from Sandham Road to 1.0 m from the nearest residential dwelling on the subject premises.

Table 2-2 Identified noise sensitive receivers (along Sandham Road)

Receiver	Receiver type	Address	Distance from Sandham Road (metres)
R4	Residential	399 Chifley Road	198
R5	Residential	371 Chifley Road	180
R6	Residential	363 Chifley Road	156
R7	Residential	361 Chifley Road	197
R8	Residential	357 Chifley Road	214
R9	Residential	347 Chifley Road	178
R10	Residential	345 Chifley Road	168
R11	Residential	339 Chifley Road	175
R12	Residential	333 Chifley Road	230
R13	Residential	329 Chifley Road	184
R14	Residential	327 Chifley Road	239
R15	Residential	291 Chifley Road	196
R16	Residential	289 Chifley Road	163
R17	Residential	287 Chifley Road	245
R18	Residential	310 Sandham Road	90
R19	Residential	275 Chifley Road	263
R20	Residential	267 Chifley Road	139
R21	Residential	225 Chifley Road	141
R22	Residential	221 Chifley Road	165
R23	Residential	215 Chifley Road	267
R24	Residential	213 Chifley Road	128
R25	Residential	97 Chifley Road	284

Receiver	Receiver type	Address	Distance from Sandham Road (metres)
R26	Residential	5 Boronia Street	310
R27	Residential	1-3 Boronia Street	292
R28	Residential	32 Sandham Road	80
R29	Residential	30 Sandham Road	142
R30	Residential	28 Sandham Road	149
R31	Residential	27 Sandham Road	171
R32	Residential	19 Sandham road	16
R33	Residential	18 Sandham Road	16
R34	Residential	15 Sandham Road	33
R35	Residential	13 Sandham Road	16
R36	Residential	12 Sandham Road	78
R37	Residential	10 Sandham Road	190
R38	Residential	2 Sandham road	16

Legend

- Bell Quarry site
- Residential buildings
- Background Noise Monitoring Locations

Paper Size A4

0 75 150 300

Metres

Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

N

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Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation

Location of site, sensitive receivers and noise monitoring locations

Job Number	21-25774
Revision	A
Date	29 May 2018

Figure 2-1

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

G:\21\25774\GIS\Maps\Deliverables\21_25774_Z008_NoiseSiteLocation.mxd (SMA record: 1)

Data source: Aerial Imagery: Sixmaps (2017 NSW LPI); General Topo: NSW LPI DTDB 2012. Created by:afoddy

Legend

- Bell Quarry site
- Residential buildings
- Sandham Road

Paper Size A4

0 200 400 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation

Senstive residential receivers along Sandham Road

Job Number	21-25774
Revision	A
Date	29 May 2018

Figure 2-2

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G:\21\25774\GIS\Maps\Deliverables\21_25774_Z009_NoiseReceivers.mxd (SMA record: 2)

Data source: Aerial Imagery: Sixmaps (2017 NSW LPI); General Topo: NSW LPI DTDB 2012. Created by:afoddy

2.2 Noise monitoring methodology

The methodology for the noise monitoring program included the following:

- Identification of sensitive receivers including residences and other sensitive land uses in the vicinity of the proposal
- Noise logging was conducted from Thursday 27th July 2017 to Monday 7th August 2017.
- A calibration check was performed on the noise monitoring equipment using a sound level calibrator with a sound pressure level of 94 dBA at 1 kHz. At completion of the measurements, the meter's calibration was re-checked to ensure the sensitivity of the noise monitoring equipment had not varied. The noise loggers were found to be within the acceptable tolerance of ± 0.5 dBA
- Noise monitoring was undertaken using Rion NL-52 environmental noise loggers. The noise logger was programmed to accumulate L_{A90}, L_{A10}, and L_{Aeq} noise descriptors continuously over the entire monitoring period. Details of the noise monitoring equipment are provided in Table 2-3
- The data collected by the logger was downloaded and analysed, and any invalid data removed. Invalid data generally refers to periods of time where average wind speeds were greater than 5 m/s, or when rainfall occurred. Meteorological data was sourced from the Bureau of Meteorology's Mount Boyce weather station (number 063292) and is located within 30 kilometres of the noise monitoring site in accordance with the NPI.

All noise monitoring activities were undertaken and processed in accordance with the NPI long-term monitoring method. All noise logger settings and descriptors used were based on this method.

2.3 Summary of noise monitoring results

Details of the noise monitoring equipment and location are provided in Table 2-3. Noise logger data results are summarised in Table 2-4. Noise monitoring charts are presented in Appendix A.

Table 2-3 Unattended noise monitoring details

Location	Equipment photo	Equipment details	Equipment settings
Northern boundary of Bell quarry site		Rion NL-52 SN: 00131630	A-weighted Fast time response 15 minute intervals Pre to post calibration variance: 0.4 dB
Western boundary of 310 Sandham Road		Rion NL-52 SN: 00131631	A-weighted Fast time response 15 minute intervals Pre to post calibration variance: 0.4 dB

Table 2-4 Summary of noise monitoring results, dBA

Location	Background noise descriptors $L_{A90(Period)}$			Ambient noise descriptors $L_{Aeq(period)}$		
	Day	Evening	Night	Day	Evening	Night
Northern boundary of Bell quarry site	23	22	18	38	36	39
Western boundary of 310 Sandham Road	24	15	14	43	42	41

2.3.1 Local meteorology

Meteorology data was obtained from the Bureau of Meteorology's Mount Boyce Automatic Weather Station for this assessment, situated approximately 5 km to the south east. Meteorological modelling (based on the obtained data from Mount Boyce AWS data) was conducted as part of GHD's air quality impact assessment (Volume 2, Appendix F) to predict meteorological conditions at the Bell Quarry site.

2.3.2 Temperature inversions

Site operations are proposed from 6.00 am to 6 pm weekdays and as detailed below in Section 4.1.4. The noise predictions are considered conservative as the model takes into account a moderate temperature inversion.

2.3.3 Wind effects

Noise propagation can be enhanced by wind conditions. The NPI states that when there is greater than a 30% occurrence of wind of up to 3 m/s, in any period (day, evening, night) in any season, from source to receiver, wind should be considered in noise prediction calculations.

Wind conditions at the Bell Quarry site are based on meteorological modelling conducted for GHD's air quality assessment (derived from weather data obtained from Mount Boyce AWS). The proposed operations will occur during the daytime period. Figure 2-3 and Figure Figure 2-4 presents annual wind roses during the daytime and night-time shoulder (6 am to 7 am) periods for 2011 - 2016 at the Bell Quarry site. Analysis of the seasonal wind rose data indicates that winds up to 3 m/s do not occur more than 30% of the time in the direction[1] of nearest sensitive receivers to the north-west.

[1] The NPI specifies for a 16-direction wind compass to use the arithmetic sum of the direction being reported and the four closest directions

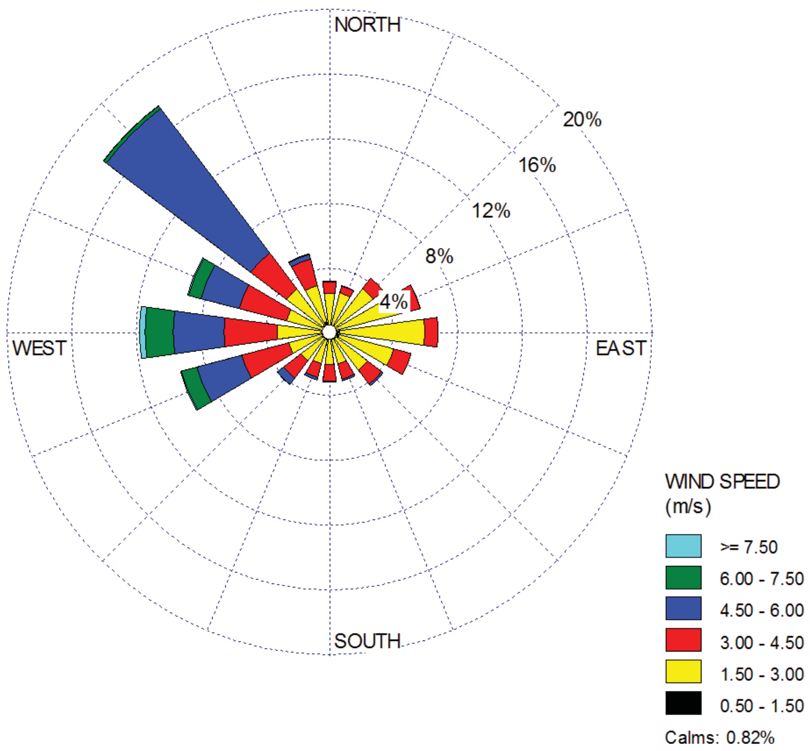


Figure 2-3 Annual daytime wind roses at Bell Quarry site

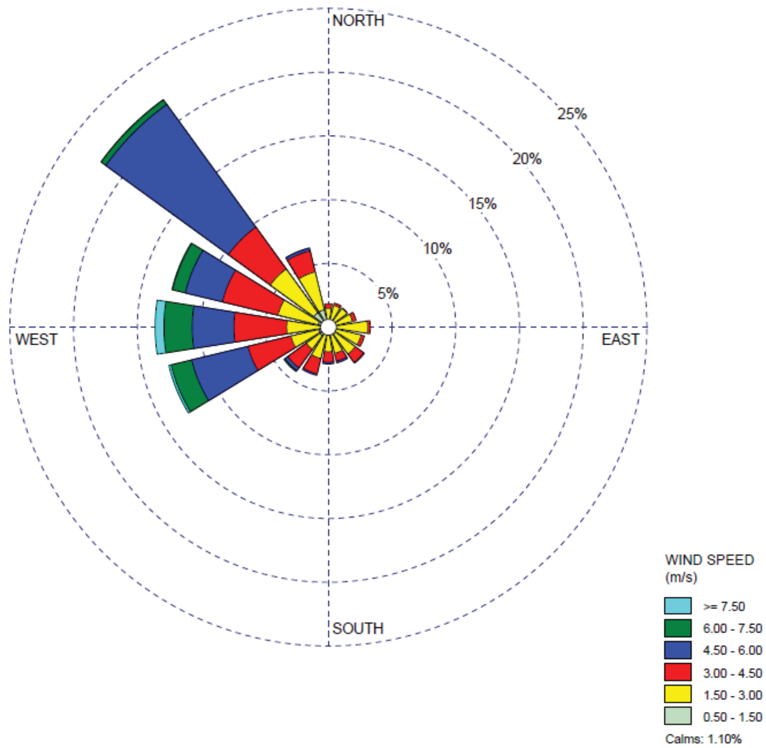


Figure 2-4 Annual night time shoulder wind roses at Bell Quarry (6am – 7am)

3. Compliance criteria

3.1 Legislative requirement (SEARs)

The acoustic requirements outlined within the SEARs are consistent with the compliance criteria detailed below.

3.2 Project noise trigger levels

The Noise Policy for Industry (NPI) provides guidance on the assessment of operational noise impacts. The guideline includes both intrusiveness and project amenity noise levels that are designed to protect receivers from noise significantly louder than the background level, and to limit the total noise level from industry near a receiver.

The NPI project noise trigger levels provide an objective for assessing a proposal and are not mandatory limits required by legislation. The project noise trigger levels assist the regulatory authorities to establish licensing conditions. Where project noise trigger levels are predicted to be exceeded, feasible and reasonable noise mitigation strategies should be considered. In circumstances where noise criteria cannot be achieved, residual noise impacts are used to assess noise impacts and manage noise from the site in negotiation between the regulatory authority and community. The regulatory authority then sets statutory compliance levels that reflect the achievable and agreed noise limits from the development.

The intrusiveness noise level controls the relative audibility of operational noise compared to the background level at residential receivers. The amenity noise level limit the total level of extraneous noise for all receiver types. Both levels are calculated and the lower of the two in each time period is set as the project noise trigger level. The intrusiveness noise level is assessed over a 15 minute period however the amenity noise level is assessed over the day, evening or night time period. For the purposes of assessment to standardise the approach the NPI recommends that the $L_{Aeq(15min)} = L_{Aeq(period)} + 3$ dBA unless an alternative approach can be justified.

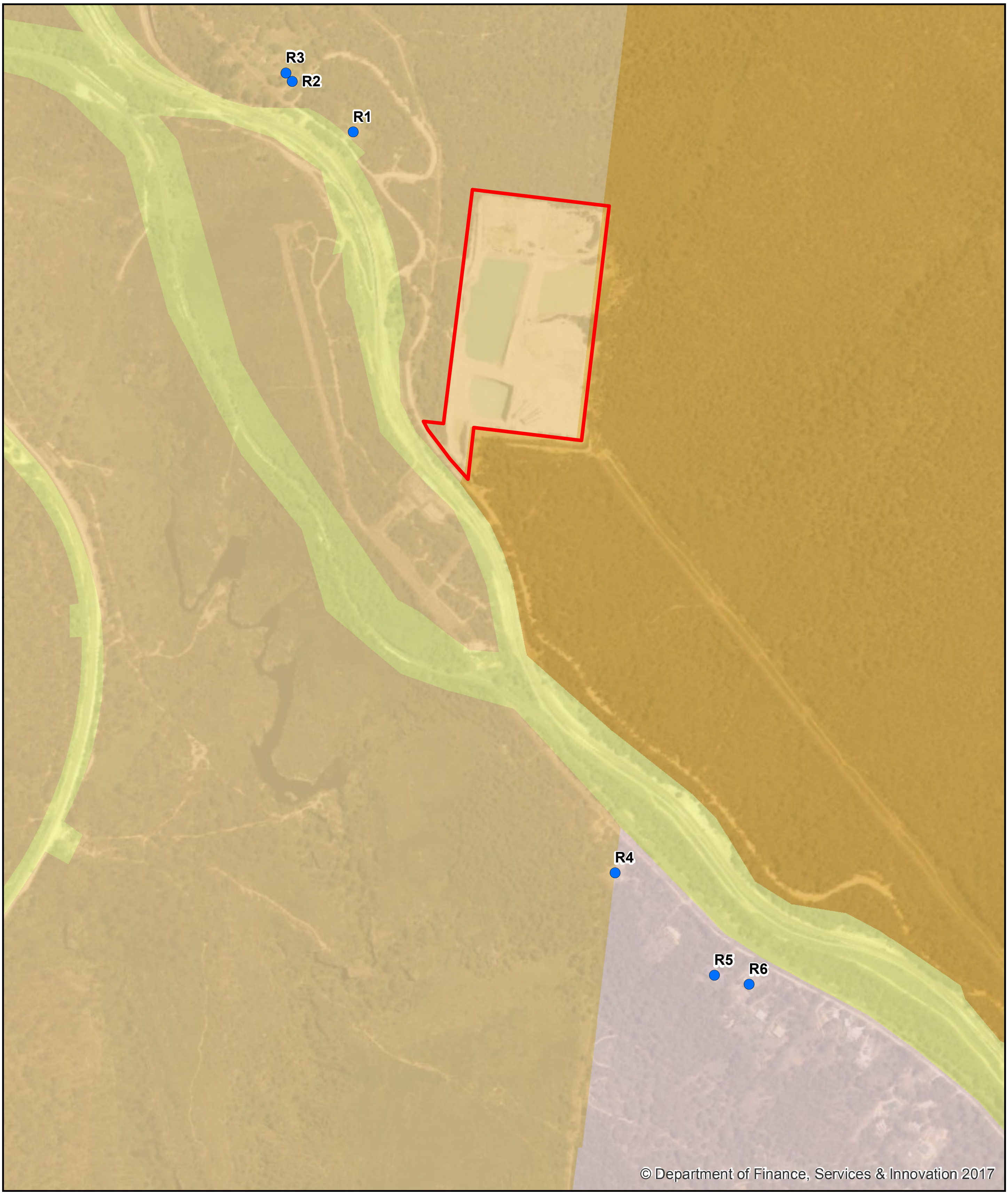
3.2.1 Intrusiveness noise level

The intrusiveness noise level is determined by a 5 dB addition to the measured or adopted background noise level with a minimum intrusiveness noise level of 35 dBA for the evening and night period and 40 dBA for the day period. The NPI recommends that the intrusiveness noise level for the evening and day period should not exceed the daytime period. The intrusiveness noise levels are only applicable to residential receivers.

3.2.2 Project amenity noise level

The recommended amenity noise level applies to all industrial noise in the area which when combined should remain below the recommended amenity noise level. The recommended amenity noise level represents the total industrial noise at a receiver location and a Project Amenity Noise Level is set at 5 dBA below the recommended amenity noise level.

Residential receiver areas are characterised into ‘urban’, ‘suburban’, ‘rural’ or other categories based on land uses and the existing level of noise from industry and road traffic. With consideration to the NPI ‘noise amenity area’ classification, the residential receivers identified for this assessment are located in an E3 Environmental Management and R5 Large Lot Residential planning zones as per the Lithgow Council Local Environmental Plan 2014 and classified as ‘Rural’ as presented in Figure 3.1 below.



Legend

- Bell Quarry site
- Residential buildings
- E1 National Parks and Nature Reserves
- E3 Environmental Management
- R5 Large Lot Residential
- SP2 Infrastructure

Paper Size A4
0 75 150 300
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Bell Quarry Rehabilitation

Job Number	21-25774
Revision	A
Date	29 May 2018

Residential receivers and planning zones

Figure 3-1

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G:\21\25774\GIS\Maps\Deliverables\21_25774_Z009_NoiseSiteLocation_Zoning.mxd (SMA record: 1)

Data source: Aerial Imagery: Sixmaps (2017 NSW LPI); General Topo: NSW LPI DTDB 2012; Zoning: NSW DPE 2017. Created by:afoddy

3.3 Summary of project noise trigger levels

For residential receivers, the project noise trigger levels are provided in Table 3-1. The project noise trigger levels reflect the most stringent noise level requirements derived from the intrusiveness and project amenity noise level. Daytime and night time project noise trigger levels should aim to be achieved since the quarry will operate during this time periods. Project noise trigger levels at the sensitive receivers are determined based on the respective logger location, however in this instance the Rating Background Level (RBL) was below the minimum threshold at all logger locations.

Table 3-1 – Project noise trigger levels – residential noise receivers, dBA

Criteria $L_{Aeq(15min)}$	Residential Receivers		
	Day	Evening	Night
Intrusiveness noise level	40	35	35
Project amenity noise level (rural)	48	43	38
Project noise trigger levels	40	35	35

Notes:

- The NPI defines Day as 7 am to 6 pm Monday to Friday and 8 am to 1 pm Sunday and Public Holidays, Evening 6pm to 10 pm and Night as the remaining periods.
- In accordance with the NPI, the minimum assumed Rating Background Level (RBL) during the daytime is 35 dBA and 30 dBA for the evening and night periods (measured background noise levels are lower than these RBLs)
- Noise from the site is to be measured at the most affected point within the residential boundary, or at the most affected point within 30 metres of the dwelling where the dwelling is more than 30 metres from the boundary, to determine compliance with the project noise trigger levels, except where otherwise specified below.
- The Blue Mountains National Park area directly to the south and east of the site is classified as a passive recreation area with a recommended amenity noise level of L_{Aeq} 50 dB (when in use). However, the national park area to the south and east of the site is not easily accessible by the public.

3.3.1 Hours of operation

It is understood that the operations of at the quarry site will be limited to the hours presented in Table 3-2.

Table 3-2 Operating hours

Activity	Day of week	Time	Assessment period
Rehabilitation related activities and transport of materials	Monday-Friday	7:00 am to 6:00 pm	Day
	Saturday	7:00 am to 1:00 pm	Day
	Sunday and Public Holidays	None	-
Preparation of ground on-site for haul trucks	Monday-Friday	6:00 am to 7:00 am	Night
	Saturday	6:00 am to 7:00 am	Night
	Sunday and Public Holidays	None	-

3.3.1 Sleep disturbance

The OEH's *Noise Guide for Local Government* (NGLG) provides guidelines for assessing sleep disturbance from short-term noise events. To assess potential disturbance during night-time hours (6:00 am to 7.00 am), Section 2.4.5 of the NGLG recommends that $L_{A1,1min}$ levels outside a bedroom window should not exceed the background level by more than 15 dBA.

Table 3-3 below summarises the background noise level at the nearby residential receivers and the sleep disturbance criterion.

Table 3-3 Sleep disturbance criteria, $L_{A1(1min)}$ dBA

Receiver Type	Night-time shoulder L_{A90} Background Noise Level	Criterion $L_{A1(1min)}$
Nearby Residential Receivers	30	45

3.4 Road traffic noise criteria

The *Road Noise Policy* (RNP) (DECCW), 2011) provides traffic noise criteria for residential receivers in the vicinity of existing roads, shown in Table 3-4. The criteria is applied to operational and construction traffic on public roads to identify potential road traffic impacts and the requirement for reasonable and feasible mitigation measures.

The RNP application notes state that *"for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of or exceeds, the relevant day or night noise assessment criterion."*

If road traffic noise increases from the development are within 2 dBA of current levels then the objectives of the RNP are met and no specific mitigation measures are required.

Table 3-4 Road traffic noise criteria, $L_{Aeq(period)}$ dBA

Type of Development	Day 7 am to 10 pm	Night 10 pm to 7 am
Existing residence affected by additional traffic on existing local roads generated by land use developments	55 $L_{eq(1hr)}$	50 $L_{eq(1hr)}$

The Roads and Maritime *Noise Criteria Guideline* (2015) defines sub-arterial, collector and local roads as shown in Table 3-5. Based on these definitions, Sandham Road has been classified as a local road which is assessed under the local road criteria as outlined in Table 3-4.

Table 3-5 Roads and Maritime road classification criteria

Road	Definition
Sub-arterial	Connects arterials to regions of development and carry traffic from one part of a region to another. Provide connection between arterial roads and local roads. May support arterial roads during peak periods. A road that collects local traffic leaving a locality and connects to another local road, sub-arterial or arterial. Note not all networks are large enough to have both sub-arterial and collector roads

Road	Definition
Collector	Connects the sub-arterial roads to the local road system in developed areas. May support sub-arterial roads during peak periods. May have been designed as local streets but can serve major traffic-generating developments or support non-local traffic. Note not all networks are large enough to have both collector and sub-arterial roads. The Road Noise Policy does not provide separate noise criteria for collector roads. Roads and Maritime applies sub-arterial noise criteria to collector roads and still considers collector roads and sub-arterial roads to be different functional classes.
Local	Provide vehicular access to abutting property and surrounding streets. They are the subdivisional roads within a particular developed area.

4. Noise impact assessment

4.1 Quarry site stages

The rehabilitation process will be done in six (6) stages, with each stage localised to a specific area of the quarry. Stage 1 to Stage 6 of the quarry rehabilitation process is shown below in Figure 4-1 and the complete rehabilitated site is shown below in Figure 4-2. For each stage, tipper trucks will transport material to the quarry site, where loaders and dozers will distribute the material throughout the fill area. Rollers and graders will be used to compact the material as the quarry is filled and a water cart will be used for dust suppression. Water pumps will be required to progressively dewater the existing quarry voids. A fuel truck will be also required on site to deliver fuel to the plant described above.

4.2 Site preparation

Between 6:00 am and 7:00 am (Monday to Saturday), a grader and a roller will compact the internal haulage road in preparation for the tipper trucks transporting material to the quarry. There will be no heavy vehicle haulage along Sandham Road or filling activities undertaken at the site prior to 7 am.

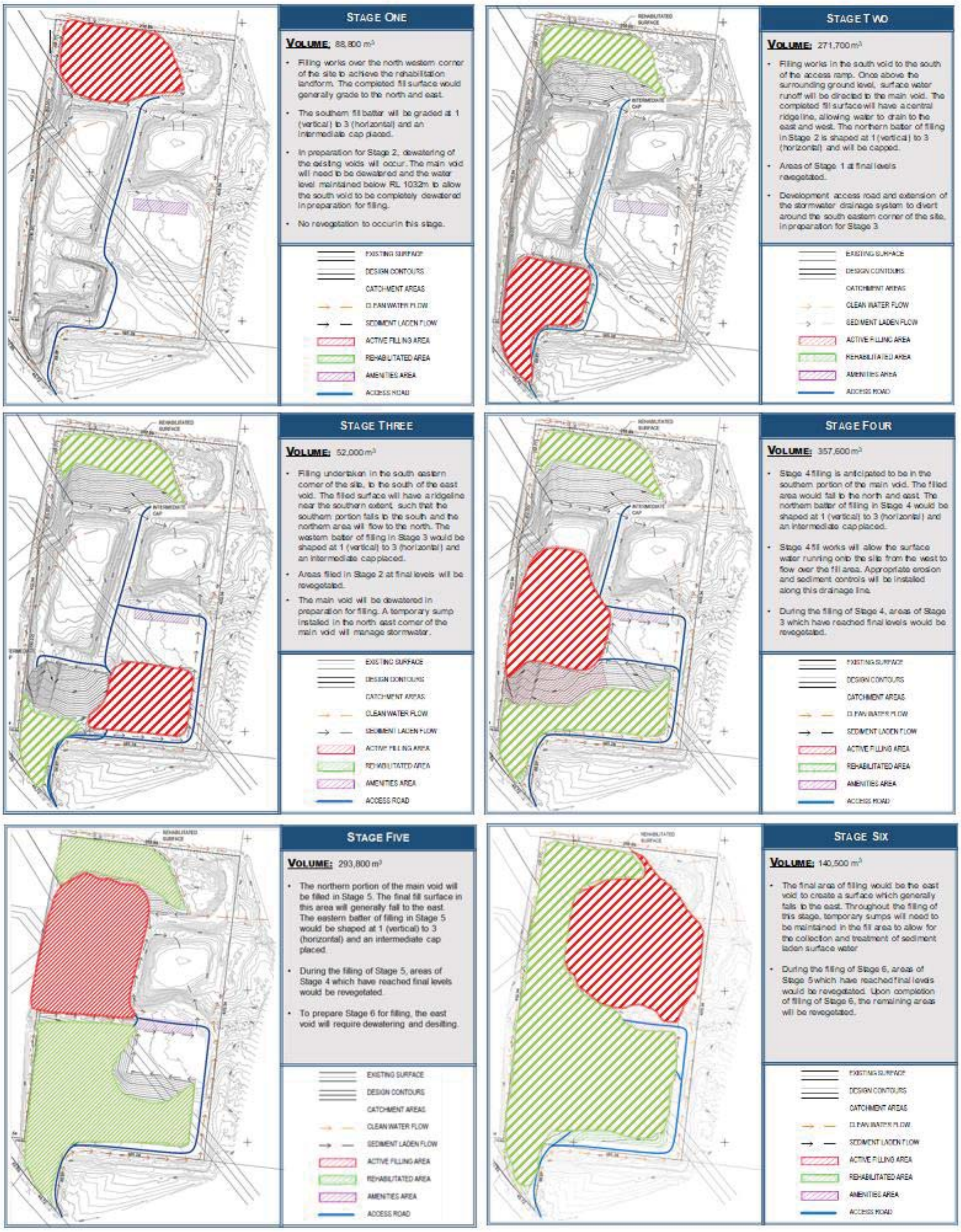


Figure 4-1 Stage one to stage six

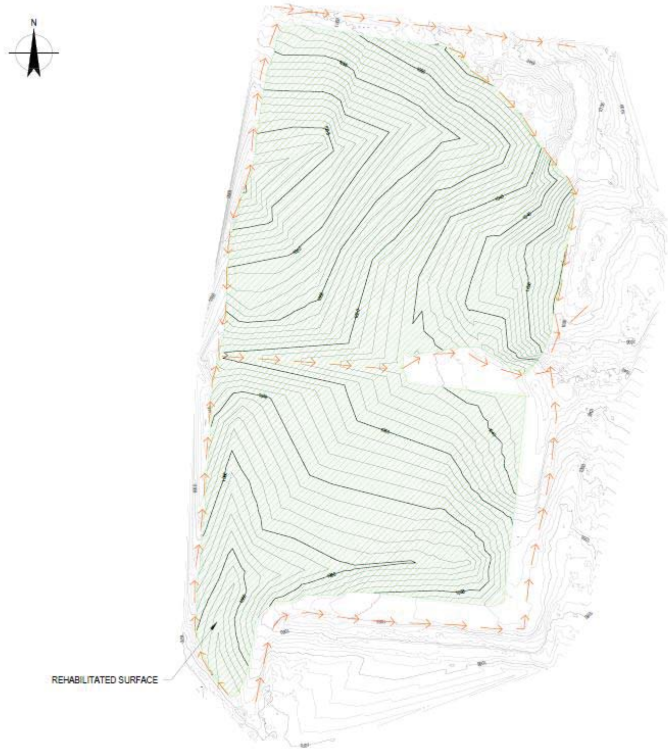


Figure 4-2 Complete rehabilitated site

4.3 Modelling method

4.3.1 Site and quarry road operation

Acoustic modelling was undertaken using CadnaA 2017 noise modelling software to predict the effects of industrial noise generated by the proposed quarry rehabilitation site.

CadnaA is a computer program for the calculation, assessment and prognosis of noise propagation. CadnaA calculates environmental noise propagation according to *ISO 9613-2, Acoustics – Attenuation of sound during propagation outdoors*. Terrain topography, ground absorption, atmospheric absorption and relevant shielding objects are taken into account in the calculations.

The ISO 9613-2 algorithm also takes into account the presence of a well-developed moderate ground based temperature inversion, such as commonly occurs on clear, calm nights or 'downwind' conditions which are favourable to sound propagation. The site operating hours are 6.00 am to 6 pm weekdays and until 1 pm on Saturdays meaning that temperature inversions are not likely. Additionally, the wind roses in Figure 2.3 and Figure 2.4 indicate that winds during the proposed operating hours are predominantly in a north-westerly direction (away from the nearest residential receivers). As such, modelling moderate temperature inversions and downwind during the daytime and between 6:00 am and 7:00 am is considered conservative.

General parameters used in the model are listed in Table 4-1.

Table 4-1 Noise model parameters

Variable	Parameter Used
Calculation method	ISO 9613
Meteorology	Well-developed moderate ground based temperature inversion, such as commonly occurs on clear, calm nights or 'downwind' conditions which are favourable to sound propagation.
Topography	Site – 0.1 m resolution
	Off site – 0.5 m resolution
Receiver heights	1.5 m above building ground level
Ground absorption	0.75, where 0 is non-porous ground and 1 is porous ground such as that found in a rural setting comprising of mainly grass and vegetation

Table 4-2 shows the mobile quarry plant included in the model and their adopted sound power levels. Table 4-3 shows the stationary quarry equipment in the model and their adopted sound power levels. Plant and equipment sound power levels have been derived from industry standard sound power levels for construction equipment and noise measurements taken from another quarry site (screen).

Table 4-2 – Modelled mobile quarry plant and sound power levels - dBA

Equipment	Frequency Band (Hz) (dBA)								Sound power LW (A)	Source
	63	125	250	500	1000	2000	4000	8000		
Water cart	76	94	97	99	103	102	96	86	107	AS 2436
Grader	103	102	99	95	100	97	93	85	108	AS 2436
Tipper truck	82	92	100	105	104	103	96	87	110	RMS CNVG
Dozer	82	97	102	99	103	100	95	85	108	AS 2436
Front end loader	88	83	101	101	98	96	91	83	106	AS 2436
Roller/ Compactor	90	85	102	103	100	98	94	85	108	AS 2436
Fuel delivery truck	55	69	81	97	100	97	89	76	103	DEFRA

Table 4-3 – Modelled stationary quarry equipment and sound power levels - dBA

Equipment	Frequency Band (Hz) (dBA)								Sound power LW (A)	Source
	63	125	250	500	1000	2000	4000	8000		
Generator for pump	57	69	67	78	80	79	79	68	89	DEFRA
Water pump	59	72	80	95	102	102	95	84	106	DEFRA
Screen	82	89	89	95	95	96	94	87	102	GHD - measured

The noise modelling assumptions for the daytime period are as follows:

- The grader, dozer, loaders and roller/compactor were modelled as operating at the bottom of the material extraction area of each stage as area sources. As the quarry is filled, the relative height of the grader, dozer, loaders and roller/compactor will progressively move higher towards the level ground. It is considered that the worst-case scenario from a noise propagation perspective is when the machinery is at the highest point on the active excavation face as each stage nears completion.

- The tipper truck, fuel truck and water truck were modelled as an area source along the highest points of the quarry site
- The generator and water pump are modelled as point sources adjacent to the relevant stage areas and at a reference level (RL) height of 1056 m.
- At the beginning of each stage a dozer and a loader were assumed to be operating simultaneously for the entire 15 minute period as a worst-case scenario.
- As each stage nears completion, a grader is assumed to be operating for 50% of a 15 minute period and roller is assumed to be operating for the entire 15 minute period as a worst-case scenario.
- The fuel truck and water truck were assumed to be operating simultaneously for 50% of the time over a 15 minute period.
- A screen was assumed to be operating continuously over a 15-minute period in the south-west portion of the quarry.
- The generator and water pump were assumed to be operating continuously over a 15-minute period.
- The tipper truck movement was modelled as one truck arriving, dumping material and leaving within a 15-minute period.
- Buildings were included in the noise model where visible through aerial photos of the region.
- Noise receivers have been modelled as single storey dwellings at a height of 1.5 m above ground.

The noise modelling assumptions for the night period are as follows:

- A grader and a roller (modelled as point sources) operating simultaneously for 66% of the time over a 15 minute period and modelled as point sources in the southern portion of the quarry.

The noise modelling scenarios for each stage are summarised in Table 4-4 below.

Table 4-4 Summary of modelled scenarios

Stage	Modelling scenario	Average RL of plant (m)
Stage 1A	Operations at the beginning of Stage 1	1042
Stage 1B	Operations nearing completion of Stage 1	1056
Stage 2A	Operations at the beginning of Stage 2	1037
Stage 2B	Operations nearing completion of Stage 2	1060
Stage 3A	Operations at the beginning of Stage 3	1055
Stage 3B	Operations nearing completion of Stage 3	1065
Stage 4A	Operations at the beginning of Stage 4	1030
Stage 4B	Operations nearing completion of Stage 4	1055
Stage 5A	Operations at the beginning of Stage 5	1035
Stage 5B	Operations nearing completion of Stage 5	1056

Stave 6A	Operations at the beginning of Stage 6	1042
Stage 6B	Operations nearing completion of Stage 6	1055

4.3.2 Road traffic noise modelling

A separate model was created using the noise intrusion modelling software CadnaA in order to determine the effects of the trucks on receivers along Sandham Road. Road traffic noise propagation was calculated according to the *Calculation of Road Traffic Noise* (CoRTN) 1998 standard. The following modelling assumptions were used as shown in Table 4.5.

Table 4-5 Road traffic modelling assumptions

Input	Assumptions
Traffic speeds	60 km/hr for cars and 40 km/hr for trucks as per GHD's traffic report
Traffic volumes	Average traffic counts from weekdays during 1-7 December 2016 were used as the base for calculations as per GHD's traffic report.
Existing Traffic - Northbound	Five light vehicles and one heavy vehicle between 4:00 pm and 5:00 pm
Existing Traffic - Southbound	One light vehicle and two heavy vehicles between 4:00 pm and 5:00 pm
Traffic growth	Four trucks and two cars northbound and four trucks and two cars southbound were added to the measured traffic counts during the 4:00 pm and 5:00 pm peak period.
Road gradient	Taken into account based on existing topography
Road surface correction	+2.0 dBA
Buildings	Buildings close to receivers were included in the model to account for reflection and wake effects
Receiver heights	1.5 metres above building ground level
Ground absorption	G = 0.75, where 0 is non-porous ground and 1 is porous ground such as that found in a rural setting comprising of mainly grass and vegetation
Ground topography	A digital terrain model with a 1 metre resolution has been used
Façade correction	+2.5 dBA to account for noise reflected from the façade (from Road Noise Policy – DECCW)
CoRTN factor (Adapted to Australian conditions through research undertaken by the Australian Road Research Board)	-1.7 dBA at the façade

The existing traffic counts along Sandham Road are provided in Table 4-6, the additional traffic associated with the quarry site is presented in Table 4-7 and the predicted traffic counts during peak hour is presented in Table 4-8. The resulting noise levels at sensitive receivers are shown in Table 4-11.

Noise emission maps for the existing and predicted road traffic noise along Sandham Road are also provided in Appendix D.

Table 4-6 Existing traffic counts used for modelling - peak hour

Location	Traffic count per hour	
	Cars	Trucks
Sandham Road Northbound	5	1
Sandham Road Southbound	1	2

Table 4-7 Additional traffic counts used for modelling – peak hour

Location	Traffic count per hour	
	Cars	Trucks
Sandham Road Northbound	2	4
Sandham Road Southbound	2	4

Table 4-8 Predicted traffic counts used for modelling – peak hour

Location	Traffic count per hour	
	Cars	Trucks
Sandham Road Northbound	7	5
Sandham Road Southbound	3	6

4.4 Operational noise impact

4.4.1 Site operation

The site operation, consisting of plant and equipment within the quarry, was modelled with the above assumptions and is based on the scenarios at the quarry site detailed above:

The resulting noise levels at sensitive receivers is shown in Table 4-9 below. Results show that all stages of the rehabilitation process will comply with the project noise trigger levels at all sensitive receivers. Noise emission maps of each stage are provided in Appendix C.

Table 4-9 Noise levels at sensitive receivers from onsite operation – day, $L_{Aeq(15min)}$ dBA

Stage	Receiver	Predicted noise level	Project noise trigger level	Compliance
Stage 1A	R1	34	40	Yes
	R2	37	40	Yes
	R3	37	40	Yes
	R4	29	40	Yes
	R5	29	40	Yes
	R6	28	40	Yes
Stage 1B	R1	39	40	Yes
	R2	39	40	Yes
	R3	40	40	Yes
	R4	30	40	Yes
	R5	29	40	Yes
	R6	29	40	Yes
Stage 2A	R1	32	40	Yes
	R2	33	40	Yes
	R3	33	40	Yes
	R4	24	40	Yes
	R5	23	40	Yes
	R6	22	40	Yes
Stage 2B	R1	35	40	Yes

Stage	Receiver	Predicted noise level	Project noise trigger level	Compliance
	R2	36	40	Yes
	R3	36	40	Yes
	R4	28	40	Yes
	R5	28	40	Yes
	R6	27	40	Yes
Stage 3A	R1	36	40	Yes
	R2	36	40	Yes
	R3	37	40	Yes
	R4	27	40	Yes
	R5	27	40	Yes
	R6	26	40	Yes
Stage 3B	R1	38	40	Yes
	R2	37	40	Yes
	R3	37	40	Yes
	R4	30	40	Yes
	R5	29	40	Yes
	R6	28	40	Yes
Stage 4A	R1	33	40	Yes
	R2	33	40	Yes
	R3	33	40	Yes
	R4	25	40	Yes
	R5	25	40	Yes
	R6	24	40	Yes
Stage 4B	R1	34	40	Yes
	R2	35	40	Yes
	R3	36	40	Yes
	R4	30	40	Yes
	R5	29	40	Yes
	R6	28	40	Yes
Stage 5A	R1	32	40	Yes
	R2	33	40	Yes
	R3	34	40	Yes
	R4	27	40	Yes
	R5	27	40	Yes
	R6	25	40	Yes
Stage 5B	R1	35	40	Yes
	R2	36	40	Yes
	R3	37	40	Yes
	R4	30	40	Yes
	R5	29	40	Yes
	R6	28	40	Yes
Stage 6A	R1	35	40	Yes
	R2	36	40	Yes
	R3	36	40	Yes
	R4	27	40	Yes
	R5	27	40	Yes
	R6	26	40	Yes
Stage 6B	R1	39	40	Yes
	R2	38	40	Yes

Stage	Receiver	Predicted noise level	Project noise trigger level	Compliance
	R3	38	40	Yes
	R4	30	40	Yes
	R5	29	40	Yes
	R6	28	40	Yes

Table 4-10 Noise levels at sensitive receivers from onsite operation - night $L_{Aeq(15min)}$ dBA

Scenario	Receiver	Predicted noise level	Project noise trigger level	Compliance
Preparation of ground on-site for haul trucks (6:00 am to 7:00 am) Monday to Saturday	R1	33	35	Yes
	R2	34	35	Yes
	R3	34	35	Yes
	R4	21	35	Yes
	R5	20	35	Yes
	R6	19	35	Yes

The results presented in Table 4-9 indicate that noise emission from the site will be the greatest as works near completion at Stage 1 and at Stage 6. These stages of the project are in the closest proximity to the sensitive receivers to the north and do not have the benefit of acoustic shielding provided by the existing walls of the quarry. Noise levels are lower during Stage 2, Stage 3, Stage 4 and Stage 5 works due to the larger distance between the works and the sensitive receivers and the acoustic shielding provided by the existing quarry wall. All noise generating works associated with the proposal during the daytime are predicted to comply with the project noise trigger levels.

The results presented in Table 4-10 indicate that the noise levels due to site preparation works between 6 am and 7 am are predicted to achieve compliance with the night-time project noise trigger levels at all nearby residential receiver locations.

Note should be made that the Blue Mountains National Park area directly to the south, north-east and east of the site is classified as a passive recreation area in accordance with the NPI. However, the national park areas directly adjacent to the site are not easily accessible by the public and as such, this area should not be deemed as a sensitive receiver.

Nevertheless, the maximum noise emission levels from the site are not greater than L_{Aeq} 50 dBA (NPI's recommended amenity noise level for passive recreational area) when calculated to either 200 metres south, north-east or north of the site boundary. The national park areas beyond 200 metres from the site are predicted to receive noise levels from the quarry site below L_{Aeq} 50 dBA.

4.5 Sleep disturbance impacts

Loud transient events have potential to cause sleep disturbance impacts during the night period. The activities associated with the proposal with the most likelihood to cause sleep disturbance impacts will likely be the operation of a grader or roller (L_{A1} sound power level of 110 dBA) within the southern portion of the quarry site. The predicted noise level is calculated to the nearest open window and is assessed against the night-time (between 6 am and 7 am) background noise level + 15 dBA, being 45 dBA. The maximum $L_{A1,1min}$ predicted noise level at the nearest open window at R1 - R3 is 35 dBA and will not likely cause any adverse sleep disturbance impacts. Compliance at the nearest residential receiver locations ensures compliance at all other residential dwellings further away.

4.6 Traffic noise impacts

The impact on traffic levels and resulting noise at sensitive receivers along Sandham Road was modelled using CadnaA as outlined above. The noise impact was assessed against the noise criteria for a local road of 55 dBA $L_{Aeq(1hr)}$, as stated in section 3. The resulting noise levels at sensitive receivers are shown in Table 4-11.

Table 4-11 Noise levels at sensitive receivers from vehicles along Sandham Road

Receiver	$L_{Aeq(1hr)}$ Noise levels from existing traffic	$L_{Aeq(1hr)}$ Noise levels from predicted traffic	Criteria, dBA	Compliance
R4	32	37	55	Yes
R5	30	35	55	Yes
R6	31	37	55	Yes
R7	28	33	55	Yes
R8	28	34	55	Yes
R9	36	41	55	Yes
R10	36	41	55	Yes
R11	37	42	55	Yes
R12	32	37	55	Yes
R13	37	42	55	Yes
R14	33	38	55	Yes
R15	36	41	55	Yes
R16	38	43	55	Yes
R17	32	37	55	Yes
R18	40	45	55	Yes
R19	29	34	55	Yes
R20	37	42	55	Yes
R21	37	42	55	Yes
R22	37	42	55	Yes
R23	32	37	55	Yes
R24	40	45	55	Yes
R25	28	34	55	Yes
R26	32	37	55	Yes
R27	32	38	55	Yes
R28	42	47	55	Yes
R29	35	41	55	Yes
R30	34	40	55	Yes
R31	33	38	55	Yes
R32	49	55	55	Yes
R33	48	54	55	Yes
R34	46	52	55	Yes
R35	49	55	55	Yes
R36	41	46	55	Yes
R37	34	40	55	Yes
R38	48	53	55	Yes

Noise levels due to the use of heavy vehicles along Sandham Road is the greatest at residential dwellings within 20 metres of Sandham Road, being R32 – R36 and R38. However, the increase in traffic noise levels during maximum operation complies with the Road Noise Policy criteria of $L_{Aeq(1hour)}$ 55 dBA.

4.1 Traffic Impacts

Haul trucks entering and leaving the quarry will use Darling Causeway and Bells Line of Road to access Sandham Road. Vehicle numbers along these roads are high (over 3,000 vehicles per day with 12% heavy vehicles – RMS Traffic Volume Viewer, Station ID T0384) and therefore the additional 74 truck movements per day (as predicted in the GHD Traffic Impact Assessment) generated from the quarry activity will be negligible and is not expected to cause adverse noise impacts.

4.2 Vibration Impacts

Safe working buffer distances to comply with the human comfort, cosmetic damage and heritage structural damage criteria were sourced from the CNVG and are presented in Table 4-12 for the equipment relevant to the rehabilitation project.

Table 4-12 Vibration safe working buffer distances, m

Activity	Human comfort	Cosmetic damage	
		Heritage building/structure	Standard dwellings
Vibratory roller (7-13 tonnes)	100 m	30 m	15 m
Vibratory roller (4-6 tonnes)	40 m	24 m	12 m
Vibratory roller (2-4 tonnes)	20 m	12 m	6 m
Vibratory roller (1-2 tonnes)	15 m	10 m	5 m

Typical vibration levels from activities such as rolling are generally negligible at distances greater than 100 metres. Therefore, given the nearest receiver is more than 200 metres from the rolling activities, vibration levels from quarry equipment are not anticipated to adversely impact receivers.

5. Mitigation measures

5.1 General mitigation measures

From the results outlined in section 4 above, the proposed development is predicted to comply with the project noise trigger levels on the assumption that the following noise mitigation and management measures are implemented. These measures should be incorporated in the Environmental Management Plan.

Work ethics

- All activities on site should be confined between the hours: daytime hours of 7:00 am to 6:00 pm from Monday to Friday and 7:00 am to 1:00 pm on Saturday, with the exception of site preparation works between 6:00 am and 7:00 am Monday to Saturday. In particular, haul trucks should not arrive on site (or depart) before 7:00 am.
- Site preparation works should not occur between the hours of 6:00 pm and 6:00 am.
- All personnel on site should be made aware of the potential for noise impacts and should aim to minimise impact or elevated noise levels, where possible.

Site machinery

- All engine covers should be kept closed while equipment is operating.
- Vehicles should be kept properly serviced and fitted with appropriate mufflers. The use of exhaust brakes should be eliminated, where practicable.
- Machines found to produce excessive noise compared to industry best practice should be removed from the site or stood down until repairs or modifications can be made.
- Plant operating between 6:00 am and 7:00 am are to be fitted with broadband reversing alarms.

Sandham Road

- All trucks entering and exiting the quarry should keep at or below the required speed limit of 40 kilometres per hour on Sandham Road.
- No trucks are to utilise Sandham Road outside the hours of 7:00 am and 6:00 pm on weekdays and 7:00 pm and 1:00 pm on Saturdays.

6. Conclusion

GHD has undertaken an assessment of the noise impacts from the proposed operations and additional truck movements at the Bell Quarry site. The assessment found that based on the assumptions in the report the quarry site is predicted to achieve compliance with the project noise trigger levels at the residential receiver locations.

The noise associated with the additional light and heavy vehicles using Sandham Road is predicted to achieve compliance with the NSW Road Noise Policy at all nearby receiver locations.

The proposal should be considered acceptable from an acoustic perspective if the mitigation measures in Section 5 of the report are implemented.

7. References

NSW Government SEAR 1105 16/13848

EPA, 2013, Noise Guide for Local Government

GHD's report "2125774 Traffic Impact Assessment Bells Quarry" dated Dec 2017

GHD's report "2125774 REP-A Air Quality Assessment" dated Dec 2017

Bureau of Meteorology's Mount Boyce Airport Weather Station (ID 063292)

DECCW, 2011, *Road Noise Policy*

DECC, 2009, *Interim Construction Noise Guideline*

DECC, 2006, *Assessing Vibration: a Technical Guideline*

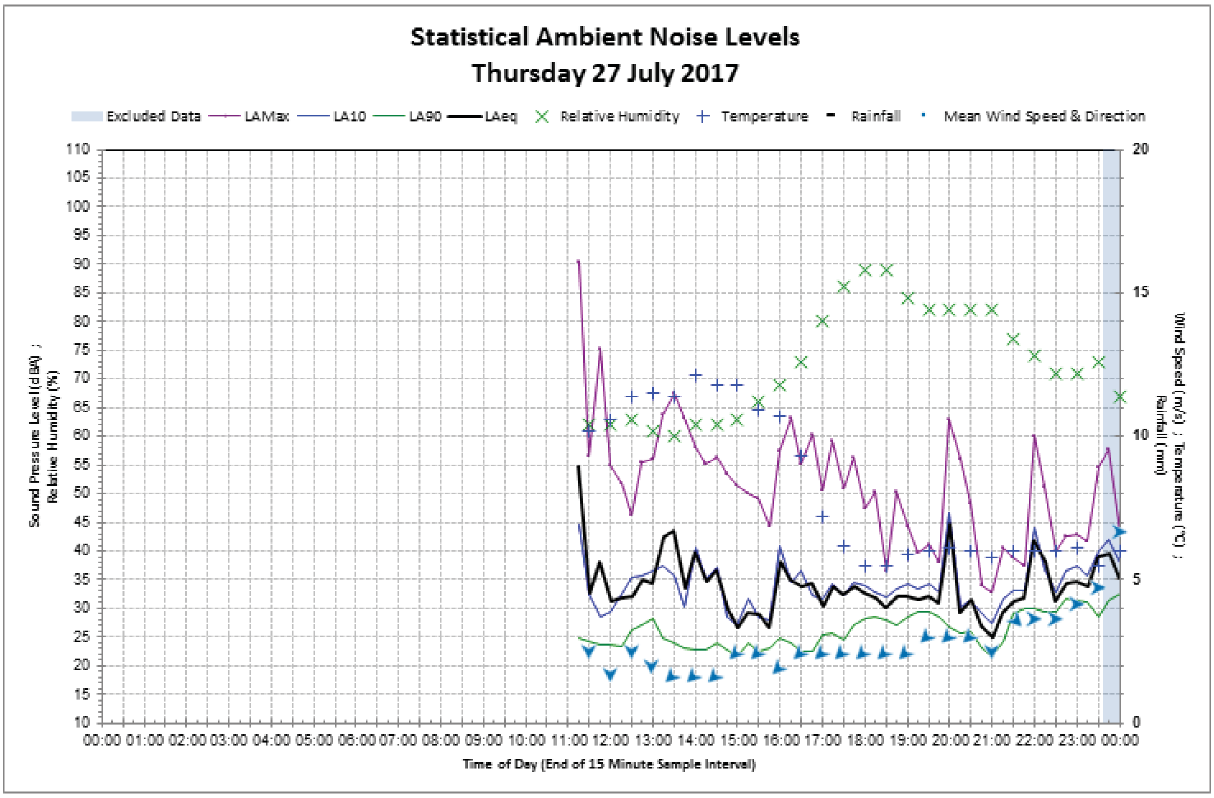
EPA, 2017, *Noise Policy for Industry*

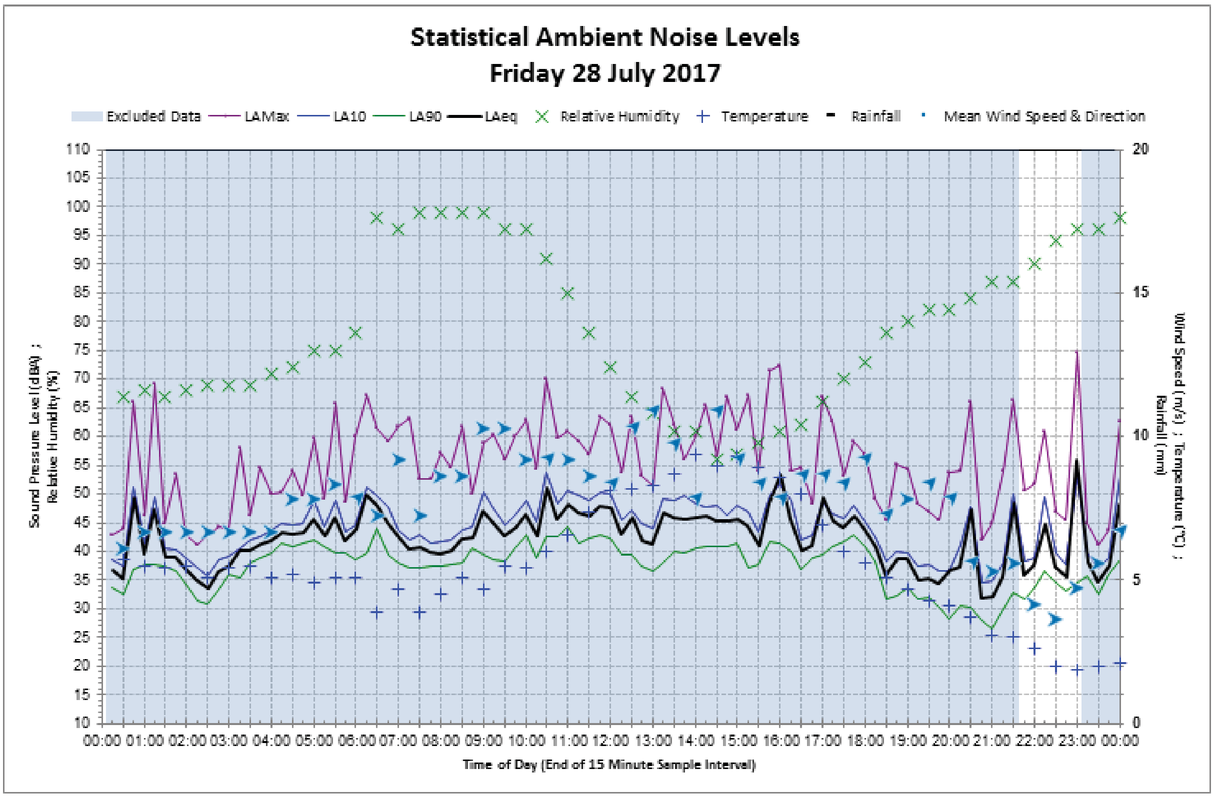
RMS, 2016, *Construction Noise and Vibration Guideline*

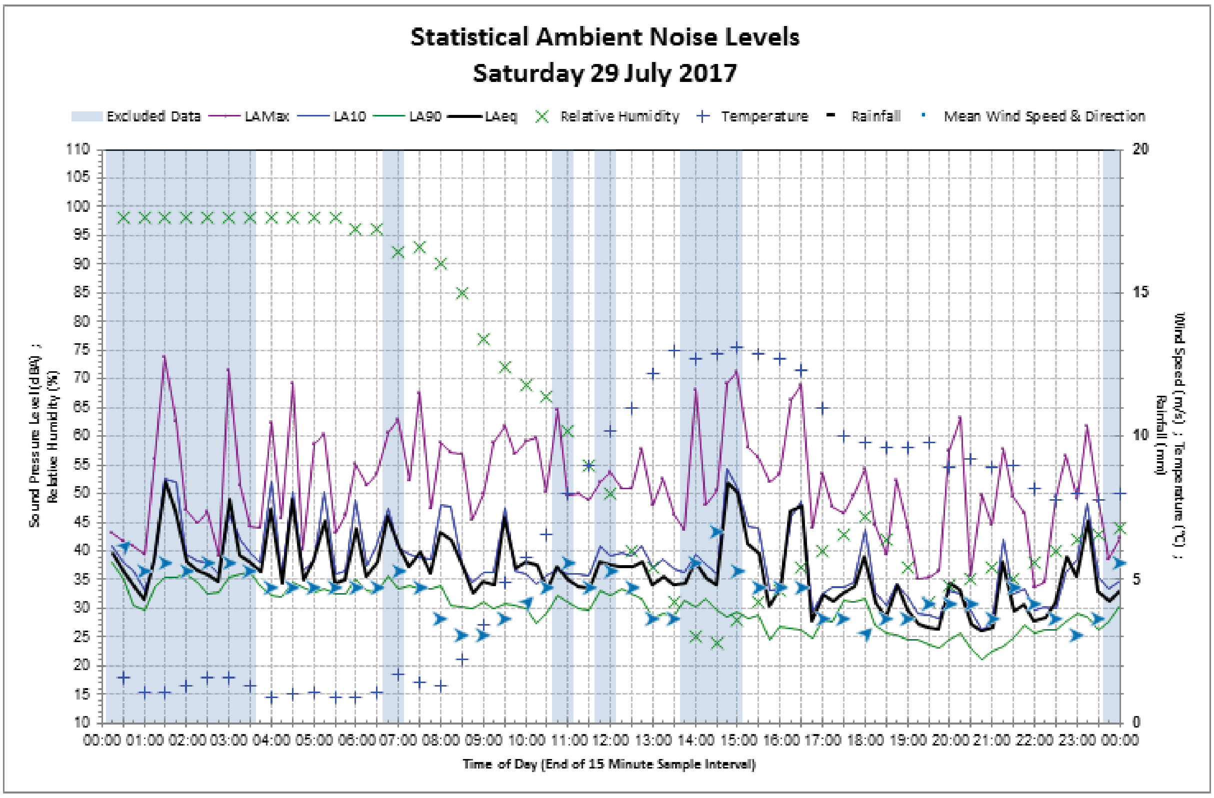
RMS, 2014, *Noise Criteria Guideline*

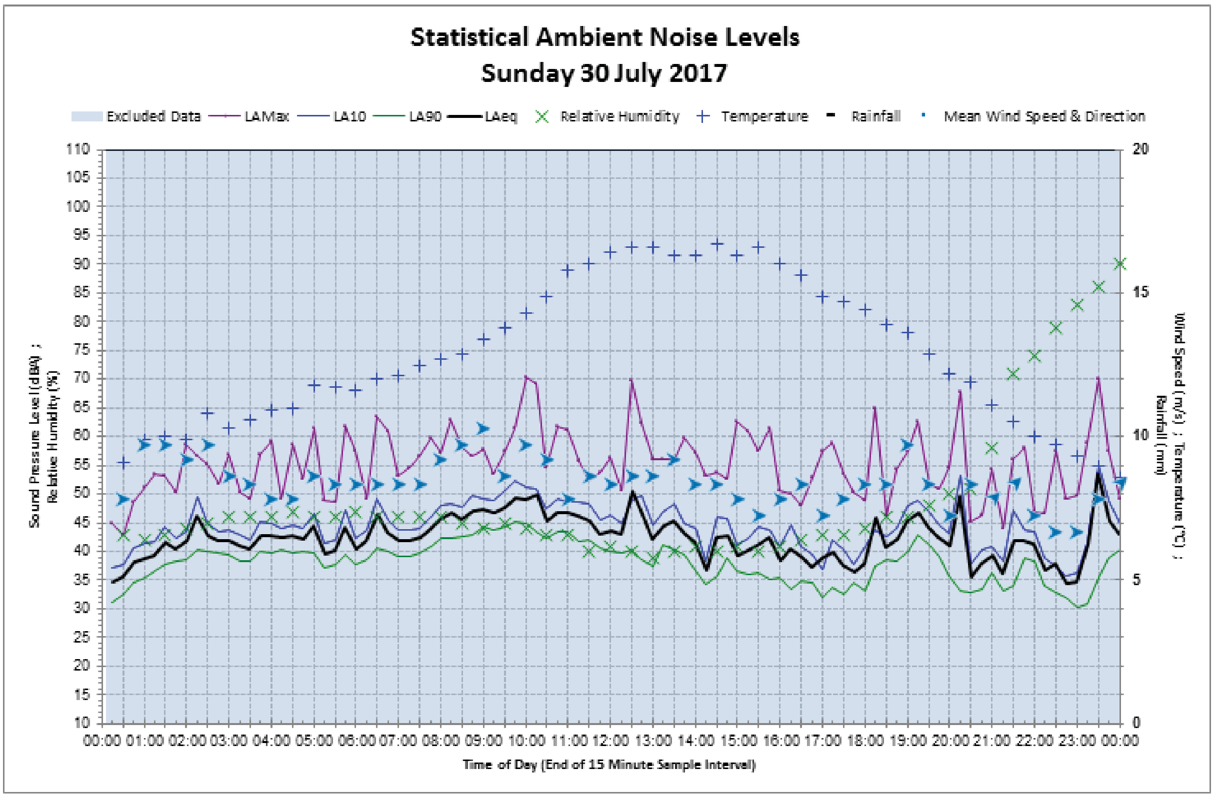
Appendices

Appendix A – Noise monitoring charts – Bell Quarry






Statistical Ambient Noise Levels
Saturday 29 July 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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LA90
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Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
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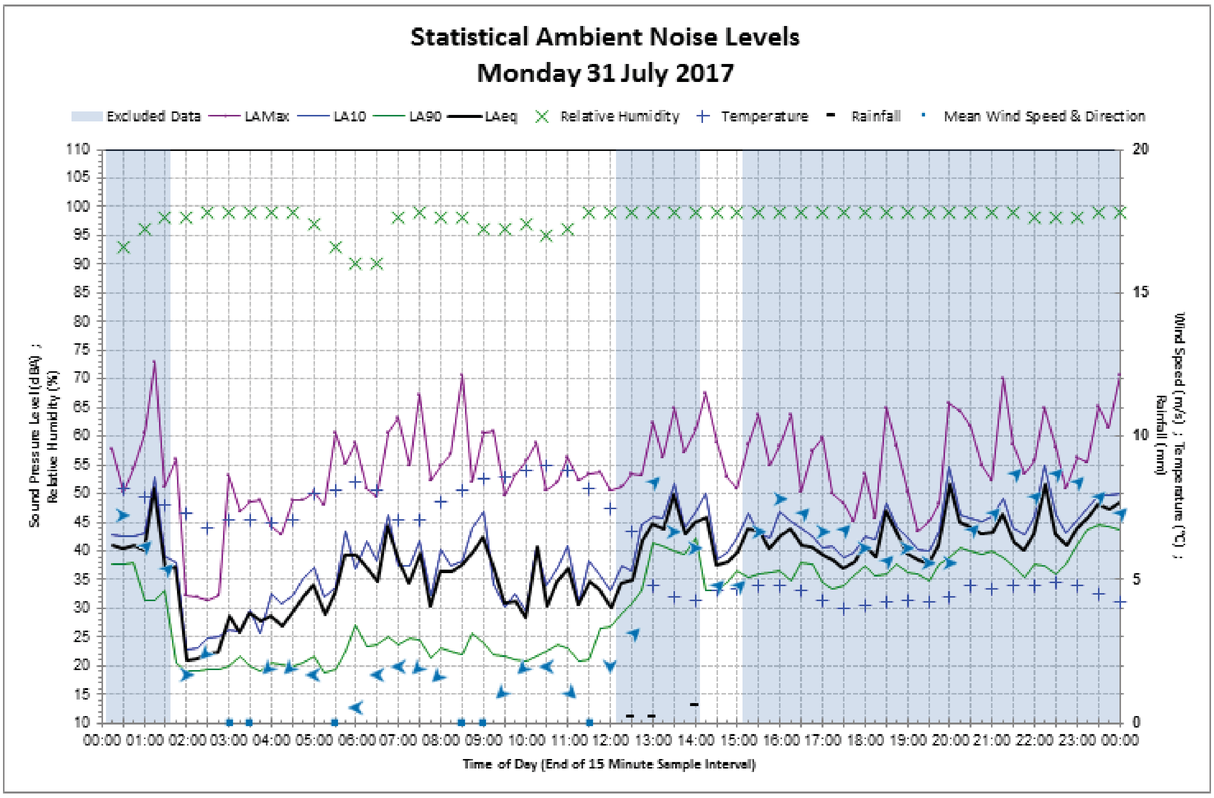
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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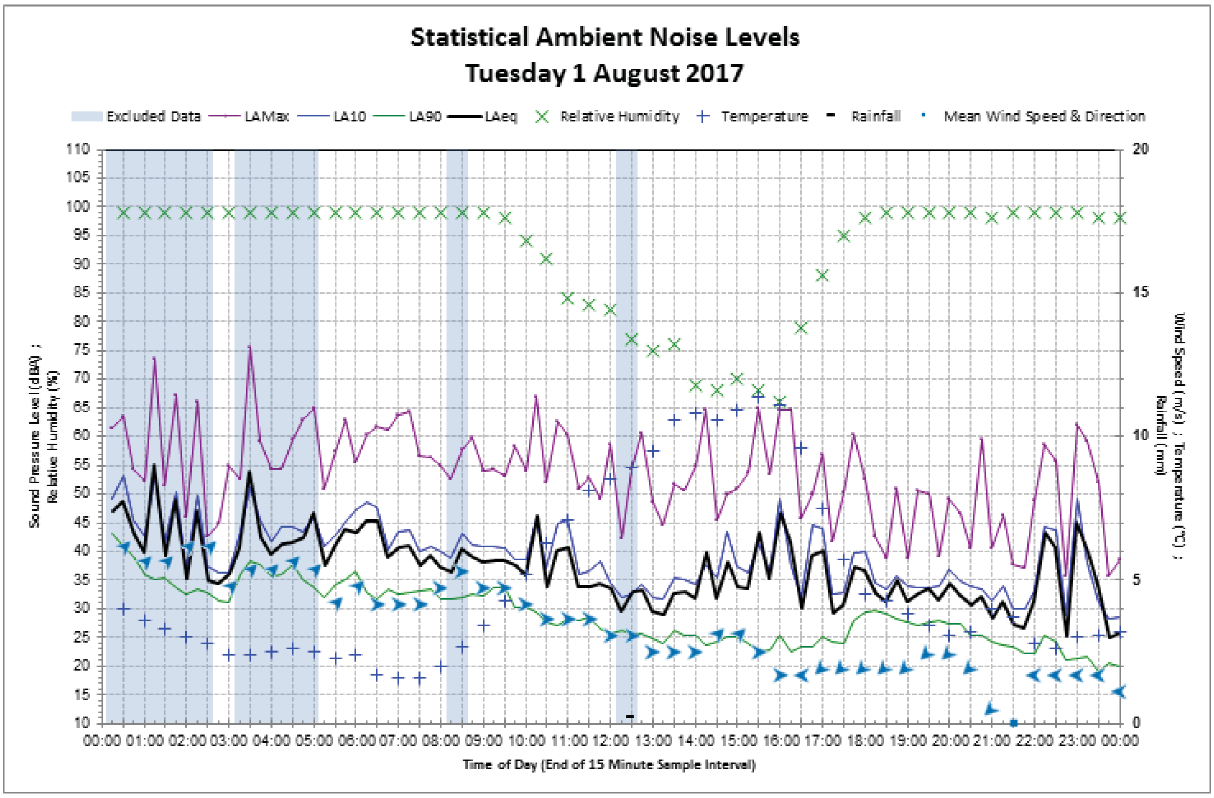
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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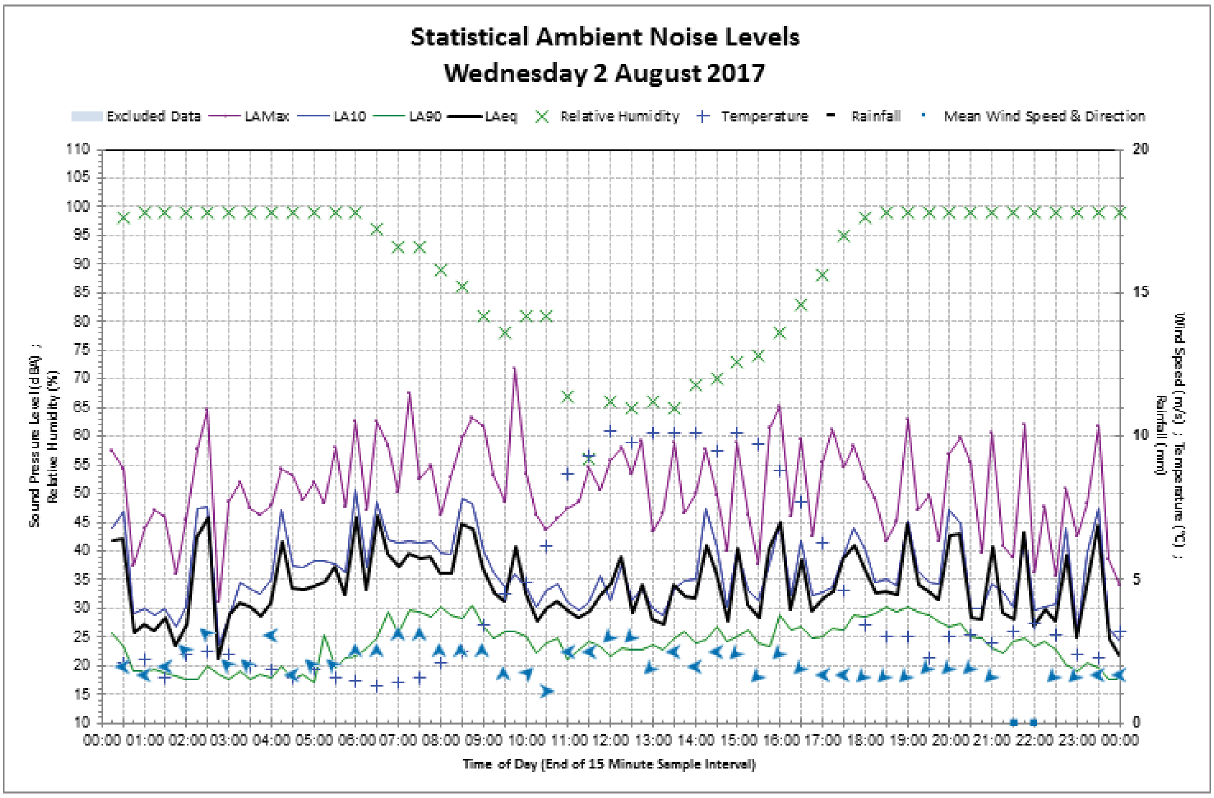
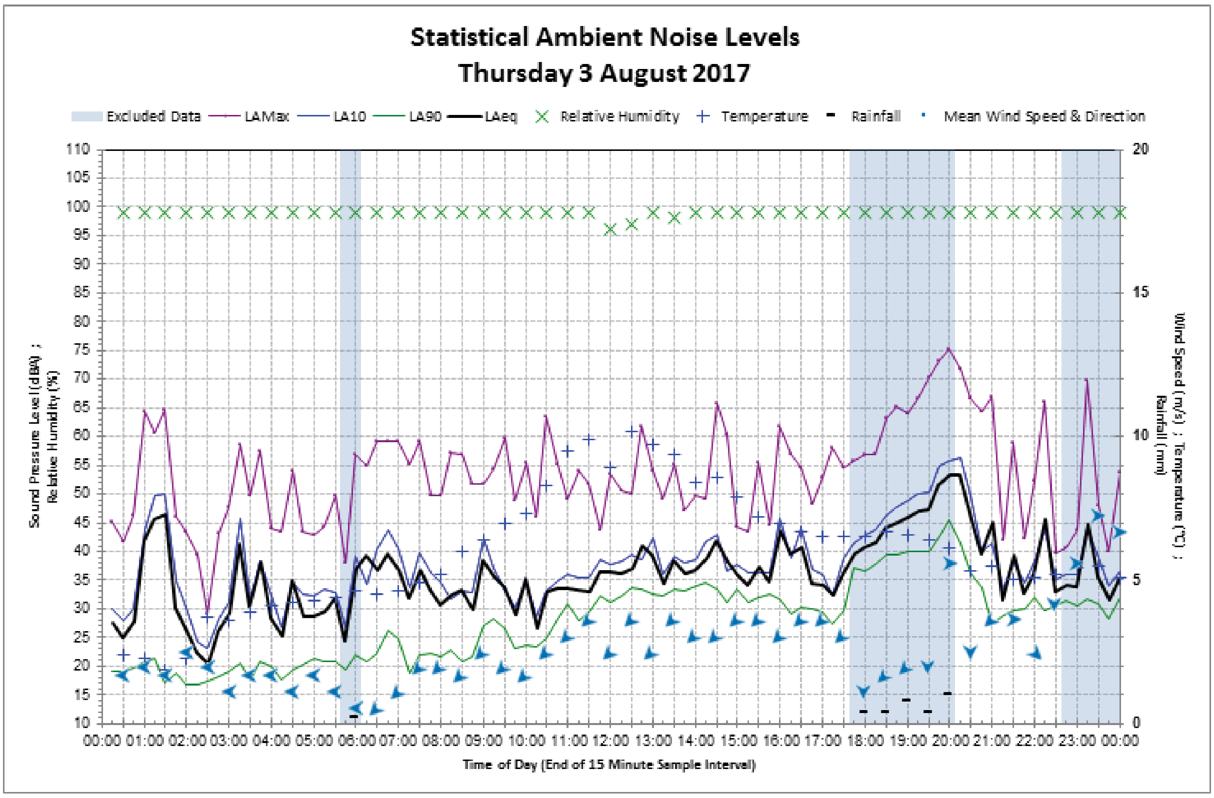
Tuesday 1 August 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Wednesday 2 August 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Thursday 3 August 2017
Excluded Data
LAMax
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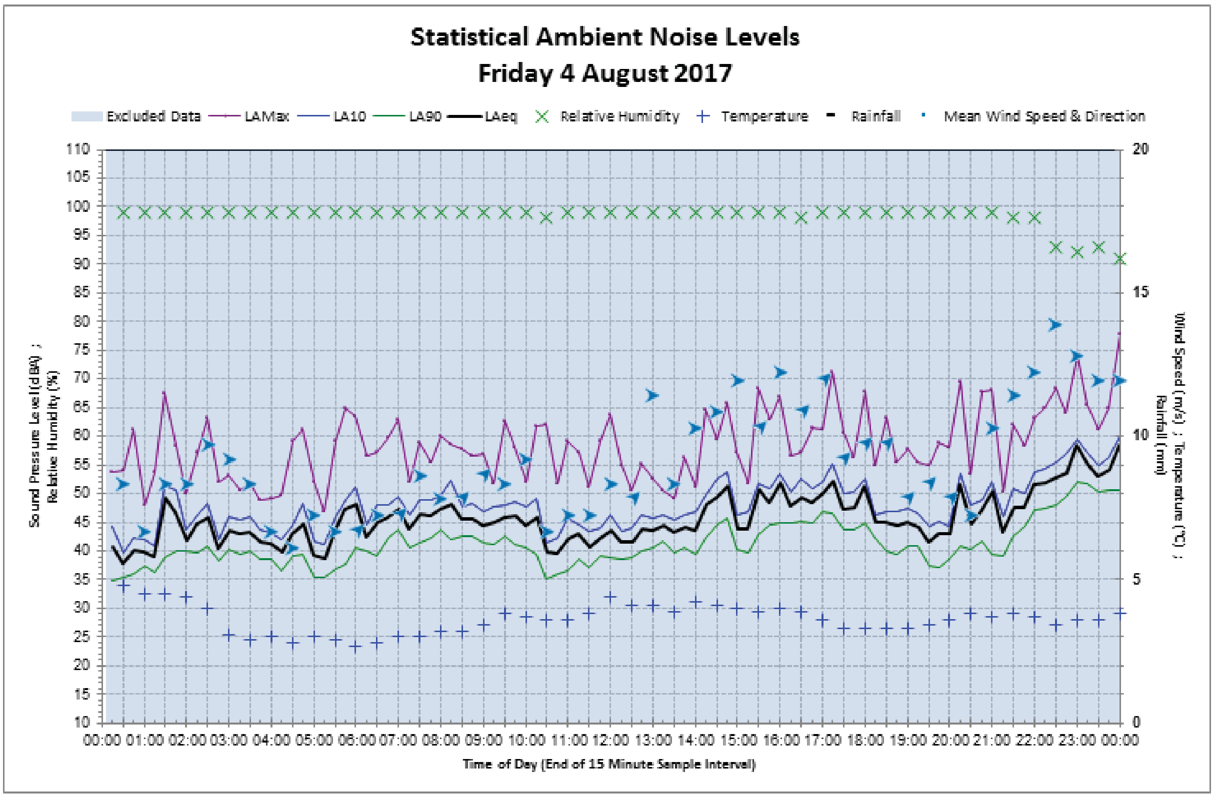
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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Friday 4 August 2017
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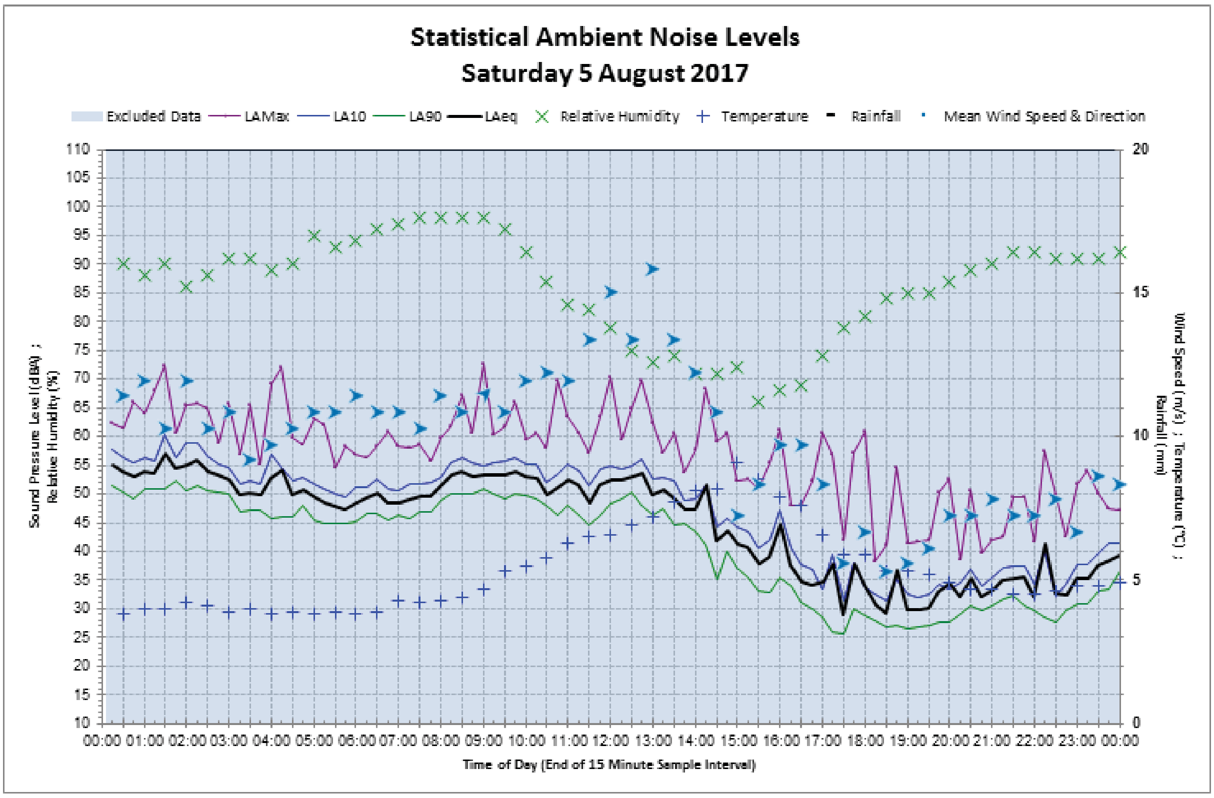
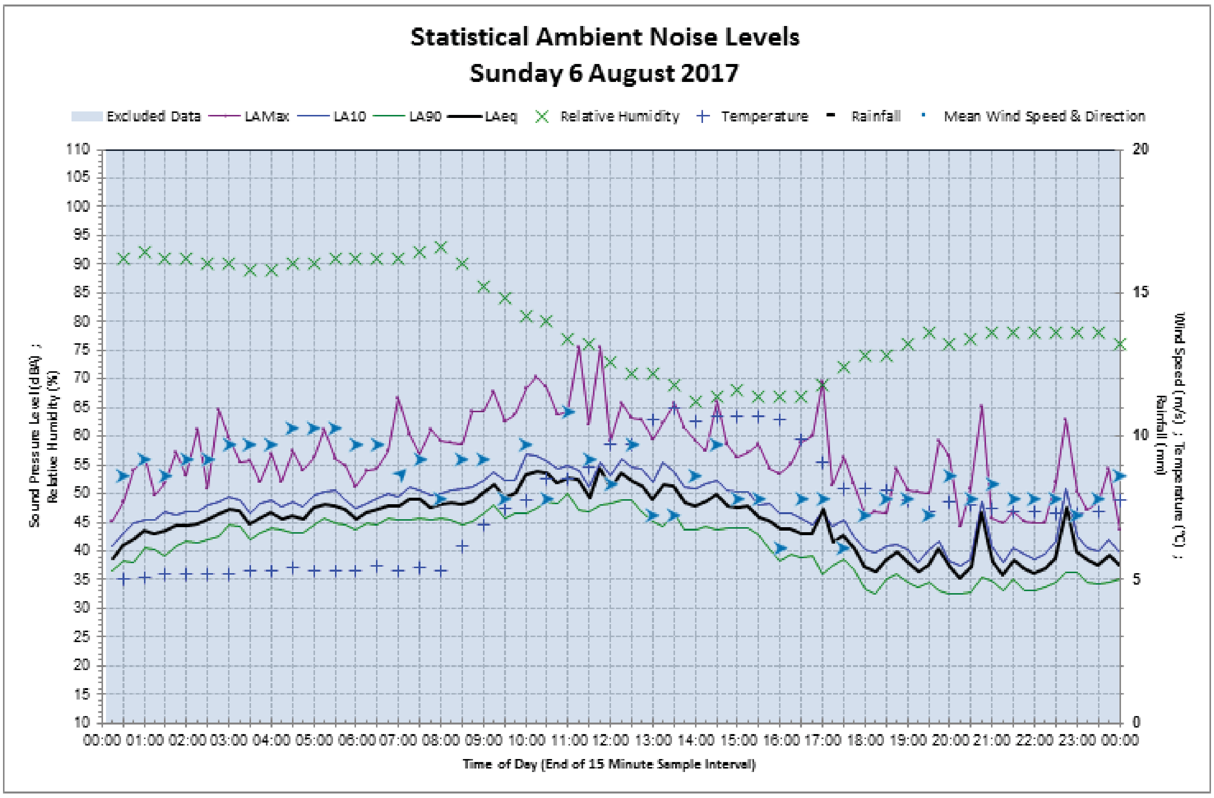
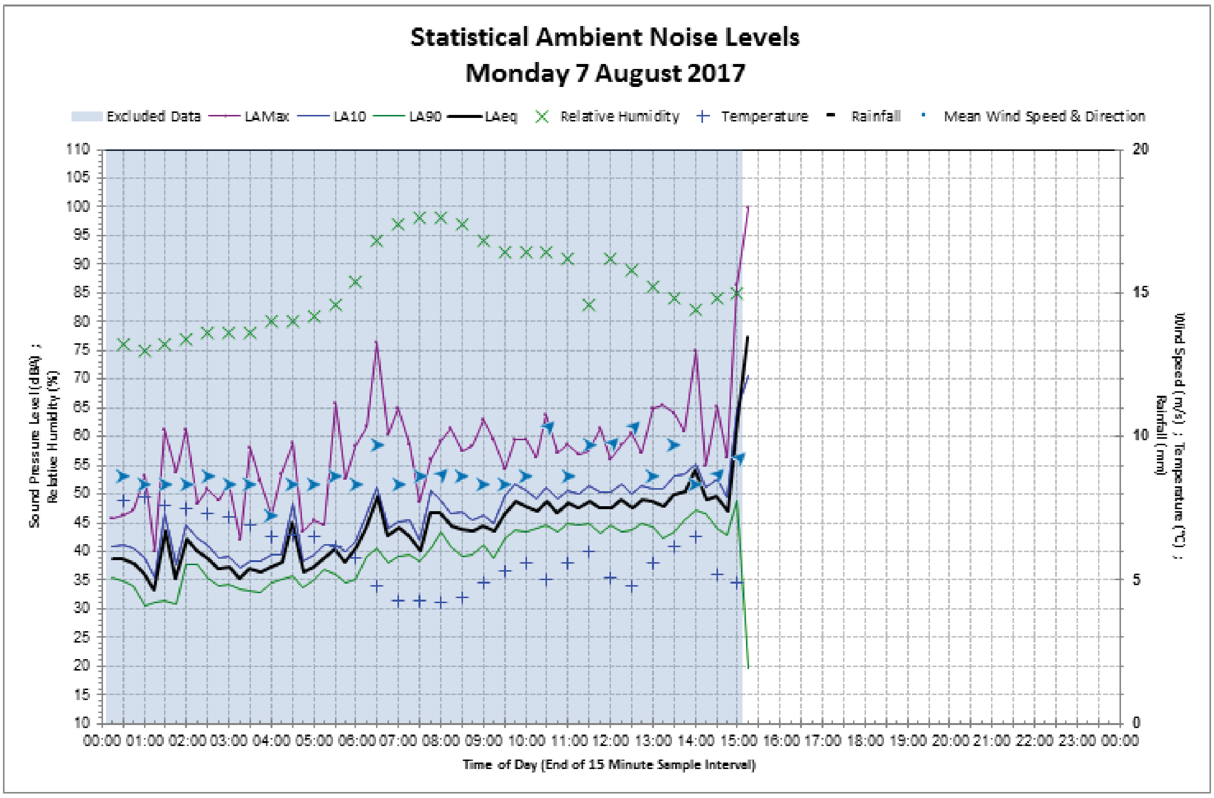
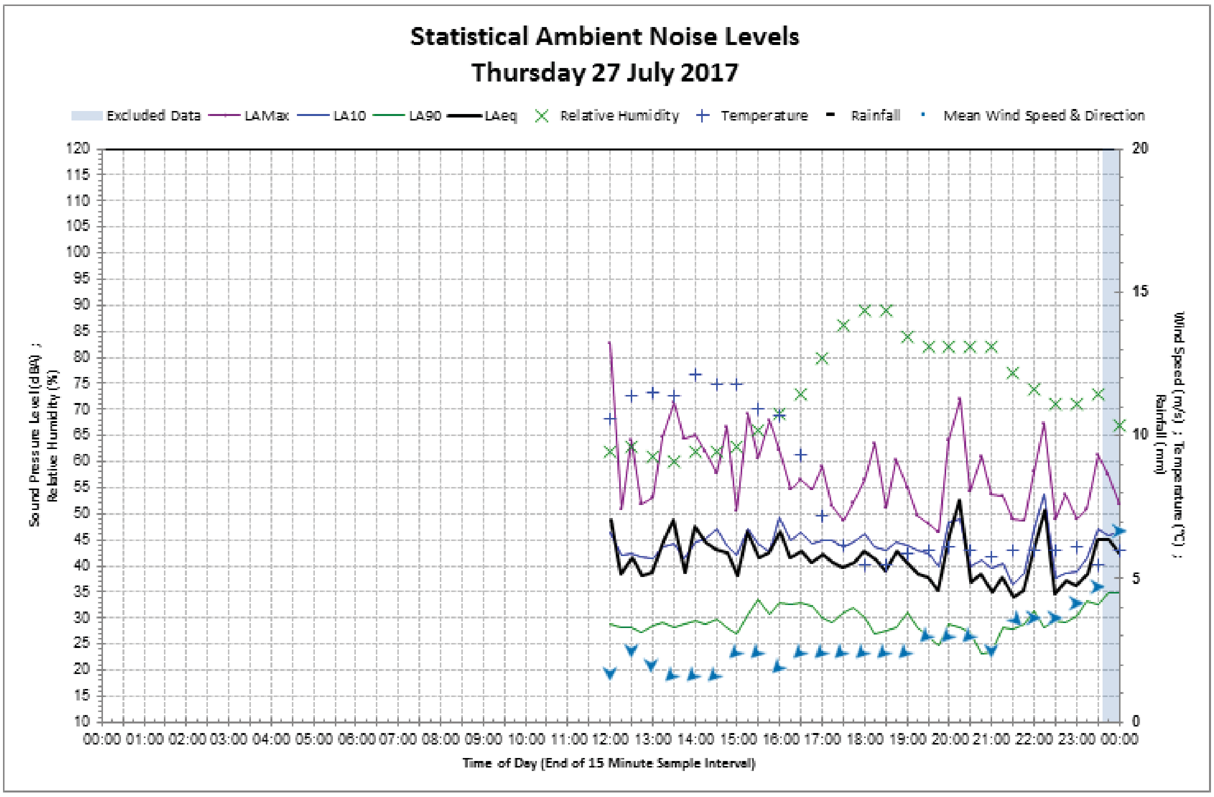
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

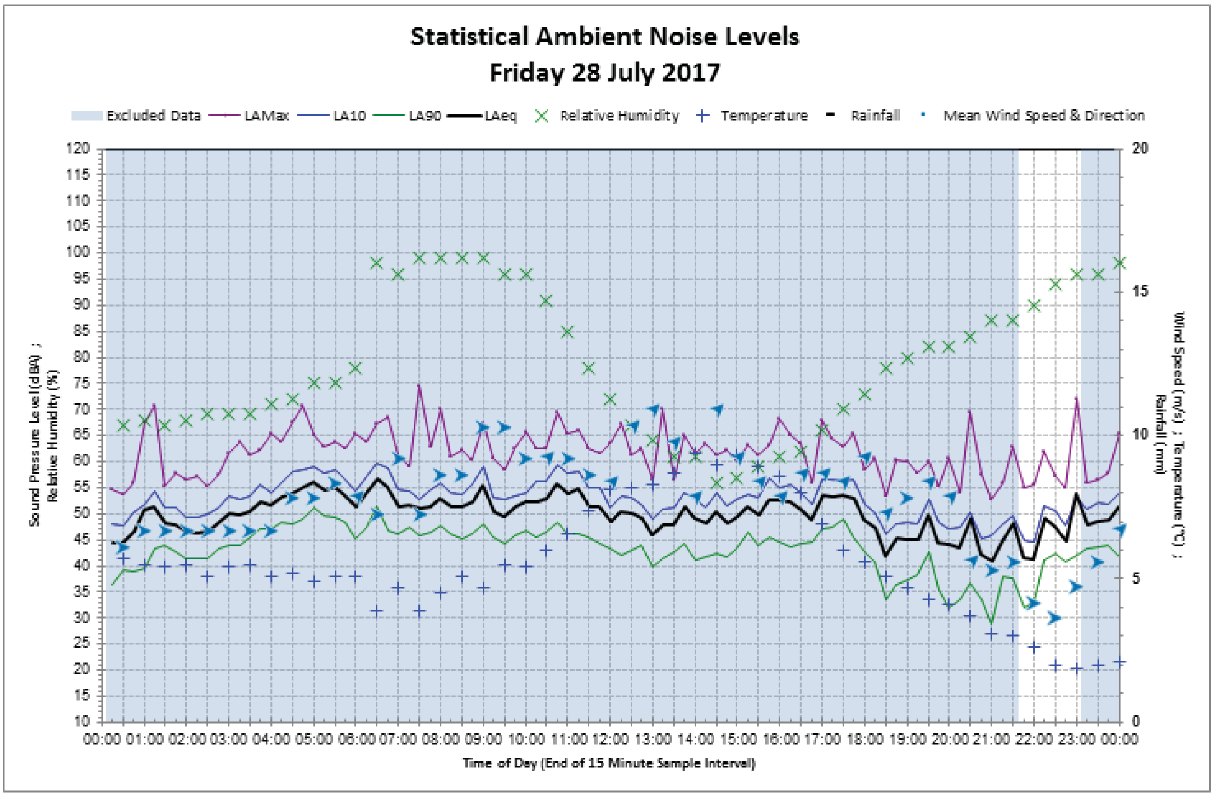

Statistical Ambient Noise Levels
Saturday 5 August 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

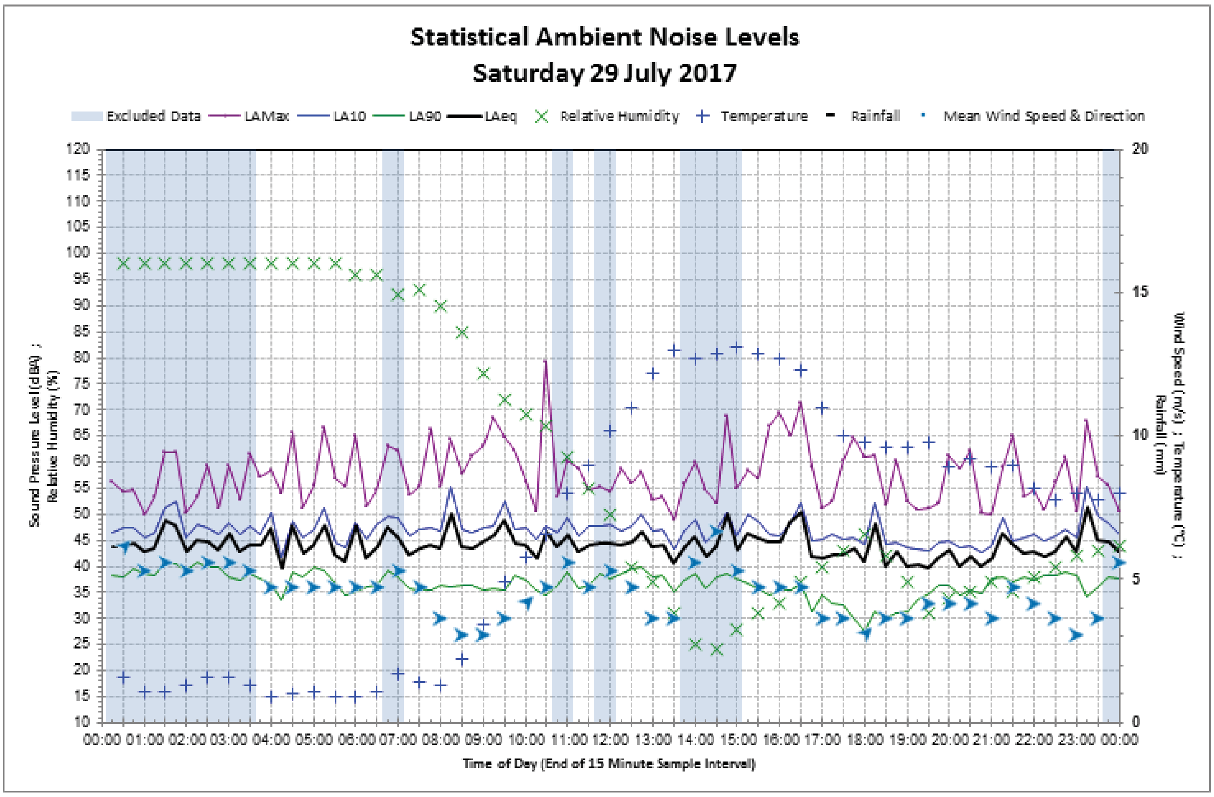

Statistical Ambient Noise Levels
Sunday 6 August 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Monday 7 August 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

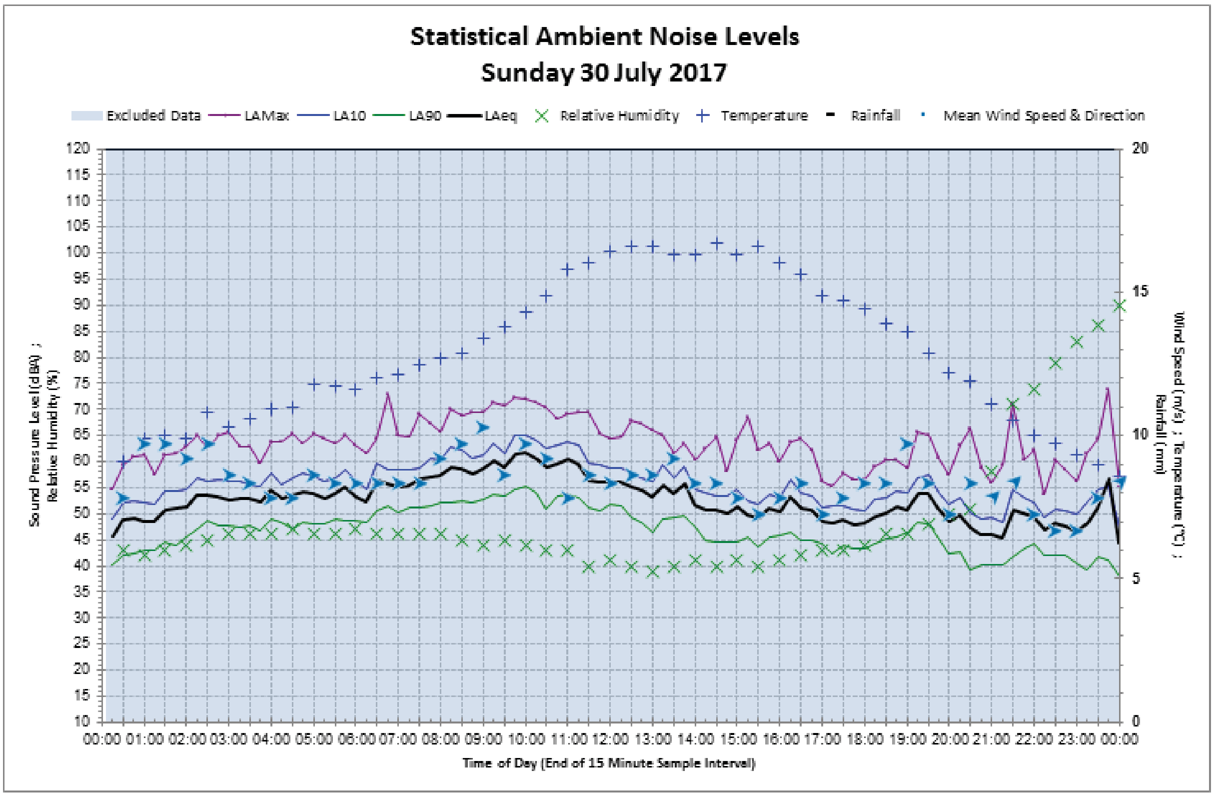
Appendix B – Noise monitoring charts – 310 Sandham Road







Statistical Ambient Noise Levels
Saturday 29 July 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



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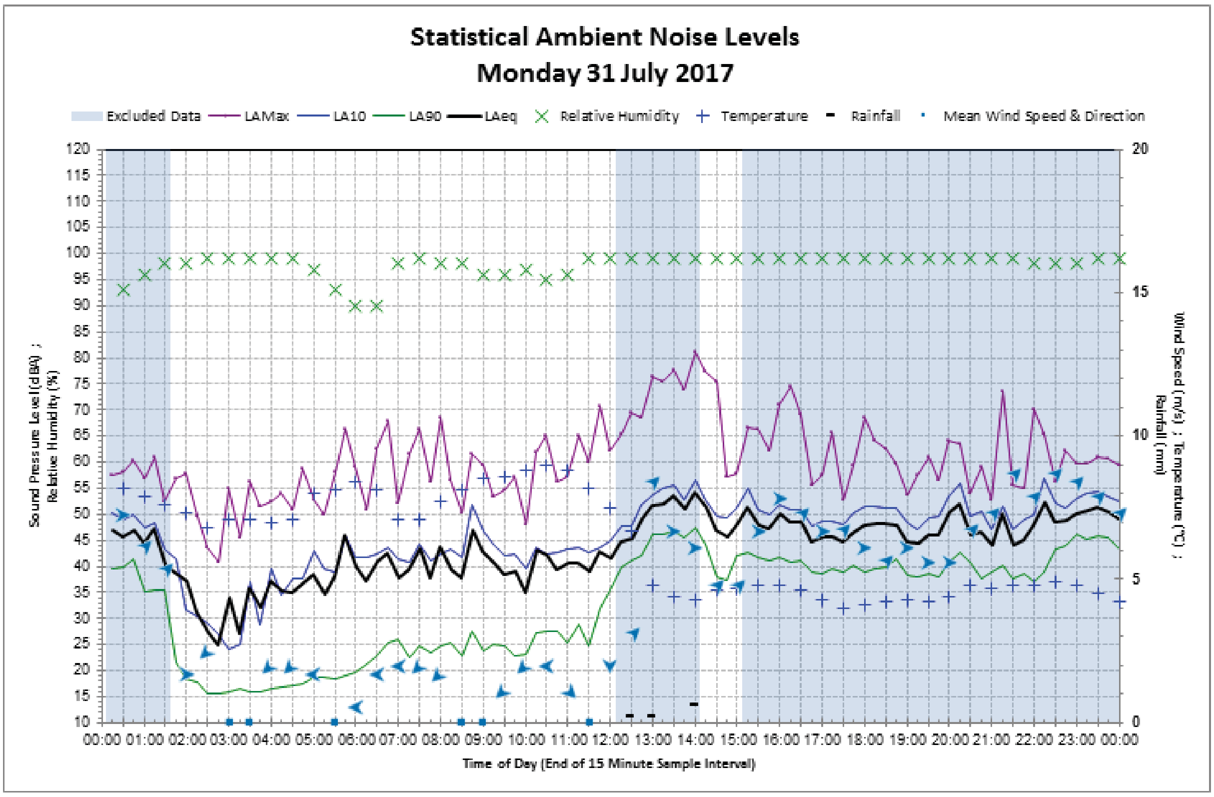
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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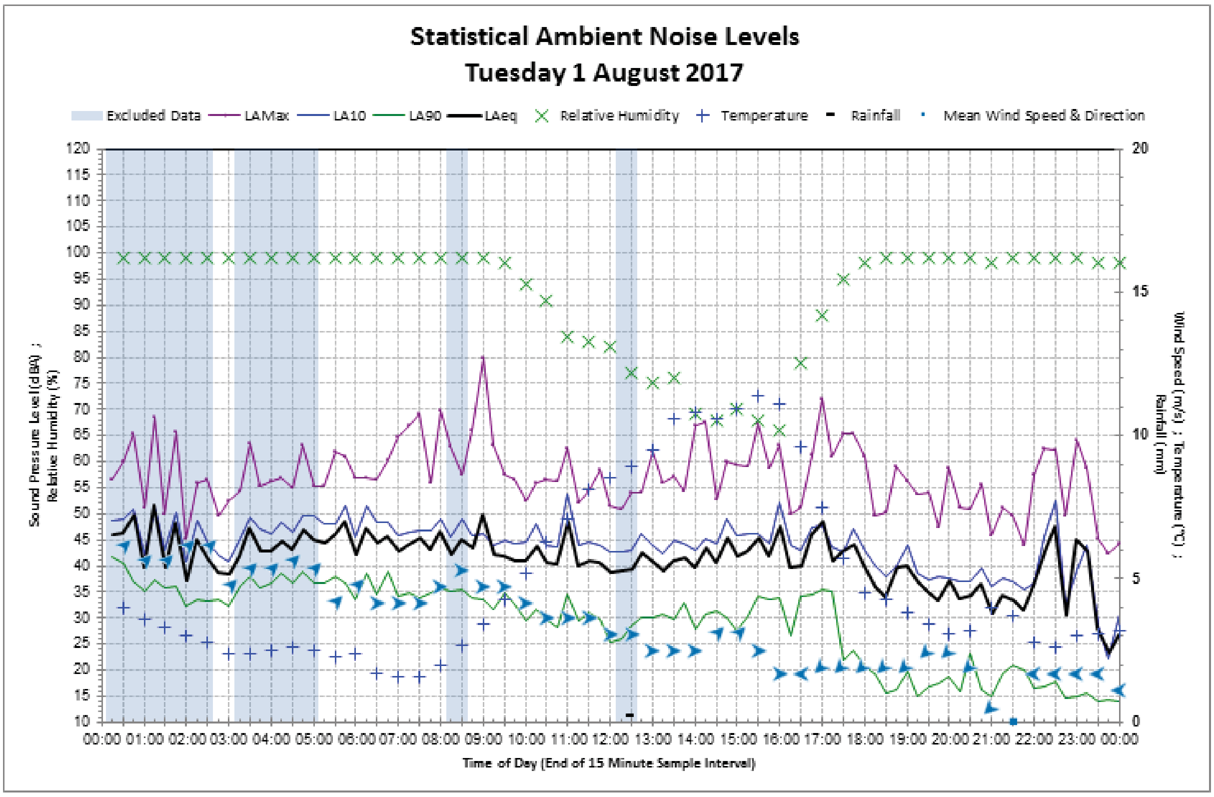
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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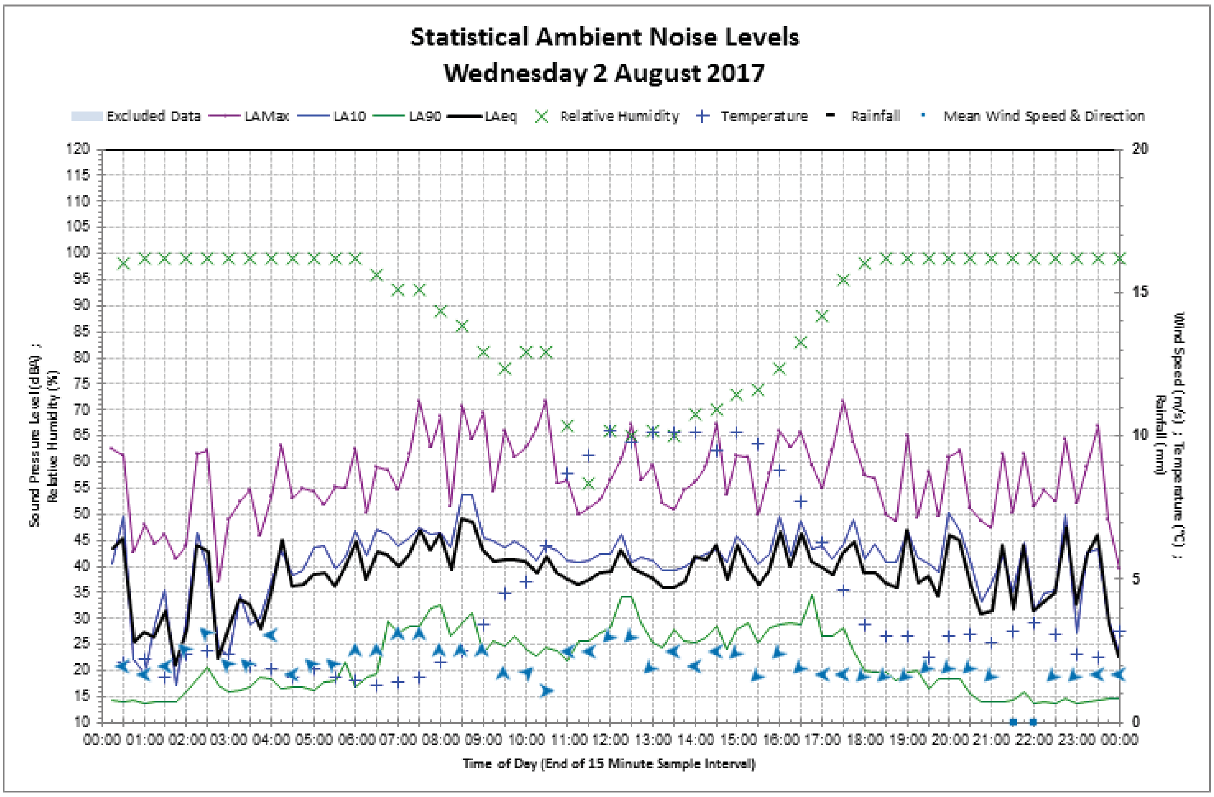
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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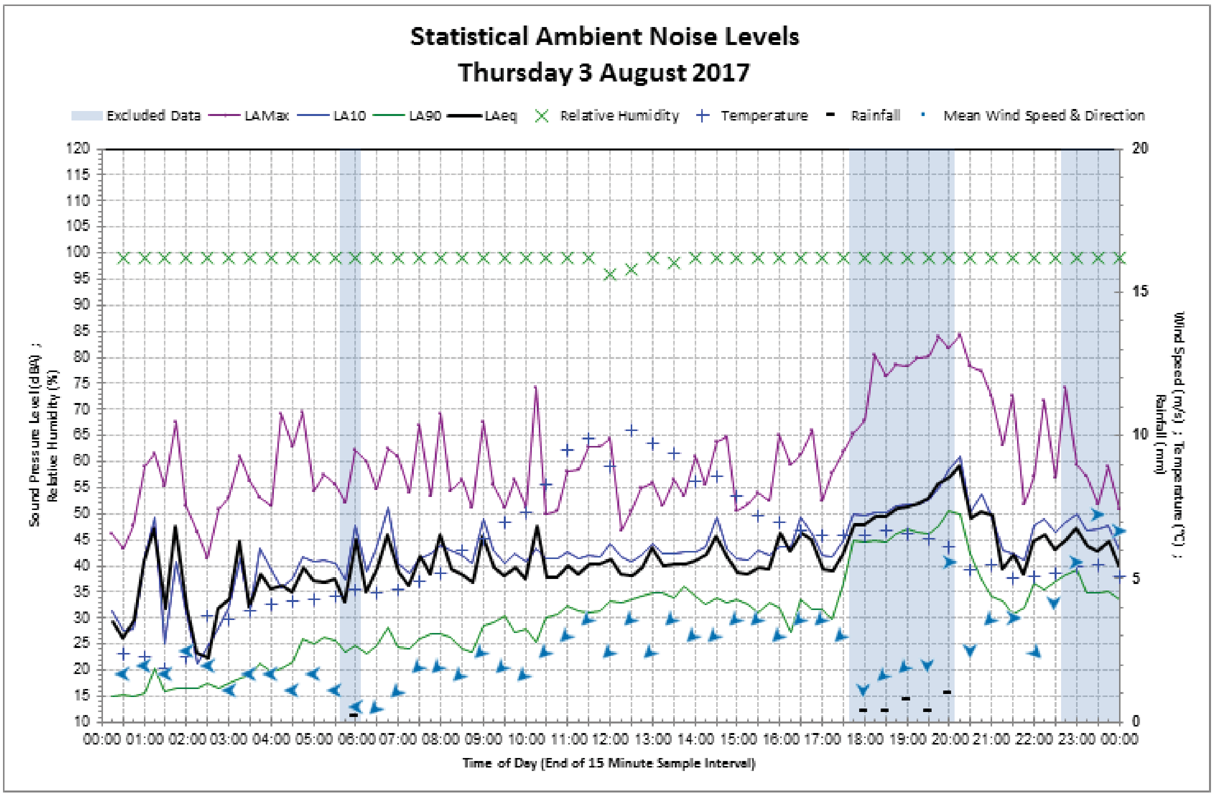
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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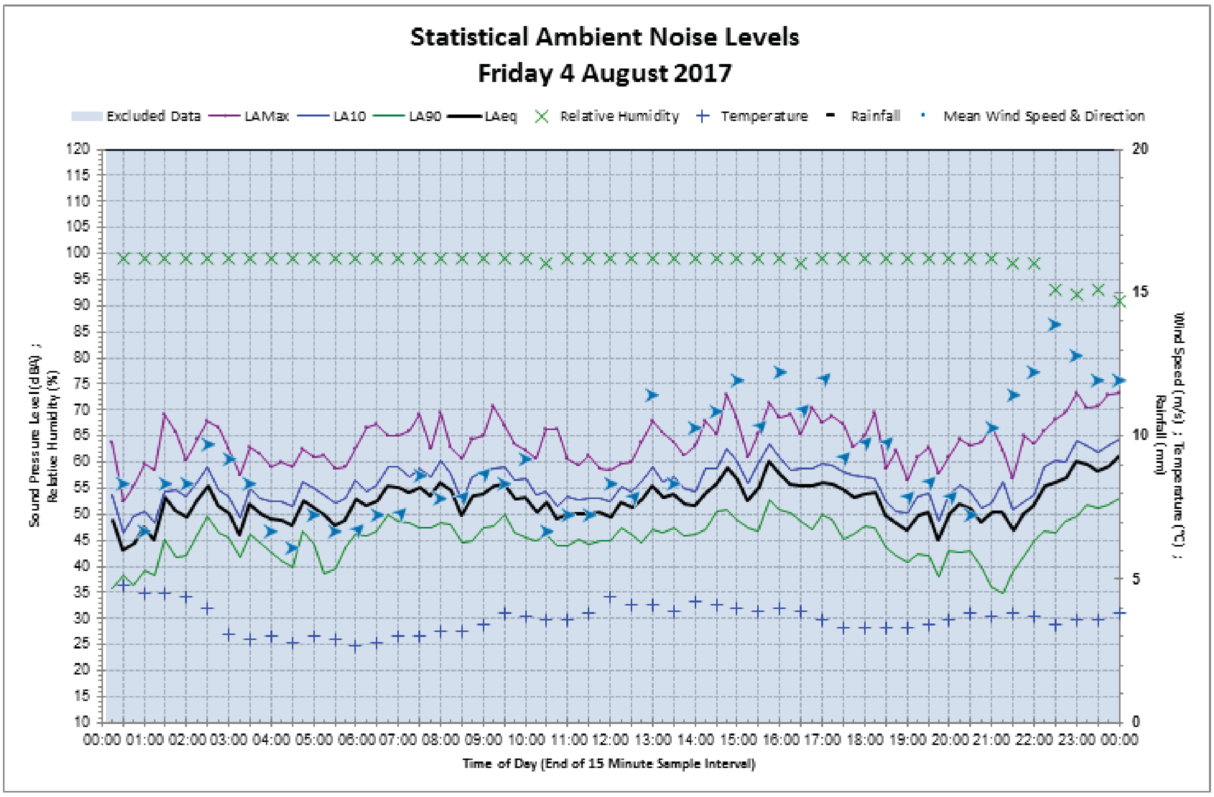
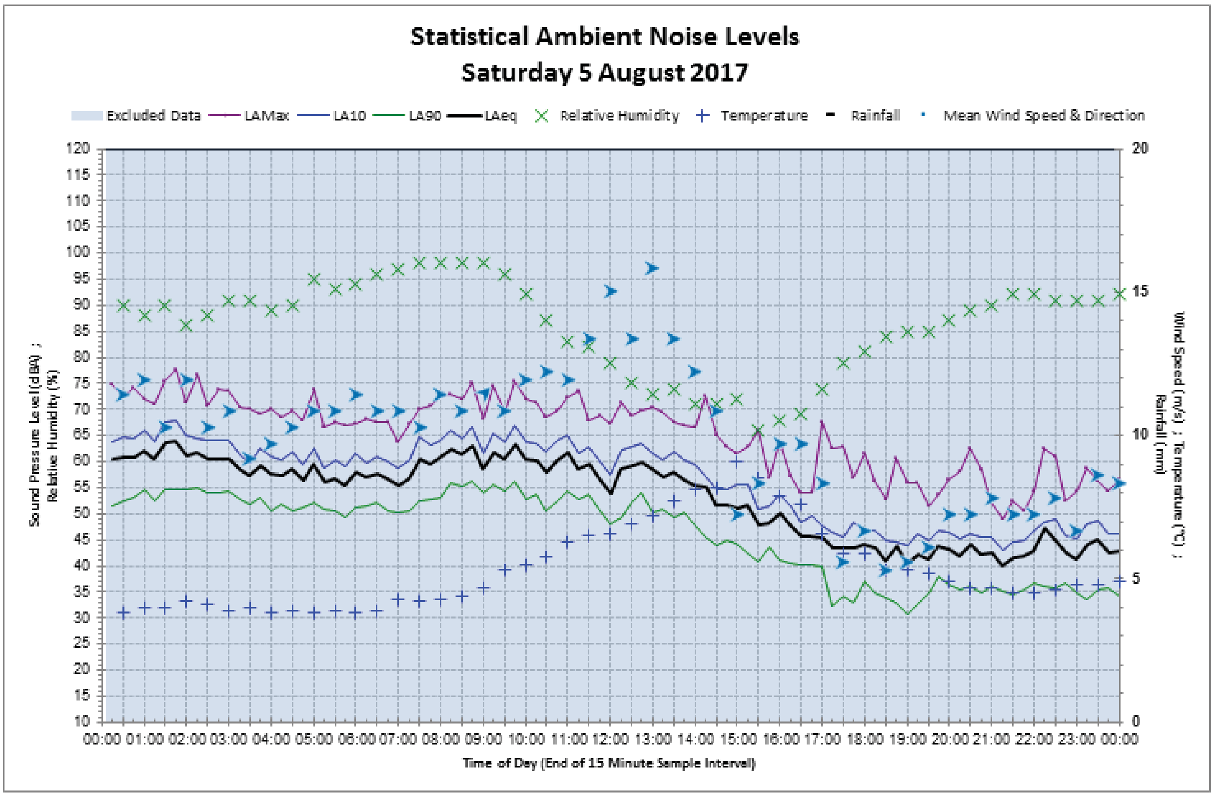
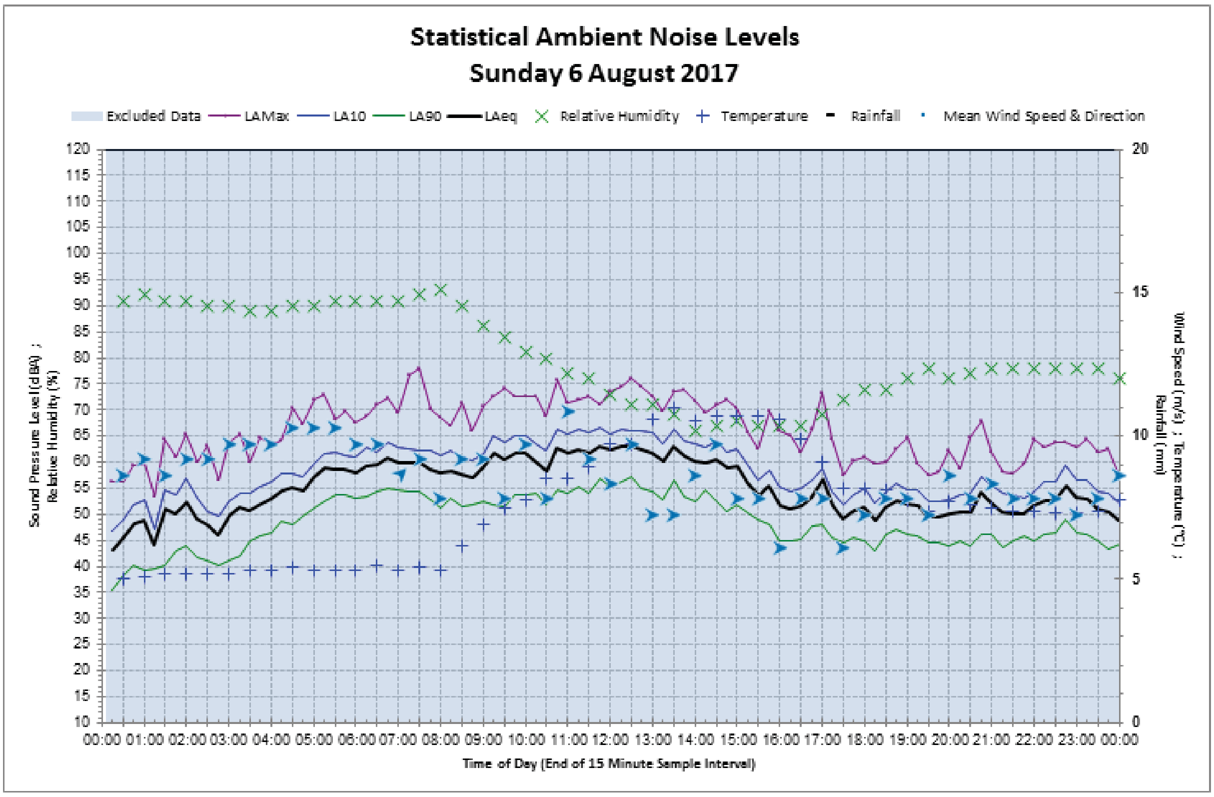
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



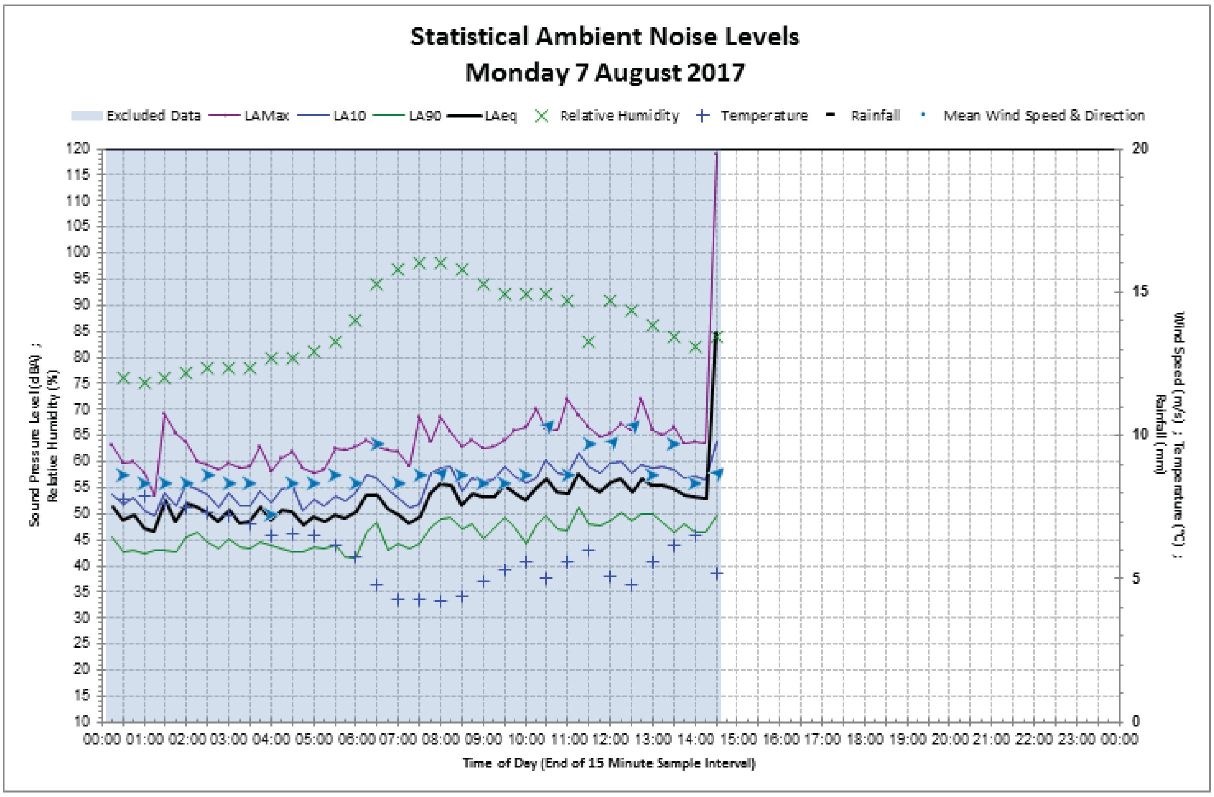
Statistical Ambient Noise Levels
Friday 4 August 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Saturday 5 August 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Sunday 6 August 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
Monday 7 August 2017
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

Appendix C – Operational noise emission maps

Legend

Residential buildings

$L_{Aeq(15\ min)}$ **Noise Contours, dBA**

35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85

Paper Size A4

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

Job Number 21-25774
Revision A
Date 29 May 2018

Predicted $L_{Aeq(15\ min)}$ – noise contours Stage 1A
Operations at the beginning of Stage 1

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

G:\21\25774\GIS\Maps\Deliverables\21-25774_SMA.mxd (SMA record: 7)

Data source: LPI, topographic base data, 2012. Created by:afoddy

Legend

● Residential buildings

$L_{Aeq(15\ min)}$ **Noise Contours, dBA**

35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85

Paper Size A4

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

Job Number	21-25774
Revision	A
Date	29 May 2018

Predicted $L_{Aeq(15\ min)}$ – noise contours Stage 1B
Operations nearing completion of Stage 1

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

G:\21\25774\GIS\Maps\Deliverables\21-25774_SMA.mxd (SMA record: 8)

Data source: LPI, topographic base data, 2012. Created by:afoddy

Legend

- Residential buildings

$L_{Aeq(15\ min)}$ **Noise Contours, dBA**

35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85

Paper Size A4

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

Job Number 21-25774
Revision A
Date 29 May 2018

Predicted $L_{Aeq(15\ min)}$ – noise contours Stage 2A
Operations at the beginning of Stage 2

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

G:\21\25774\GIS\Maps\Deliverables\21-25774_SMA.mxd (SMA record: 9)

Data source: LPI, topographic base data, 2012. Created by:afoddy

Legend

● Residential buildings

$L_{Aeq(15\ min)}$ Noise Contours, dBA

35	55	75
40	60	80
45	65	85
50	70	

Paper Size A4

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

Job Number	21-25774
Revision	A
Date	29 May 2018

Predicted $L_{Aeq(15\ min)}$ – noise contours Stage 2B
Operations nearing completion of Stage 2

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

G:\21\25774\GIS\Maps\Deliverables\21-25774_SMA.mxd (SMA record: 10)

Data source: LPI, topographic base data, 2012. Created by:afoddy

Legend

- Residential buildings

$L_{Aeq(15\ min)}$ Noise Contours, dBA

35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85

Paper Size A4

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

Job Number	21-25774
Revision	A
Date	29 May 2018

Predicted $L_{Aeq(15\ min)}$ – noise contours Stage 3A
Operations at the beginning of Stage 3

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

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Data source: LPI, topographic base data, 2012. Created by:afoddy

Legend

Residential buildings

$L_{Aeq(15\ min)}$ **Noise Contours, dBA**

35	55	75
40	60	80
45	65	85
50	70	

Paper Size A4

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

Job Number	21-25774
Revision	A
Date	29 May 2018

Predicted $L_{Aeq(15\ min)}$ – noise contours Stage 3B
Operations nearing completion of Stage 3

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

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Data source: LPI, topographic base data, 2012. Created by:afoddy

Legend

● Residential buildings

$L_{Aeq(15\ min)}$ **Noise Contours, dBA**

35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85

Paper Size A4

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

Job Number 21-25774
Revision A
Date 29 May 2018

Predicted $L_{Aeq(15\ min)}$ – noise contours Stage 4A
Operations at the beginning of Stage 4

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

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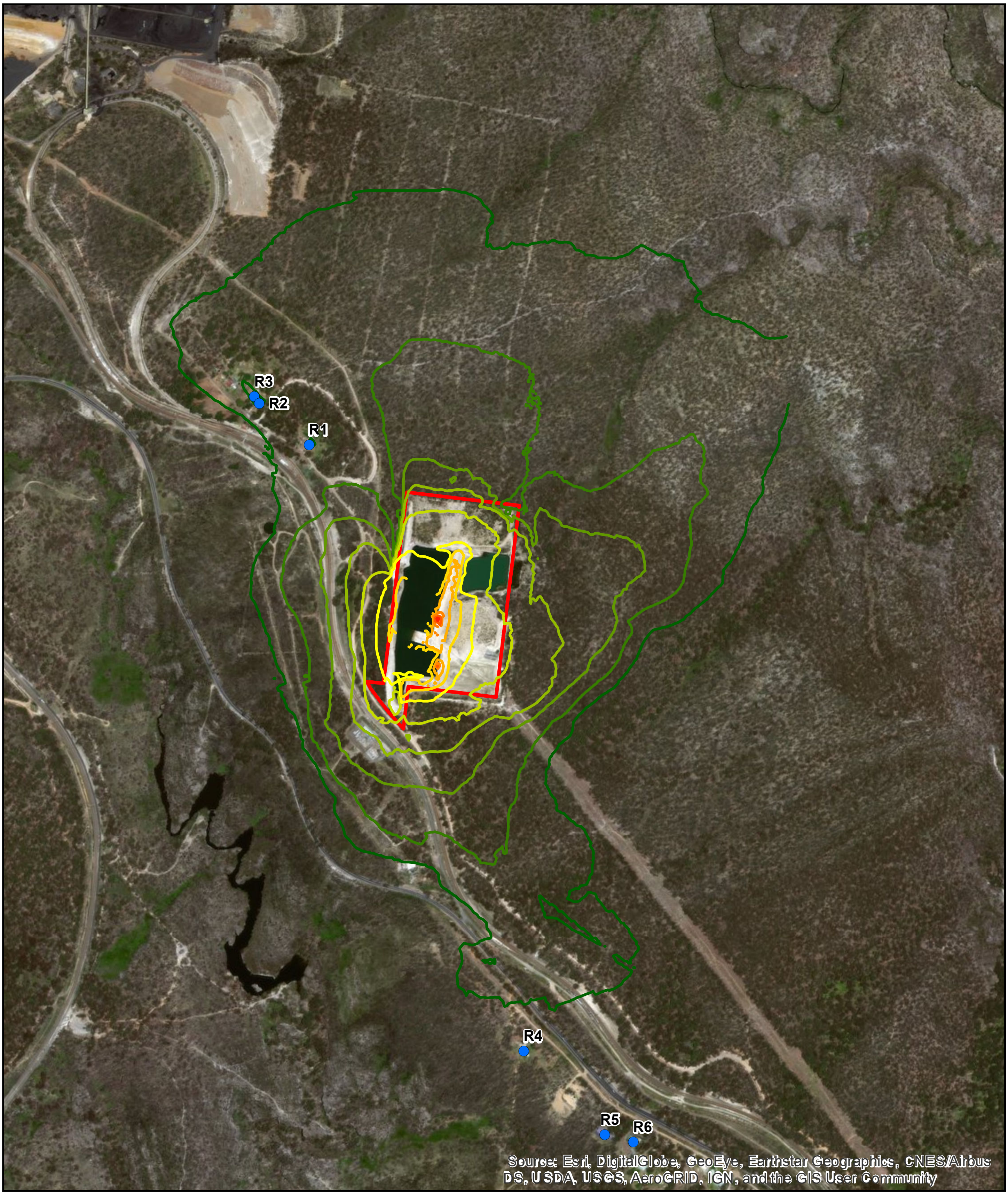

Legend

Residential buildings

$L_{Aeq(15\ min)}$ **Noise Contours, dBA**

35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85

Paper Size A4

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

Job Number 21-25774
Revision A
Date 29 May 2018

Predicted $L_{Aeq(15\ min)}$ – noise contours Stage 4B
Operations nearing completion of Stage 4

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

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Legend

Residential buildings

$L_{Aeq(15\ min)}$ Noise Contours, dBA

35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85

Paper Size A4

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

Job Number	21-25774
Revision	A
Date	29 May 2018

Predicted $L_{Aeq(15\ min)}$ – noise contours Stage 5A
Operations at the beginning of Stage 5

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

G:\21\25774\GIS\Maps\Deliverables\21-25774_SMA.mxd (SMA record: 15)

Data source: LPI, topographic base data, 2012. Created by:afoddy

Legend

● Residential buildings

$L_{Aeq(15\ min)}$ Noise Contours, dBA

35	55	75
40	60	80
45	65	85
50	70	

Paper Size A4

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

Job Number	21-25774
Revision	A
Date	29 May 2018

Predicted $L_{Aeq(15\ min)}$ – noise contours Stage 5B
Operations nearing completion of Stage 5

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

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Data source: LPI, topographic base data, 2012. Created by:afoddy

Legend

● Residential buildings

$L_{Aeq(15\ min)}$ **Noise Contours, dBA**

35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85

Paper Size A4

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

Predicted $L_{Aeq(15\ min)}$ – noise contours Stage 6A
Operations at the beginning of Stage 6

Job Number	21-25774
Revision	A
Date	29 May 2018

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

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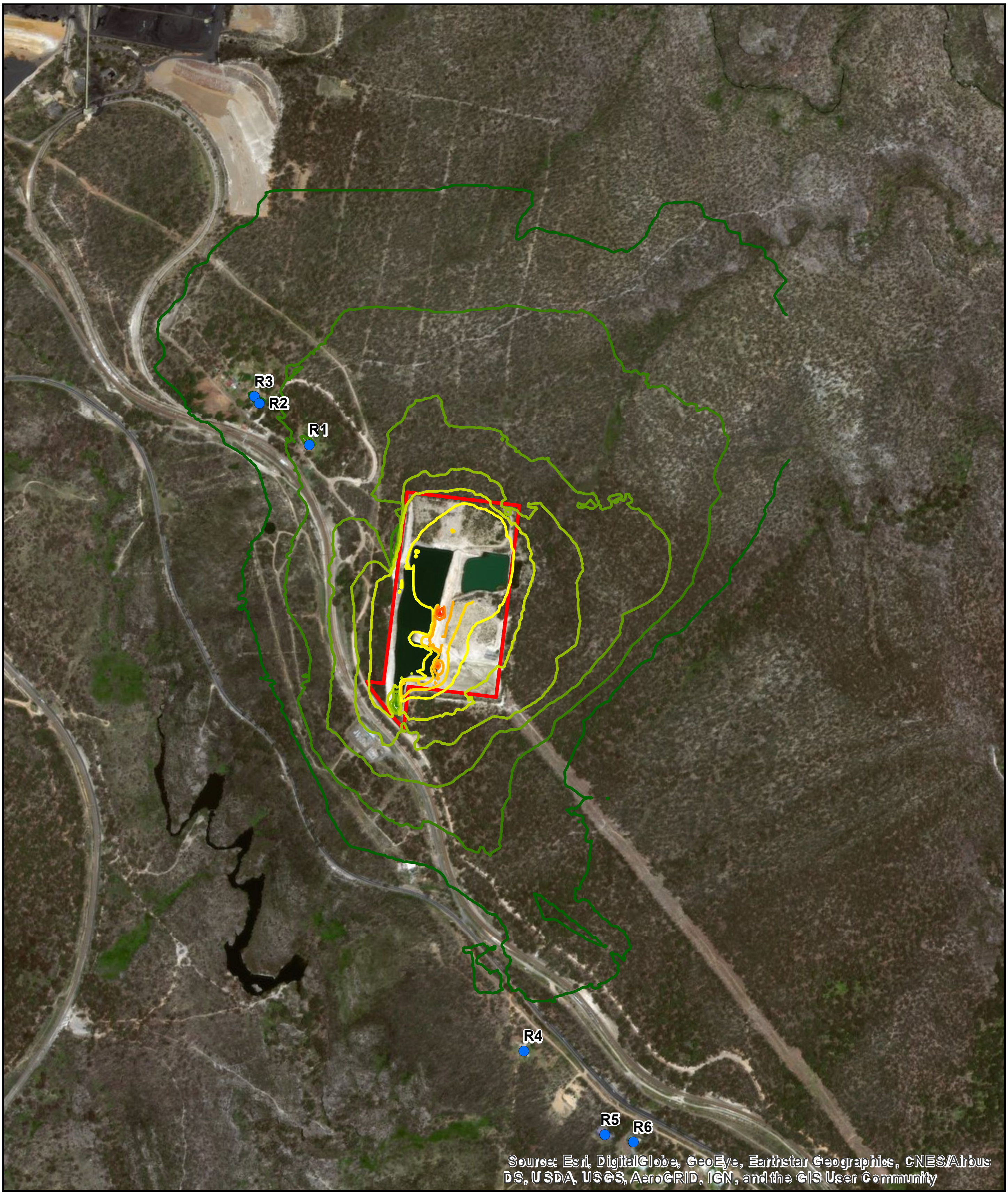

Legend

Residential buildings

$L_{Aeq(15\ min)}$ **Noise Contours, dBA**

35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85

Paper Size A4

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

Predicted $L_{Aeq(15\ min)}$ – noise contours Stage 6B
Operations nearing completion of Stage 6

Job Number	21-25774
Revision	A
Date	29 May 2018

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

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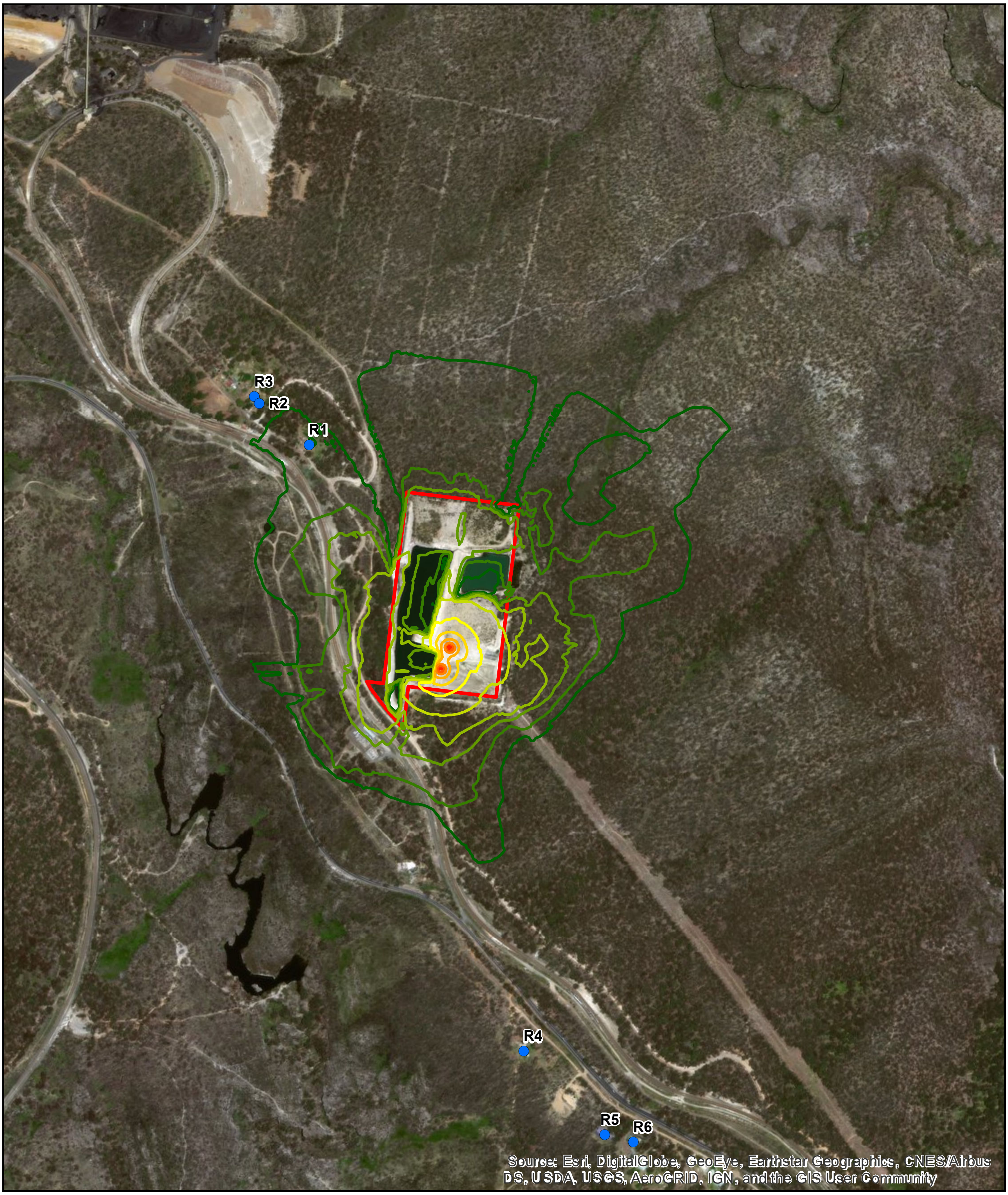

Legend

● Residential buildings

$L_{Aeq(15\ min)}$ **Noise Contours, dBA**

35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85

Paper Size A4

0 75 150 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

Job Number	21-25775
Revision	A
Date	29 May 2018

Predicted $L_{Aeq(15\ min)}$ – noise contours Night operations
Site preparation – night operations (6 am to 7 am)

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

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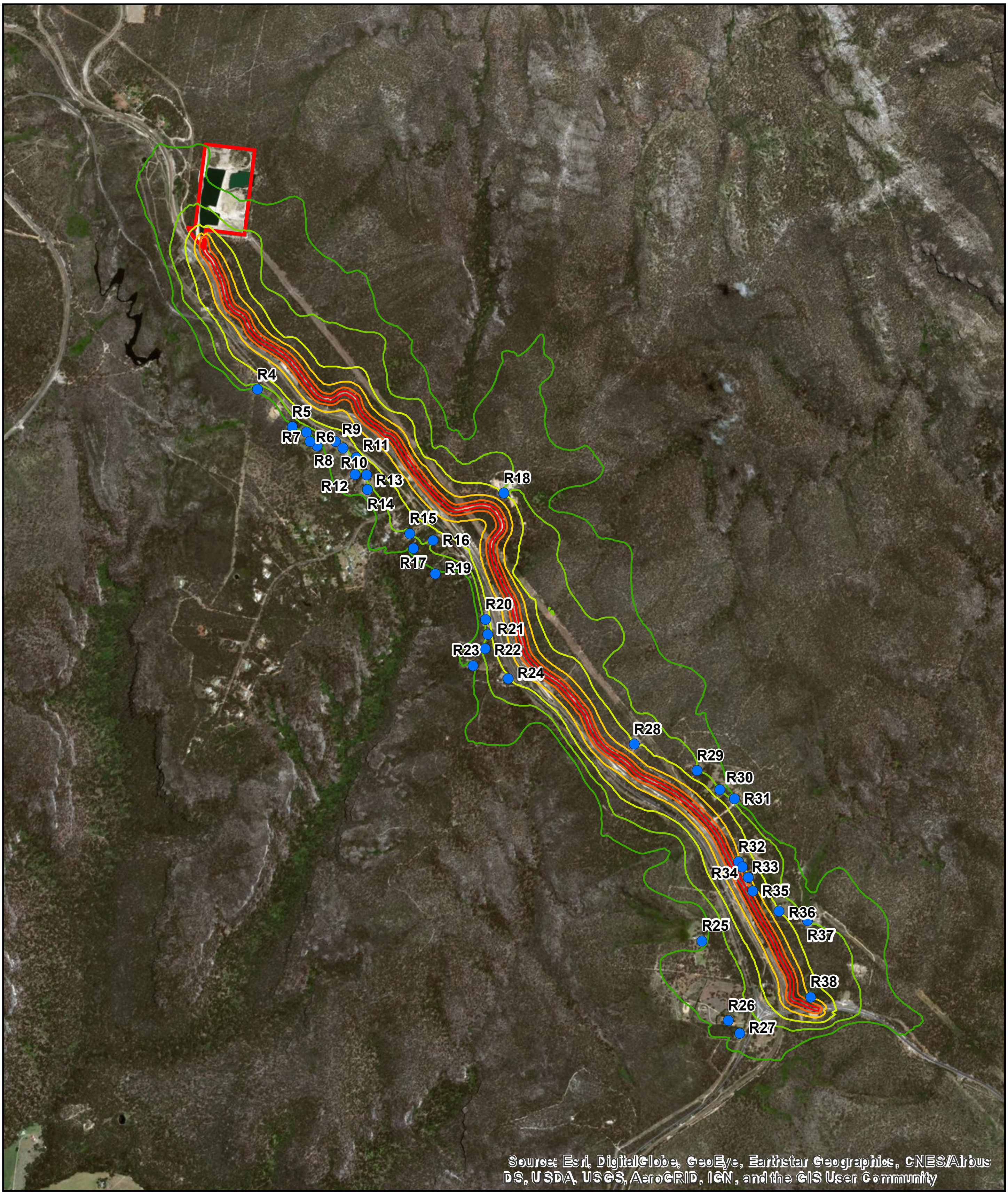
Appendix D – Road noise emission maps



Legend

● Residential buildings

$L_{Aeq(15\ min)}$ Noise Contours, dBA

Noise Contours, dBA

- 35
- 40
- 45
- 50
- 55
- 60

Paper Size A4

0 175 350 700

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

$L_{Aeq(1\ hour)}$ noise contours - Existing road traffic noise

Job Number	21-25774
Revision	A
Date	29 May 2018

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

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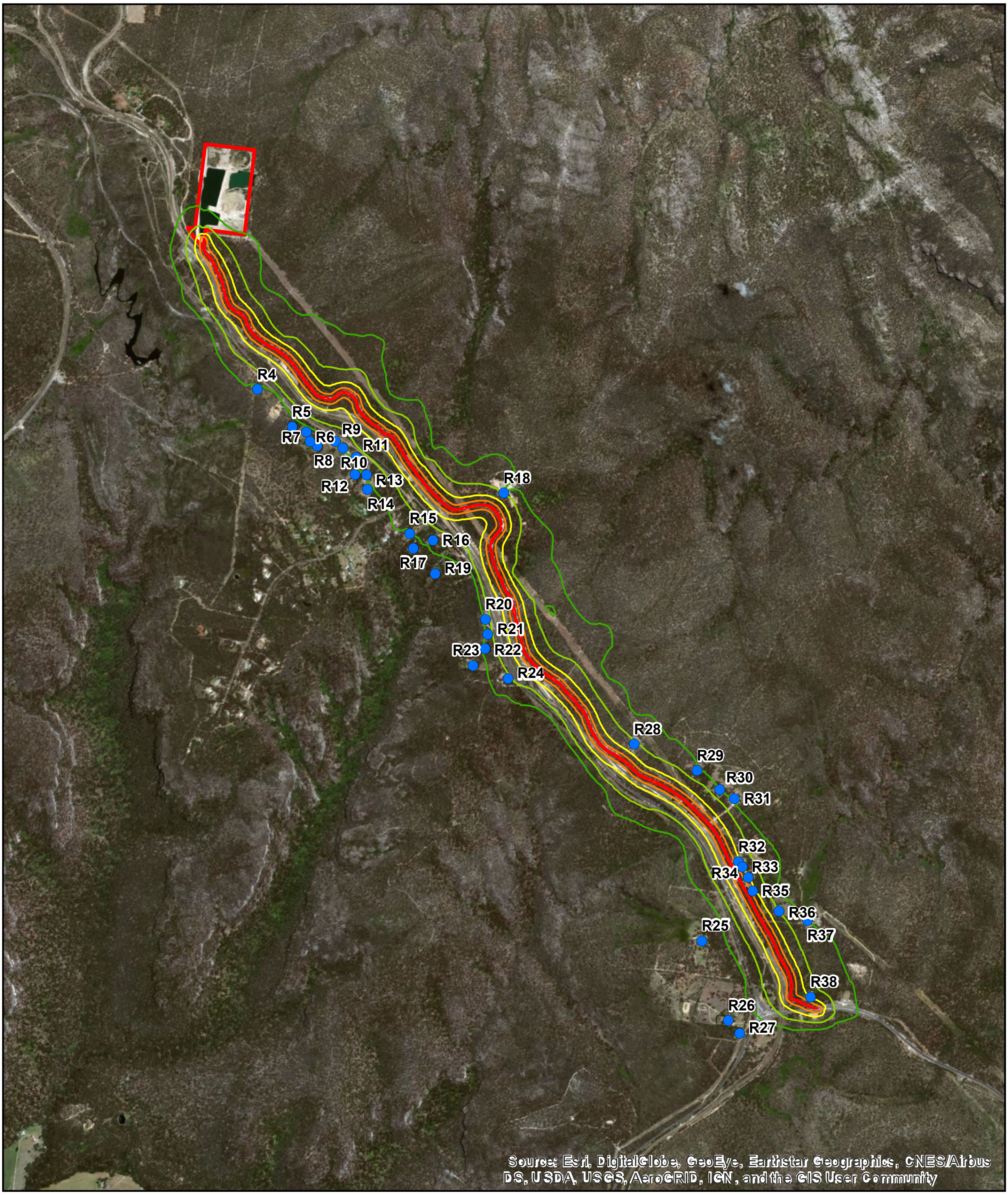

Legend

Residential buildings

$L_{Aeq(15\ min)}$ Noise Contours, dBA

Noise Contours, dBA

35
40
45
50
55

Paper Size A4

0 175 350 700

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Appendix C

$L_{Aeq(1\ hour)}$ noise contours - Predicted road traffic noise

Job Number	21-25774
Revision	A
Date	29 May 2018

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

G:\21\25774\GIS\Maps\Deliverables\21-25774_SMA.mxd (SMA record: 21)

Data source: LPI, topographic base data, 2012. Created by:afoddy

GHD

Level 15
133 Castlereagh Street
T: 61 2 9239 7100   F: 61 2 9239 7199   E: sydmail@ghd.com

2125774-81826/https://projects.ghd.com/oc/Sydney/bellquarryrehabilita/Delivery/Documents/2125774_REP-0_Noise Impact Assessment.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	M.Velasco	E.Smith		K Rosen		8/12/17

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Appendix H

Bushfire Assessment

Bell Quarry

Report for Sandham Road Dargan NSW Bushfire Assessment

July 2018

Table of contents

Table index

Figure index

1. Site Overview

1.1 Introduction

This bushfire risk assessment report is prepared to support an Environmental Impact Statement (EIS) to accompany a development application (DA) under Part 4 of the Environmental Planning and Assessment Act, 1979 (EP&A Act)..

The subject land is designated as:

- Sandham Road, Dargan, 2786 Lot / Plan no. 23/DP751631 Council: Lithgow

The following is proposed:

- Rehabilitation of the former Bell Quarry through the importation of up to 1.2 million cubic of VENM, ENM and other clean fill material.
- Upgrade of existing haul road to provide safe entry and exit to the site for haulage vehicles.
- A stockpile area for unloading of clean fill in the early stages, to allow haulage vehicles to leave their load in the centre of the pit, prior to placement in the active rehabilitation cell by suitable earthmoving plant.
- A portable site office and amenities building established in a central portion of the site. The site office caters for staff requirements and single administration / first aid area and amenities area. The amenities area would be serviced with a pump-out sewerage system with the sewage to be disposed off-site.

The site is identified as 'bush fire prone land' for the purposes of Section 10.3 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the legislative requirements for building on bushfire prone lands are applicable.

The proposed development could be considered as an infill development as defined within Chapter 4.3.5 of Planning for Bushfire Protection 2006 (PBP) and this report has been prepared in accordance with the requirements of Section 4.14 of the EP&A Act, although the development is not a residential development.

The proposed building is an administration and amenities structure that under the Building Code of Australia (BCA) is a Class 5 structure. As the BCA does not provide for any bushfire specific performance requirements for Class 5-8 buildings, the Australian Standard AS3959 2009 does not apply (as a deemed to satisfy provision), and is not applicable as a construction standard for the development. PBP accepts the general fire safety construction provisions of the BCA are taken as acceptable solutions; however, the aims and objectives of PBP must be considered and are addressed in this report.

This assessment includes an analysis of the hazard, threat and subsequent risk to the development proposal and provides recommendations that satisfy the Aims and Objectives of PBP.

It should be noted that the measures identified in this report cannot guarantee that a building or structure will survive a bushfire event on every occasion. This is greatly due to the degree of vegetation management, the unpredictable nature and behaviour of fire, and extreme weather conditions.

1.2 Description of the property

1.2.1 Location Details

Address:	Sandham Road, Dargan, 2786
Lot / Plan No.:	23/DP751631
LGA:	Lithgow

1.2.2 Development proposal and building classifications

The proposal is for the rehabilitation of a former quarry with VENM, ENM and other clean fill material, including an internal haulage road and site office/amenities building (classified under the BCA as a Class 5: an office building used for professional or commercial purposes).

1.2.3 Site description

The subject land is located 10 kilometres east of Lithgow and 2.7 kilometres north of Bell NSW.

It is within Lithgow City Council that is within the 'Central Ranges' and has a corresponding FDI rating of 80 (NSWRFS 2006).

The subject land is currently zoned as E3 Environmental Management.

The subject land is shown in Figure 1 and is bounded to the:

- South and west by Sandham Road (an all-weather two-wheel drive partially unsealed access road) and the western railway; and
- East and north by an undeveloped dry sclerophyll forest.

Access to the subject land is via Sandham Road (2.7km) from the Great Western Highway at Bell or informally from the north through the Clarence Colliery (emergency access only).

1.3 Vegetation classification

The identification of bush fire prone areas is required under Section 10.3 of the Environmental Planning and Assessment Act (1979). The subject land is designated as bushfire prone (as per NSW Planning and Environment mapping -see Figure 2) due to the presence of bushfire prone land within and adjoining the site.

LEGEND

Bell Quarry
Reserves and State Forests
Waterways
Rail
Roads

Paper Size A4
0 200 400 800
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation Project
Environmental Impact Statement

Job Number	21-25774
Revision	A
Date	29 May 2018

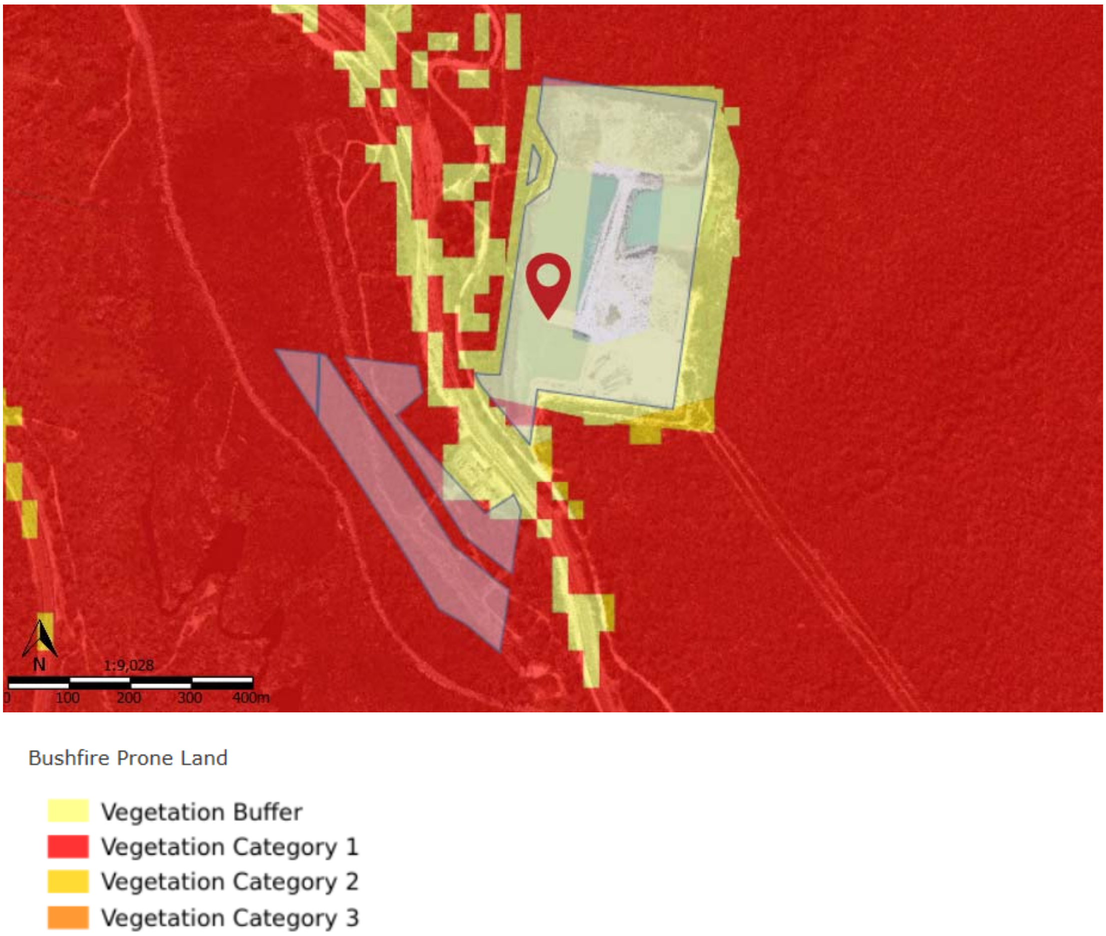
Site area map

Figure 2-1

\\ghdnet\ghd\AU\Sydney\Projects\21\25774\GIS\Maps\Deliverables\EIS\21_25774_Z001_EIS_SiteLocation.mxd Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: Aerial imagery - sixmaps 2016, Inset map - Geoscience Australia, General topo - NSW LPI DTDB 2012, Mining Titles: Geology Survey NSW. Created by:afoddy

Figure 2 Bushfire Prone Lands Mapping



The vegetation classes broadly correspond with the vegetation types identified in Table 1.

Table 1 Vegetation Type, Formation and Classification

Vegetation Type	Vegetation Formation (Keith 2004[1])	AS3959:2009[2] Classification
Sydney Peppermint (*Eucalyptus piperita*), Silvertop Ash (*Eucalyptus sieberi*) heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin	Dry Sclerophyll Forests (Shrub subformation)	Forest

The vegetation identified as 'Sydney Peppermint (Eucalyptus piperita), Silvertop Ash (Eucalyptus sieberi) heathy open forest' matches the description of Dry Sclerophyll Forest – Shrubby Grass vegetation formation (NSWRFS 2006) for the following reasons;

- Dominated by eucalypts >10m tall with foliage cover 20-50%;
- Presence of grasses in the understorey; and
- A significant shrub component in areas.

This vegetation formation can support high intensity bushfires, most likely burning as a crown fire in forest formations and as a faster moving surface fire in open woodland communities without a shrubby understorey. The subject land has been subject to high intensity bushfires in the past, including most recently in October 2013.

[1] Keith, D.A. (2004) Ocean Shores to Desert Dunes, the native vegetation of New South Wales and the ACT. NSW Department of Environment and Conservation, Sydney.
[2] Standards Australia 1999. AS3959 – 2009 Construction of Buildings in Bushfire-prone areas. Standards Australia, Sydney.

A photograph of this vegetation formation is shown in Figure 3 and vegetation formations presented in Figure 4.

Figure 3 Vegetation photograph – Silvertop Ash-Sydney Peppermint

1.4 Slope description

“Effective Slope” in accordance with Planning for Bush Fire Protection (NSWRFS 2006) within the vegetation hazard immediately adjoining this site is >0 -5 degrees downslope. There are some areas adjoining the proposal area where the slope is upslope - 0 degrees, as well as steeper sections, however the >0 -5 degrees downslope slope class is most likely to influence fire behaviour.

1.5 Significant environment values

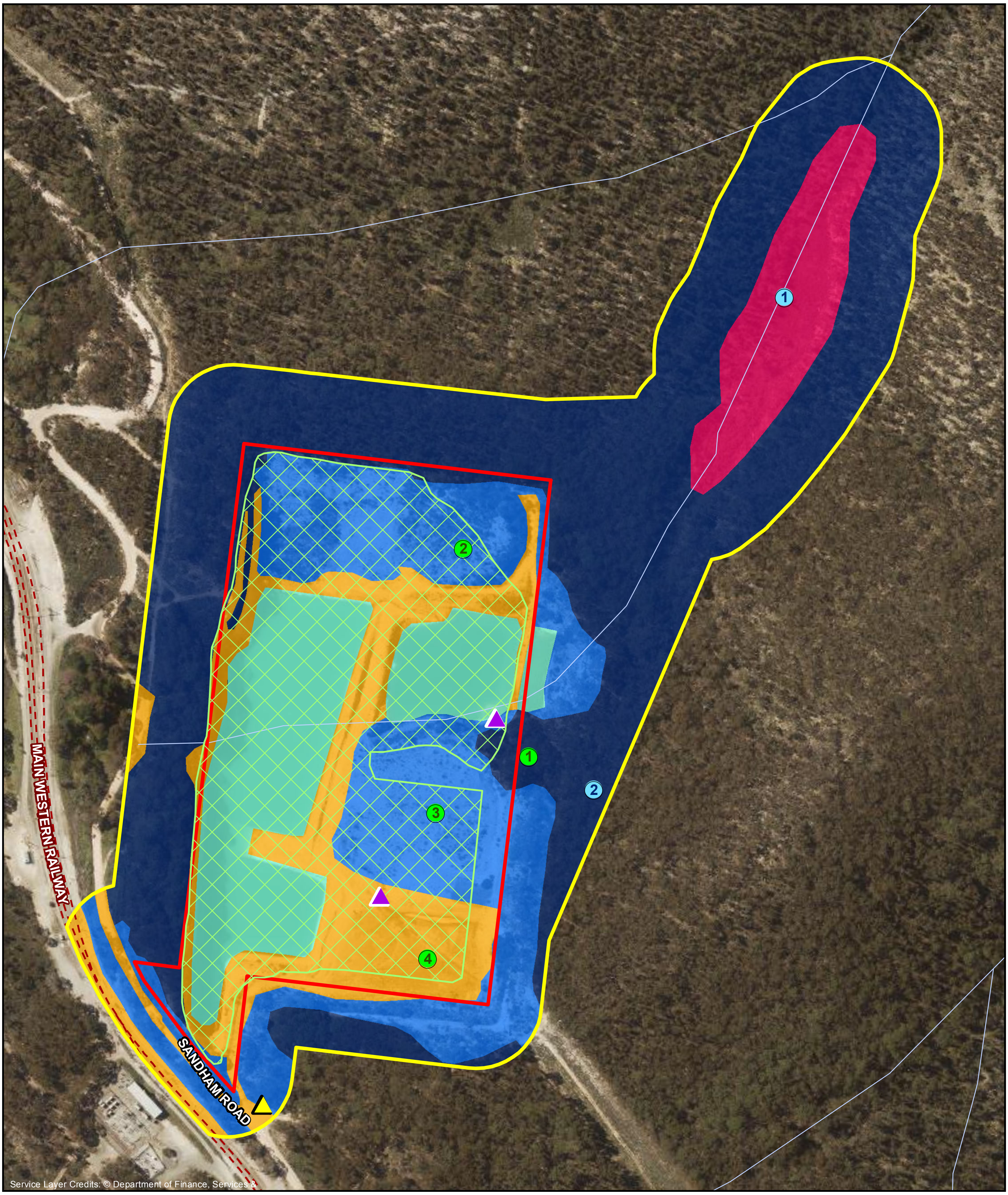
The site adjoins Blue Mountains National Park on the eastern boundary. Newnes State Forest is located to the north of the property.

1.6 Threatened fauna and threatened flora

No threatened ecological communities or threatened flora are recorded from within the subject land.

1.7 Aboriginal Cultural Heritage sites present

There is no Aboriginal object (within the meaning of the National Parks and Wildlife Act 1974) or Aboriginal place (within the meaning of that Act) that is known to the applicant situated on the property.



LEGEND

- Bell Quarry site
- Study area
- Project area
- Waterways
- Rail
- Plot/transect
- Area search
- Anabat
- Call playback

Vegetation zones

- 1, Sydney Peppermint - Silvertop Ash heathy open forest
- 2, Poor condition Sydney Peppermint - Silvertop Ash heathy open forest
- 3, Cleared land
- 4, Artificial wetland
- 5, Prickly Tea-tree - sedge wet heath

Paper Size A4

0 25 50 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Remedial Civil Solutions Pty Ltd
Bell Quarry Rehabilitation

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Vegetation and survey effort

Figure 4

\\ghdnet\ghd\AU\Sydney\Projects\21\25774\GIS\Maps\Deliverables\Biodiversity\21_25774_Z006_Biodiversity_Vegetation.mxd

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: Aerial imagery - AStute 2015 & sixmaps 2016, Inset map - Geoscience Australia, General topo - NSW LPI DTDB 2012, Landuse zoning - SILEP LZN. Created by:afoddy

2. Bush fire risk assessment of the proposed development

The following is an assessment of the extent to which the proposed development conforms or deviates from the Aims and Objectives of Planning for Bush Fire Protection (NSWRFS 2016).

2.1 The extent to which the development is to provide for setbacks, including asset protection zones

Asset Protection Zones (APZ) are determined based on vegetation and slope. APZ's for the subject land shall be applied from the building wall outwards and accommodated entirely within the lot. They must comprise of Inner Protection Area (IPA) and an Outer Protection Area (OPA) of the dimensions shown in the table below. The APZ widths in Table 2 are in accordance with Appendix 2 of the PBP (NSWRFS 2006).

Table 2 APZ dimensions applying to Administration Building

Vegetation	Slope Class	APZ	IPA	OPA
Forest	0-5 degrees	20 m	10 m	10 m

Inner Protection Area (IPA)

The IPA will extend from the building line. It is contained within the lot and will be maintained in accordance with PBP (NSWRFS 2006):

An IPA should provide a tree canopy cover of less than 15% and should be located greater than 2 m from any part of the roofline of a dwelling. Garden beds of flammable shrubs are not to be located under trees and should be no closer than 10 m from an exposed window of door. Trees should have lower limbs removed up to a height of 2 metres above ground.

The property manager is responsible for the maintenance of the IPA.

Outer Protection Area (OPA)

The OPA will extend from the IPA (i.e. from the building line) towards the hazard. The landholder is responsible for the OPA contained within the subject land. Parts of the OPA may comprise an all-weather access road or fire trail managed. The OPA is to be maintained in accordance with PBP (NSWRFS 2006) as a minimum requirement:

An OPA should provide a tree canopy cover of less than 30% and should have understorey managed (mowed) to treat all shrubs and grasses on an annual basis in advance of the fire season (usually September).

Maintenance of bushfire fuel

Within the IPA and OPA fuels are to be managed in accordance with the Standards for Asset Protection Zones (NSWRFS 2005), this requires;

1. Raking or manual removal of fine fuels:

Ground fuels such as fallen leaves, twigs (less than 6 mm in diameter), and bark should be removed on a regular basis.

2. Mowing of grass:

Grass needs to be kept short (<100mm) and where possible, green.

3. Removal or pruning of trees, shrubs and understorey:

Prune or remove trees so that there is discontinuous canopy leading from the hazard to the asset. Separate tree crowns by at least two to five metres. A canopy should not overhang within two to five metres of any building.

Native shrubs and trees should be retained as clumps or islands and should maintain a covering of no more than 20% of the area.

Performance Criteria Summary

✓	APZs established, managed and maintained adjacent to the administration / amenities building to reduce the potential for fire spread
✓	APZ maintenance is practical, soil stability is not compromised and the potential for crown fires is negated

2.2 Utility Services

2.2.1 Adequacy of water supply – non reticulated

A dedicated tank water will be supplied for the administration/amenities building and will include dedicated water tanks for fire fighting:

- Of 10,000 litre capacity
- Located within the IPA (but away from the structure)
- Fitted with a 65mm Storz outlet (and gate or ball valve fitted)
- Manufactured of concrete or metal (for above ground tanks), with shielding where located on the hazard side of the building
- With associated external piping and taps made of metal

Where located, underground tanks must have an access hole of 200 mm to allow tankers to direct fill from the tank, and a hardened ground surface for truck access within four metres of the hole.

2.2.2 Electricity

Electricity lines within the subject land and servicing the proposed development will be either underground or overhead lines with the powerline owner responsible for installing, inspecting and completing powerline vegetation clearance works which comply with required regulatory requirements.

2.2.3 Gas

In order to comply with the Rural Fires Regulation, all bottled gas will be installed and maintained in accordance with AS/NZS 1596 – 2014

Performance Criteria Summary

✓	For the administration building, a dedicated accessible water supply for fire fighting must be:

o	Of 10,000 litre capacity
o	Located within the IPA (but away from the structure)
o	Fitted with a 65mm Storz outlet (and gate or ball valve fitted)

- o Manufactured of concrete or metal (for above ground tanks), with shielding where located on the hazard side of the building
- o With associated external piping and taps made of metal
- o Where located, underground tanks must have an access hole of 200 mm to allow tankers to direct fill from the tank, and a hardened ground surface for truck access within four metres of the hole.

✓ Any gas and electricity services provided to the site must be installed appropriately to limit the potential for ignition to bushland

2.3 Adequacy of arrangements for access to and egress from the development site for an emergency response

The subject land is accessed from the Bells Line of Road from Sandham Road and Clarence Colliery Road (emergency access only).

The existing public roads are two way, two-wheel drive, all weather roads (comprised of sealed and unsealed sections) and are of sufficient width to allow fire fighting vehicles to work. The width of the road complies with Table 4.1 of Planning for Bushfire Protection 2006.

The public road network provides suitable access and egress for fire management and emergency response purposes.

Performance Criteria Summary

✓ Two-way all weather access to the site is provided for fire fighters and evacuating staff

✓ Road capacity is sufficient to carry a fully loaded fire vehicle

2.4 Adequacy of bush fire maintenance plans and fire emergency procedures for the development site

An emergency evacuation plan should be prepared from the commencement of construction and during operations. An emergency response and evacuation plan is recommended as a condition of consent.

Performance Criteria Summary

✓ An emergency response and evacuation plan will be prepared for the site

2.5 Construction standards to be used for building elements in the development

The National Construction Code does not provide for any bush fire specific performance requirements for Class 5 to 8 buildings. As such, the Australian Standard AS 3959 (Construction of buildings in bush fire prone areas) and the NASH standard are not considered as a set of 'deemed to satisfy' provisions for construction, and do not apply.

3. Recommendations

The following bushfire protection measures are made for the subject land on Sandham Road, Dargan, 2786 (Lot / Plan no. 23/DP751631). Application of these measures allows the development to conform to the aim and objectives of Planning for Bush Fire Protection (NSWRFS 2006), as detailed in Section 2 of this report.

1. Asset protection zones	From the commencement of rehabiliation and in perpetuity, the administration building shall incorporate a 20m APZ, including an Inner Protection Area and Outer Protection Area, in accordance with the dimensions identified in Table A2.5 in Appendix 2 of PBP, and the NSW RFS document ‘Standards for asset protection zones’. The IPA should provide a tree canopy cover of less than 15% and should be located greater than 2 m from any part of the roofline of a dwelling. Garden beds of shrubs are not to be located under trees and should be no closer than 10 m from an exposed window of door. Trees should have lower limbs removed up to a height of 2 metres above ground. An OPA should provide a tree canopy cover of less than 30% and should have understorey managed (mowed) to treat all shrubs and grasses on an annual basis in advance of the fire season (usually September).
2. Water supplies and services	For the administration building, a dedicated fire fighting water supply must be: • Provided at 10,000 litre capacity • Located within the IPA (but away from the structure) • Fitted with a 65mm Storz outlet (and gate or ball valve fitted) • Manufactured of concrete or metal (for above ground tanks), with shielding where located on the hazard side of the building • With associated external piping and taps made of metal • Where located, underground tanks must have an access hole of 200 mm to allow tankers to direct fill from the tank, and a hardened ground surface for truck access within four metres of the hole. Electricity will be supplied via underground transmission or overhead powerlines with 30 m pole spacing and in accordance with Energy Australia specifications (NS179, 2002) and maintained according to National distribution network standards. Portable gas supplies will be in accordance with AS/NZS 1596 (2014).
3. Emergency and evacuation planning	An emergency evacuation plan is to be prepared as a condition of consent to cover the construction and operation of the site.
4. Construction Standard	The National Construction Code does not provide for any bush fire specific performance requirements for Class 5 to 8 buildings and therefore they do not apply to the development.

4. Summary

This report consists of a bushfire risk assessment to support an Environmental Impact Statement (EIS) prepared to accompany a development application (DA) under Part 4 of the Environmental Planning and Assessment Act, 1979 (EP&A Act) for Sandham Road, Dargan, 2786 (Lot / Plan no. 23/DP751631).

Application of the recommendations identified in this report allows the development to conform to the aim and objectives of Planning for Bush Fire Protection (NSWRFS 2006), as detailed in Section 2 of this report.

5. References

NSWRFS (NSW Rural Fire Service) 2005. Standards for Asset Protection Zones.

NSWRFS (NSW Rural Fire Service) 2006. Planning for Bush Fire Protection: A Guide for Councils, Planners, Fire Authorities and Developers. Prepared by NSW Rural Fire Service in cooperation with the Department of Planning.

Standards Australia 2009. AS3959 – 2009 Construction of Buildings in Bushfire-prone areas. Standards Australia and the Australian Building Codes Board, Sydney.

Standards Australia 2014 AS/NZS 1596 The Storage and Handling of LP Gas.

Standards Australia 2005. AS2419.1 – 2005 Fire Hydrant installations – System design, installation and commissioning

6. Scope and limitations

This report: has been prepared by GHD and may only be used and relied on by for the purpose agreed as set out in Section 1 of this report.

The measures identified in this report cannot guarantee that a building/structure will survive a bushfire event on every occasion. This is substantially due to the degree of vegetation management, the unpredictable nature and behaviour of fire, and extreme weather conditions.

GHD otherwise disclaims responsibility to any person arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

Determination of vegetation types is based on the vegetation types identified in the approved OEH biobank plan which adjoins the subject land. Slope classes are as based on state based mapping data sets.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

GHD

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Document1

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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