REPORT

EA Application RFI Response Vulcan South

for Vitrinite Pty Ltd

10/03/2023

VITRINITE
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1 Introduction

Vulcan South (the Project or VS) is a small-scale coal-mining operation proposed by Vitrinite Pty Ltd owner of Qld Coal Aust No.1 Pty Ltd and Queensland Coking Coal Pty Ltd (Vitrinite). A site-specific Environmental Authority (EA) and Progressive Rehabilitation and Closure Plan (PRCP) application (A-EA-NEW-100265025) was lodged on 6 June 2022 with the Department of Environment and Science (DES). The application includes the establishment of an open-cut hard coking coal mine which will extract material via three separate pits over a seven year period on MLA 700073. DES considered the application and informed Mining and Energy Technical Services (METServe) on the 1 August 2022 that further information was required to assess the application. The information request is replicated in **Table 1** below along with responses from Vitrinite.

Selected responses are supported by further technical assessment documents, which are appended to this response. These comprise:

- Appendix A- Air Quality Assessment;
- Appendix B- Noise Impact Assessment;
- Appendix C- The Groundwater Quality and Level Trigger Assessment;
- Appendix D- Groundwater Monitoring Data; and
- Appendix E- Connectivity Assessment.

If the technical assessment document has been included in the PRCP document, reference to the PRCP will be outlined in the table below.

Table 1 RFI Response Summary – Vulcan South Project

Document	Item number	Relevant Document Section	Issue	Information Requested	Technical Discipline	Final Response
Site-Specific EA Application	1.1	Supporting Information	The degree to which the Vulcan South Project (VSP) and the Vulcan Complex Project (VCP) are integrated [also referred to as the Vulcan Coal Mine] is not clear. A greater description of the relatedness and integration of the VSP and VCP is required. Further, the justification is required as to why the applicant considered the VSP and VCP as separate projects, requiring separate environmental authorities (EAs).	(a) Provide additional details as to the relatedness and integration between VSP and VCP including how project timeframes may overlap; and (b) Justify why VSP and VCP are considered separate projects, requiring separate environmental authorities (EAs).	General	Vulcan South (VS) and Vulcan Coal Mine (VCM) are independent projects, approximately 10km apart. VS construction is planned to be completed at a similar time to the cessation of activities at VCM. If there is an opportunity to commence the highwall trial during the VS construction period, ROM coal extracted from the trial may be handled through the VCM infrastructure. Dependant on timing, personnel, plant and equipment, may be transferred from VCM to VS. The VCM is Vitrinite's first mining project and is scaled accordingly from a capital expenditure and operational cost management perspective. The VCM and VS have separate underlying landholders. Land access for each of the projects has required different negotiation pathways and timeframes.
Site-Specific EA Application	1.2	Appendix F, s4.2 Appendix G, 3.2	The number of sensitive receptors is not consistent between Appendix F and Appendix G for air and noise impacts, respectively. Additional justification is required to explain why the sensitive receptors for air and those for noise are not the same.	(a) Justify why the sensitive receptors for impacts to air and those for noise are not the same.	General	As described in Section 4.2 of the Air Quality Assessment (**Appendix A**), commercial sensitive receptors (being the sensitive receptors included in the noise assessment) have been omitted from the air quality modelling assessment intentionally (please see text below) "*There are a number of industrial commercial receptors that are located at nearby operating coal mines to the VS that have not been classed as sensitive receptors. These receptors (Processing plant, rail loadouts and remote crib room areas) are located within nearby operational coal mines and are likely to be exposed to dust from their own onsite operations at levels greater than that produced by VS, and therefore, any potential exposure should be attributable to onsite conditions. As such, only receptors designated as residential have been considered for impacts as part of the assessment.* However, for consistency with the noise assessment, all sensitive receptors (including commercial) have been listed in table 3 of the Air Quality Assessment (**Appendix A**).
Site-Specific EA Application	1.3	Appendix G, s4.7	Appendix G, Table 4.2 includes proposed noise limits for sensitive receptors. Additional justification is required to justify the appropriateness of the use of the 'Z' weighted indoor noise level for unbalanced noise emissions (where dBZ – dBA > 15 dB).	(a) Justify why the 'Z' weighted indoor noise level for unbalanced noise emissions is an appropriate indicator of noise impact; and (b) Provide additional details as to the noise emissions from mining operations which would be expected to exhibit an 'unbalanced spectrum'.	Noise	(a) The approach is justified because it references DES's low frequency noise guide document which outlines recommendations regarding low frequency assessments. The referenced limit is for an initial screening of low frequency impacts. (b) Further clarification has been added to Section 4.6 of the Noise Impact Assessment (**Appendix B**) to state what an unbalanced spectrum is with some examples (see below) "*An unbalanced frequency spectrum that characteristically shows a general increase in sound pressure level with decrease in frequency. Annoyance due to low frequency noise can be high even though the dBA level measured is relatively low. With regards to mining operations, processing plant including screens and crushers (also potentially associated with diesel engines) are a potential sources of low frequency noise.*".
Site-Specific EA Application	1.4	Appendix F, s4.41; and Appendix G, s6.2	Appendix G, section 6.2 discusses the significant affect the meteorological conditions may have on noise levels [15 to 20dB(A)] at sensitive receptors due to wind speed, direction, time of day, etc. The meteorological scenarios (as outlined in Table 6.1 Meteorological Scenarios) for the Noise Assessment, provide for a wind speed of zero (0) m/s and two (2) m/s. Further, 2 m/s is described as adverse meteorological conditions. However, there is insufficient justification as to why 2 m/s should be taken as representative of 'worst-case' adverse conditions. The department notes that Appendix F states the annual average wind speed as 2.53 m/s and Figure 8, 9 and 10 describe the range of meteorological conditions at the project. This would suggest the 'worst-case' scenario would be regularly exceeded.	(a) Justify the meteorological scenario taken to be 'worst-case' in terms of noise impact to sensitive receptors; and (b) Pending a response to (a), complete additional modelling under a wind speed parameter which is justifiably representative of the 'worst-case' impact to sensitive receptors.	Noise and general	(a) The adopted meteorological conditions have been accepted by DES in previous EIS Noise Assessments undertaken, hence the use. There is no current DES guideline, however, reference is made to the DES (formerly EHP) Planning for Noise Control Guideline (last official version 2004, and more recently draft 2013). In this document, it allows for the use of default worst-case meteorological parameters for the night period (i.e. F Class Stability, 2 m/s winds), which have been considered in this assessment. See page 8-10 of the Planning for Noise Control guideline. (b) no further modelling is required.
Site-Specific EA Application	1.5	Appendix G, s6.7	Appendix G, section 6.7 discusses a period in which coal is proposed to be transported to a coal washing	(a) Provide additional details as to whether the transportation of coal for washing and	Noise and general	(a) VS ROM coal is proposed to be washed through VS CHPP. If there is an opportunity to commence the highwall trial during the VS construction period, ROM coal extracted from the trial may be handled through

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			and load out facility located on the Peak Downs Highway. It is noted this proposal does not appear to be discussed elsewhere in the Supporting Information.	loading is still proposed; and (b) Provide additional details as to whether impacts to environmental values from coal haulage are constrained to noise/the acoustic environment. If additional impacts are identified, provide additional details of said impacts.		the VCM infrastructure or potentially transported to a facility along the Peak Downs Highway (north of VS). The Noise Impact Assessment (**Appendix B**) has been amended to reflect that this movement of ROM coal to an off-site CHPP is a potential rather than a certain outcome. (b) Given the nature of the haul route, noise is the most likely element that could be impacted by the Haul truck route and therefore, this is the only environmental factor included in this scenario. Other technical assessments did not determine that a potential haul road would have any measurable impacts, such as the Terrestrial Ecology and Air quality assessment.
Site-Specific EA Application	1.6	Appendix F, s7	The department notes that as per Appendix 7, section 6.2, compliance with the 24-hour average ground level concentration of PM10 air quality objective (AQO) can only be maintained with 'proactive mitigation measures' and periods of ceased operations. Appendix F, section 7 provides brief details the proposed mitigation measures to be employed to reduce impacts to the environmental values of air. The department recognises the following are proposed: -an air quality management plan; -water application on all major haul routes within the VS domain; and -progressive rehabilitation of areas that have been mined. However, this does not sufficiently describe the 'proactive mitigation measures' and periods of ceased operations.	(a) Provide additional details of all proposed mitigation measures to be implemented to comply with the AQOs. This should include measures identified as proactive for the purposes of compliance with the 24-hour average concentration of PM10; and (b) Provide additional details of the circumstances under which operations are to cease to maintain AQOs, and the nature and extent to which operations will cease (i.e. complete shutdown, partial, CHPP, etc.)	Air quality	(a) Sensitive receptors located directly adjacent to the VS operations are most at risk of being impacted by air quality. The sensitivity of these receptors is anticipated to be reduced through an agreement with the landholder before the project proceeds. They will need to be managed as they are located within or in very close proximity to the mine footprint. Dust management and mitigation measures will still be implemented at VS so that the operation complies with air quality objectives at remaining sensitive receptors. (b) Further analysis into shutdown protocols are now described in Table 14, Table 15 and Section 6.2 in the Air Quality Assessment (**Appendix A**). However, given the above statement, shutdowns will likely not be a requirement.
Site-Specific EA Application	1.7	Appendix G, s8.1 and 8.2	Appendix G, section 8.1 and 8.2 suggests that several mitigation and management measures may be employed to achieve indoor acoustic quality objectives (i.e. noise quality objectives [NQOs]). However, it is unclear which, if any, of these measures are proposed to be implemented to prevent or minimise impacts the acoustic environment.	(a) Provide additional details of the full extent of proposed mitigation measures to be implemented to comply with the NQOs – with specific regard to indoor noise limits; and (b) Provide additional details of the circumstances under which operations are to cease to maintain NQOs, and the nature and extent to which operations will cease (i.e. complete shutdown, partial, CHPP, etc.)	Noise	(a) All the sensitive receptors at most risk to noise are dwellings directly adjacent to the mining operations. These sensitive receptors will be acquired by Vitrinite through an agreement with the landholder before the project proceeds. These receptors will need to be acquired as they are located within or in very close proximity to the mine footprint. Noise management and mitigation measures will still be implemented at VS so that the operation complies with noise quality objectives. (b) Analysis into shutdowns due to exceedances have been documented in Table 8.1 and discussed further in Section 8.3 (**Appendix B**).
Site-Specific EA Application	1.8	Appendix A, 5.3	Appendix A, section 5.3 contends that 'surface water' (i.e. non-mine affected water [MAW]) should include surface water run-off that has come into contact with areas disturbed by mining operations including out-of-pit waste rock emplacements. Additionally, it is argued that whilst this surface water may have a high sediment load, it will remain compliant with water quality objectives (WQOs). The department notes that the applicant proposes to manage this surface water via sediment removal at sediment dams prior to any release. However, additional evidence is required to support the determination that any surface water released will be compliant with the WQOs for the receiving waters.	(a) Provide additional details, including maps of the 'areas disturbed by mining operations' proposed to produce 'surface water' as opposed to MAW. (b) Provide additional evidence to support the proposed management of 'surface water'. Evidence in the form of water quality monitoring data from the VCP and/or an appropriate analogous site/s is permissible. (c) Provide additional details of the management measures to be employed to prevent the contamination of surface water with coal, carbonaceous material and other contaminants. Where surface water becomes contaminated,	Surface Water	Refer to Appendix A of the Supporting Information and Responses to Surface Water Requests (Appendix I of the PRCP).

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			The applicant must demonstrate that this water can be managed appropriately and will not cause environmental harm to the receiving environment if released. Further, it is unclear how areas disturbed by mining operations could be effectively managed to prevent the contamination of surface water with coal, carbonaceous material or other contaminants. Coal and carbonaceous material would likely be present on haul road surfaces, laydowns and the exposed surfaces of out-of-pit waste rock dump.	provide additional details as to how this is proposed to be managed and monitored.		
Site-Specific EA Application	1.9	Appendix A, s9.2	Section 2.1.2.2 Release source – waste water from the relevant activity of the department's guideline – 'Reef discharge standards for industrial activities' (Version 1.02) [ESR/2021/5627] specifies when section 41AA of the Environmental Protection Regulation 2019 (EP Reg) applies. Assuming that surface water is justifiably determined to contain sediment only, and no coal, carbonaceous material or other contaminants, section 41AA does not apply. The department notes that nitrogen may also be relevant where blasting is carried out. However, regardless of this determination, appropriate erosion and sediment control measures will be conditioned through the pending environmental authority to prevent as much sediment as is practical from entering the Great Barrier Reef catchment waters. The applicant is advised to propose an updated Erosion and Sediment Control Plan (ESCP) that is robust and effective in minimising contributions of total suspended sediment (TSS) and dissolved inorganic nitrogen (DIN) to support the aim of reducing end-of-basin fine-sediment and DIN loads.	(a) Confirm potential sources of DIN for the project. (b) Update the contents and requirements of the proposed ESCP. As a minimum, the ESCP should include: (i) an assessment of the size and characteristics of all catchment areas; and (ii) an assessment of relevant properties of soils and waste materials; and (iii) identification of receiving waters environmental values, water quality objectives and management intent; and (iv) specification of minimum design criteria for erosion and sediment control structures to achieve the management intent of receiving waters; and (v) locations and descriptions of all erosion and sediment control measures; and (vi) an audit schedule to ensure erosion and sediment control measures are maintained.	Surface Water and general	Refer to Appendix A of the Supporting Information and Responses to Surface Water Requests (Appendix I of the PRCP).
Site-Specific EA Application	1.100	Appendix A, s7.3.10	Appendix A, section 7.3.10 includes an assessment of the effects of releases from sediment dams on the water quality of receiving waters. However, these scenarios only account for the electrical conductivity and release flow rate from sediment dams. It is unclear why TSS or other relevant WQOs have not been included in the modelled scenarios.	(a) Justify why the 'worst-case' scenario modelling for impacts to receiving waters only includes EC and flow rate; and (b) Pending the response to (a), provide additional modelling that accounts for key contaminants including TSS and heavy metals – selenium, arsenic and molybdenum.	Surface Water and general	Refer to Appendix A of the Supporting Information and Responses to Surface Water Requests (Appendix I of the PRCP).
Site-Specific EA Application	1.11	Section 5.8.4 and Appendix H	The geochemical assessment recommends several mitigation and management measures to minimise the risk of environmental harm to the receiving environment from mine resource, materials and waste. It is unclear if the recommendations are proposed to be implemented, and how these	(a) Confirm the measures to be implemented as recommended by the geochemical assessment; and (b) Provide additional details of how the measures will be employed. This should include details of monitoring and management practices to be employed, timeframes, methodology and parameters for confirmatory testing of material; and	Geochemical	(a) The Geochemical assessment (Appendix H of the PRCP) has been updated to ensure that all management measures will be adopted and complied with by Vitrinite. (b) RGS has updated the Geochemical Assessment of Waste Rock, Coal Reject and Coal Technical Report to provide additional information on how the recommended mitigation and management measures will be implemented and how coal rejects (co-disposed coarse rejects and tailings) will be placed in the in-pit and ex-pit waste rock emplacement areas. Please refer to section 5.4 as well as table E1 of the Geochemical assessment (located in Appendix H of the PRCP).

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			recommendations would be implemented in practice.	how coal reject and tailings material will be placed within waste rock dumps, including minimum capping depth and general capping design.		
Site-Specific EA Application	1.12	Section 2.6.1	Section 2.6.1 indicates that tailings and rejects will be deposited in ex-pit waste rock dumps. However, the Supporting Information does not provide sufficient detail as to this proposal. Tailings storage ex-pit poses a far greater geotechnical and environmental risk than in-pit disposal. The application does not provide information on the management of tailings which is commensurate to this risk. The application does not provide sufficient detail as to the required characteristics for 'dry tailings' to be stored ex-pit and the management of tailings where characteristics do not meet the required minimum requirements (e.g. excessive moisture within tailings, etc.).	(a) Provide additional details of the structure and geotechnical design, including capping and closure design for the ex-pit tailings storage facility; (b) Provide a risk assessment of the ex-pit disposal of tailings, including risks presented to surface water and groundwater; and (c) Provide additional details as to how tailings disposal will be managed to minimise risk of environmental harm to surface water and groundwater.	Geochemical	(a) Please note there is no ex-pit TSF. There are no traditional wet tailings storage facilities. Small quantities of dry tailings cake is proposed to be stored in the ex-pit dump; however, the majority of dry tailings cake will be stored in pit. Please refer to the geotechnical assessment in Appendix G – of the PRCP for further details on ex-pit design. Landform evolution modelling (LEM) has been undertaken to: • determine the long-term stability of the rehabilitated landforms and the level of potential environmental risk of emplacing reject materials in the waste rock dumps (WRD); and • analyse the future stability of the proposed landform cover designs and justify the reasonability of the targeted landform design objectives as outlined in the PRCP. The results of the LEM assessment (Appendix F of the PRCP) were used to inform landform rehabilitation design, demonstrate how the results support the current targeted landform rehabilitation objectives and demonstrate the requirements for long term stability of the landforms during closure. For further information on the post closure design, please refer to Section 6.2 of the PRCP. As described in Geochemical Assessment, 1.2.2 and 2.2.2 (Appendix H of PRCP) - Waste rock removal and placement " assessment of waste rock geochemistry has concluded that the waste rock does not propose a significant risk of generating acid, saline or metalliferous drainage. Therefore, no selective handling and treatment measures are proposed. Furthermore, low permeability capping over the dump surface is considered not to be required. "Geochemical analysis has concluded that the waste rock material poses a very low environmental risk to either ex-pit or in-pit waste rock dumps and therefore, a risk assessment together with further mitigation measures have not been included in the assessment. This is further discussed in Section 5.8.4 of the EA Application. Given that Section 2.6.1 or 2-Project Description is to discuss the project rather than impacts, the section has been left as is. Environmental Impacts are (as mentioned) dealt with in Section 5.8.4 and note that waste rock is very low risk. (b) RGS has undertaken a risk assessment of the ex-pit disposal of coal rejects (coarse rejects and tailings), including risks presented to surface water and groundwater, which is located in Table E-1 of the Geochemical Assessment (Appendix H of the PRCP). (c) All risk mitigation and management measures for storing coal rejects (coarse rejects and tailings) in ex-pit waste dumps to minimise the risk of environmental harm to surface water and groundwater is provided in the updated geochemical report (Appendix H of the PRCP) in Section 5.4 and Table E-1. This practice of placing rejects into the ex-pit WRD would only occur early in mine life where there is insufficient capacity to preferentially store these materials within the in-pit emplacement. These management measures have been reviewed and confirmed by Vitrinite
Site-Specific EA Application	1.13	Appendix A, s5	The department notes that MAW will be generated in areas disturbed by highwall mining. With reference to Appendix A, Figures 1.9 and 1.10, it is unclear how MAW will be effectively managed so as to prevent releases to the receiving environment and maintain separation of MAW from other waters such as surface run-off. Specifically, Figures 1.9 and 1.10 do not appear to include mine water infrastructure needed to	(a) Provide additional details as to how surface water is to be managed within the extent of areas disturbed for highwall mining, with specific regard to MAW. Clarification should include conceptual drainage plans for all years of active highwall mining before rehabilitation is completed.	Surface Water	Refer to Appendix A of the Supporting Information and Responses to Surface Water Requests (Appendix I of the PRCP).

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			manage MAW such as mine water dams – or in place of dams – drains, sumps and/or piping for the conveyance of MAW to a suitable storage.			
Site-Specific EA Application	1.14	Appendix A, s5.5.1	Appendix A, section 5.5.1 discusses the sizing and placement of sediment dams for surface water management. However, this section also explains that runoff from haul roads and access roads is to be captured by sediment basins, before being either released to the receiving environment or returned to the mine water system. Additional justification is required to support the treatment of surface water collected from haul roads as surface water and not MAW.	(a) Provide additional details of water collected from haul roads, including whether this water will be MAW and if said water will be contaminated by coal, carbonaceous material, hydrocarbons, or other contaminants which are predicted to exceed the identified water quality objectives for release (WQOs). (b) Should the response to (a) confirm that water is determined to be MAW, provide updated and/or additional information pertaining to: (i) the proposed surface water management strategy and infrastructure; (ii) updated conceptual drainage plans; and (iii) any further updates to the supporting information necessary to ensure consistency and accuracy (i.e. water balance modelling or water management system assessment).	Surface Water	Refer to Appendix A of the Supporting Information and Responses to Surface Water Requests (Appendix I of the PRCP).
Site-Specific EA Application	1.15	Supporting Information	The application refers to and relies upon 'field-verified' regional ecosystem (RE) mapping. However, it is not clear if this field verified mapping has been validated and accepted by the Queensland Herbarium.	(a) Provide additional details of the field verified RE mapping; (b) Confirm if any previous mapping submitted by the applicant to the Queensland Herbarium covers the full the extent of the VSP project and has been accepted by the Herbarium; and (c) Provide evidence of acceptance by the Queensland Herbarium and the accepted spatial files.	Ecology	The field-verified mapping for the entire survey area has already been submitted to the QLD Herbarium and was incorporated into version 12 of the certified regional ecosystem mapping. However, there were some minor components of the field-verified mapping that were not incorporated into the regional ecosystem map: 1) The *Corymbia aureola* and *Eucalyptus melanophloia* dominated unit that was widespread on rocky sandstone escarpments does not conform to any described regional ecosystem. The herbarium decided to retain it as a variant of 11.10.1, despite it being floristically very different from typical 11.10.1 (dominated by *Corymbia citriodora*, *Corymbia trachyphloia* and *Eucalyptus crebra*). As both variants were located within the vicinity of VS and they differ greatly in habitat value for fauna (true 11.10.1 contains hollows for Greater Gliders and food tree for Koalas, whereas the C. aureola variant does not), the field-verified mapping presented in the report shows these as separate units. 2) *Eucalyptus crebra* growing on sandstone foothills was mapped as 11.10.7 in field-verified mapping, but the herbarium preferred to assign either 11.10.1 or 11.5.9 to such units. Again, because these units lacked E. citriodora (a food and den tree for Greater Gliders, and a dominant tree in true 11.10.1), we preferred to retain our original distinction between true 11.10.1 and those lacking E. citriodora (of which 11.10.7 is the closest match). It is important to note that all impact assessments on regulated vegetation presented in the report are based on the updated regulated vegetation map (which already incorporates the vast majority of the field-verified mapping), not the field-verified map. The field-verified map was only used for mapping habitats of threatened fauna and for quantifying impacts to these species. The reason the field-verified map was used for this purpose rather than the certified mapping was primarily because it provided greater distinction between the sub-types of RE 11.10.1 across the study area, which varied in their habitat values.
Site-Specific EA Application	1.16	Appendix B, s7.2	Appendix B, section 7.2 states that "No mitigation measures are currently proposed or required as part of the Project" [with respect to groundwater]. However, it is noted that a selection of management and mitigation measures are proposed in the preceding section 7.1.3. It is unclear if the project does or does not propose	(a) Provide additional details of the management and mitigation measures to be implemented to prevent or minimise impacts to groundwater.	General	As mentioned in Section 7.2 (Appendix B of the PRCP), " Should monitoring and subsequent assessment determine potential impacts, mitigation strategies would be considered commensurate with the level and risk of environmental impact". Therefore, Section 7.1.3 should be regarded as mitigation recommendations that can be implemented should monitoring and assessment determine there are impacts.

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			to implement management and mitigation measures, or if only a selection of management measures are proposed.			
Site-Specific EA Application	1.17	Appendix B, s2.1.3 and s6.2.1	Appendix B, section 2.1.3 identifies the information requirements for applications that involve the exercise of underground water rights. Additionally, section 5.7.1 identifies third-party users of groundwater in the surrounding region. Additionally, section 6.2.1 predicts the proposed pits may have groundwater inflows up to 43 m3 /day. As the proposed resource activity involves the exercise of underground water rights the applicant may have additional obligations under Chapter 3 of the Water Act 2000. An underground water impact report (UWIR) may be required.	(a) Contact the department's Energy and Extractive unit for assistance in determining if a UWIR is required. Email: UndergroundWater@des.qld.gov.au (b) Pending the outcome of (a), advise the business centre of said outcome.	Groundwater	After consultation with the Energy and Extractive unit department, we have determined that a UWIR will be required to be completed prior to Vitrinite exercising their underground water rights. This is currently underway and will be completed prior to commencement of the activity, understanding that the department may take up to 60 business days to process the UWIR after submission.
Site-Specific EA Application	1.18	Section 5.3.1 and spatial files	Section 5.1.3 describes the vegetation communities within the bounds of the proposed disturbance footprint. The disturbance footprint is stated to contain 1,996.6 ha of remnant vegetation, 87 ha of regrowth and a remaining 642.4 ha of cleared pasture. However, this is inconsistent with the area of the disturbance footprint as stated within the main text of the Supporting Information and within the spatial files at only 1,757 ha.	(a) Confirm the quantities of remnant, regrowth and cleared land within the proposed disturbance footprint.	Ecology	The values presented in the Executive Summary are in error (they reflect a previous version of the project) and have now been amended in the EA and Terrestrial Ecology report. The values presented in Section 5.1.1, Section 5.3.1 and the spatial files (i.e., total disturbance footprint of 1,757 ha, of which 1,567.2 ha is to be cleared and the remainder is above highwall panels) are correct. Table 5-1 breaks down this disturbance by vegetation type.
Site-Specific EA Application	1.19	Table 5-4	The application appears to be inconsistent with respect to the identification of, and impacts to, wetlands. Appendix A, section 3, states there are no matters of state environmental significance (MSES) wetlands, wetland values or wetland protection areas identified in or adjacent to the project area. Appendix C, section 4.4.4 states that there are no wetlands or watercourses of high ecological significance are located within the survey area. However, Appendix C, Figure 4-2 identifies a 'natural wetland' within the extent of the project's mining lease area. The wetland does not appear to be identified or discussed elsewhere in the supporting information.	(a) Provide additional details as to the nature of this wetland and the extent of predicted impacts.	Ecology	Please refer to Figure 2-2 which displays the project disturbance footprint, noting that the singular wetland identified on site does not fall within this and is therefore not considered to be impacted.
Site-Specific EA Application	1.200	Appendix B, 5.7.3;	Appendix B, section 5.7.3 states that is it highly unlikely for aquatic groundwater dependent ecosystems (GDEs) to exist within one (1) kilometre of the proposed pits. Further, Appendix B, section 5.8.3 Aquatic ecosystems indicates that groundwater was too deep or saline to support freshwater aquatic ecosystems. However, Appendix D, section 5.6 states that the main stem of Hughes Creek and small areas in the east of the project area is mapped as a potential	(a) Provide additional details with respect to the nature of the potential GDEs associated with Hughes Creek; and (b) Provide additional details as to the extent of ground-truthing undertaken to verify the presence or absence of mapped GDEs.	Aquatic ecology and Groundwater	Please refer to section 5.3.2 of Terrestrial Ecology Assessment (Appendix D of PRCP), which states that "The groundwater quality is unlikely to be significantly altered by Vulcan South and, in any case, all local potentially groundwater-dependent ecosystems occur upgradient (in terms of the groundwater flow, which mimics the surface water drainage pattern from west to east) of potential effects. In summary, no impacts to GDEs are predicted to result from Vulcan South, beyond that which will occur due to vegetation clearing". Please also refer to section 4.1.3.5 (Appendix D of PRCP) which states "there are likely to be some GDEs contained within the project area". Therefore, GDE's are likely to occur as outlined in Appendix B and Appendix D; however, given their location being upgradient of works, no impacts are anticipated and consequently no mitigation measures proposed.

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			aquatic GDE. Further, Appendix B, section 5.7.3 also states that there is an area of mapped terrestrial GDE associated with Hughes Creek.			
Site-Specific EA Application	1.21	Section 5.13	Section 5.13 indicates that regulated waste will be generated on-site. However, insufficient detail is given regarding the regulated wastes expected to be generated on-site, such as tyres, industrial wastes and tailings/rejects. Further, the department considers the disposal of tailings and rejects likely meets the definition regulated waste as defined by the Environmental Protection Regulation 2019 (EP Reg). Resultingly, the proposed activity must include authorisation to carryout environmentally relevant activity (ERA) 60: Waste disposal.	(a) Provide additional details as to the types of wastes expected to be generated on-site. (b) Provide additional details as to the constituent materials and chemical characteristics of waste to be disposed of within waste rock dumps. This should include any chemical inputs to coal processing and tailings generation.	General	a) The wastes expected to be generated as part of the development of VS can be broken down into coal mining wastes, general wastes and regulates wastes. The primary coal mining specific wastes generated by VS will include: -waste rock -coarse and fine reject material. Other sources of waste generation include: -used machinery parts and other scrap metal, such as wire cables; -expired diesel and lubricants; -waste oil and filters; -hydrocarbon drums; -sewage; -gaseous emissions; -general waste; -wooden pallets. b) Processing of coal in the CHPP will involve crushing, sizing, density separation and froth flotation. To undertake this process, Anionic flocculant (dry powder), Cationic flocculant (liquid) and Acrylate polymer materials will be used. Regulated waste is defined under the *Environmental Protection Regulation 2019* as a waste that— (a) is commercial waste or industrial waste; and (b) is of a type, or contains a constituent of a type, mentioned in schedule 9, part 1, column 1. Flocculants and polymers are not listed in schedule 9, so it is argued tailings and coarse reject materials generated as part of the coal processing at VS do not meet the definition of a regulated waste. As such, environmentally relevant activity (ERA) 60: Waste disposal, is not relevant to VS.
Site-Specific EA Application	1.22	Appendix B, s.5.8.4; s.7.1.2	Appendix B, section 5.8.4 provides preliminary monitoring data for groundwater. It is unclear if interim guidelines have been developed and proposed as part of the application. Further, it is unclear if analytes are appropriate to detect potential contamination to groundwater such as total petroleum hydrocarbons.	(a) Provide additional details as to the proposed interim guidelines for WQO for groundwater; (b) Provide groundwater monitoring data for all analytes and physical parameters; and (c) Provide additional details as to how potential contaminants to groundwater from mining activities will be monitored.	Groundwater	(a) The Groundwater Quality and Level Trigger Assessment has been provided (**Appendix C**). (b) Groundwater monitoring data has also been attached to this response (**Appendix D**) (c) VS does not currently require the development of an extensive groundwater water quality monitoring plan at this stage of development. However, a broad overview of potential groundwater monitoring methodology for VS, as derived from the adjacent VCM, which is similar in terms of analytes and the monitoring plan methodology, is provided below. Water quality monitoring *Purging* Groundwater samples from monitoring bores are required to be representative and repeatable. To achieve this, the groundwater that is collected for analysis needs to be sourced from the target aquifer and should not be a sample from the column of water within the bore that may be stagnant. The bores should be purged to ensure that three bore volumes of groundwater are removed from the bore prior to collection of the laboratory sample. The field parameters of pH and EC should be monitored during purging to ensure stabilisation of the parameters has occurred. Appropriate purging methods for these bores include hand bailing, 12 volt submersible pumps or inertia pumps. Where three bore volumes of groundwater are unable to be removed from the monitoring bore (in situations

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						where there is low permeability or a limited water column in the bore) it may be appropriate to either dewater the bore during purging and return the next day to allow for recovery, or install a passive sampling technique such as a hydrasleeve. Hydrasleeves are installed in a number of monitoring bores in the VS Project monitoring network. *Field parameters and sample collection* As discussed above, appropriate purging methods for the monitoring bores include hand bailing, 12 volt submersible pumps or inertia pumps. The purging technique will also be used to provide the groundwater sample for field measurements and laboratory analyses. The field parameters are generally monitored and recorded for two reasons: ▪ The monitoring of field parameters during the purging process assists in determining whether or not a stable or representative sample is being purged from the monitoring bore. ▪ There are several parameters which are affected by atmospheric conditions immediately after sampling. Notably pH should be assessed in the field as the laboratory holding time for pH is six hours, and this is generally breached by the time the sample is received by the laboratory. The field water quality meter should be calibrated daily and in accordance with manufacturer's instructions. The meter should be calibrated using standard calibration solutions. All laboratory samples should be collected in laboratory supplied sample containers appropriate for the required laboratory parameters. The sample bottles should be clearly labelled with the sample ID and date and time of sampling. The laboratory samples should be accompanied by a Chain of Custody (CoC) form to define the number of, and identity of the samples, the required parameters to be analysed and the persons or companies in control of the samples. *Field QA/QC* Field quality control and quality assurance (QA/QC) processes should be in consideration in respect of the following guidelines: ▪ Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009. Brisbane, Department of Environment and Science (DES, 2018); ▪ AS/NZ 5667 11 1998 - Water quality sampling. Part 11, guidance on sampling of groundwater (Standards Association of Australia & Standards New Zealand, 1998); and ▪ Australian Governments Groundwater Sampling and Analysis – A Field Guide (2009:27). Currently a duplicate field sample is collected per monitoring round across the Vulcan Complex Project monitoring network to assess repeatability in the laboratory testing methods. *Storage/transport of samples* As discussed above, all laboratory samples should be collected in laboratory supplied sample containers appropriate for the required laboratory parameters. The samples should immediately be stored on ice, or refrigerated, and transported as soon as is reasonably practical to the laboratory for analysis. Samples should remain on ice or refrigerated during storage and transportation. As discussed above, the laboratory samples should be transported under conditions documented in a chain of custody (CoC) form, to define the number of, and identity of the samples, the required parameters to be analysed and the persons or companies in control of the samples. It is important to note the laboratory holding times vary for individual analytes. The holding times represent the maximum time that a sample can be stored for representative analysis of a parameter. Transportation of samples should consider the holding times and the time taken for delivery of the samples to the laboratory from site. Most laboratory sample bottles are plastic, however some parameters require glass bottles. Glass bottles should be packed (e.g. bubble wrap), stored and transported to minimise breakage. Labels showing an adequate amount of information are necessary to prevent misidentification of samples. Paper labels or tags should be avoided, as they are susceptible to destruction when wet. Labels should include the following information, as a minimum: ▪ bore number;

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						▪ project name and number; ▪ signature or initials of sampler; ▪ date and time of sample collection; and ▪ type of preservation used. Labels should be affixed to the sample container prior to or at the time of sampling. The labels should be filled out at the time of sample collection using a marker pen with indelible ink. The exact sample location and type of sample must be recorded on the CoC. *Laboratory analyses* The laboratory undertaking the analytical testing of groundwaters should be accredited by the National Association of Testing Authorities (NATA) for the requested analyses. The laboratory will typically have internal QA/QC protocols which will be reported as part of the analyses.
Site-Specific EA Application	1.23	Section 5.3.5; Section 5.3.6 Appendix C, s5.2	Avoidance and Mitigation of Impacts to Prescribed Environmental Matters. An offset proposal cannot be considered for the application at this time as the department is not satisfied that all reasonable avoidance and mitigation measures have been or will be undertaken to address impacts on prescribed environmental matters (PEMs). The application does not apply the offset policy/framework in such a way that first considers how impacts to PEMs have been demonstrably avoided, then mitigated; before considering the use of offsets. Offsets are intended to only compensate for unavoidable impacts to PEMs. As per section 1.3 of the statutory instrument – 'Queensland Environmental Offsets Policy' (Version 1.12) [EPP/2015/1658], all offsets must meet seven (7) offset principles. Principle 2 requires that "impacts must first be avoided, then mitigated, before considering the use of offsets for any remaining impact". Several PEMs are identified to be part of a contemplated offset proposal. As per section 5.3.5 – Matters of National Environmental Significance (MNES) these include— · Threatened ecological communities; o 120.3 ha of Brigalow (*Acacia harpophylla* dominant and co-dominant) [endangered]; and · Threatened species; o 1,023.6 ha of Koala (*Phascolarctos cinereus*) [endangered] habitat, composed of— - 21.3 ha of high-quality habitat; - 559.1 ha of moderate-quality habitat; and - 443.2 ha of low-quality habitat; and o 1,364.1 ha of Squatter Pigeon (Geophaps scripta scripta) [vulnerable]	(a) Justify how impacts to each PEM will be or have been avoided in the first instance. (b) Provide additional details as to how impacts to each PEM have been avoided and can be further avoided or minimised to reduce impacts to each matter. (c) Provide further details of how each matter will be mitigated – and why avoidance is not reasonable. (d) Confirm the scale, intensity and duration of impacts to the identified PEMs after the implementation of (a) and (b) – including PEMs of Ornamental Snake, Northern Quoll, Short-Beaked Echidna, Glossy Black-cockatoo and Common Death Adder.	Ecology	As is the case with all resource projects, the location of the Project is determined by the location of the resource and the economics of its extraction. However, VS has strategically been designed to avoid impacts to PEM's where practicable. In which case, the current design is the best-case scenario. Mitigation measures described in the Terrestrial Ecology Assessment (Appendix D of the PRCP) will be implemented as part of the projects PEM's environmental obligations. In accordance with best practice techniques, VS has been strategically positioned to avoid disturbance to as many matters of state and/or national environmental significance as practicable. No protected conservation estates or secured offset areas will be disturbed due to the project. The scale, intensity and duration of impacts to identified PEM's are described in section 5.3 (Appendix D of the PRCP).

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			habitat, composed of— - 671.2 ha of foraging habitat (524.3 ha of which is also breeding habitat); and - 692.9 ha of dispersal habitat; and o 71.1 ha of Central Greater Glider (*Petauroides armillatus*) [vulnerable] habitat; o Ornamental Snake habitat; and o Northern Quoll habitat. As per section 5.3.6 – Matters of State Environmental Significance (MSES) impacted PEMs also include— · Regulated vegetation; o 25.6 ha of regional ecosystem (RE) 11.3.2 [of concern]; and o 58.3 ha of REs 11.3.25, 11.5.3, 11.5.9b, 11.9.2, 11.10.1 and 11.10.3 [located within a defined distance from the defining banks of a relevant watercourse]. · Protected wildlife habitat: o Short-Beaked Echidna (*Tachyglossus aculeatus*) [special least concern]; o Glossy Black-Cockatoo (*Calyptorhynchus lathami*) [vulnerable]; and o Common Death Adder (*Acanthophis antarcticus*) [vulnerable]. Additional information is required before the department may be satisfied that an offset proposal can be pursued. Particularly, justification is required that clearly demonstrates how the 'avoid, mitigate, offset' approach has been provided for each PEM. The applicant must: · Demonstrate how impacts to each PEM has been avoided in the first instance. This may include details such as site planning, site selection, etc.; · Where avoidance cannot be reasonably achieved, demonstrate how impacts to each PEM is to be carefully managed and minimised (mitigation measures); and · Where avoidance and mitigation measures cannot be reasonably achieved or implemented, demonstrate how the impacts to each PEM are unavoidable and/or incapable of being completely mitigated. The department notes that Appendix C, section 5.2 and Table 5-3 contemplate a variety of mitigation measures. However, it is unclear if these measures are proposed to be implemented and the corresponding PEMs to which each measure is aimed to protect.			
Site-Specific EA Application	1.24	Section 5.3.5; · Section 5.3.6; · Appendix C, s5.2	Determining Significant Residual Impact As per the guideline – 'Significant Residual Impact Guideline' (2014) [the SRI	(a) Complete an SRI assessment for remaining impacts to PEMs and provide a	Ecology	Section 5.3 of the Terrestrial Ecological Assessment (Appendix D of the PRCP) outlines the residual impacts on protected matters. Relevant sub-sections are listed below: -5.3.1 (Regulated vegetation)

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			guideline], the department may only impose offsets where it is satisfied that the prescribed activity will or is likely to have a 'significant residual impact' (SRI) on a PEM. SRIs are only those impacts to PEMs that— (a) remain despite the implementation of avoidance and mitigation measures; and (b) are 'significant' as guided by an SRI assessment under the SRI guideline. The SRI guideline provides 'significant impact criteria' for identifying a 'significant' impact to PEMs. An SRI assessment must be conducted for each PEM which will be impacted. If the significant impact criteria are exceeded by an impact, then offsets may be considered – and if so, must be considered for the entirety of the impact – not just the component of impact which exceeded the criteria. An SRI assessment must be completed for the following PEMs at a minimum: · Regulated vegetation; · Connectivity areas; · Wetlands and watercourses; · Protected wildlife habitat; and · Any additional PEMs identified as being impacted. Note: When assessing Connectivity areas, the output of the Landscape Fragmentation Tool should be provided to the department as part of the SRI assessment. Also note, if at the time of the application to DES a decision by the Commonwealth has not been made regarding impacts to overlapping PEMs, then DES is required to assess and if a significant residual impact has been identified then impose offset conditions. The applicant can seek to remove the offset requirement from their state approval once a decision has been made at a federal level.	report of said SRI assessment/s to the department.		-5.3.1 (Wetlands and watercourses) -5.3.3 (Wildlife habitat protected under the EPBC Act -4.4 (Wildlife habitat protected under the NC Act). A Connectivity Assessment (**Appendix E**) has been provided as part of the response.
Site-Specific EA Application	1.25	Section 5.3.5; · Section 5.3.6; · Appendix C, s5.2	Determining Offsets as a Suitable Outcome Finally, should a significant residual impact remain for any of the above PEMs, the applicant must successfully demonstrate that an offset is a 'suitable outcome'. As per section 3.6 of the 'General guide for the Queensland Environmental Offsets Framework' (V1.03) [EPP/2021/5541] the department must have a high level of confidence that a suitable offset can be selected, designed and managed to achieve a conservation outcome and maintain the viability of the PEMs to be offset.	(a) Provide additional details of the availability and viability of land-based offsets for each impacted matter in order to deliver a conservation outcome. Please note that an available offset area must demonstrate the known sightings of the species and that the landholder is willing and able to implement conservation management to improve the conservation outcome for the species population within the proposed offset area. (b) Pending the response to (a), provide an	Ecology	See offsets strategy (Appendix J of the PRCP)

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				assessment of the area in hectares (ha) of each PEM which is available to be used as an offset in the bioregion and subregion. Areas available for offsets include those which contain the PEM in question, are on freehold or leasehold land, are not already protected, are not at risk from completing land uses (e.g. mining, quarrying or forestry) and are not otherwise inappropriate for use as an offset area. The assessment must include a spreadsheet and shapefiles of lot-on-plans identified as suitable for offsets and available to deliver a conservation outcome.		
Site-Specific EA Application	1.26	Appendix A, s.7.3.7.2; s.9.3.1;	Appendix A contemplates the proposed release of 'surface water' via sediment dams. Section 3 of Appendix A identifies the WQO trigger levels for the receiving waters. Further, section 9.3.1 of Appendix A identifies the receiving water contaminant trigger levels. The trigger levels of Table 3.1 and Table 9.3 are compared below. Parameter Table 3.1 Table 9.3 pH 6.5 – 8.5: 6.5 – 8.0 EC [µS/cm] 720 (base flow),250 (high flow) : 1,500 TDS [mg/L] <2,000: ? TSS [mg/L] <55: ? Sulfate (SO42-) [mg/L] 25: 1,000 It is unclear in Table 9.3 how levels have been formulated to protect environmental values (EVs) and why interim trigger levels have been developed for parameters with the exception of TDS and TSS. Further, it is unclear how impacts to the receiving waters can be managed and minimised without proposed trigger limits for TDS and TSS.	(a) Provide additional details as to how the proposed levels were formulated. (b) Provide additional details as to how the proposed levels will protect EVs of the receiving waters. (c) Provide additional details as to the formulation of interim trigger levels for TDS and TSS – that will protect the EVs of the receiving waters.	Surface Water Quality	Refer to Appendix A of the Supporting Information and Responses to Surface Water Requests (Appendix I of the PRCP).
Site-Specific EA Application	1.27	Appendix A, s9.5	Section 9.5 of Appendix A states that sediment dams will be monitored for a suite of water quality parameters. (i.e. pH, EC, major anions [sulfate, chloride and alkalinity], major cations [sodium, calcium, magnesium and potassium], TDS and a broad suite of soluble metals/metalloids). However, it is unclear if parameters will include those which are necessary to determine 'surface water' reporting to sediment dams is not MAW and is otherwise suitable for release. Specifically, parameters to be confirmed include: · Dissolved inorganic nitrogen (DIN); · Turbidity (NTU); · TSS; · Total Petroleum Hydrocarbons (TPH); and · Any other proposed parameters required to verify 'surface water' is not MAW.	(a) Provide additional details as to the parameters to be monitored for at sediment dams.	Surface Water Quality	Refer to Appendix A of the Supporting Information and Responses to Surface Water Requests (Appendix I of the PRCP).

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Proposed PRC Plan and Schedule	2.1	Proposed Progressive Rehabilitation and Closure Plan (PRC plan) · s.10.2.2 Proposed Progressive Rehabilitation and Closure Plan Schedule (PRCP schedule) · RA3 Worksheet Supporting Information. · Section 2.1 · Appendix G	The PRC plan, Schedule and Supporting Information for the EA Application appear to be inconsistent with respect to the timing of rehabilitation of highwall mining benches and haul roads. It is unclear if these areas are to be rehabilitated as soon as they become available. Section 2.1 of the Supporting Information describes the highwall mining trial program as being completed within one (1) year of mining operations. Table 2-3 also indicates that mining in the highwall mining areas will cease after the first year of operations. Appendix G, Figures 2.2, 2.3 and 2.4 indicate that the highwall mining area will not be rehabilitated after the first year of mining. Whilst overburden dumps are indicated to be available for rehabilitation, the highwall mining benches and haul roads appear to be omitted. Further, section 10.2.2 of the PRC Plan and the Rehabilitation Area (RA) 3 worksheet of the PRCP schedule indicate that 44.21 ha of land will be rehabilitated in 2025. However, it cannot be discerned if this rehabilitation relates to the highwall mining benches and haul road.	(a) Provide additional details as to when highwall mining benches and haul roads become available for rehabilitation; (b) Pending the response to (a), update the PRC plan and schedule to account for the rehabilitation of the highwall mining benches and haul roads when they become available for rehabilitation; and (c) Update the Supporting Information to be consistent with the PRC plan and schedule.	General	a) Table 10-1 of the PRCP shows that all the Highwall mining area exclusive of the haul road to the Highwall mining area and the magazine (which both form part of the footprint) will be rehabilitated in 2025. Specifically, 20.7 ha of haul road and 10.4 ha of magazine will be rehabilitated in 2032. b) The PRCP and schedule have been updated to account for all rehabilitation required for the highwall mining area. c) No changes are proposed to the site-specific EA Application supporting information document. All updates in regard to the PRCP schedule have been made either in the PRCP or formal PRCP schedule excel spreadsheet.
Proposed PRC Plan and Schedule	2.2	PRC plan PRCP schedule Spatial Files	The PRC plan, schedule and spatial files are not consistent with the proposed post-mining land uses (PMLUs). It is noted that the PRCP schedule proposes the following four (4) PMLUs: · Low-intensity cattle grazing; · Low-intensity cattle grazing with habitat for Koalas and Squatter Pigeons; · Low-intensity grazing with habitat for Koalas and Squatter Pigeons; Native Ecosystems; and · Saraji Road. However, these PMLUs are not consistent across the PRC plan and spatial files. For example, section 4 of the PRC plan refers to three (3) PMLUs: · Low-intensity cattle grazing (also provides some habitat for threatened fauna); Public road; and ·Railway used for coal transport. Further, this is inconsistent with Table 5-1 which includes only two (2) PMLUs: · Low-intensity cattle grazing; and · Road reserve Further, the spatial files refer to three PMLUs: · 'GRAZ' (grazing); · 'NAT_ECO' (native ecosystem); and · 'PERM_INFRA' (permanent infrastructure). The proposed PMLUs must be referred to consistently throughout all	(a) Update the PRC plan, schedule and spatial files to use consistent terminology and descriptions of the proposed PMLUs. This should include the instances raised and any other instances within the application documents where the proposed PMLUs are referred to or described. Terminology must be clear as to the type of PMLU including whether the PMLU will include threatened fauna habitat and/or native ecosystem. (b) Update the PRC plan, section 4, to clearly describe each of the proposed PMLUs including relevant indicators of success	General	The PMLU's have been made consistent throughout the PRCP. The PMLU's include the following: -Low intensity cattle grazing -Low intensity cattle grazing with habitat for threatened fauna -Native ecosystems -Saraji road

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			documentation and files. This is to ensure clarity as to the exact nature of the PMLUs being proposed and which PMLUs are to be achieved at end-of-minelife.			
Proposed PRC Plan and Schedule	2.3	PRC plan · s.1.2.10 Pre-mining Land Use à Land Suitability Ratings PRCP schedule	The proposed PMLU of "Low-intensity grazing with habitat for Koalas and Squatter Pigeons; Native Ecosystems" (assumed to be equivalent to the PMLU of "NAT_ECO" as per the spatial files) is proposed for the northern portion of MLA700073. However, the department is not satisfied that this proposed PMLU is likely to be achievable. As per section 1.2.10 and Figure 1-38, the pre-mining land suitability for the proposed PMLU has a land suitability of only '5' (i.e. unsuitable land with extreme limitations). With consideration for the pre-mining land use being generally unsuitable for grazing, it is unclear how the applicant proposes to rehabilitate land to a "stable condition" where the PMLU includes grazing.	(a) Provide additional details for the proposed PMLU for the area identified to be "NAT_ECO" as per the spatial files. (b) Provide additional details in terms of rehabilitation milestone criteria that will demonstrate the achievement of a stable condition with a PMLU of "Low-intensity grazing with habitat for Koalas and Squatter Pigeons; Native Ecosystems".	General	The spatial files have now been updated to clearly represent each of the PMLU's.
Proposed PRC Plan and Schedule	2.4	PRC plan · s.6.1.6 Surface Water · Appendix A PRCP schedule · Rehabilitation milestones	The department notes sediment dams are proposed to be removed from 'completely rehabilitated' catchments to allow run-off to shed to the receiving environment. The catchment of a sediment dam is proposed to be considered 'rehabilitated' when water monitoring data of runoff from rehabilitated areas is consistent with natural background conditions. However, the rehabilitation milestones (RMs), including the completion criteria, do not reflect the above proposal. The RMs should be updated to account for the proposed removal of sediment dams. Corresponding completion criteria must be developed in line with the SMART principles.	(a) Update the RMs and corresponding criteria to account for the proposed rehabilitation works; (b) Provide additional details as to how water monitoring data for runoff from rehabilitated areas will be collected; (c) Provide additional details as to how natural background conditions will be determined including the characteristics of water quality; and (d) Pending the responses to the above, update the PRC plan and schedule accordingly.	General	The Rehabilitation Milestones do already include reference to rehabilitation of sediment dams, under RA4, as part of: - Rehabilitation Milestone 2: Remediation of Contaminated Land (Section 9.1.2 - refers to them as sediment dams/ponds) - Rehabilitation Milestone 3: Landform Development and Reshaping/Reprofiling (Section 9.1.3) - Rehabilitation Milestone 4: Surface Preparation (Section 9.1.4) - Rehabilitation Milestone 5: Revegetation (Section 9.1.5) - Rehabilitation Milestone 6: Land Suitable for the Commencement of Grazing (Section 9.1.6) - Rehabilitation Milestone 7: Establishment of Target Vegetation Type (Section 9.1.7) - Rehabilitation Milestone 8: Achievement of a Stable PMLU(Section 9.1.8) Therefore, the milestone criteria has not been updated. Under RM8, it is outlined how field monitoring programs will assist in providing a stable landscape to support low-intensity cattle grazing, including erosion monitoring and surface water monitoring. Water monitoring data from rehabilitation area runoff is described in Section 1.2.4 of the PRCP "when sediment dam catchments are completely rehabilitated, and water quality monitoring of the runoff has established that it is consistent with natural background conditions, the sediment dam and associated drainage infrastructure will be decommissioned. " as well as briefly in the REMP section, otherwise, please refer to section 6.8 and 9 of the Surface water monitoring program (Appendix A of the PRCP), which discuss baseline monitoring data for water quality at Vulcan South. Given that all the information is provided, the PRCP schedule has not been updated.
Proposed PRC Plan and Schedule	2.5	PRC plan · s.6.2.8	The department recognises that rehabilitation at VCP is proposed to be taken as rehabilitation trials for the VSP. The PRC plan must stand on its own merit and as such, must meet the legislative requirements of the Environmental Protection Act 1994 (EP Act). In accordance with section 126C(1)(j) of the EP Act, if rehabilitation trials are planned, the rehabilitation planning part must state: -the objective of the trial(s) -the trial design including, but not limited to, the	(a) Update the PRC plan to include the necessary information. The additional information should clearly demonstrate how rehabilitation trials at VCP can inform rehabilitation at VSP; and (b) Consider the need for additional or modified trials to support rehabilitation for the native ecosystem PMLU.	General	To be of value, trials need to occur on remediated landforms, this could not occur until 2027. As originally proposed, learnings from Vulcan Coal Mine are anticipated to be far more valuable than a trial at Vulcan South.

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			location, underlying land characteristics and potential issues -the details of how the trial(s) will be carried out -when the trial(s) will commence -the duration of the trial(s) -how the trial(s) will be assessed for success -how the results of the trial(s) will be incorporated into rehabilitation strategies and the development of milestones, and -where the trials have previously been carried out by the applicant. The PRC plan must be updated to include details of the above, with specific regard to how the rehabilitation trials at VCP will be carried out to inform rehabilitation at VSP. Further, it is noted that VSP may require specialised rehabilitation trials when considering the impacts of highwall mining and the PMLU which includes native ecosystem.			
Proposed PRC Plan and Schedule	2.6	PRC plan · Section 6.1.6 Surface Water à Final Landform Drainage · Appendix A, s5.9 · Appendix D	The PRC plan indicates the mine water dams are proposed to be retained post-mining to support the PMLUs. As per section 3.2 Post-mining land use of the statutory guideline – 'Progressive rehabilitation and closure plans (PRC plans)' (ESR/2019/4964), infrastructure may be accepted as part of a PMLU where the relevant land holder has agreed through a signed land holder statement declaring that they will accept responsibility for the infrastructure once mining has ceased. All infrastructure to be retained onsite should be safe, stable and not cause environmental harm. If the underlying landholder is also the EA holder (or a parent corporation or a subsidiary corporation) they must justify how the infrastructure will provide a benefit or improvement to the use of the land and/or community once mining has ceased.	(a) Provide additional details as to the mine water dams – or any other infrastructure that will be retained'; (b) Provide evidence of agreement from the underlying landowner to accept said infrastructure post-mining; If the EA holder is the underlying landowner justify why retaining said infrastructure provides a beneficial outcome; and (c) Provide additional details as to the treatment/s for mine water dams that will ensure they are safe, stable, do not cause environmental harm – and are fit for purpose (i.e. free of contaminants, free of silt and sediment, suitable water quality for stock watering, etc.).	General	The water management section (Section 6.1.6) of the PRCP outlines that mine water dams will be decommissioned following rehabilitation of infrastructure areas. This is also described in Section 1.2.4 Final Landform "when sediment dam catchments are completely rehabilitated, and water quality monitoring of the runoff has established that it is consistent with natural background conditions, the sediment dam and associated drainage infrastructure will be decommissioned. " However, a sentence has been added to Section 6.1.2 of the PRCP -*Infrastructure to be retained*, stating that "Infrastructure that is beneficial to the landholder, pending a written agreement between Vitrinite and the post-mining landholder, will be retained. This may include specific water infrastructure for stock watering purposes." Discussion of mine affected water dams is provided in Section 5.6.1 of the Surface Water Assessment (Appendix A of PRCP).
Proposed PRC Plan and Schedule	2.7	PRC plan · Section 10.3, Table 10-2 PRCP schedule	The RAs listed against each RM in Table 10-2 are not consistent with the corresponding schedule. Further, it is unclear as to why RM2 is not applicable to RA2.	(a) Update the PRC plan and/or schedule to be consistent; and (b) Justify why remediation of contaminated land is not applicable to RA2. Alternatively, include RM2 against RA2.	General	Table 10-2 has been amended to include RA2 within the RM2. RA5 has also been amended to substitute RM8 with RM9.
Proposed PRC Plan and Schedule	2.8	PRC plan · Section 6.1.3, Table 6-1 · Section 6.1.5, Table 6-2 · Section 10.3, Table 10-2 PRCP schedule · RM4	RM4 includes a milestone criterion (MC) which requires subsoil to be applied to RA2 (in-pit dumps). Note that is excludes RA1 (ex-pit dumps). Further, section 6.1.3 discusses that the application of subsoil will enhance the water holding capacity of soil and provide better conditions for revegetation. Table 6-1 states that RA1 will not receive subsoil treatment due to insufficient quantity of material at an appropriate stage of project development. However, Table 6-2 suggests that there will be a	(a) Update section 6.1.5 and Table 6-2 to clearly outline the predicted quantities of topsoil, subsoil and waste rock available to be used in rehabilitation; (b) Provide further justification to support the lack of subsoil application to ex-pit dumps (noting it is proposed to be applied to in-pit dumps); and (c) Clarification is required as to the feasibility	General	Table 6-2 has been updated to reflect the predicted subsoil and waste rock quantity. As described in the Soil and Land Suitability technical assessment (Appendix C), the vast majority of the subsoil is considered dispersive and acidic, and therefore is not suitable for rehabilitation without management. It is likely that the subsoil; will be mixed with waste rock primarily as a function to fill the void in the land rather than a medium for rehabilitation and plant growth. The most important soil layer for rehabilitation in terms of plant growth is the topsoil layer, which is considered fertile. The project scheduling and design has dictated that the in-pit dumps will need to be rehabilitated first before the ex-pit dumps. It is for this reason that the subsoil will be used to rehabilitate this area prior to ex-pit dumps which may mean there is less available when the ex-pit dump is rehabilitated. Regardless, as described above, topsoil is the most important for rehabilitation of plant species and communities and subsoil is primarily used as a

Document	Item number	Relevant Document Section	Issue	Information Requested	Technical Discipline	Final Response
			surplus of topsoil material for use in rehabilitation. Clarification is required regarding the predicted quantity of topsoil, subsoil and waste rock for rehabilitation available over the duration of mining operations. Additional clarification is required as to the feasibility of strategic placement of subsoil on ex-pit dumps where supply is limited.	of partial or strategic use of subsoil where supply is limited.		structural mechanism to fill the void. In this way, if there is less subsoil or none at all when the ex-pit dump is rehabilitated, it will likely only have a marginal effect on the completion of the rehabilitation milestone criteria, as topsoil will not be limited. Thus, more topsoil can be used to replace the lacking subsoil. The incidence of surplus topsoil and lacking subsoil has been accounted for in the finalisation of project PMLU's and the associated vegetation types and corresponding root depth and soil depth requirements. Please see above.
Proposed PRC Plan and Schedule	2.9	PRC plan · Section 6.2 PRCP schedule · RM4	The need for soil amelioration is discussed in section 6.2 of the proposed PRC plan. Criteria for soil amelioration have not been included in the proposed PRCP schedule.	(a) Provide a revised PRCP schedule that includes appropriate RM criteria for soil amelioration.	General	Refer to Table 10-2, RM4, which mentions ameliorants: "Remediation of any erosion or subsidence is complete; Growth media (topsoil) has been sourced, carted and spread; Ameliorants to improve or stabilise soils have been added; and Deep ripping has been undertaken. "Ameliorants for soil have also been mentioned in Table 10-3.
Proposed PRC Plan and Schedule	2.100	PRC plan · Section 6.2.3 · Table 5-1 PRCP schedule · RM7 and RM8	The proposed PRCP schedule provides limited milestone criteria to demonstrate achievement of the proposed PMLU of native ecosystem and the habitat features of low intensity grazing with habitat for koalas and squatter pigeons. The proposed PMLU for RA2, RA3 and RA4 incorporates habitat for Koalas and Squatter Pigeons. The proposed PMLU for RA2 includes both grazing and native ecosystem. Section 6.2.3 states habitat for Koalas and Squatter Pigeons can be incorporated into low intensity grazing PMLU and native ecosystem PMLU and habitat for the greater glider can be included in the native ecosystem PMLU. The proposed PRCP schedule includes RM6 for land becoming suitable for the commencement of grazing, RM7 for establishment of target vegetation and RM8 for the achievement of the PMLU to a stable condition. Table 5-1 of the proposed PRC plan refers to completion criteria regarding the prevalence of eucalyptus species, however these have not been incorporated in to the proposed PRCP schedule.	(a) Provide a revised PRCP schedule that includes appropriate RM and milestone criteria to demonstrate the achievement of the proposed PMLU including the provision of habitat for koalas and squatter pigeons.	General	The PRCP schedule has been revised and includes the appropriate rehabilitation milestones to demonstrate the proposed PMLU. A description of Eucalyptus species inclusion into rehabilitation milestone criteria has been added for RM7 and RM8 of Table 10-3. *Eucalyptus crebra* and/or *Eucalyptus populnea* are to constitute 21% of the total basal area of woody vegetation on sand plains. *Eucalyptus camaldulensis* is to constitute 33% of the total basal area of woody vegetation along Ripstone Creek and North Creek.
Proposed PRC Plan and Schedule	2.11	PRC plan · Table 5-1 PRCP schedule · RM8	The proposed PRCP schedule refers to operational water quality limits contained within the EA for an adjacent site (VCP). Table 5-1 of the proposed PRC plan refers to site specific water quality triggers that will be established to present the most accurate measure of effect on water quality.	(a) Provide revised milestone criteria relating to water quality or further information to justify the proposed water quality criteria in RM8.	General	Table 10-3 has been amended to reference the Surface Water Assessment (Appendix A of PRCP) and Groundwater Assessment (Appendix B of PRCP) for Water Quality Criteria for RM8.
Proposed PRC Plan and Schedule	2.12	tables for RA1, RA2, RA3 and RA5	For rehabilitation tables for RA1, RA2, RA3 and RA4, entries for areas when each milestone is completed by require revision to reflect cumulative areas. The tables must reflect the progression of each portion of each RA through the relevant milestones progressively over time (e.g. currently the table for RA1 depicts progression of 151.4ha through milestones 1 to 5 between 2025 and	(a) Revise cumulative areas achieved in rehabilitation tables for RA1, RA2, RA3 and RA4 to reflect the cumulative area for each milestone achieved as time progresses.	General	The PRCP Schedule now shows progression of the rehabilitation areas over time.

Document	Item number	Relevant Document Section	Issue	Information Requested	Technical Discipline	Final Response
			2027, however, in 2030 the entire area of the RA (196 ha) is depicted as only being progressed through milestones 1 to 3).			

Appendix A
Air Quality Assessment

Vulcan South Air Quality Assessment

Prepared for:

Vitrinite Pty Ltd

September 2022

Final

Prepared by:

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Glossary

Term	Definition
µg/m^3	micrograms per cubic metre
µm	microns
°C	degrees Celsius
km	kilometre
km/h	kilometre per hour
m	metre
m/s	metres per second
m^2	square metres
m^3	cubic metres
m^3/s	cubic metres per second
Nomenclature	**Definition**
PM_{10}	particulate matter with a diameter less than 10 micrometres
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometres
TSP	total suspended particles
Abbreviations	**Definition**
Air EPP	*Environmental Protection (Air) Policy 2019*
BoM	Bureau of Meteorology
DES	Department of Environment and Science
EF	Emission Factor
EP Act	*Environmental Protection Act 1994*
ER	Emission Rate
ML	Mine Lease
NPI	National Pollutant Inventory database
OB	Overburden
ROM	Run of Mine
TAPM	The Air Pollution Model
US EPA	United States Environmental Protection Agency
VCM	Vulcan Coal Mine
VS	Vulcan South

EXECUTIVE SUMMARY

Katestone Environmental Pty Ltd (Katestone) was commissioned by Mining and Energy Technical Services Pty Limited (METServe), on behalf of Vitrinite Pty. Ltd., owner of Qld Coal Aust No.1 Pty. Ltd. and Queensland Coking Coal Pty. Ltd. (Vitrinite), to complete an air quality assessment of Vulcan South (VS), a proposed small scale open-cut coking coal mine located 30 km south of Moranbah with a mine life of 9 years.

The air quality assessment has investigated the potential for the VS to affect air quality in the region. Year 2 and Year 7 of VS operations have been assessed based on the proposed mining schedule and the proximity of sensitive receptors to critical emission generating activities. The assessment has used meteorological and dispersion models to assess the effect of particulate matter (dust) emissions on concentrations of TSP, PM_{10}, $PM_{2.5}$ and dust deposition rates in the surrounding region.

Concentrations of air pollutants due to proposed activities associated with the VS in isolation, and with the inclusion of background levels of dust, were determined at sensitive residential receptors and on a cartesian grid covering the region. Predicted ground-level concentrations of air pollutants and dust deposition rates were compared with the relevant air quality objectives and guidelines.

It is significant to note that in past years the ambient concentrations of PM_{10} and $PM_{2.5}$ exceed the Air EPP objectives for 24-hour average and annual average PM_{10}. Dry conditions likely contributed to or exacerbated conditions with 2019 showing the lowest rainfall for the Moranbah region over the period 2012 – 2020; Australia-wide 2019 had the lowest annual rainfall since 1900. The assessment has included these ambient concentrations as background and therefore represents an upper bound of ambient concentrations for Moranbah.

The air quality assessment of the VS found the following:

TSP

- Predicted ground-level concentrations of TSP ***comply*** with the relevant air quality objective at all residential receptors, in isolation and cumulatively for Year 2 and Year 7.

PM_{10}

- Predicted 24-hour average ground-level concentrations of PM_{10} for Year 2 and Year 7 comply with the relevant air quality objective at all sensitive receptors, in isolation and cumulatively, with the application of proposed proactive mitigation measures as discussed in Section 6.2.1; and
- Existing annual average concentrations of PM_{10} are higher than the relevant air quality objective. The contribution from VS to the annual average concentrations PM_{10} at a sensitive receptor is at most 2.8 µg/m³ or 11% of the Air EPP objective.

$PM_{2.5}$

- Predicted 24-hour average ground-level concentrations of $PM_{2.5}$ ***comply*** with the relevant air quality objective at all residential receptors, in isolation and cumulatively for Year 2 and Year 7;
- Predicted annual average ground-level concentrations of $PM_{2.5}$ ***comply*** with the relevant air quality objective at all residential receptors, in isolation and cumulatively for Year 2 and Year 7; and
- The background annual average concentration of $PM_{2.5}$ is 6.4 µg/m³ or 80% the Air EPP objective of 8 µg/m³. The maximum contribution of the VS to annual average $PM_{2.5}$ at the sensitive receptors is at most 0.6 µg/m³ or approximately 2.3% of the Air EPP objective.

Dust Deposition

- Predicted dust deposition rates due to the VS ***comply*** with the relevant air quality objective at all residential receptors, in isolation and cumulatively for Year 2 and Year 7.

1. INTRODUCTION

Vitrinite Pty. Ltd. (Vitrinite) is the proponent of Vulcan South (VS), a small scale open cut coal mine located 45 km south of Moranbah in Queensland's Bowen Basin (Figure 1). The VS Mining Lease (ML) is located immediately to the south of Vitrinite's initial mining project, the Vulcan Coal Mine (VCM), located on ML700060 and immediately west of several established mining operations including BMA's Peak Downs and Saraji mines. The VS mining lease application area abuts the VCM ML700060. The proposed mining activities at VS will be located approximately 7km further south than VCM and will not commence until VCM is complete. .

The VS will operate for 9 years and will extract approximately 13.5 million tonnes (Mt) of Run of Mine (ROM) hard coking coal at a rate of up to 1.95 million tonnes per annum (Mtpa). Truck and shovel mining methods will be employed to develop three open cut pits. Year 1 will involve a high wall mining trial to the immediate north of the VS in addition to the three main pits. This trial will occur across four highwall mining benches with a target of extracting approximately 750 kilotonnes (kt) of hard coking coal. The site will include development of a mine infrastructure area and a modular coal handling and preparation plant (CHPP), rail loop and train load-out facility (TLO). The CHPP will include tailings dewatering technologies to maximise water recycling and to produce a dry tailings waste product for permanent storage within active waste rock dumps. Waste rock material will be dumped in previously excavated active pit areas for progressive rehabilitation.

Katestone Environmental Pty Ltd (Katestone) was commissioned by Mining and Energy Technical Services Pty Limited (METServe), on behalf of Vitrinite, to complete an air quality assessment of the VS to support an environmental authority (EA) application.

This air quality assessment has been carried out in accordance with the Queensland Department of Environment and Science's (DES) requirements. The following scope of works has been completed:

- Describe the VS with a focus on elements pertaining to impacts to air quality;
- Describe regulatory requirements relevant to the VS, including air quality objectives and indicators in the *Environmental Protection (Air) Policy 2019*;
- Describe the environmental values in and surrounding the VS areas including sensitive receptors, site topography and built environment, ambient air quality, and an assessment of meteorology;
- Describe onsite sources of air pollutants and develop an air pollutant emission inventory for two operational years of the mine;
- Conduct dispersion modelling to predict ground-level concentrations of dust associated with the mine, providing all model input data/parameters and assumptions;
- Analyse the incremental and cumulative concentrations of dust against the relevant air quality criteria and objectives for dust deposition and particulates;
- Discuss any requirements for proactive mitigation measures, including the need to cease specific operations, and details of dates, durations, and meteorological conditions relevant to these occasions; and
- Prepare an air quality assessment report for inclusion in the EA application.

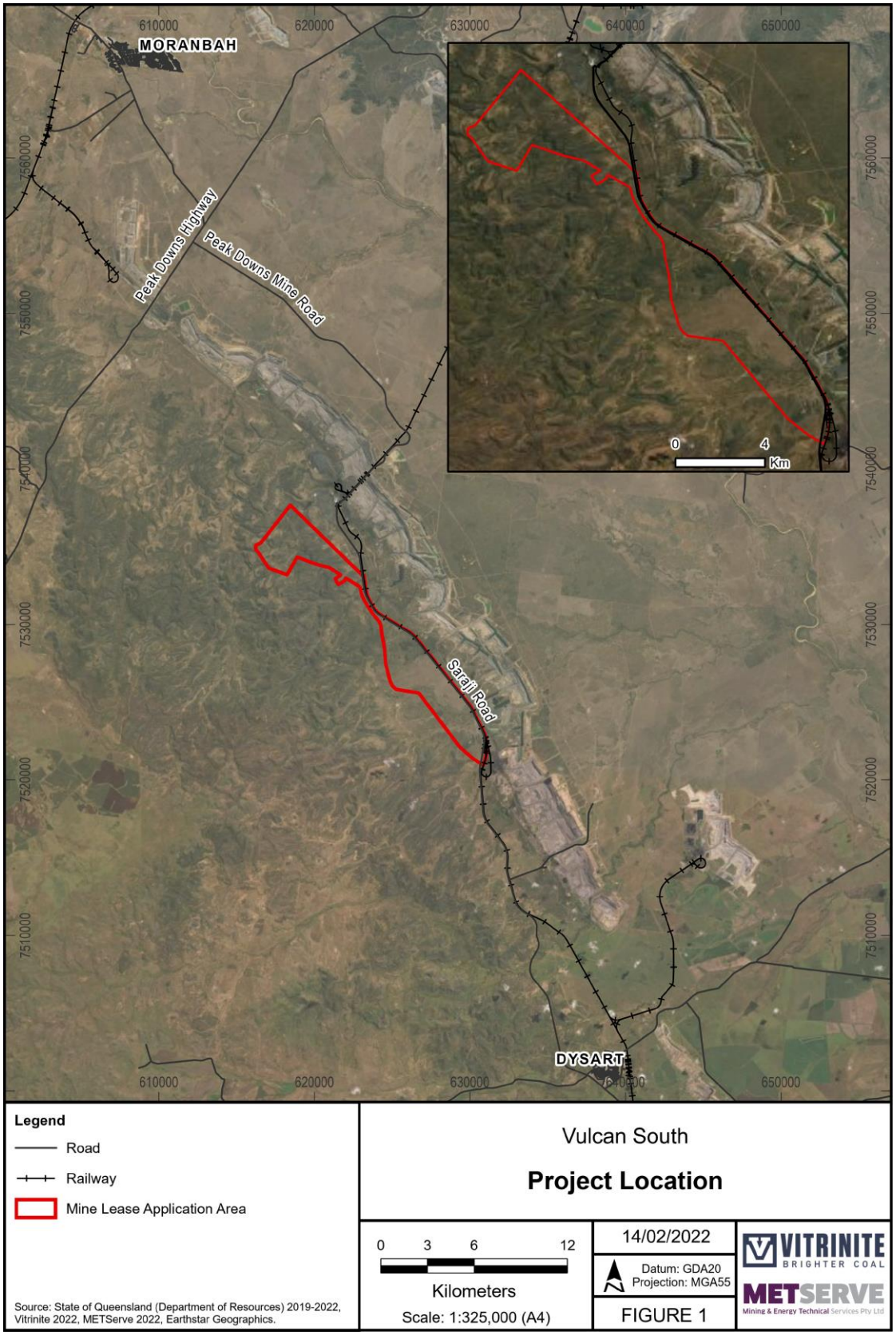

Figure 1 **Vulcan South – Location Plan**

2. OVERVIEW OF THE ASSESSMENT METHODOLOGY

The purpose of this air quality assessment is to address the potential impact to the air environment through consideration of the requirements in the DES's *Application requirements for activities with impacts to air* (DES, 2021). The following sections outline the methodologies adopted in this assessment.

2.1 Assessment scenarios

The VS is a small-scale mining operation, with coal extraction planned for approximately 8 years, followed by completion of rehabilitation activities in Year 9. This air quality assessment has considered two scenarios selected to represent worst-case years based upon volumes of total material extracted, location of activities and location of sensitive receptors. Mine years 2 and 7 have been selected.

Mining information is provided in Table 1 for the eight extraction years. The Year 2 and Year 7 general arrangements are provided in Figure 2 and Figure 3.

Table 1 Project schedule for assessment year

Project Year	Topsoil (t)	Waste Rock (t)	ROM Coal (t)
Year 1	716,977	11,509,214	776,137
Year 2	611,505	41,185,398	1,890,350
Year 3	338,083	40,546,244	1,809,366
Year 4	305,290	40,431,863	1,841,120
Year 5	389,958	40,855,127	1,728,933
Year 6	325,525	41,206,793	1,810,451
Year 7	456,390	40,977,582	1,949,667
Year 8	273,137	25,536,073	1,488,437

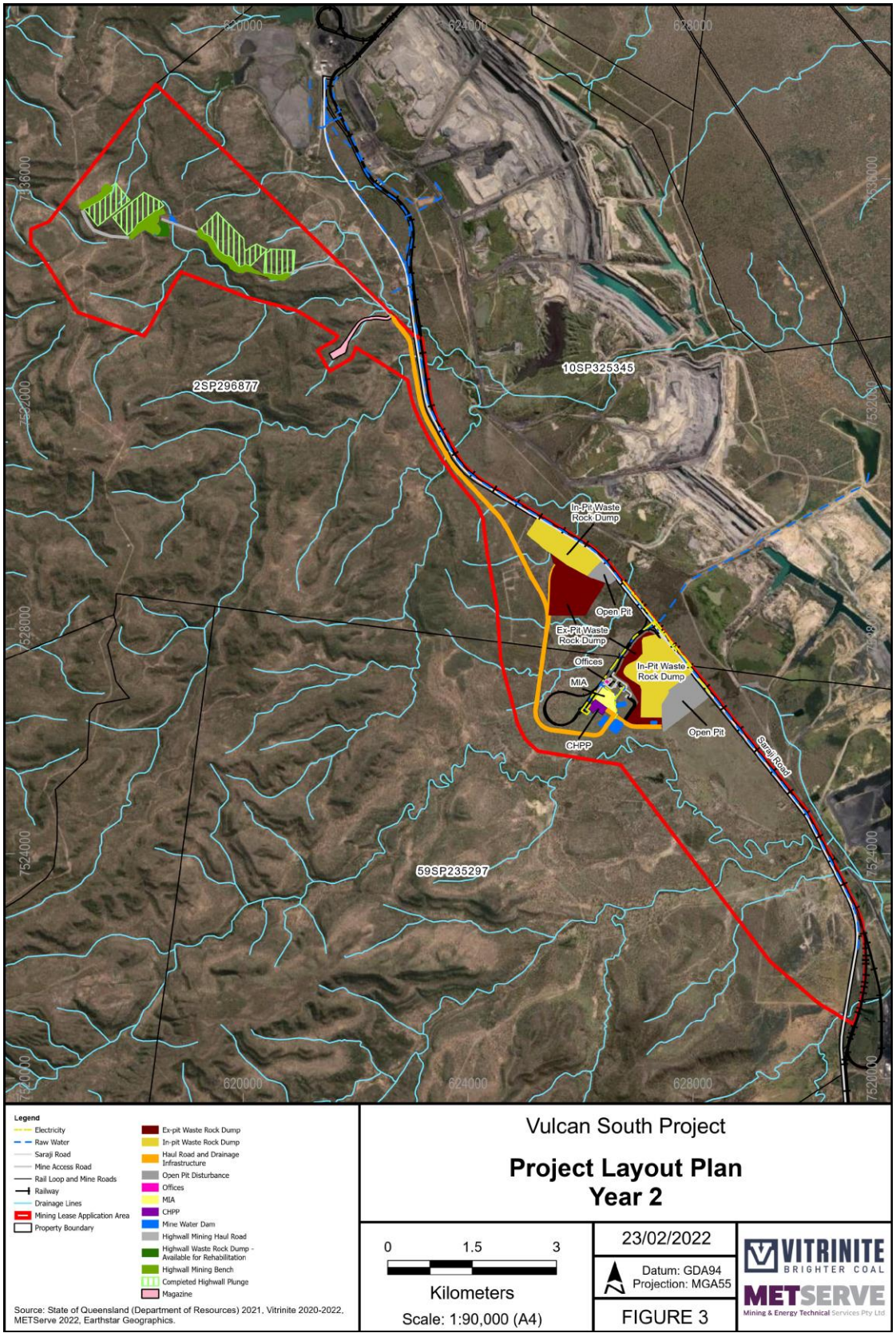

Figure 2 VS Year 2 - Project General Arrangement

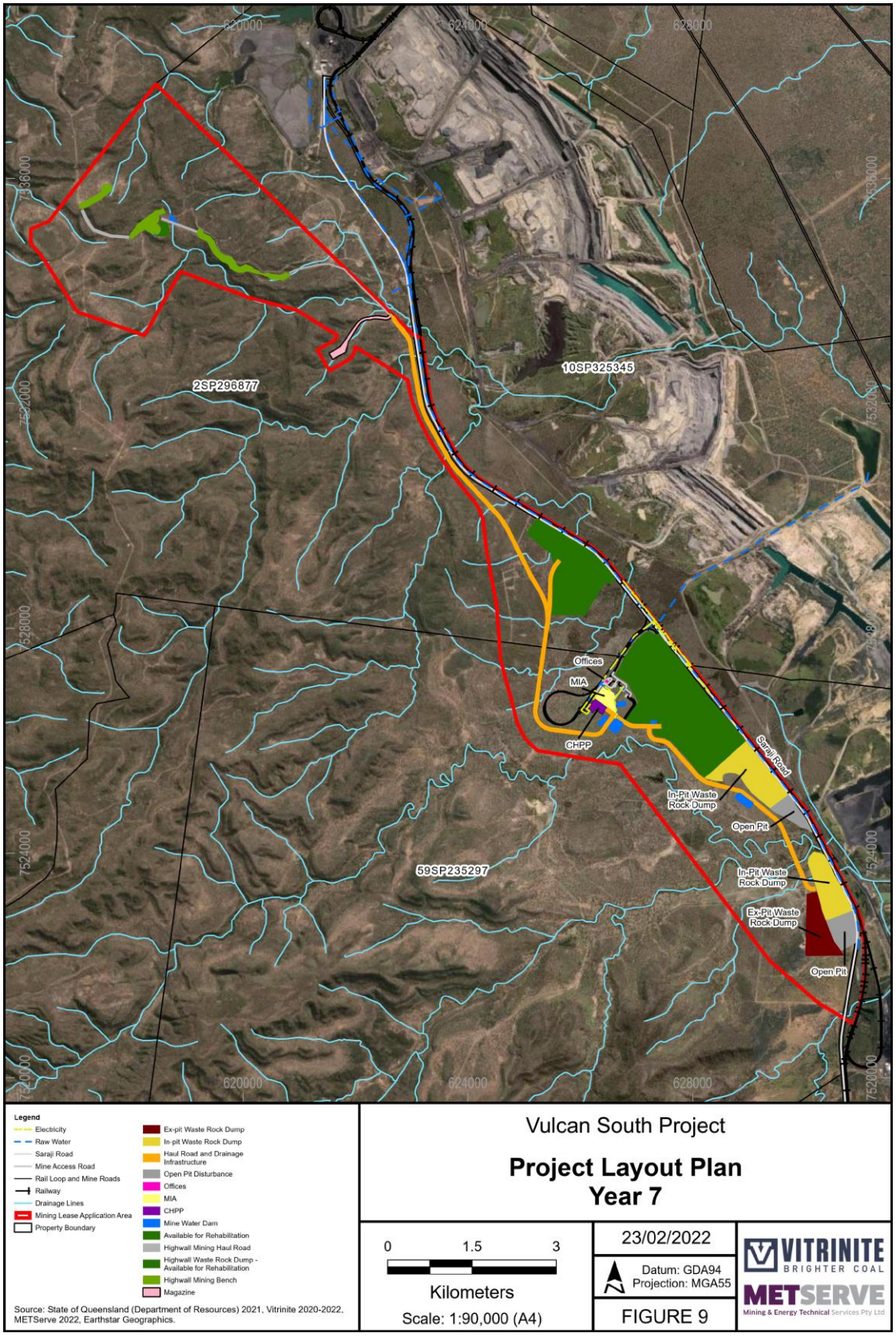

Figure 3 **VS Year 7 - Project General Arrangement**

2.2 Considerations for assessing air quality

Air pollutants likely to be emitted from the VS have been identified and the current Queensland regulatory requirements pertaining to these air pollutants have been reviewed and relevant objectives presented. Results of the dispersion modelling of air emissions from the VS have been assessed against the applicable air quality objectives.

2.3 Existing environment

The assessment includes an analysis of the existing environment characteristics in the project area that are important for the dispersion of air pollutants from the site, and that may influence the level of air pollutants in the surrounding area. Characteristics include the climate and local meteorology (temperature, wind, humidity and rainfall), any terrain features, the neighbouring land uses and the location of sensitive receptors. The existing air quality in the project area has been quantified through analysis of available ambient air quality monitoring data. Existing sources of similar air pollutants to the air pollutants released by the VS have been identified.

2.4 Emissions

Emissions to the atmosphere associated with the proposed Year 2 and Year 7 VS mining activities have been estimated. The primary air pollutant emitted from mining activities is particulate matter (PM) made up of various sized particles, including: TSP (total suspended particulates), PM_{10} (particulate matter with an aerodynamic diameter less than 10 microns) and $PM_{2.5}$ (particulate matter with an aerodynamic diameter less than 2.5 microns). Other air pollutants anticipated to be generated by the VS, such as combustion emissions related to haul trucks, will be emitted in relatively small quantities and, have therefore, been addressed qualitatively.

2.5 Impact assessment

The potential of the VS to impact air quality has been assessed through a dispersion modelling study and comparison with the air quality assessment criteria.

Source characteristics and dust emission rates from VS activities were incorporated into the CALPUFF dispersion model. CALPUFF is an advanced non-steady-state air quality modelling system. The meteorological data for 2018 generated by the TAPM/CALMET model was used as input for the dispersion model in order to include all weather conditions likely to be experienced in the region during a typical year.

Dust emissions for each scenario have been modelled over a full year assuming 24 hours/day mining activities, except for blasting, which has been modelled between 6 am and 6 pm.

To determine the impact of the VS upon the surrounding environment in a cumulative way, a representative background concentration for relevant air pollutants is required. Background levels of TSP, PM_{10}, $PM_{2.5}$ and dust deposition have been added to the dispersion modelling results of each scenario to provide a cumulative impact.

Where necessary, proactive mitigation measures will be discussed, identifying sources with emissions that require additional control and the duration that the controls are required. Meteorological conditions occurring during these periods of mitigation will also be discussed to aid in identifying conditions which may facilitate increased impacts at sensitive receptors.

The modelling has been used to predict maximum ground-level concentrations and deposition rates of dust across a Cartesian grid of the VS region and at the locations of the identified sensitive receptors.

Technical details of the configuration of the CALPUFF model are discussed in Appendix B.

2.6 Limitations of dispersion modelling

This study relies on the accuracy of several datasets including, but not limited to:

- Third party meteorological information;
- Mine plans and mining activity information; and
- DES ambient air quality monitoring data.

It is important to note that numerical models are based on an approximation of governing equations that represent complex natural processes. These will inherently incorporate some degree of uncertainty. The more complex the physical model, the greater the number of physical processes that must be included. Where uncertainty exists in characterising important properties of the environment or activities associated with the VS, this study has erred on the side of caution and selected conservative inputs. The model outputs are therefore considered to be conservative.

3. CONSIDERATIONS FOR ASSESSING AIR QUALITY

3.1 Pollutants

Particulate matter (i.e. dust) is the key air pollutant anticipated to be generated by activities on the VS site.

3.1.1 Particulate matter

Mining activities can give rise to dust that, in elevated concentrations, has the potential to cause adverse impacts on the amenity and health of people living in the vicinity.

Dust can affect communities in various ways, depending upon the source and size of particles present. Dust typically emitted as a result of mining activities is assessed using the following metrics: TSP (total suspended particulates), dust deposition rate, PM_{10} and $PM_{2.5}$.

Dust from mining activities consists primarily of larger particles generated through the handling of rock and soil, as well as through wind erosion of stockpiles and exposed ground. Larger particles (measured as dust deposition and TSP) are mostly associated with dust nuisance or amenity impacts in residential areas, through settling or deposition of the particles. Elevated dust deposition rates can reduce public amenity, through soiling of clothes, buildings and other surfaces in the area.

Smaller particles such as PM_{10} and $PM_{2.5}$ can also be generated through mining activities. Elevated levels of PM_{10} and $PM_{2.5}$ have the potential to affect human health as these particles can be trapped in the nose, mouth or throat, or be drawn into the lungs. Fine particles (i.e. $PM_{2.5}$) are typically generated through combustion processes.

3.1.2 Other pollutants

Quantities of other air pollutants, such as oxides of nitrogen (NO_x), carbon monoxide (CO) and sulfur dioxide (SO_2), may also be emitted from vehicle traffic and blasting within the VS site. The emission rates of these air pollutants are very low compared to the emission rates of particulate matter from mining activities. Further, the emissions are transient in nature, and therefore, are unlikely to have any negligible effect on air quality outside of the pit and haul road corridor. Hence, particulate matter is considered the critical air pollutant for this assessment.

Odour is unlikely to be emitted from typical mining activities. Spontaneous combustion is a potential source of odour from mining activities but the potential for this is low and, therefore, odour has not been assessed further.

3.2 Legislative framework for air quality

The *Environmental Protection Act 1994* (EP Act) provides for the management of the air environment in Queensland. The EP Act gives DES the power to create Environmental Protection Policies that identify, and aim to protect, environmental values of the atmosphere that are conducive to the health and well-being of humans and biological integrity. *The Environmental Protection (Air) Policy* (Air EPP) was made under the EP Act and gazetted in 1997; the Air EPP was revised and reissued in 2019.

The purpose of the Air EPP is to identify the environmental values of the air environment to be enhanced or protected and to achieve the object of the Act, that is, ecologically sustainable development.

The environmental values to be enhanced or protected under the Air EPP are the qualities of the environment that are conducive to:

- protecting health and biodiversity of ecosystems;
- human health and wellbeing;
- protecting the aesthetics of the environment, including the appearance of building structures and other property; and
- protecting agricultural use of the environment.

The administering authority (DES) must consider the requirements of the Air EPP when it decides an application for an environmental authority, amendment of a licence or approval of a draft environmental management plan. Schedule 1 of the Air EPP specifies air quality indicators and objectives for pollutants that may be present in the air environment.

The air quality objectives that are relevant to the key air pollutants that may be generated from the VS are presented in Table 2.

Also relevant is DES's *Application requirements for activities with impacts to air*, which outlines the information required to be provided to DES as part of the EA application process for environmentally relevant activities and how the information is used. It also outlines how the proposed activity will be assessed in the context of the requirements stipulated in the EP Act. In particular this requires an application to include, if applicable:

- Description of the site and surrounding areas, including topography, prevailing winds and ambient air quality (Section 4);
- Identification and appropriate assessment of any nearby sensitive places (Section 4.2);
- Proposed management and mitigation measures (Section 5 and Section 7); and
- Identification and evaluation of possible impacts on air quality (Section 6).

Table 2 Air quality objectives (Air EPP)

Pollutant	Environmental value	Averaging period	Air quality objective/ guideline
TSP	Health and wellbeing	1-year	90 µg/m³
PM_{10}	Health and wellbeing	24-hour	50 µg/m³
		1-year	25 µg/m³
$PM_{2.5}$	Health and wellbeing	24-hour	25 µg/m³
		1-year	8 µg/m³
Dust deposition	Amenity	1-month	120 mg/m²/day[1]

Note:

[1] The dust deposition guideline is not defined in the Air EPP. DES's Model Mining Conditions (DEHP, 2017a) contains this guideline for dust deposition, which applies to total insoluble solids.

4. EXISTING ENVIRONMENT

4.1 Local terrain and land-use

The VS is located approximately 35 km north of Dysart and 30 km south of Moranbah in central Queensland's Bowen Basin. The VS is located on the lower eastern slopes of the Peak Downs Range.

The terrain rises steeply to the west of the VS, due to the Peak Downs Range, with a maximum elevation of approximately 500 m above sea level. To the east the land is relatively flat and comprised of the plains adjacent to the Isaac River.

The land use within the region is predominantly rural, with the townships of Dysart and Moranbah located to the south and north. State forest, low intensity cattle grazing, and coal mining are the dominant land uses in the VS area.

4.2 Sensitive receptors

Sensitive receptors in proximity to the VS have been identified by METServe, as shown in Table 3 and Figure 4. It is noted that two of the receptors are located within the VS ML (property manager and workers accommodation) and are likely to be removed once VS is approved or when mining occurs in the southern half of the ML (Year 3 onwards). Notwithstanding this, they have been considered as receptors in this assessment (Year 2 only).

There are a number of industrial commercial receptors that are located at nearby operating coal mines to the VS that have not been classed as sensitive receptors. These receptors (Processing plant, rail loadouts and remote crib room areas) are located within nearby operational coal mines and are likely to be exposed to dust from their own onsite operations at levels greater than that produced by VS, and therefore, any potential exposure should be attributable to onsite conditions. As such, only receptors designated as residential have been considered for impacts as part of the assessment.

Table 3 Nearest receptors to the VS

Receptor ID	Type	Description	Easting (km)	Northing (km)	Distance and direction from the VS ML
1	Residential	Property Manager	630.434	7523.439	Within VS ML
2		Workers Accommodation	630.689	7522.987	Within VS ML
3		O'Sullivan Residence	629.573	7519.127	2.3 km S
4	Industrial/Commercial	BMA Peak Downs	621.289	7536.144	0.8 km NE
5		BMA Peak Downs	622.256	7536.261	1.6 km NE
6		BMA Peak Downs	622.156	7536.420	1.6 km NE
7		BMA Peak Downs	621.439	7537.872	2.2 km NE
8		BMA Saraji	631.500	7520.239	1 km S
9	Residential	Luxor Residence	615.449	7508.336	19.5 km SW
10		Cheeseboro Residence	605.305	7519.510	18.4 km W

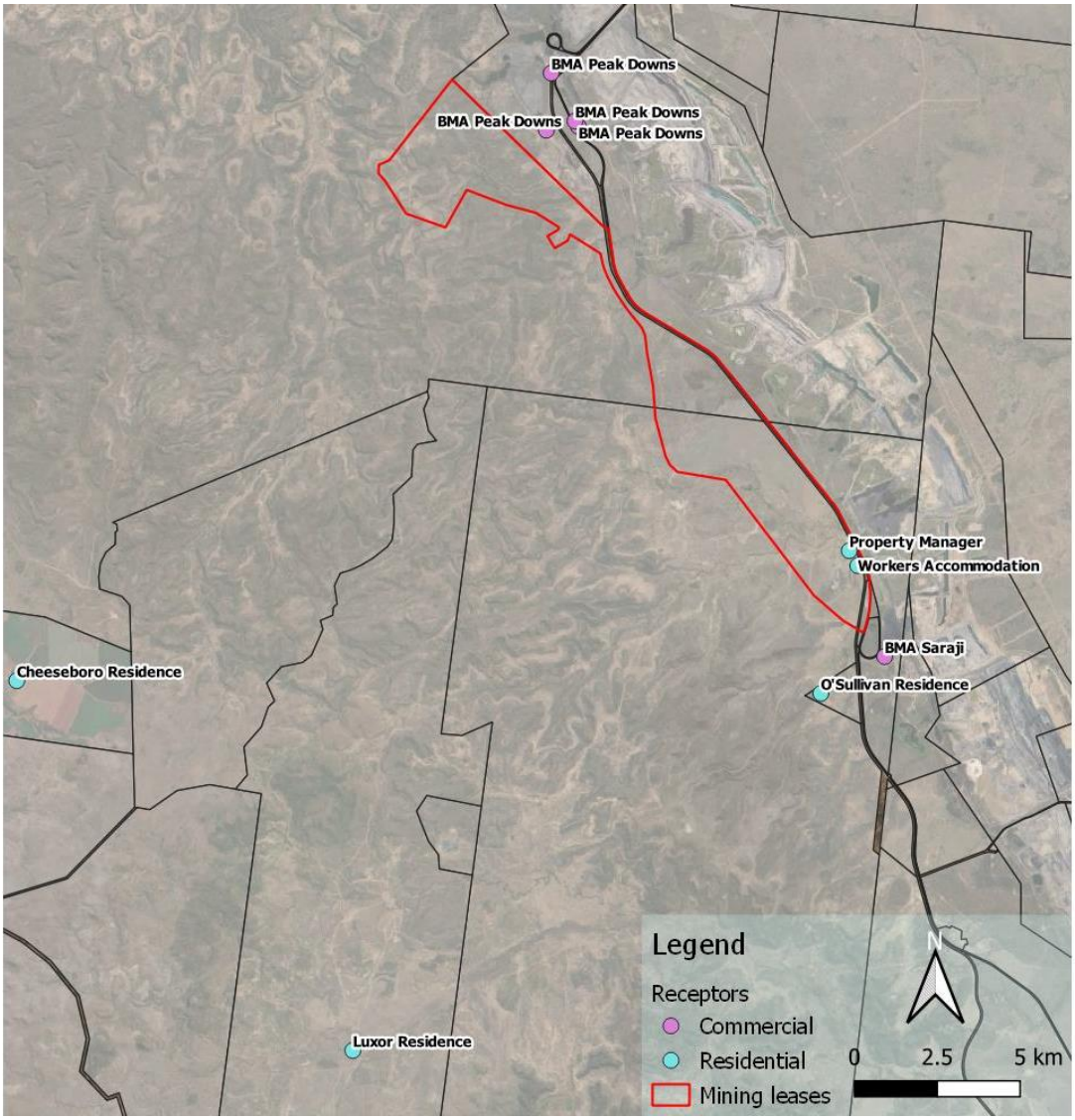

Figure 4 Location of sensitive receptors

4.3 Climate

Central Queensland has a sub-tropical continental climate characterised by high variability in rainfall, temperature and evaporation. The region can experience droughts, floods, heatwaves and frosts. In general, winter days are warm and nights are cool, while summer days are hot and nights are warm. Rainfall is summer dominant with almost half of the average annual rainfall occurring from December to February due to storms and tropical low-pressure systems associated with cyclones.

The Bureau of Meteorology (BoM) weather monitoring station nearest to the VS is located at Moranbah Airport, approximately 35 km northwest. However, this weather station has only been in operation since 2012. Long-term climate data in the VS region, from 1972 to 2012, has been collected from the (now decommissioned) BoM weather monitoring station located at Moranbah Water Treatment Plant. The data is described in the sections below.

4.3.1 Temperature and solar exposure

The mean daily maximum and minimum temperatures by month are presented in Figure 5. The analysis identifies a seasonal temperature profile typical of the sub-tropical Queensland climate, with cooler winter months of June to August and warmer summer months of December to February. The highest mean maximum daily temperature at the Moranbah monitoring station was 33.8 degrees Celsius (°C), recorded during the summer. The lowest mean minimum daily temperature at the monitoring station was 9.9°C, recorded during July.

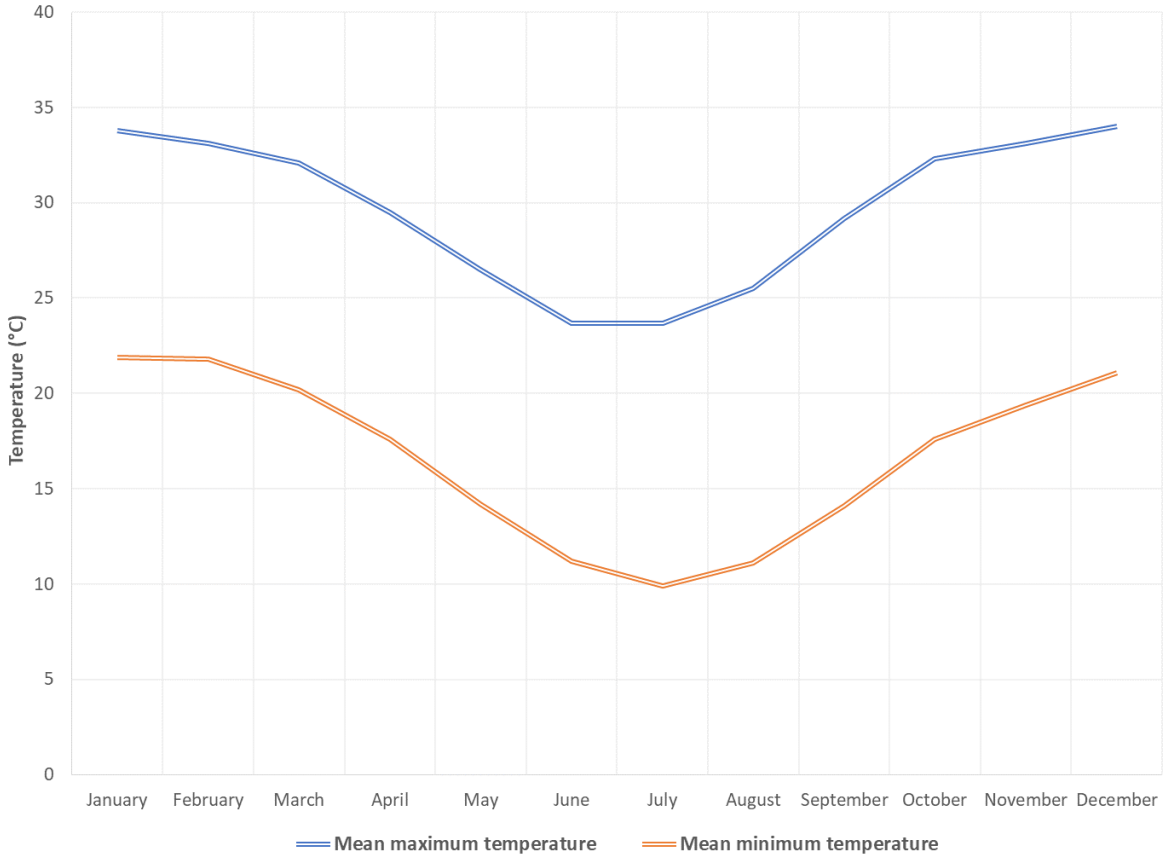

Figure 5 **Monthly mean temperature (°C) measured at Moranbah Water Treatment Plant (1986-2012)**

The amount of solar radiation received at ground-level is a primary driver for the weather patterns and climatic cycles that influence the Central Queensland region. The average daily solar radiation in megajoules per square metre (MJ/m²) by month is presented in Figure 6. This figure illustrates a clear seasonal pattern whereby summer solar radiation is much greater than during the winter months.

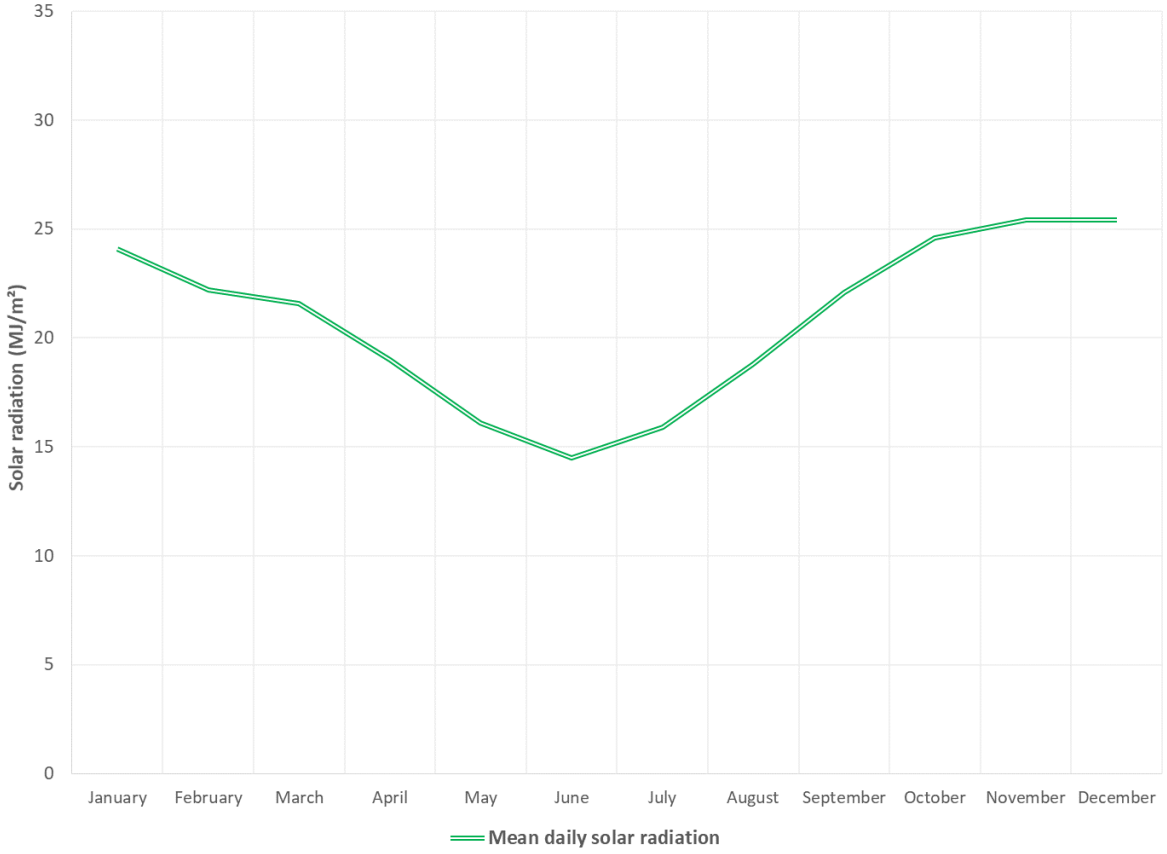

Figure 6 **Mean daily solar radiation (MJ/m²) by month at Moranbah Water Treatment Plant (1986-2012)**

4.3.2 Rainfall

The range of total monthly rainfall (mean and highest) at the Moranbah Water Treatment Plant for 1986-2012 is illustrated in Figure 7. The annual average rainfall is 614 millimetres (mm), with the wettest period occurring during the warmer months from December to February when, on average, 50% of the annual rainfall occurs.

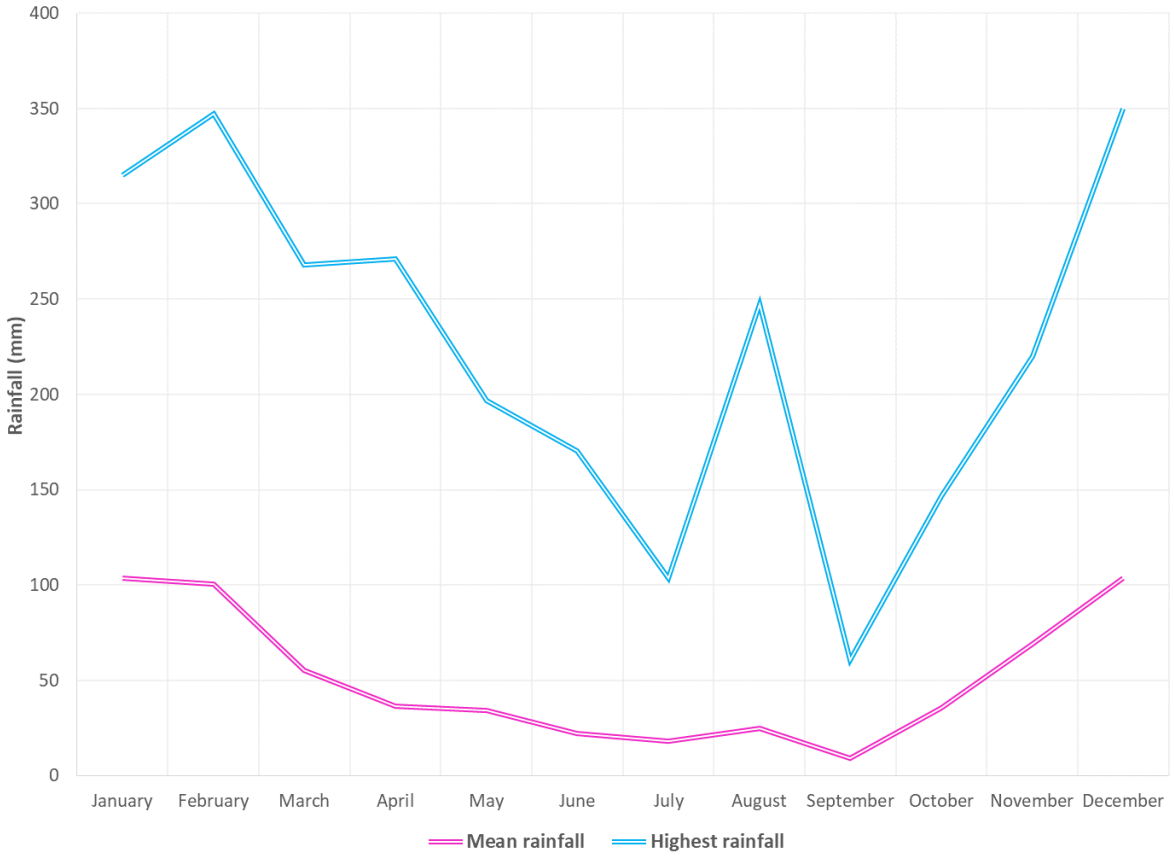

Figure 7 **Range of total monthly rainfall measured at Moranbah Water Treatment Plant (1986-2012)**

4.4 Local Meteorology

The prognostic model TAPM (2008) (developed by the Commonwealth Scientific and Industrial Research Organisation [CSIRO]) and the diagnostic meteorological model CALMET (developed by Earth Tech, Inc.) were used to generate the three-dimensional meteorological dataset at the location of the VS for use in the dispersion model assessment.

The year 2018 was selected as a representative year for meteorological modelling based on analysis of the last five complete years (2014 to 2018) of observations at the BoM Moranbah Airport monitoring station. The year 2018 was selected as representative, as observations of wind speed, wind direction and temperature in 2018 were closest to the average of the 2014 to 2018 period. The three-dimensional wind field for 2018 produced by TAPM/CALMET was then used to create a meteorological file suitable for use with the CALPUFF dispersion model.

The following sections describe the local meteorology of the VS area, focusing on parameters that are important for dispersion of air pollutants, namely wind speed, wind direction, atmospheric stability and boundary layer mixing height.

Details of the TAPM/CALMET model configuration and evaluation are discussed in Appendix B.

4.4.1 Wind speed and wind direction

Wind speed and wind direction influence the rate of dispersion of dust emissions from sources such as wheel generated dust, material transfers, material processing and wind erosion. Wind speed also determines the amount of dust lifted into the air by wind erosion. The 2018 annual, seasonal and diurnal frequencies of winds at the VS site are shown as wind roses in Figure 8, Figure 9 and Figure 10, respectively.

The majority of winds at the site are from the north and south, with the remainder coming primarily from the east to southeast. Seasonally, autumn and winter see winds predominantly from the south, with some south-easterly winds. Wind direction shifts to come predominantly from the north during Spring and Summer, with Summer also observing some winds from the east. Annual average wind speed for the site is 2.53 m/s.

There is a diurnal variation in the wind distribution, with a higher frequency of light winds occurring overnight (6 pm to 6 am) compared to the day. Strong winds from the east and southeast occur during the afternoon (midday to 6 pm). Morning winds (6 am to midday) are mostly from the south and southeast.

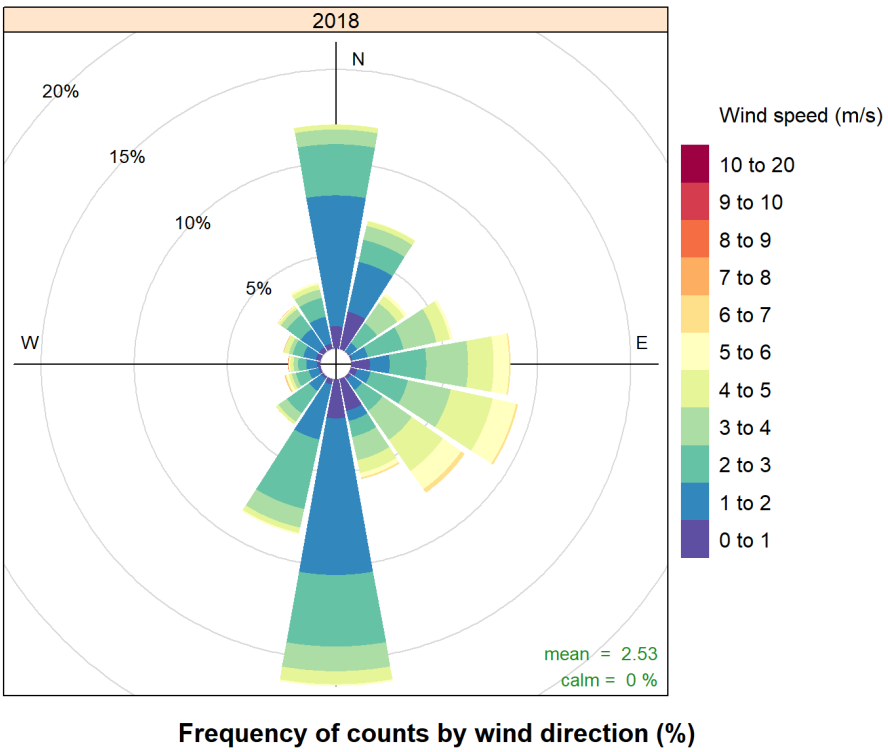

Figure 8 **Annual wind rose for the VS site (extracted from CALMET) - 2018**

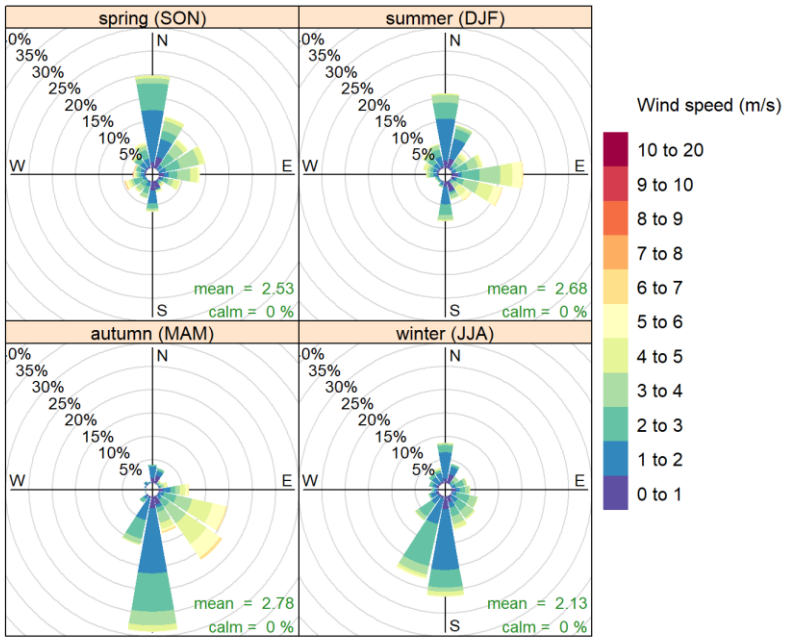

Figure 9 **Seasonal wind roses for the VS site (extracted from CALMET) – 2018**

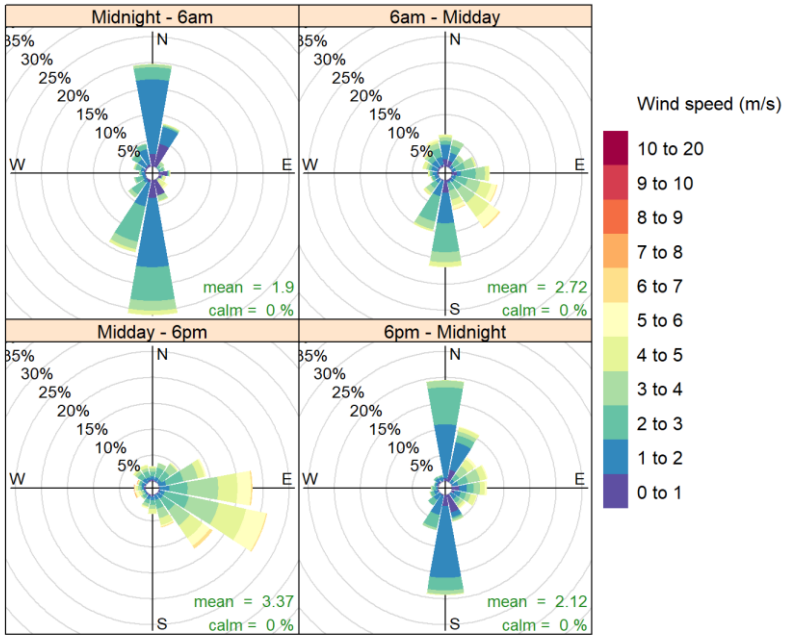

Figure 10 **Diurnal wind roses for the VS site (extracted from CALMET) - 2018**

4.4.2 Atmospheric stability and mixing height

Atmospheric stability class is a measure of the stability of the atmosphere. Stability classes range from A class to F class. Figure 11 shows the predicted annual frequency of stability classes in the VS area (taken from the meteorological dataset generated by the TAPM/CALMET models).

Class A represents the most unstable conditions and Class F the most stable conditions. Unstable conditions (Classes A to C) are characterised by strong to moderate solar heating of the ground. This induces turbulent mixing in the atmosphere close to the ground. This turbulent mixing is the main driver of dispersion during unstable conditions. Dispersion processes for the most frequently occurring Class D conditions are dominated by mechanical turbulence, generated as the wind passes over irregularities in the local surface. During light wind and clear sky conditions at night, the atmosphere is generally stable (classes E and F). Strong winds and/or overcast conditions at night lead to Class D conditions.

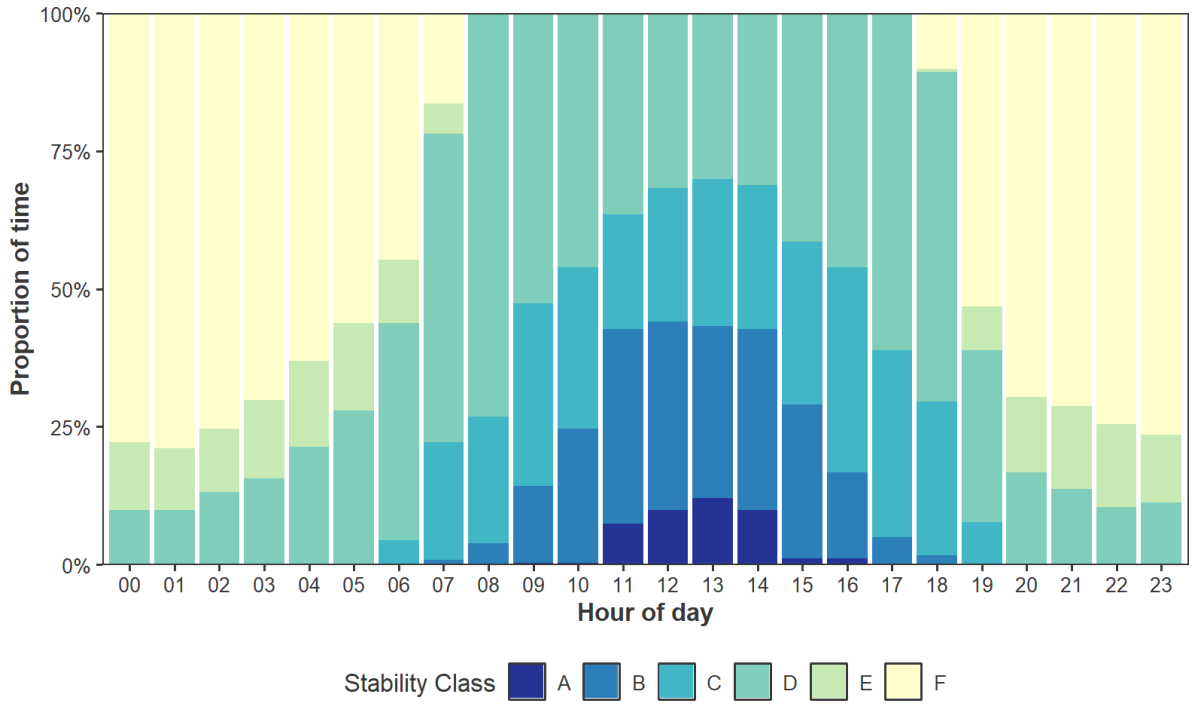

Figure 11 Stability class frequency for the VS site (extracted from CALMET) - 2018

The mixing height defines the height of the mixed atmosphere above the ground (mixed layer), which varies diurnally. Particulate matter, or other pollutants released at or near the ground, will become dispersed within the mixed layer. During stable atmospheric conditions, the mixing height is often quite low and particulate dispersion is limited to within this layer. During the day, solar radiation heats the ground and causes the air above it to warm, resulting in convection and an increase to the mixing height. The growth of the mixing height is dependent on how well the warmer air from the ground can mix with the cooler upper level air and, therefore, depends on meteorological factors such as the intensity of solar radiation and wind speed. During strong wind speeds, the air will be well mixed, resulting in a high mixing height.

Hourly mixing height information in 2018 has been extracted from the CALMET simulation over the VS area and is presented in Figure 12 as a diurnal frequency plot. The data shows that, on average (blue dots), the mixing height develops at approximately 7 am, increases to a peak between 3 pm and 4 pm before descending rapidly until 6 pm.

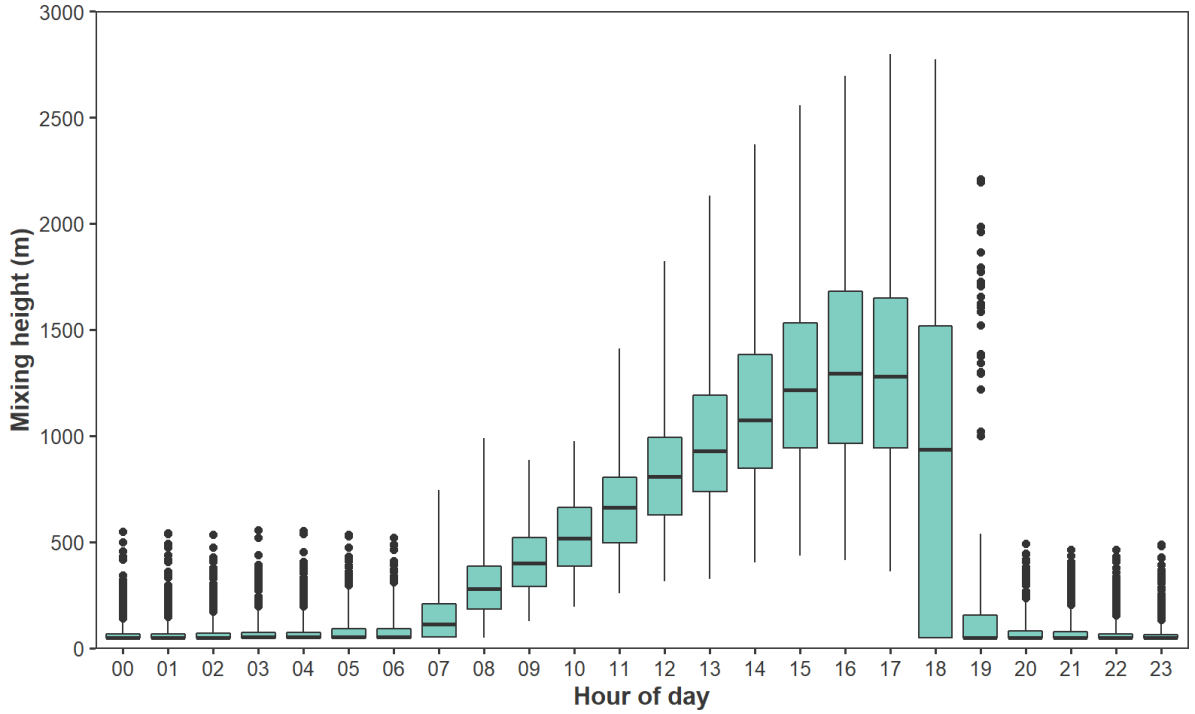

Figure 12 Diurnal variation in mixing height at the VS site (extracted from CALMET) - 2018

4.5 Ambient air quality

There are several existing sources in the vicinity of the VS that may generate dust, including a number of existing coal mines (BMA's Caval Ridge, Peak Downs and Saraji mines). Naturally generated dust in the environment may also be generated in the VS region, sources include pollen and grass seeds; dust from the use of dirt roads; agricultural activities and wind erosion of non-vegetated areas.

Existing air quality has been determined from a review of available information on dust emissions and representative ambient air quality monitoring data in the region.

4.5.1 Existing sources of air pollutants

Industries within 35 km of the VS that produce noteworthy dust emissions (PM_{10} and $PM_{2.5}$) have been identified through a review of the National Pollutant Inventory (NPI) database. The dominant contributing industry in the region is coal mining.

Table 4 details the dust emissions (PM_{10} and $PM_{2.5}$) reported to the NPI for 2018/19 (the most recent publicly available dataset) from identified industries in the VS region.

Table 4 Dust emissions reported to NPI for 2019/2020

Facility Name	Main Activities	Distance and Direction from VS CPP	PM_{10} (tonnes/year)	$PM_{2.5}$ (tonnes/year)
Caval Ridge Mine	Coal Mining	18.4 km Northwest	7,588	109
Daunia Mine	Coal Mining	27.5 km Northeast	1,934	69
Lake Vermont	Open cut coal mining	34.9 km Southeast	9,921	663
Peak Downs Mine	Coal Mining	1.6 km North	14,600	191
Poitrel Coal Mine	Coal Mining	26 km Northeast	2,340	76
Saraji Mine	Coal Mining	17.3 km South	8,218	167
South Walker Creek Mine Operations	Coal Mining	4.8 km East	3,458	57

4.5.2 Existing ambient air quality

4.5.2.1 PM_{10} and $PM_{2.5}$

Long-term continuous monitoring data for PM_{10} and $PM_{2.5}$ in the Project area is available from two DES monitoring stations located in the township of Moranbah (approximately 28 km north-northwest). A summary of the two stations is provided below in Table 5.

Table 5 Summary of DES Monitoring locations

Monitoring Station	Monitoring Period	Parameters Monitored
Moranbah East (Utah Drive)	March 2011 - Current	PM_{10}, $PM_{2.5}$[1]
Moranbah West (Cunningham Way)	June 2020 – Current	PM_{10}, $PM_{2.5}$
Table notes: [1] $PM_{2.5}$ monitoring at Moranbah East started in October 2019		

As monitoring at Moranbah West (Cunningham Way) only commenced in June 2020, it has not been considered further. Relevant PM_{10} statistics from data measured from 2011 to 2021 at DES's Moranbah East (Utah Drive) site are presented in Table 6, while $PM_{2.5}$ statistics from data measured from 2019 to 2021 are presented in Table 7. (Queensland Data, 2019).

The Moranbah East PM_{10} data shows the following:

- The Moranbah monitoring station has recorded 109 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³ (Air EPP objective) over the 11 years of monitoring. In particular, 2012, 2018 and 2019 show a large number of PM_{10} concentrations greater than 50 µg/m³;
    - In 2012, there were 36 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that, for a period of 4 months, housing construction work was occurring within 100 meters of the monitoring station and was the likely cause of the elevated concentrations;

- In 2017, there were 7 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that bushfires contributed to these elevated concentrations;
- In 2018, there were 19 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that dust storms and bushfires contributed to these elevated concentrations;
- In 2019, there were 32 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that a combination of emission sources including dust storms, bushfires, and hazard-reduction burning contributed to these elevated concentrations;
- In 2020, there were 5 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that a combination of emissions sources including dust storms, smoke from bushfires and local dust sources contributed to these elevated concentrations; and
- Annual average concentrations of PM_{10} at the Moranbah monitoring station were greater than the Air EPP objective of 25 µg/m³ for four of the nine years, 2012, 2017, 2018 and 2019.

The Moranbah East $PM_{2.5}$ data shows the following:

- The Moranbah monitoring station has recorded 5 days when the 24-hour average concentration of $PM_{2.5}$ was greater than 25 µg/m³ (Air EPP objective) over the last 2 years of monitoring.
  - From October onwards in 2019, there was 1 day when the 24-hour average concentration of $PM_{2.5}$ was greater than 25 µg/m³. DES's monthly monitoring reports indicate that a combination of smoke haze from bushfires and local dust sources contributed to this elevated concentration;
  - In 2020, there were 4 days when the 24-hour average concentration of $PM_{2.5}$ was greater than 25 µg/m³. DES's monthly monitoring reports indicate that it is most likely that smoke and dust generated by vehicles on unsealed roads contributed to elevated concentrations on days in May and July. DES has not yet released the monthly bulletins for September, when the other two exceedance days occurred; and
  - Annual average concentrations of $PM_{2.5}$ at the Moranbah East monitoring station were greater than the Air EPP objective of 8 µg/m³ for the three-months of monitoring in 2019.

Of the available monitored concentrations of $PM_{2.5}$ at the Moranbah East monitoring station, only 2020 data is validated and complete. Hence, the 2020 dataset provides the most representative ambient $PM_{2.5}$ concentrations in the vicinity of the Project, and thus were used in the cumulative assessment.

Table 6 Summary of 24-hour average PM_{10} concentrations measured at Moranbah East (Utah Drive)

Year	PM_{10} (µg/m³)			
	24-hour average (Maximum)	No. days above 50 µg/m³	24-hour average (70th percentile)	Annual average
2011	67.6	5	23.4	20.3
2012	492.8	36	29.5	27.9
2013	99.9	1	26.5	22.4
2014	49.9	0	24.0	20.4
2015	91.9	4	25.3	21.3
2016	49.5	0	27.2	22.1
2017	68.8	7	29.6	26.1
2018	113.6	19	34.6	30.3
2019	217.8	32	35.5	31.2
2020	89.8	5	23.4	21.1
2021[1,2]	47.3	0	23.6	20.8
Objective	**50**	**-**	**-**	**25**

Table note:

[1] Eleven months of data in 2021 for Utah Drive

[2] Data downloaded from DES portal. Data was unvalidated at time of assessment.

Table 7 Concentrations of $PM_{2.5}$ at Moranbah East (Utah Drive) monitoring station from 2019 to 2021 inclusive

Year	$PM_{2.5}$ (µg/m³)			
	24-hour average (Maximum)	No. days above 25 µg/m³	24-hour average (70th percentile)	Annual average
2019[1]	26.1	1	13.6	11.7
2020	53.9	4	6.6	6.4
2021[2,3]	11.3	0	6.3	5.6
Objective	**25**	**-**	**-**	**8**

Table note:

[1] 2019 does not represents a full year of monitoring, it represents a period from October 2019

[2] Eleven months of data in 2021 for Utah Drive

[3] Data downloaded from DES portal. Data was unvalidated at time of assessment.

Analysis of rainfall at the BoM Moranbah Airport meteorological monitoring station for the period 2012 to 2020 indicates that the last three years were driest. Total days of rainfall per annum were close to the 2012 to 2020 average (Figure 13); however, total annual rainfall was well below average for 2018, 2019, and 2020, with 2019 being the lowest compared to other years, reaching 35% below average (Figure 14). Annual total rainfall for all Australia shows 2019 was the driest overall year for the last 120 years (Table 8) with 275.71 mm of rain compared

to the 120-year annual average rainfall of 457.21 mm, approximately 40% below average (BoM, 2020). These dry conditions are likely to exacerbate the potential for air-borne dust.

Therefore, the use of monitoring data from any of the last three years is likely to provide a conservative assessment of cumulative impacts.

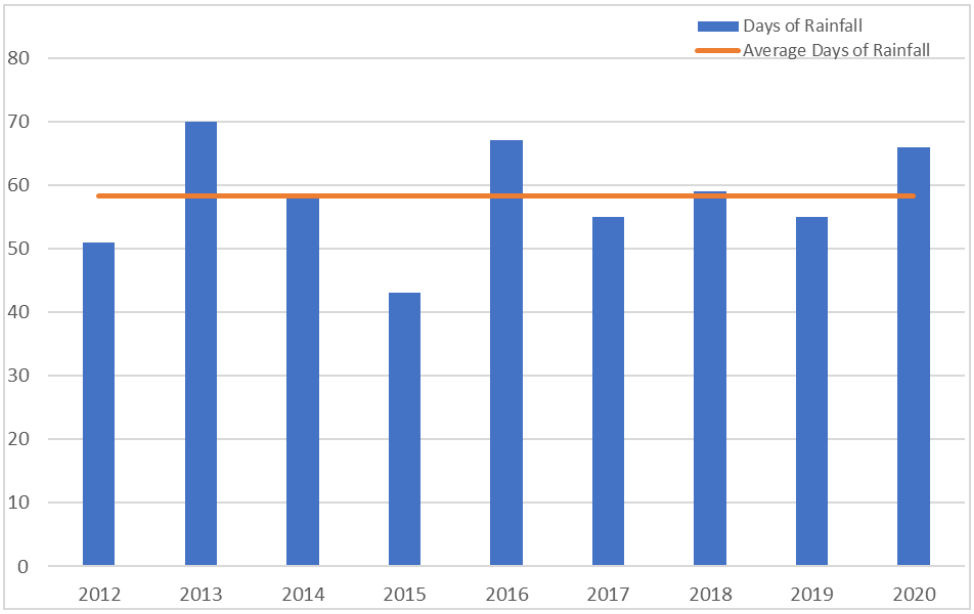

Figure 13 **Total rain days recorded at the Moranbah Airport BoM meteorological station 2012-2020**

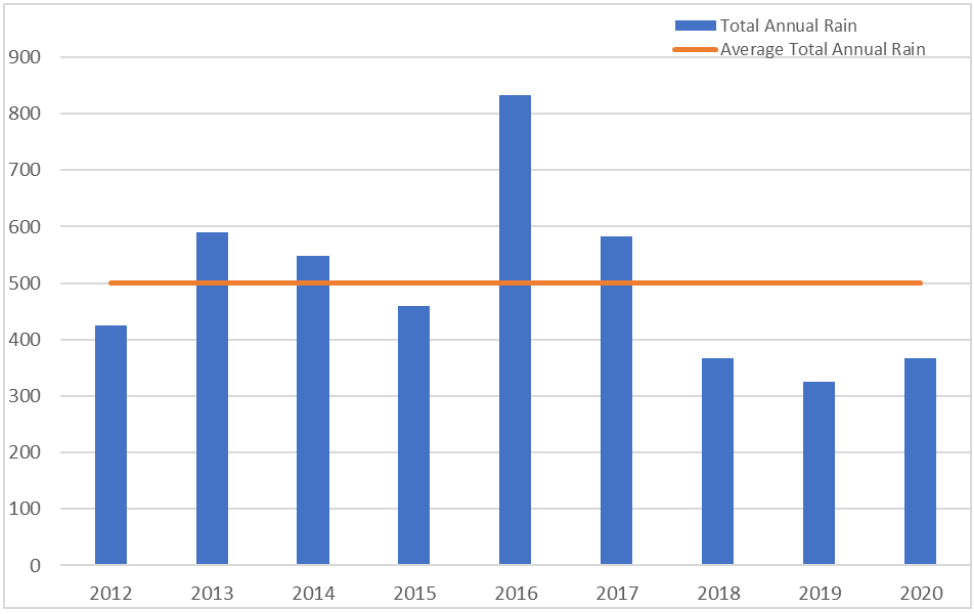

Figure 14 **Total annual rainfall (mm) recorded at the Moranbah Airport BoM meteorological station 2012-2020**

Table 8 Summary of 120 years of annual average rainfall data for Australia (BoM 2020)

Average Rainfall (1900 to 2019)	Min Rainfall (1900 to 2019)	Max Rainfall (1900 to 2019)	2019 Annual Rainfall
457.21	275.71	760.57	275.71

4.5.2.2 TSP

DES does not conduct monitoring for TSP at its Moranbah site. TSP has been calculated from DES Moranbah PM_{10} data, assuming TSP is twice the PM_{10}. This assumption is based on the TSP/PM_{10} ratios found in the NPI manual mining emission factors for fugitive dust that range from 25% to 52%.

4.5.2.3 Dust deposition rate

DES began monitoring dust deposition at its Moranbah stations in 2020. Moranbah East began monitoring in February 2020, while Moranbah West began in July 2020. Validated monthly maximum concentrations for both stations are available until July 2021 currently. Moranbah West data was not considered due to having only 12 months of validated data compared to 18 months at Moranbah East. Rolling annual averages were calculated for data from Moranbah East, with the maximum rolling annual average being 79.4 mg/m^2/day.

4.5.3 Summary of background dust levels

Background levels of TSP, PM_{10}, $PM_{2.5}$ and dust deposition used in this assessment are summarised in Table 9. The background levels have been derived from the publicly available data presented in the previous sections.

Table 9 Ambient background concentrations used to assess cumulative impacts

Pollutant	Averaging Period	Concentration	Comment
TSP	Annual	62.4 µg/m^3	Used annual average PM_{10} of 31.2 and assumed PM_{10} is 50% of TSP
PM_{10}	24-hour	35.5 µg/m^3	Highest 70th percentile value at DES Moranbah East, 2019
	Annual	31.2 µg/m^3	Highest average value at DES Moranbah East, 2019
$PM_{2.5}$	24-hour	6.6 µg/m^3	70th percentile value at DES Moranbah East, 2020
	Annual	6.4 µg/m^3	Average value at DES Moranbah East, 2020
Dust deposition	Annual average	79.4 mg/m²/day	Rolling average at DES Moranbah East

5. EMISSIONS TO THE ATMOSPHERE

Dust will be emitted over the life of the VS. Dust emissions can occur from the extraction, handling, transportation and processing of material (topsoil, overburden and coal), as well as from wind erosion of exposed areas and material stockpiles.

In addition to dust emissions, emissions of NO_X, SO_X and CO would occur due to blasting activities and the combustion of fuels on site. These emissions are transient, occur within the haul road corridor and open-cut pits and low in magnitude compared to dust emissions and have not been considered further.

Dust mitigation measures proposed by Vitrinite and a dust emissions inventory for the VS are provided in the following sections.

5.1 Overview

The key dust-generating activities over the life of the VS would be:

- Topsoil stripping;
- Drilling and blasting;
- Haulage of overburden and ROM coal;
- Wind erosion of stockpiles, exposed and rehabilitated areas;
- CHPP and rail load out;
- Dozers;
- Material handling; and
- Road grading.

5.2 Emission estimation

To assess potential air quality impacts due to the VS, potential dust emissions from individual mining activities in each scenario were accounted for and have been explicitly modelled. Specific activity information used to calculate dust emission rates associated with individual mining activities were provided or confirmed by METServe.

Dust emission rates were estimated using the base equation:

$$ER = A \times EF \times (1 - CF)$$

where:

ER	emission rate
A	activity / operations data
EF	emission factor
CF	reduction in emissions due to the implementation of control measures.

Emissions of TSP, PM_{10} and $PM_{2.5}$ from mining activities were estimated using recognised and accepted methods of dust emissions estimation. These include approximation of emission rates from NPI emissions estimation technique handbooks and the United States Environmental Protection Agency (US EPA) AP42 emission handbooks (US EPA, 1998; US EPA, 2006a; US EPA, 2006b; NPI, 2012).

The emissions estimation techniques applied in this assessment are based on standard methods that are applied throughout Australia and in the United States. These methods are consistent with those adopted for other air quality assessments conducted for other coal mines in Australia. The size distribution of dust particles was derived from the emission rates estimated for TSP, PM_{10}, and $PM_{2.5}$.

A dust emission inventory for the VS is detailed in Section 5. The activity data and emission factor equations used to estimate dust emissions are detailed in Appendix A.

5.3 Mitigation measures

5.3.1 Standard dust control measures

Dust mitigation and operational controls have been included in the VS design to limit dust emissions from mining activities, including:

- Water application on all major haul routes within the VS domain; and
- Progressive rehabilitation of areas that have been mined.

These dust mitigation measures have been accounted for in the dust emissions inventory. The effectiveness of each control measure is presented in Table 10. An additional control factor of 50% for TSP and 5% for PM_{10} has been applied to all pit activities to account for pit retention (NPI, 2012 – Table 4).

Table 10 Standard dust control measures and relative reduction in emissions

Activity	Control measure	Reduction (%)
Wheel-generated dust and grading	Water application	85
Wind erosion	Rehabilitated areas (initial)	40

5.3.2 Proactive mitigation measures

In order to maintain compliance with the Air EPP (2019) air quality objectives additional proactive mitigation measures may be required. These proactive measures involve ceasing particular operations within the VS site for certain periods when a combination of meteorological conditions and VS operations are likely to result in elevated ground-level concentrations. Details of proactive mitigation steps are provided in Section 6.

5.4 Emission inventory

A summary of the total dust emission rates estimated for Year 2 and Year 7 of the VS are presented in Table 11. A detailed breakdown of the dust inventory for each year is then provided in Table 12.

Emissions have been estimated as described in Appendix A. The inventory includes all VS mining activities up to and including loading of product coal to trains for transport off site.

Table 11 Estimated TSP, PM_{10} and $PM_{2.5}$ emission rates for the VS

Mine Year	Units	TSP	PM_{10}	$PM_{2.5}$
Year 2	kg/annum	2,607,256	1,054,308	157,387
Year 7	kg/annum	2,838,281	1,116,748	172,073

Table 12 VS Year 2 and Year 7 – breakdown of TSP, PM_{10} and $PM_{2.5}$ emission rates (g/s)

Activity	Year 2			Year 7		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Pit activities						
Drilling and blasting	5.66	2.94	0.17	2.83	1.47	0.08
Excavating overburden	33.13	15.90	2.37	32.85	15.77	2.35
Excavating ROM	2.19	0.34	0.16	2.26	0.35	0.16
Dumping activities						
Truck dumping overburden	15.74	5.62	1.04	15.69	5.62	1.12
Truck dumping ROM	2.19	0.34	0.12	2.26	0.35	0.12
Bulldozing overburden	0.77	0.21	0.08	0.69	0.17	0.07
Bulldozing ROM	2.55	0.88	0.06	2.55	0.88	0.06
Bulldozing Rehabilitation areas	0	0	0	0.23	0.06	0.02
Haulage						
ROM coal haulage	2.23	0.56	0.06	3.78	0.94	0.09
Overburden haulage	6.64	1.65	0.17	11.21	2.80	0.28
Grading haul roads	0.99	0.29	0.03	0.99	0.29	0.03
CHPP Processing						
Sizing and crushing	0.91	0.33	0.03	0.94	0.34	0.03
Truck loading and transfers including rail loadout	1.34	0.21	0.10	1.38	0.22	0.10
Wind erosion						
Stockpiles	0.39	0.19	0.03	0.39	0.19	0.03
Exposed areas	7.94	3.97	0.60	5.41	2.70	0.41
Rehabilitated areas	0	0	0	6.53	3.27	0.49
Total (g/s)	**82.68**	**33.43**	**4.99**	**90.0**	**35.4**	**5.46**

6. IMPACT ASSESSMENT RESULTS

This section presents the results of the dispersion modelling assessment of the VS. Modelling results associated with proposed Year 2 and Year 7 activities have been presented as ground-level concentrations or dust deposition rates at the residential sensitive receptors as well as contours across the modelling domain. As previously noted, Receptors 1-3 are considered in Year 2 and only Receptor 3 is considered in Year 7.

Background dust levels have been added to the incremental model predictions in order to obtain an estimate of the potential cumulative impacts of the VS at sensitive receptors. Results have been assessed by comparing the predicted concentrations and dust deposition rates with the relevant air quality objectives.

The contour plots illustrate the spatial dispersion of pollutants over time. They are constructed such that the highest 24-hour average or annual average value is obtained and stored at each point in the modelled domain. As these values may occur at different times at different grid points, the contour plots do not represent a single snapshot of concentrations at any given time, rather a peak impact.

6.1 TSP

The predicted annual average ground-level concentrations of TSP for Year 2 and Year 7 of the VS assessed in isolation and with background levels applied (cumulative assessment) are presented in Table 13.

Contour plots of the predicted annual average ground-level TSP concentrations for Year 2 and Year 7 of the VS are presented in Plate 1 and Plate 2, respectively, and provide the results for the VS in isolation.

The results show that:

- Predicted ground-level concentrations of TSP ***comply*** with the relevant air quality objective at all residential receptors, in isolation and cumulatively for Year 2 and Year 7.

Table 13 Predicted annual average ground-level concentrations of TSP (µg/m³)

Receptor	Label	Year 2		Year 7	
		VS	Cumulative	VS	Cumulative
1	Property Manager	3.0	65.4	*Not applicable to Year 7*	
2	Workers Accommodation	3.0	65.4		
3	O'Sullivan Residence	0.7	63.1	2.2	64.6
9	Luxor Residence	0.2	62.6	0.2	62.6
10	Cheeseboro Residence	0.2	62.6	0.2	62.6
	Background	-	*62.4*	-	*62.4*
Objective		**90 µg/m³**			

6.2 PM_{10}

The predicted maximum 24-hour average and annual average ground-level concentrations of PM_{10} for Year 2 and Year 7 of the VS in isolation and with background levels applied (cumulative assessment) are presented in Table 14 and Table 15, respectively.

Contours of the predicted maximum 24-hour average and annual average ground-level concentrations of PM_{10} for Year 2 and Year 7 of the VS are presented in Plate 3, Plate 4, Plate 5 and Plate 6, respectively and provide the results for the VS in isolation.

The results show that:

- Predicted 24-hour average ground-level concentrations of PM_{10} for Year 2 and Year 7 comply with the air quality objective at all sensitive receptors, in isolation and cumulatively with a combination of standard and proactive mitigation measures. Receptors 1 - 3 comply with the application of additional proactive mitigation measures including:
    - For Year 2:
        - Proactive mitigation measures may be required up to 22 nights per year to maintain compliance at R1 and R2. The modelling indicates that a complete shutdown of mining operations during the night is required. This includes all operations identified in Table 16.
        - Proactive mitigation measures may be required one night of the year to maintain compliance at R3. The modelling indicates that ceasing operation of the Main pit for one night will be sufficient to maintain compliance. The specific activities in this operational location include pre-stripping waste material with excavators, excavating OB, and excavating ROM.
    - For Year 7:
        - Proactive mitigation measures may be required up to 10 nights per year to maintain compliance at R3. On these nights the modelling indicates ceasing operation of the South pit, Main pit and South pit – outpit dump is required as shown in Table 17. The specific activities in these operational locations include pre-stripping waste material with excavators, excavating OB and ROM, and truck dumping and dozing of OB.
- Predicted annual average ground-level concentrations of PM_{10} for Year 2 and Year 7 comply with the air quality objective at all sensitive receptors in isolation.
- The background annual average concentration of PM_{10} is 31.2 µg/m³, which is above the Air EPP objective of 25 µg/m³. The maximum contribution of the VS (Year 2 or Year 7) to annual average $PM_{2.5}$ at the sensitive receptors is at most 2.8 µg/m³ or approximately 11% of the Air EPP objective.

Additional details regarding proactive mitigation measures are discussed in the following section, including when mitigation is required, which sources require reductions in activity, and meteorological conditions conducive to producing exceedances.

Table 14 Predicted ground-level concentrations of PM_{10} (µg/m³) for Year 2

Receptor	Label	Year 2			
		24-hour		Annual	
		VS	Cumulative[D]	VS	Cumulative
1	Property Manager	14.4[A]	49.9[A]	2.8	34.0
2	Workers Accommodation	14.3[B]	49.8[B]	2.8	34.0
3	O'Sullivan Residence	9.3[C]	44.8[C]	0.7	31.9
9	Luxor Residence	2.3	37.8	0.2	31.4
10	Cheeseboro Residence	2.0	37.5	0.1	31.3
	Background	-	*35.5*	-	*31.2*
Objective		**50 µg/m³**		**25 µg/m³**	

Table note:

[A] Predicted concentration accounts for shutting down all night-time activities for 22 nights per year

[B] Predicted concentration accounts for shutting down all night-time pit activities for 22 nights per year.

[C] Predicted concentration accounts for shutting down Main pit night-time activities for 1 night per year.

[D] It is important to note although different receptors require different levels of proactive mitigation, the most stringent requirement will need to be applied to achieve compliance across all receptors. Furthermore, each receptor may require mitigation on different nights and therefore the total number of nights of mitigation may be more than noted above for any individual receptor.

Table 15 Predicted ground-level concentrations of PM_{10} (µg/m³) for Year 7

Receptor	Label	Year 7			
		24-hour		Annual	
		VS	Cumulative[B]	VS	Cumulative
1	Property Manager	*Not applicable to Year 7*			
2	Workers Accommodation				
3	O'Sullivan Residence	13.3[A]	48.9[A]	2.0	33.5
9	Luxor Residence	2.5	38.0	0.2	31.4
10	Cheeseboro Residence	2.7	38.2	0.1	31.3
	Background	-	*35.5*	-	*31.2*
Objective		**50 µg/m³**		**25 µg/m³**	

Table note:

[A] Predicted concentration accounts for shutting down all night-time pit activities and South Pit – outpit dumping for 10 nights per year.

[B] It is important to note although different receptors require different levels of proactive mitigation, the most stringent requirement will need to be applied to achieve compliance across all receptors. Furthermore, each receptor may require mitigation on different nights and therefore the total number of nights of mitigation may be more than noted above for any individual receptor.

6.2.1 Proactive mitigation measures for PM_{10}

Proactive mitigation measures may be necessary to achieve compliance with the Air EPP air quality objective for 24-hour ground-level PM_{10} at sensitive receptors 1 to 3. Contributions to predicted ground-level concentrations of PM_{10} from all operations occurring within VS including standard and proactive mitigation and the level of operation reduction for each source are provided in Table 16 and Table 17 for Year 2 and Year 7, respectively. Table 18 presents the dates when ground-level PM_{10} exceedances have been predicted and, therefore, require proactive mitigation to achieve compliance.

It can be seen from the source contribution tables that existing ambient background is the primary source of 24-hour average PM_{10}, contributing between 32% to 68% to the cumulative ground-level concentrations depending upon receptor and year of operation. Besides ambient background, for each year and receptor, pit operations (Main pit, North pit, South pit) are the primary contributors to predicted ground-level PM_{10}. In each case these active areas are those nearest to the O'Sullivan residence (sensitive receptor 3) which may explain their greater contributions. Activities occurring within these pit areas include pre-stripping waste material with excavators, excavating OB, and excavating ROM. It is significant to note for Year 2 operations that the proactive mitigation measure of 22 nights complete mine shutdown is a result of the proximity of onsite sensitive receptors R1 and R2 which are owned by VS. It is, therefore, possible for VS to review the suitability of these sites as necessary to reduce impacts.

Regarding the influence of meteorological conditions on dispersion of dust, wind speed and atmospheric stability are two of the most important factors. Low wind speeds (less than 2m/s) and stable nighttime conditions result in poorly mixed air which can lead to higher concentrations of pollutants.

Therefore, proactive mitigation measures for reducing ground-level concentrations of PM_{10} have focused on ceasing operations during evening hours (7 pm – 6 am) to minimise buildup of dust in the more stable nighttime conditions.

Prevailing wind direction is also important for predicting impacts at sensitive receptors. As the nearest sensitive receptors are all located to the east and south of VS operations it is expected that winds from the directions of southwest – north/northwest may correspond with increased impacts at sensitive receptors. Indeed, analysis of dominant wind directions on occasions when proactive mitigation is required indicates winds are blowing between approximately 200^{o} – 320^{o} (SW-NW) making the sensitive receptors downwind of VS operations.

Although the described meteorological conditions are expected to facilitate increases in particulate concentrations, they do not provide an indication of where particulates are coming from. It will often be the case that background ambient concentrations of particulates is the major contributor to levels experienced at sensitive receptors, while contributions from VS only constitute a very minor part (as shown in Table 16 and Table 17).

Table 16 **Year 2 - Operation and Ambient Background contributions to predicted ground-level concentrations of PM_{10} at each receptor (maximum exceedance day) with standard mitigation and after proactive mitigation steps, and percent reduction required**

VS activities	Percent contribution of each source and percent reduction								
	Receptor 1			Receptor 2			Receptor 3		
	Standard mitigation	Proactive mitigation	% Rdtn[1]	Standard mitigation	Proactive mitigation	% Rdtn[1]	Standard mitigation	Proactive mitigation	% Rdtn[1]
CHPP	2.3%	0.3%	100%	3.4%	0.1%	100%	0.8%	0.9%	0%
Main pit	45.5%	20.3%	100%	40.4%	19.8%	100%	20.6%	7.8%	100%
Main pit - Drilling/Blasting	0.5%	0.0%	100%	0.1%	0.0%	100%	0.1%	0.1%	0%
Main pit - inpit OB dump	6.2%	2.6%	100%	5.0%	1.1%	100%	3.5%	4.1%	0%
Main pit - outpit dump	2.1%	0.8%	100%	1.0%	0.3%	100%	0.8%	0.9%	0%
Main pit - OB haul (inpit dump)	2.3%	1.0%	100%	2.5%	1.1%	100%	1.5%	1.8%	0%
Main pit - OB haul outpit dump	1.0%	0.4%	100%	0.4%	0.1%	100%	0.3%	0.4%	0%
Main pit - ROM haul	0.7%	0.3%	100%	0.5%	0.1%	100%	0.3%	0.4%	0%
North pit	2.0%	0.8%	100%	4.8%	2.9%	100%	2.2%	2.6%	0%
North pit - Drilling/Blasting	0.2%	0.4%	100%	0.1%	0.0%	100%	0.01%	0.0%	0%
North pit - inpit OB dump	1.0%	0.3%	100%	1.7%	0.9%	100%	0.6%	1.7%	0%
North pit - outpit dump	2.7%	1.2%	100%	1.8%	0.7%	100%	0.4%	0.5%	0%
North pit - OB haul (inpit dump)	0.3%	0.1%	100%	0.6%	0.3%	100%	0.3%	0.3%	0%
North pit - OB haul outpit dump	0.4%	0.2%	100%	0.4%	0.2%	100%	0.2%	0.2%	0%
North pit - ROM haul	0.5%	0.2%	100%	0.6%	0.1%	100%	0.1%	0.1%	0%
Wind Erosion	0.0%	0.0%	0%	0.0%	0.0%	0%	0.0%	0.0%	0%
Amb Background	32.2%	71%	NA	36.7%	71.3%	NA	68.2%	79.2%	NA

Table Notes:

[1] Percent operations must be reduced by to achieve compliance. These apply to nights identified in Table 14.

Table 17 **Year 7 - Operation and Ambient Background contributions to predicted ground-level concentrations of PM_{10} at each receptor (maximum exceedance day) with standard mitigation and after proactive mitigation steps, and percent reduction required**

VS activities	Percent contribution of each source and percent reduction				
	Receptor 1	Receptor 2	Receptor 3		
			Standard mitigation	Proactive mitigation	% Rdtn[1]
CHPP	Not applicable to Year 7	Not applicable to Year 7	0.0%	0.5%	0%
Main pit			11.3%	8.0%	100%
Main pit - Drilling Blasting			0.02%	0.0%	0%
Main pit - inpit OB dump			0.8%	1.1%	0%
Main pit - OB haul (inpit dump)			1.5%	2.0%	0%
Main pit - ROM haul			0.2%	0.3%	0%
South pit			21.2%	4.9%	100%
South pit - Drilling Blasting			0.1%	0.1%	0%
South pit - inpit dump			3.3%	4.4%	0%
South pit - outpit dump			3.5%	0.7%	100%
South pit - OB haul (inpit dump)			2.0%	2.6%	0%
South pit - OB haul (outpit dump)			1.7%	2.3%	0%
South pit - ROM haul			0.7%	1.0%	0%
Main pit - Rehab			0.0%	0.0%	0%
North pit - Rehab			0.0%	0.0%	0%
Highwall Rehab			0.0%	0.0%	0%
WE			0.0%	0.0%	0%
Amb Background			53.7%	72.5%	NA

Table Notes:
[1] Percent operations must be reduced by to achieve compliance. These apply to nights identified in Table 15.

Table 18 Dates of predicted ground-level PM_{10} exceedances requiring proactive mitigation

	Receptor and Model Year			
	R1 - Yr2	**R2 - Yr2**	**R3 - Yr2**	**R3 - Yr11**
Dates Requiring Proactive Mitigation	1/01/2018	1/01/2018	25/07/2018	20/01/2018
	13/01/2018	13/01/2018		15/02/2018
	1/02/2018	1/02/2018		24/02/2018
	10/02/2018	10/02/2018		3/03/2018
	13/02/2018	13/02/2018		27/07/2018
	19/02/2018	19/02/2018		31/08/2018
	26/02/2018	26/02/2018		15/09/2018
	2/03/2018	2/03/2018		19/09/2018
	10/05/2018	10/05/2018		4/10/2018
	12/06/2018	12/06/2018		7/11/2018
	13/06/2018	13/06/2018		2/12/2018
	16/07/2018	16/07/2018	-	
	29/07/2018	29/07/2018		
	16/08/2018	16/08/2018		
	8/09/2018	23/08/2018		
	16/09/2018	8/09/2018		
	4/10/2018	16/09/2018		-
	5/10/2018	4/10/2018		
	11/10/2018	5/10/2018		
	26/10/2018	11/10/2018		
	28/10/2018	26/10/2018		
	27/11/2018	28/10/2018		

6.3 $PM_{2.5}$

The predicted maximum 24-hour average and annual average ground-level concentrations of $PM_{2.5}$ for Year 2 and Year 7 of the VS in isolation and with background levels applied (cumulative assessment) are presented in Table 19 and Table 20.

Contours of the predicted maximum 24-hour average and annual average ground-level concentrations of $PM_{2.5}$ for Year 2 and Year 7 of the VS are presented in Plate 7, Plate 8, Plate 9 and Plate 10, respectively and for the VS in isolation.

The results show that:

- Predicted 24-hour average ground-level concentrations of $PM_{2.5}$ ***comply*** with the relevant air quality objective at all residential receptors, in isolation and cumulatively for Year 2 and Year 7;
- Predicted annual average ground-level concentrations of $PM_{2.5}$ ***comply*** with the relevant air quality objective at all residential receptors, in isolation and cumulatively for Year 2 and Year 7; and
- The background annual average concentration of $PM_{2.5}$ is 6.4 µg/m³ or 80% the Air EPP objective of 8 µg/m³. The maximum contribution of the VS to annual average $PM_{2.5}$ at the sensitive receptors is at most 0.6 µg/m³ or approximately 2.3% of the Air EPP objective.

Table 19 Predicted maximum 24-hour average and annual average ground-level concentrations of $PM_{2.5}$ (µg/m³) for Year 2

Receptor	Label	Year 2			
		24-hour		Annual	
		VS	Cumulative	VS	Cumulative
1	Property Manager	15.9	22.5	0.6	7.0
2	Workers Accommodation	13.5	20.1	0.6	7.0
3	O'Sullivan Residence	5.4	12.0	0.2	6.6
9	Luxor Residence	0.7	7.3	0.05	6.4
10	Cheeseboro Residence	0.5	7.1	0.04	6.4
Background		-	*6.6*	-	*6.4*
Objective		**25 µg/m³**		**8 µg/m³**	

Table 20 Predicted maximum 24-hour average and annual average ground-level concentrations of $PM_{2.5}$ (µg/m³) for Year 7

Receptor	Label	Year 7			
		24-hour		Annual	
		VS	Cumulative	VS	Cumulative
1	Property Manager	*Not applicable to Year 7*			
2	Workers Accommodation				
3	O'Sullivan Residence	9.0	15.6	0.5	6.9
9	Luxor Residence	0.7	7.3	0.05	6.5
10	Cheeseboro Residence	0.6	7.2	0.03	6.4
Background		-	*6.6*	-	*6.4*
Objective		**25 µg/m³**		**8 µg/m³**	

6.4 Dust Deposition

The predicted maximum monthly dust deposition rates for Year 2 and Year 7 of the VS in isolation and with background levels applied (cumulative assessment) are presented in Table 21.

Contours of the predicted maximum monthly dust deposition rate for Year 2 and Year 7 of the VS are presented in Plate 11 and Plate 12 for the VS in isolation.

The results show that:

- Predicted dust deposition rates due to the VS ***comply*** with the relevant air quality objective at all residential receptors, in isolation and cumulatively for Year 2 and Year 7.

Table 21 Predicted maximum monthly dust deposition rates (mg/m^2/day)

Receptor	Label	Year 2		Year 7	
		VS	Cumulative	VS	Cumulative
1	Property Manager	3.6	83.0	*Not applicable to Year 7*	
2	Workers Accommodation	3.3	82.7		
3	O'Sullivan Residence	0.7	80.1	2.2	81.6
9	Luxor Residence	0.2	79.6	0.4	79.8
10	Cheeseboro Residence	0.2	79.6	0.5	79.9
Background		-	*79.4*		*79.4*
Objective		**120 µg/m³**			

7. MONITORING AND MITIGATION

Dust management and mitigation measures will be implemented at the VS in an Air Quality Management Plan (AQMP) to ensure that dust levels are minimised as far as practicable. As discussed in Section 5.3, everyday dust management measures will include application of water to truck haul routes and progressive rehabilitation of the site.

8. CONCLUSIONS

The air quality assessment has investigated the potential for the VS to affect air quality in the region. Year 2 and Year 7 of VS operations have been assessed based on the proposed mining schedule and the proximity of sensitive receptors to critical emission generating activities. The assessment has used meteorological and dispersion models to assess the effect of particulate matter (dust) emissions on concentrations of TSP, PM_{10}, $PM_{2.5}$ and dust deposition rates in the surrounding region.

Concentrations of air pollutants due to proposed activities associated with the VS in isolation, and with the inclusion of background levels of dust, were determined at sensitive residential receptors and on a cartesian grid covering the region. Predicted ground-level concentrations of air pollutants and dust deposition rates were compared with the relevant air quality objectives and guidelines.

It is significant to note that in past years the ambient concentrations of PM_{10} and $PM_{2.5}$ exceed the Air EPP objectives for 24-hour average and annual average PM_{10}. Dry conditions likely contributed to or exacerbated conditions with 2019 showing the lowest rainfall for the Moranbah region over the period 2012 – 2020; Australia-wide 2019 had the lowest annual rainfall since 1900. The assessment has included these ambient concentrations as background and therefore represents an upper bound of ambient concentrations for Moranbah.

The air quality assessment of the VS found the following:

TSP

- Predicted ground-level concentrations of TSP ***comply*** with the relevant air quality objective at all residential receptors, in isolation and cumulatively for Year 2 and Year 7.

PM_{10}

- Predicted 24-hour average ground-level concentrations of PM_{10} for Year 2 and Year 7 comply with the relevant air quality objective at all sensitive receptors, in isolation and cumulatively, with the application of proposed proactive mitigation measures as discussed in Section 6.2.1; and
- Existing annual average concentrations of PM_{10} are higher than the relevant air quality objective. The contribution from VS to the annual average concentrations PM_{10} at a sensitive receptor is at most 2.8 µg/m³ or 11% of the Air EPP objective.

$PM_{2.5}$

- Predicted 24-hour average ground-level concentrations of $PM_{2.5}$ ***comply*** with the relevant air quality objective at all residential receptors, in isolation and cumulatively for Year 2 and Year 7;
- Predicted annual average ground-level concentrations of $PM_{2.5}$ ***comply*** with the relevant air quality objective at all residential receptors, in isolation and cumulatively for Year 2 and Year 7; and
- The background annual average concentration of $PM_{2.5}$ is 6.4 µg/m³ or 80% the Air EPP objective of 8 µg/m³. The maximum contribution of the VS to annual average $PM_{2.5}$ at the sensitive receptors is at most 0.6 µg/m³ or approximately 2.3% of the Air EPP objective.

Dust Deposition

Predicted dust deposition rates due to the VS ***comply*** with the relevant air quality objective at all residential receptors, in isolation and cumulatively for Year 2 and Year 7.

Furthermore, dust management and mitigation measures are proposed to be implemented at the VS to ensure that dust levels are minimised. A proactive dust management system will be implemented to avoid the potential for elevated cumulative air quality impacts at nearby sensitive receptors.

9. REFERENCES

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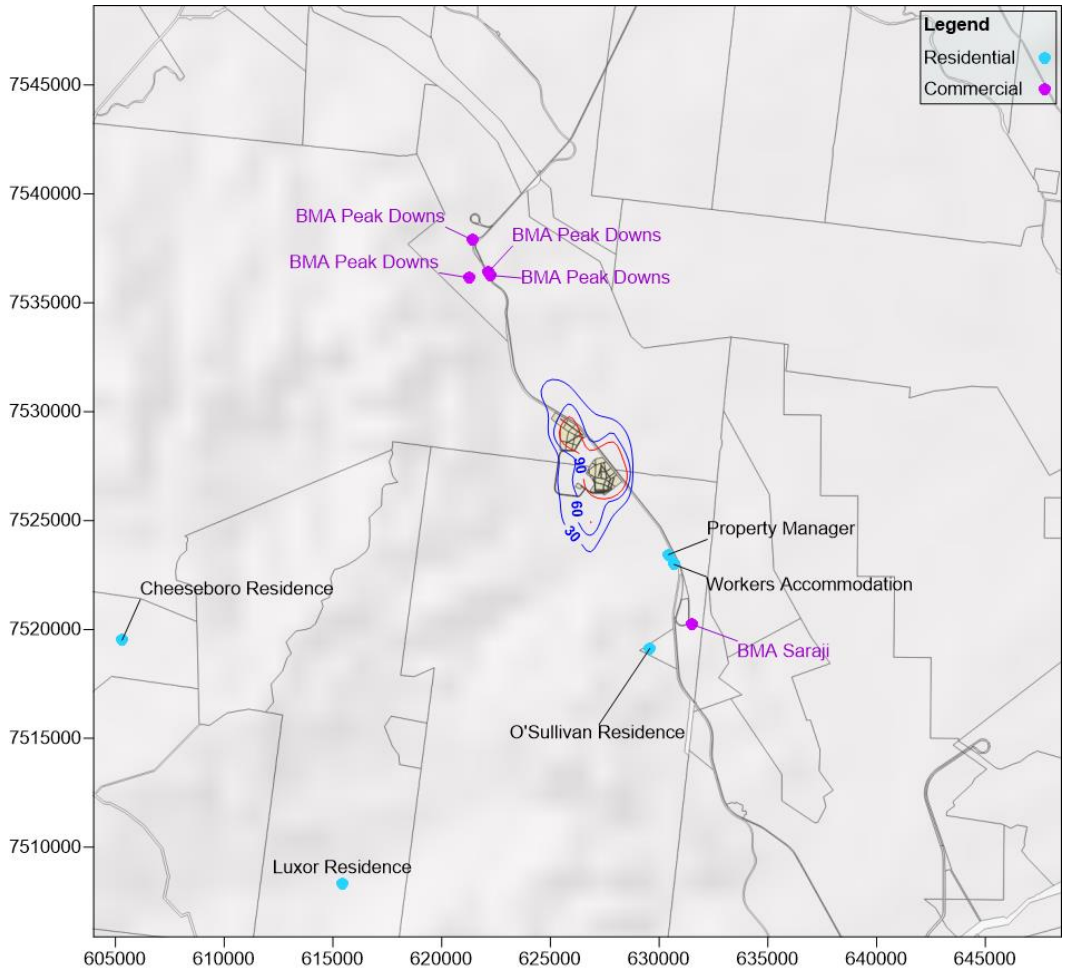

Plate 1 **Predicted annual average ground-level concentrations of TSP for the VS Year 2 in isolation using standard mitigation measures**

Location:	**Averaging period:**	**Data source:**	**Units:**
Vulcan South, Moranbah, QLD	Annual	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Average contours	90 µg/m³ (red)	Daniel Gallagher	November 2020

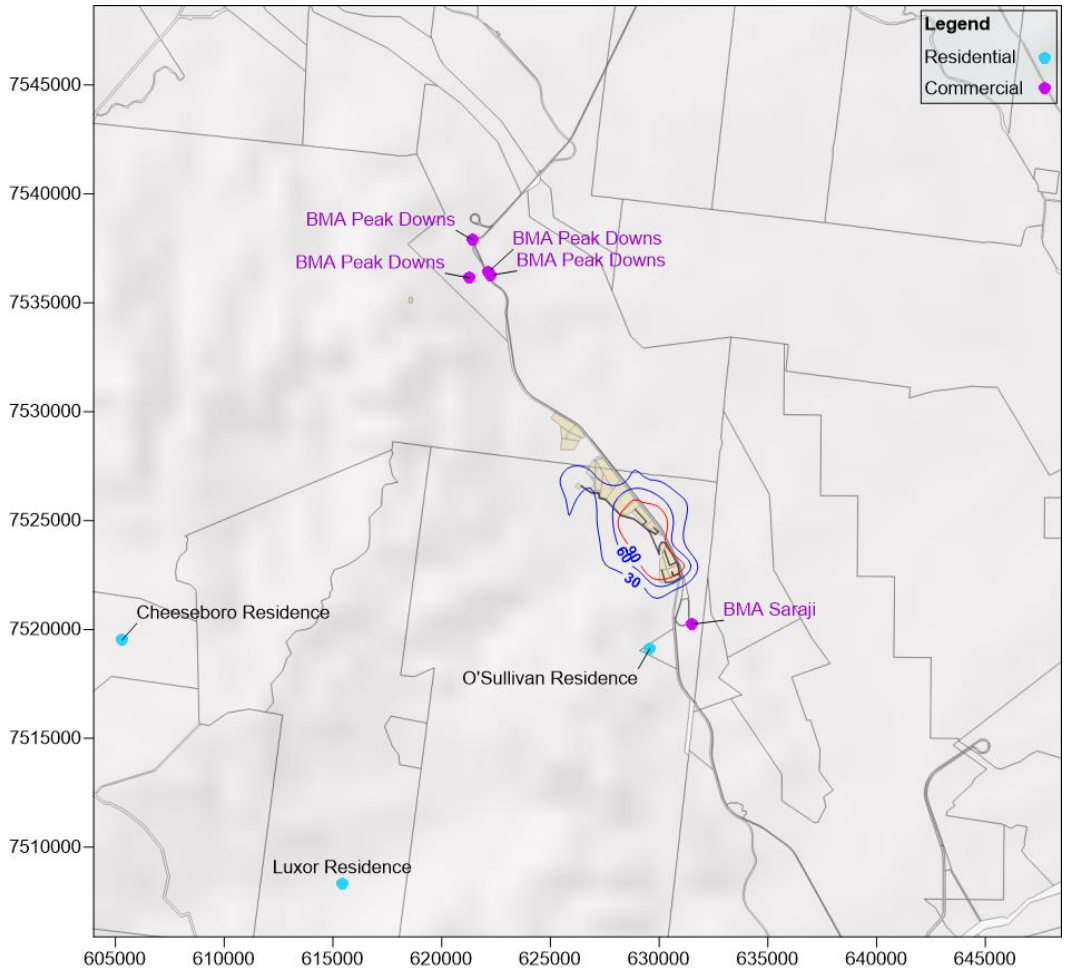

Plate 2 **Predicted annual average ground-level concentrations of TSP for the VS Year 7 in isolation using standard mitigation measures**

Location:	**Averaging period:**	**Data source:**	**Units:**
Vulcan South, Moranbah, QLD	Annual	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Average contours	90 µg/m³ (red)	Daniel Gallagher	November 2020

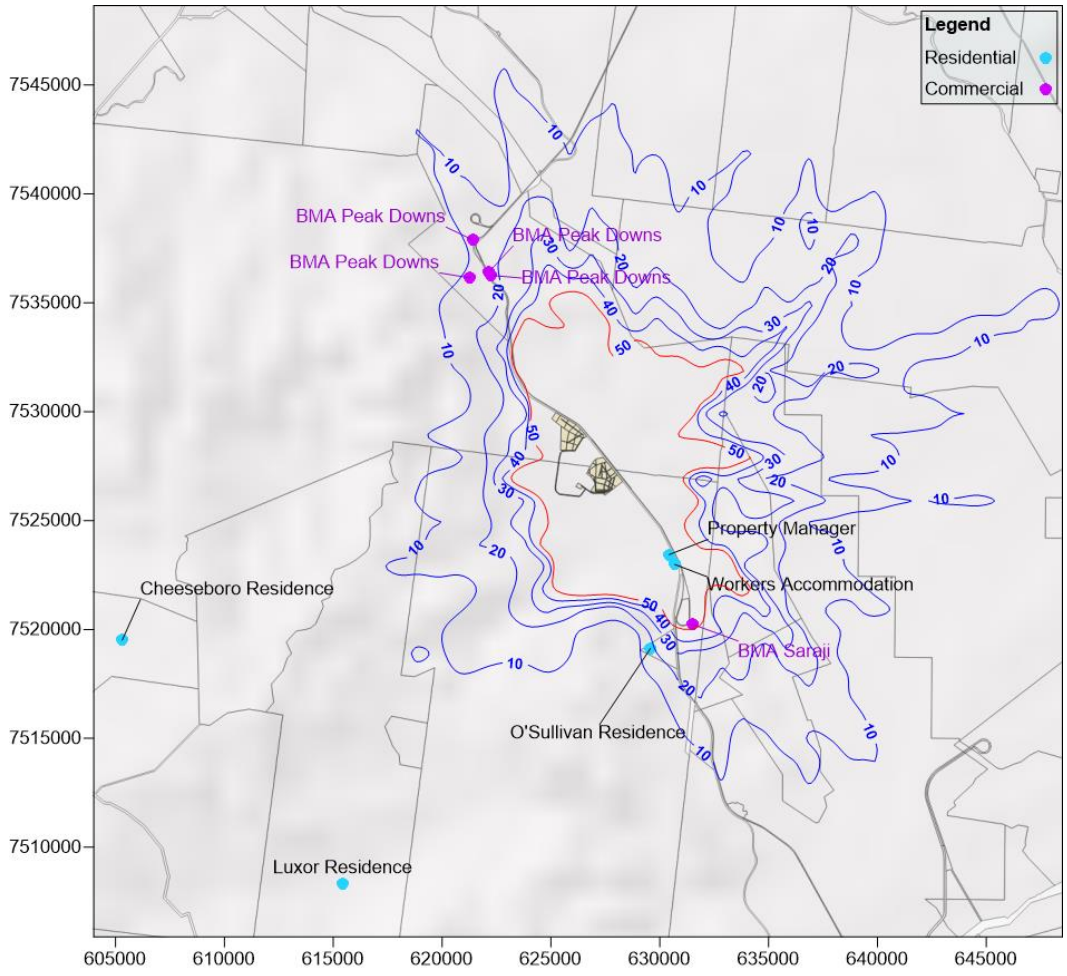

Plate 3 **Predicted maximum 24-hour average ground-level concentrations of PM_{10} for the VS Year 2 in isolation using standard mitigation measures**

Location:	**Averaging period:**	**Data source:**	**Units:**
Vulcan Mine South, Moranbah, QLD	24-hour maximum	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Maximum contours	50 µg/m³ (red)	Daniel Gallagher	November 2020

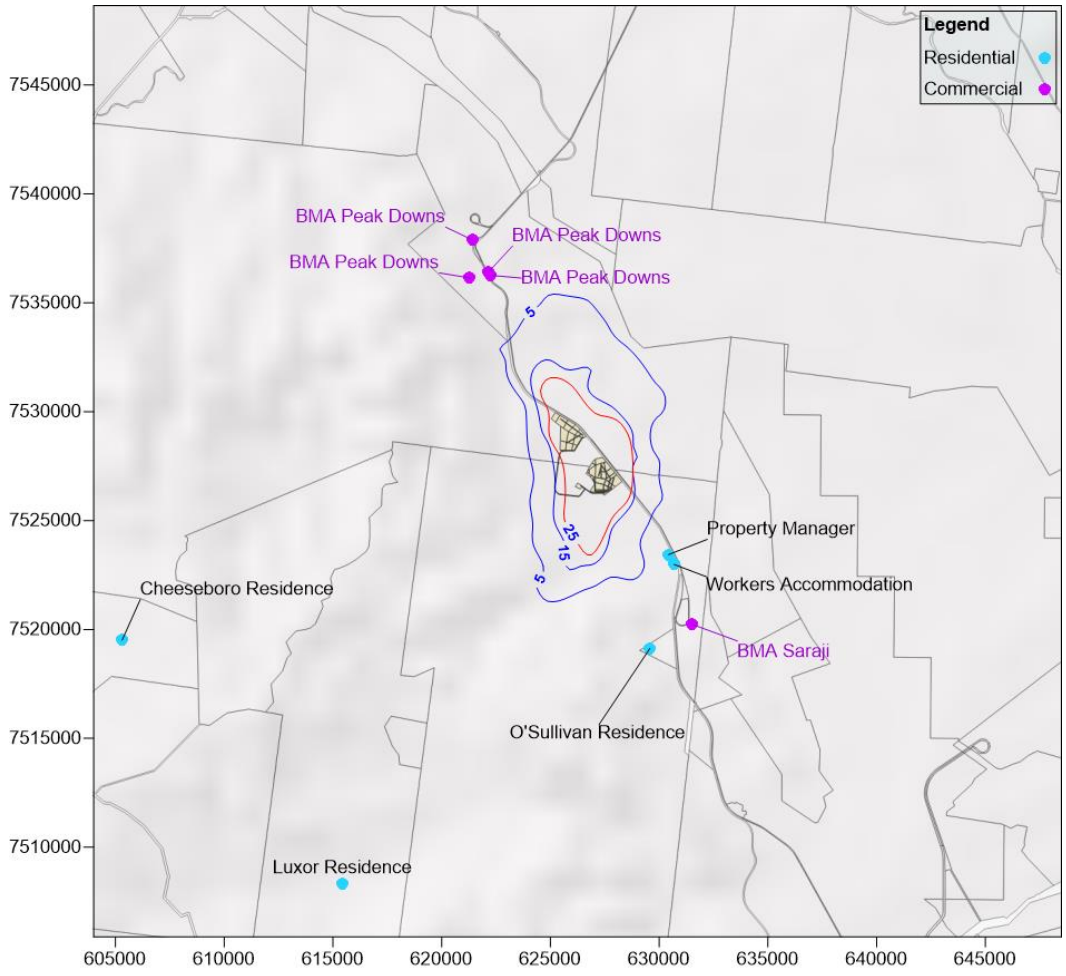

Plate 4 **Predicted annual average ground-level concentrations of PM_{10} for the VS Year 2 in isolation using standard mitigation measures**

Location:	**Averaging period:**	**Data source:**	**Units:**
Vulcan South, Moranbah, QLD	Annual	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Average contours	25 µg/m³	Daniel Gallagher	November 2020

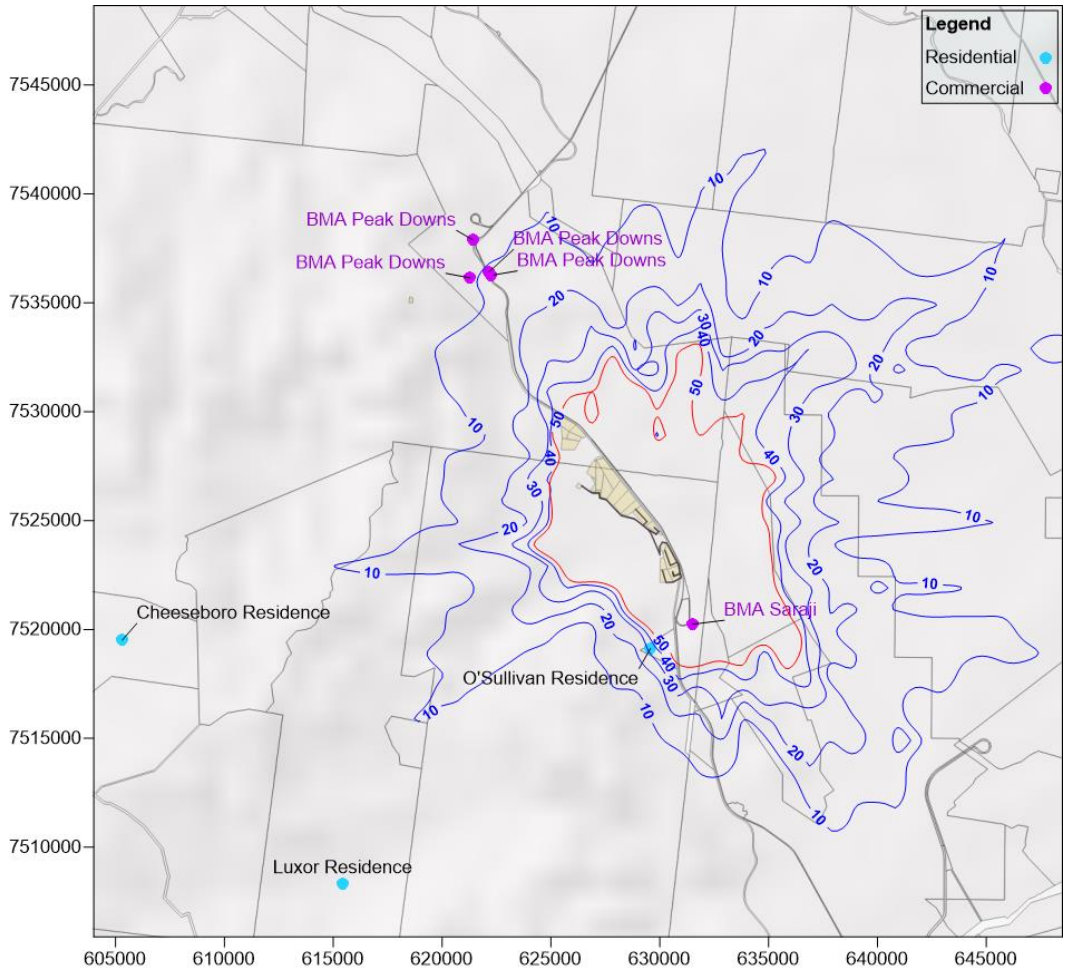

Plate 5 **Predicted maximum 24-hour average ground-level concentrations of PM_{10} for the VS Year 7 in isolation using standard mitigation measures**

Location:	**Averaging period:**	**Data source:**	**Units:**
Vulcan South, Moranbah, QLD	24-hour maximum	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Maximum contours	50 µg/m³ (red)	Daniel Gallagher	November 2020

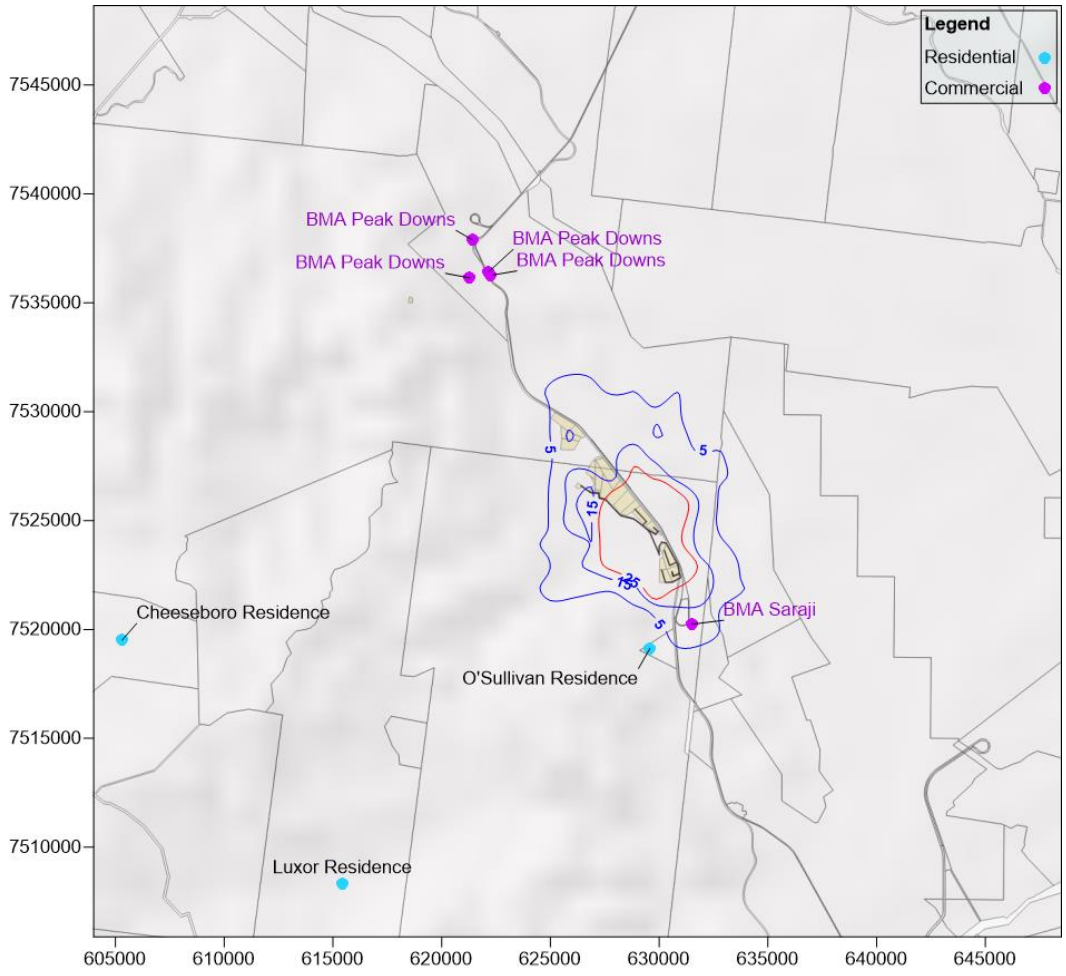

Plate 6 **Predicted annual average ground-level concentrations of PM_{10} for the VS Year 7 in isolation using standard mitigation measures**

Location:	**Averaging period:**	**Data source:**	**Units:**
Vulcan South, Moranbah, QLD	Annual	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Average contours	25 µg/m³	Daniel Gallagher	November 2020

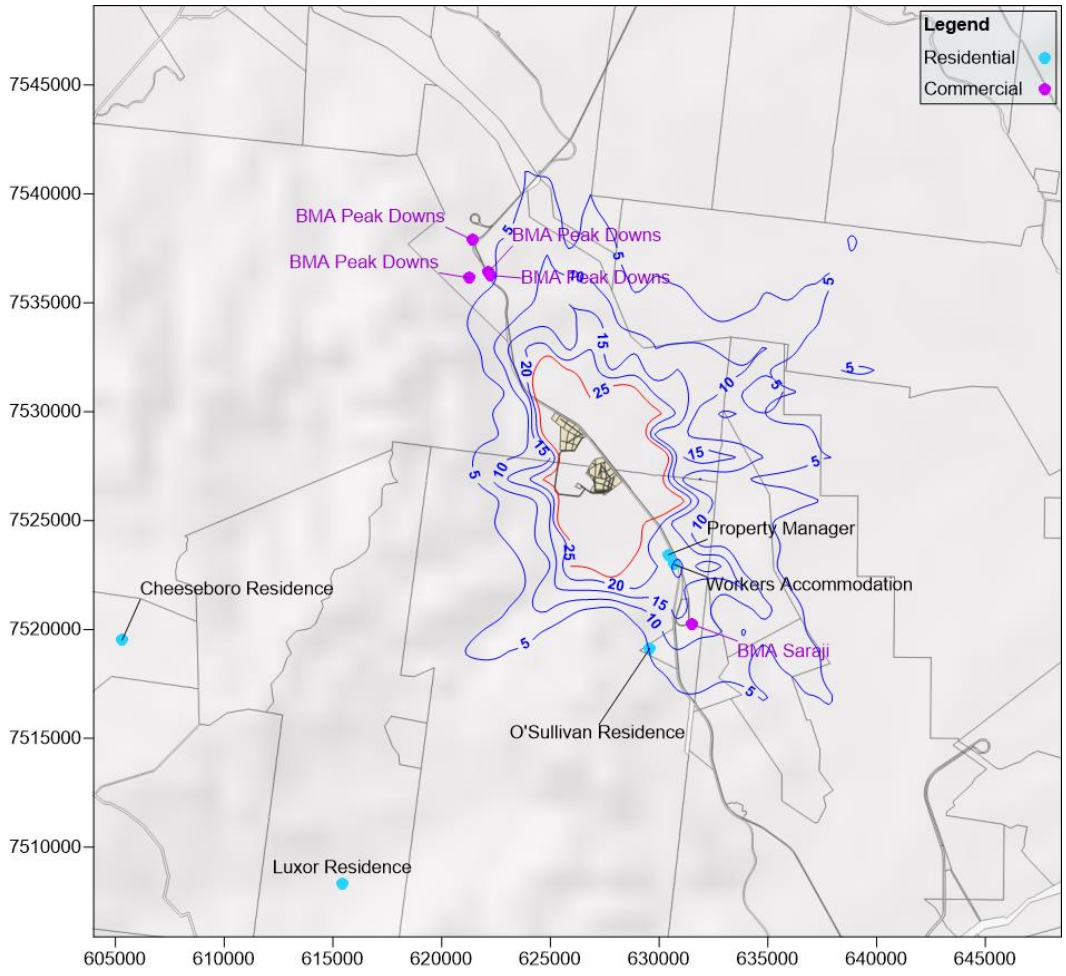

Plate 7 **Predicted maximum 24-hour average ground-level concentrations of $PM_{2.5}$ for the VS Year 2 in isolation using standard mitigation measures**

Location:	**Averaging period:**	**Data source:**	**Units:**
Vulcan South, Moranbah, QLD	24-hour maximum	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Maximum contours	25 µg/m³ (red)	Daniel Gallagher	November 2020

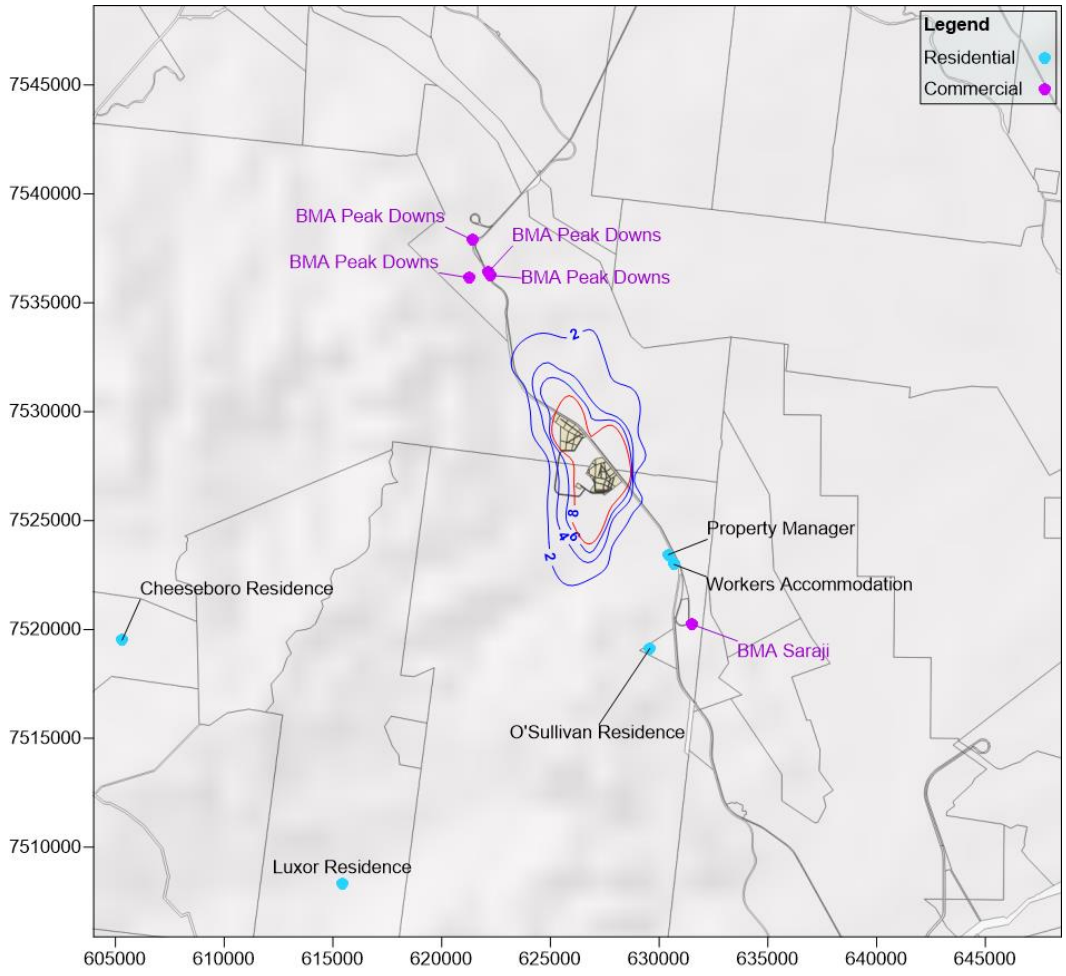

Plate 8 **Predicted annual average ground-level concentrations of $PM_{2.5}$ for the VS Year 2 in isolation using standard mitigation measures**

Location:	**Averaging period:**	**Data source:**	**Units:**
Vulcan South, Moranbah, QLD	Annual	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Average contours	8 µg/m³ (red)	Daniel Gallagher	November 2020

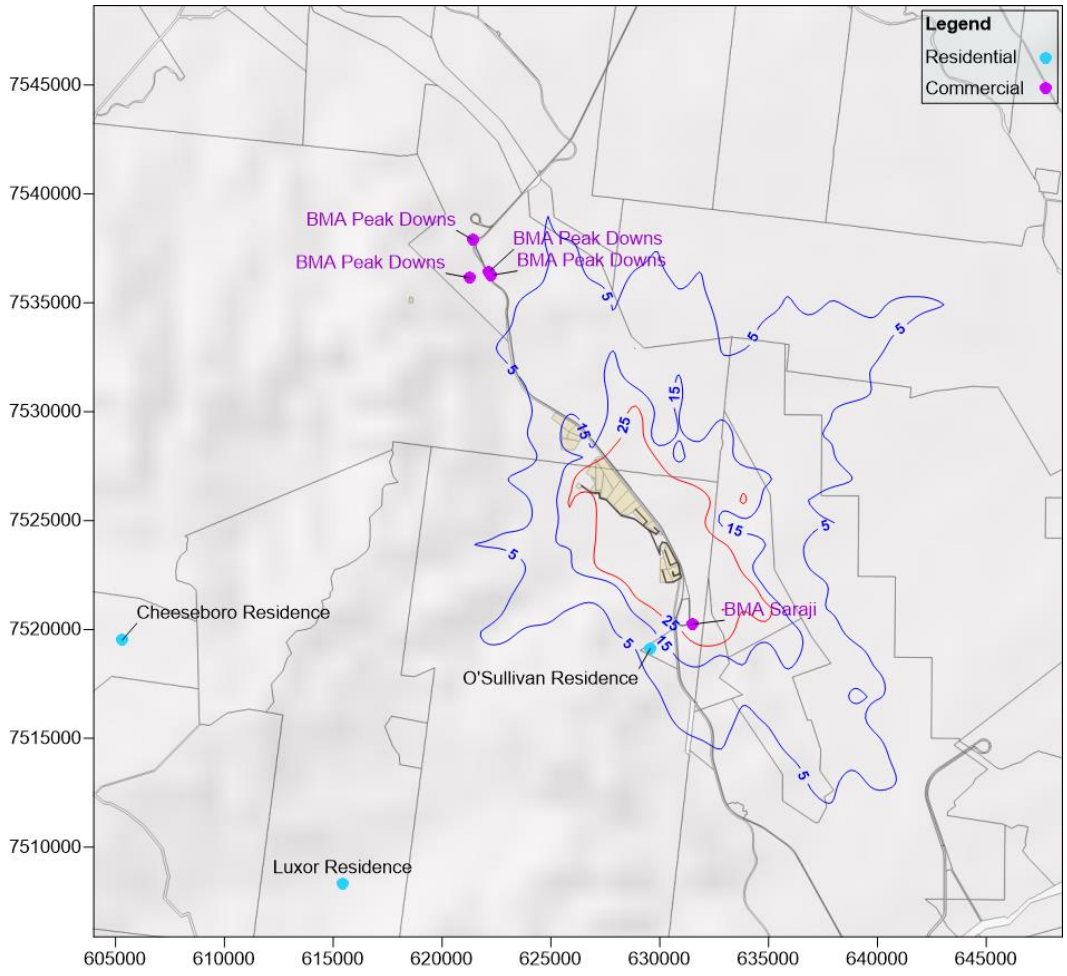

Plate 9 **Predicted maximum 24-hour average ground-level concentrations of $PM_{2.5}$ for the VS Year 7 in isolation using standard mitigation measures**

Location:	**Averaging period:**	**Data source:**	**Units:**
Vulcan South, Moranbah, QLD	24-hour maximum	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Maximum contours	25 µg/m³ (red)	Daniel Gallagher	November 2020

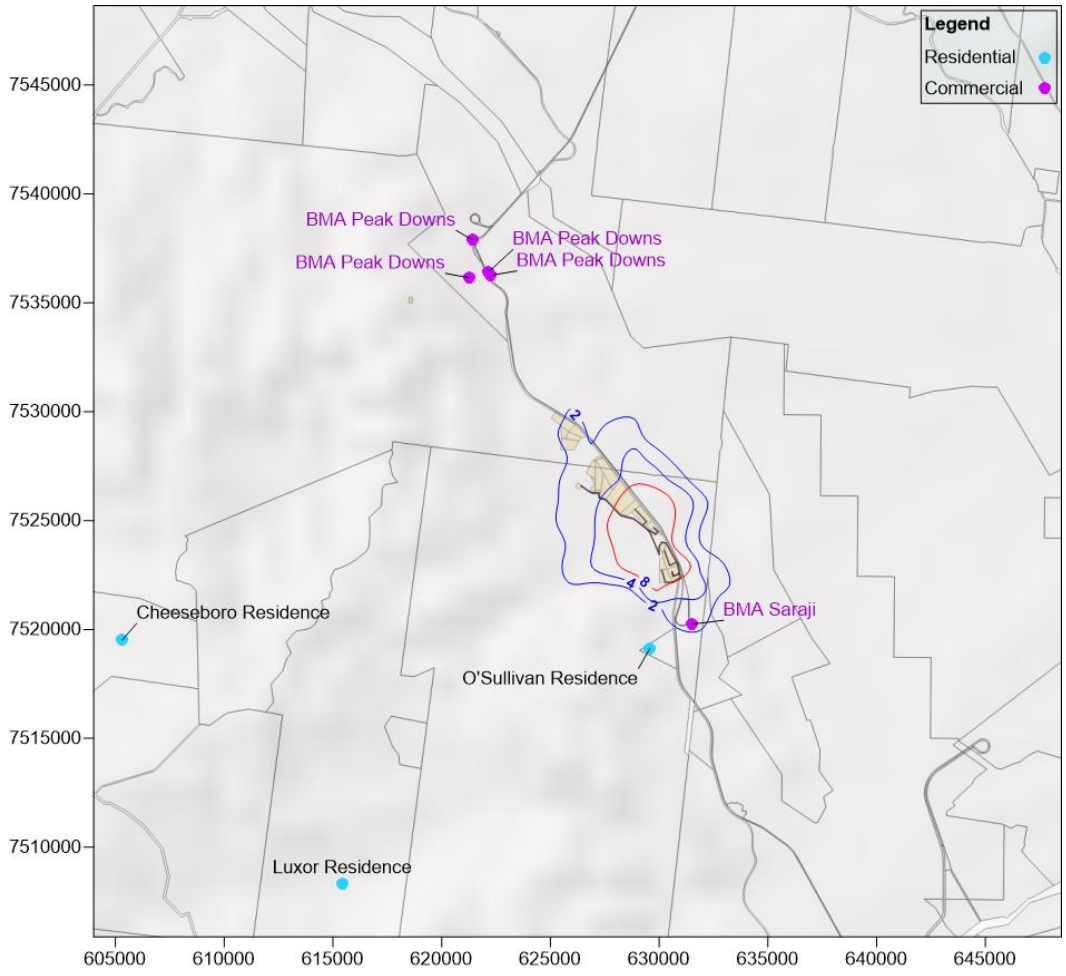

Plate 10 **Predicted annual average ground-level concentrations of $PM_{2.5}$ for the VS Year 7 in isolation using standard mitigation measures**

Location:	**Averaging period:**	**Data source:**	**Units:**
Vulcan South, Moranbah, QLD	Annual	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Average contours	8 µg/m³ (red)	Daniel Gallagher	November 2020

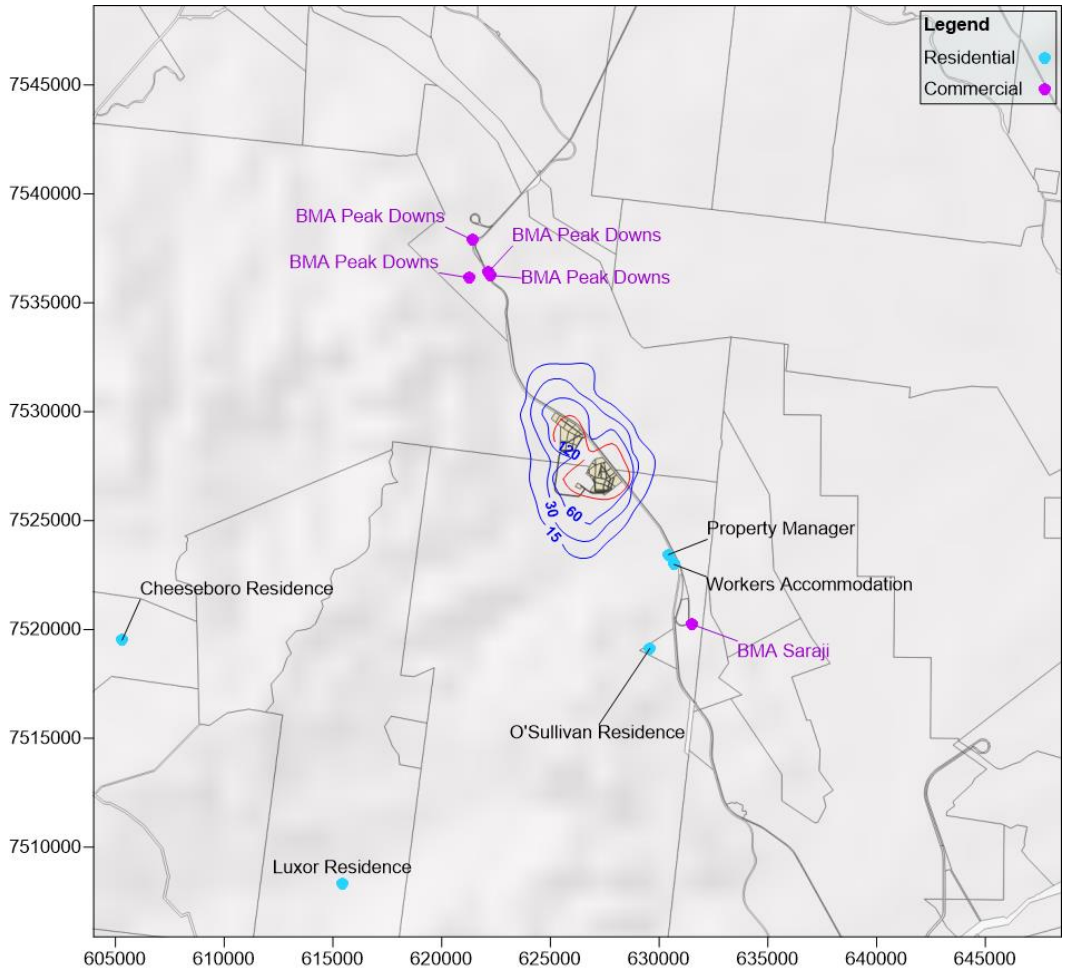

Plate 11 **Predicted maximum monthly dust deposition rate for the VS Year 2 in isolation using standard mitigation measures**

Location:	**Averaging period:**	**Data source:**	**Units:**
Vulcan South, Moranbah, QLD	Monthly	CALPUFF	mg/m^2/day
Type:	**Guideline:**	**Prepared by:**	**Date:**
Maximum contours	120 mg/m^2/day (red)	Daniel Gallagher	November 2020

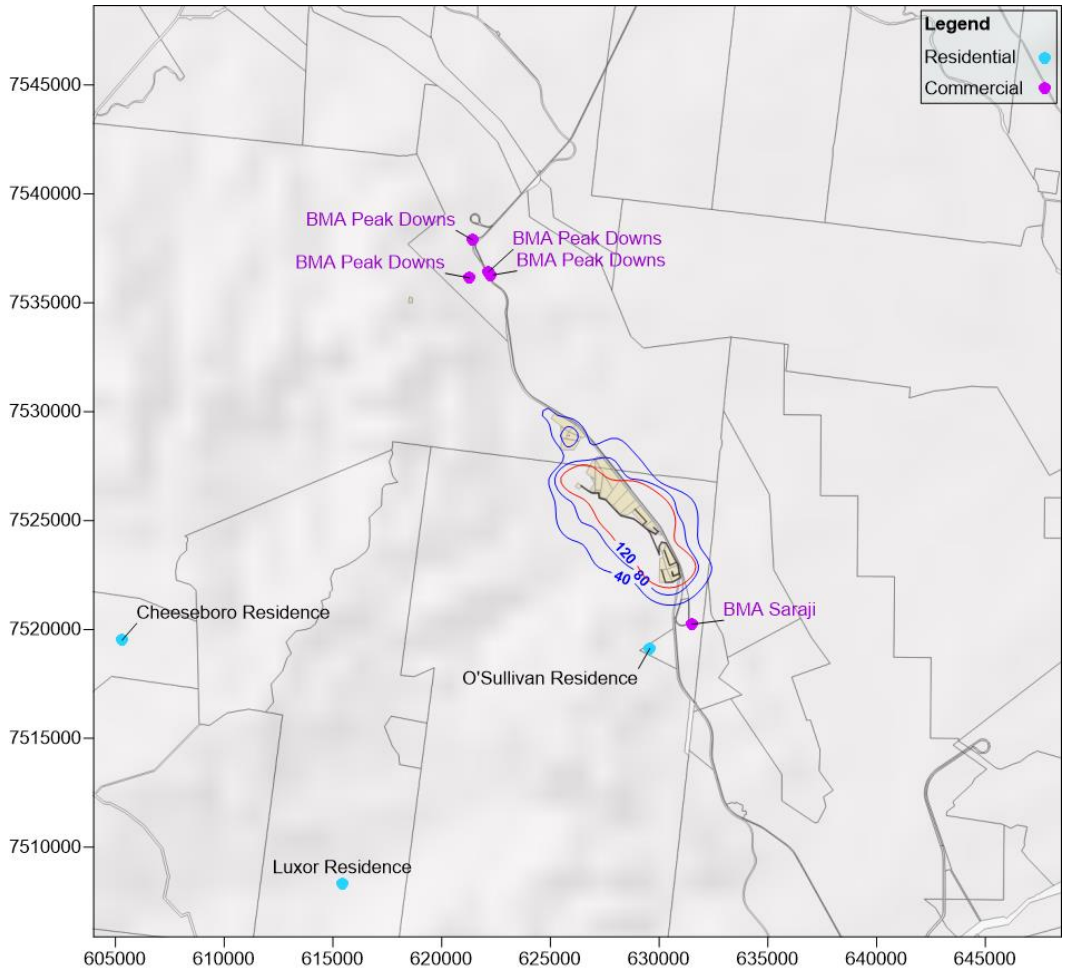

Plate 12 **Predicted maximum monthly dust deposition rate for the VS Year 7 in isolation using standard mitigation measures**

Location:	**Averaging period:**	**Data source:**	**Units:**
Vulcan South, Moranbah, QLD	Monthly	CALPUFF	mg/m^2/day
Type:	**Guideline:**	**Prepared by:**	**Date:**
Maximum contours	120 mg/m^2/day (red)	Daniel Gallagher	November 2020

APPENDIX A DETAILED DUST EMISSIONS INVENTORY DATA

A1 ACTIVITY DATA

The activity data presented in Table A1 are based on the following information:

- Information provided by METServe and Vitrinite, including site layouts, operational details, mining methods, throughput and fleet specifications; and
- Typical emissions characteristics documented in the National Pollutant Inventory (NPI) Handbooks and US EPA Compilation of Air Pollutant Emission Factors (AP-42).

Overburden and ROM extraction volumes, drilling activity, and dozer and grader utilisation have been determined based on the relative spatial extent of the active mining areas indicated in the supplied site plans. Where suitable values were not available, conservative assumptions have been used.

Table A1 Mine operations and activities data

Activity	Units	VS Year 2	VS Year 7	Information Source
Hours of operation (except blasting and Pits 7 and 8)	hours/day days/year	24	24	METServe – Copy of Noise data - VS Assessment Data Requirements.xlsx
Blasting hours	hours/day	8	8	
Overburden				
Moisture content	%	8	8	AP-42 Chapter 11.9-3, default value
Silt content	%	7	7	AP-42 Chapter 11.9-3, default value
Coal (ROM and product)				
Moisture content	%	10	10	AP-42 Chapter 11.9-3, default value
Silt content	%	9	9	AP-42 Chapter 11.9-3, default value
Road surface silt content	%	4.3	4.3	AP-42 Chapter 13.2.2, mean value for pit haul
Overburden				
Total overburden	tpa	41,185,398	40,977,582	METServe - Final Project Description_VS_June 2020 (MET00281835-010).pdf
Coal				
ROM coal total	Mtpa	1,890,350	1,949,667	METServe - Final Project Description_VS_June 2020 (MET00281835-010).pdf
Product coal total	Mtpa	1,134,210	1,169,800	
Maximum number of blasts per year	blasts/year	104	104	METServe – Copy of Noise data - VS Assessment Data Requirements.xlsx
Horizontal area of blast	m^2	20,000	20,000	
Number of holes drilled per blast	holes/blast	400	400	
Total holes drilled per year	holes/year	41,600	41,600	Calculated assuming maximum of 24 blasting days per year (METServe)
Exposed and active areas				
Total active pit area	ha	55.1	47.7	
Total overburden dump area (in-pit)	ha	147.8	114.7	

Activity	Units	VS Year 2	VS Year 7	Information Source
Total overburden dump area (ex-pit)	ha	93.7	38.3	Measured from site layouts provided by METServe – V1011_VCM Stage 2_StagePlans.pdf
Total rehabilitation area	ha	0	402.2	
Total ROM coal stockpile area	ha	4.8	4.8	
Haulage				
Total waste haulage	VKT/year	279,236	471,926	Calculated using site layouts provided by METServe
Total ROM coal haulage	VKT/year	150,140	254,272	
Total grader travel	VKT/year	138,852	138,852	
Waste trucks (Cat 789)				
Empty weight	tonnes	143.3	143.3	Manufacturer specification
Maximum payload	tonnes	181	181	Manufacturer specification
Average weight	tonnes	233.8	233.8	Calculated
Waste trucks (Cat 793)				
Empty weight	tonnes	183.8	183.8	Manufacturer specification
Maximum payload	tonnes	200	200	Manufacturer specification
Average weight	tonnes	191.9	191.9	Calculated
ROM coal trucks (Cat 777)				
Empty weight	tonnes	75.3	75.3	Manufacturer specification
Maximum payload	tonnes	89.4	89.4	Manufacturer specification
Average weight	tonnes	120.0	120.0	Calculated
Bulldozers				
Hours of operation per year	hr.op/year/vehicle	4060	4060	METServe – Copy of Noise data - VS Assessment Data Requirements.xlsx
Number	#	5	5	
Graders				
Number in operation	#	3	3	METServe – Copy of Noise data - VS Assessment Data Requirements.xlsx
Average speed	km/h	11.4	11.4	

Activity	Units	VS Year 2	VS Year 7	Information Source
Mean wind speed	m/s	2.53	2.53	CALMET modelling
Proportion of winds faster than 5.4 m/s	%	2.8	2.8	CALMET modelling
Coal stockpile height	m	15	15	Assumed (typical value)

A2 CALCULATION OF EMISSION FACTORS

A2.1 Drilling

Emission factors for drilling were calculated according to AP-42 Chapter 11.9. The default TSP emission factor of 0.59 kg/hole was used, with PM_{10} and $PM_{2.5}$ fractions of 52.5% (0.31 kg/hole) and 3% (0.02 kg/hole), respectively, according to AP-42 Chapter 11.9.

A2.2 Blasting

Emission factors for blasting were calculated according to AP-42 Chapter 11.9. The TSP emission factor is given by:

$$\mathrm{EF}_{\mathrm{TSP}} = 0.00022\ A^{1.5}$$

where:

$\mathrm{EF}_{\mathrm{TSP}}$	=	TSP emission factor (kg/blast)
A	=	horizontal blast area (m²)

PM_{10} and $PM_{2.5}$ emission factors were calculated using fractions of 52.5% and 3%, respectively, according to AP-42 Chapter 11.9.

A2.3 Bulldozing on overburden

Emission factors for dozers operating on overburden were calculated according to NPI Mining. The TSP and PM_{10} emission factors are given by:

$$\mathrm{EF}_{\mathrm{TSP}} = \frac{2.6\ s^{1.2}}{M^{1.3}}$$

$$\mathrm{EF}_{\mathrm{PM10}} = \frac{0.34\ s^{1.5}}{M^{1.4}}$$

where:

$\mathrm{EF}_{\mathrm{TSP}}$	=	TSP emission factor (kg/ hr)
$\mathrm{EF}_{\mathrm{PM10}}$	=	PM_{10} emission factor (kg//hr)
s	=	overburden silt content (%)
M	=	overburden moisture content (%)

The $PM_{2.5}$ emission factor was calculated from TSP using a fraction of 10.5% according to AP-42 Chapter 11.9.

A2.4 Bulldozing on coal

Emission factors for dozers operating on overburden were calculated according to NPI Mining. The TSP and PM_{10} emission factors are given by:

$$\mathrm{EF}_{\mathrm{TSP}} = \frac{35.6\ s^{1.2}}{M^{1.4}}$$

$$\mathrm{EF}_{\mathrm{PM10}} = \frac{6.33\ s^{1.5}}{M^{1.4}}$$

where:

$\mathrm{EF}_{\mathrm{TSP}}$	=	TSP emission factor (kg/ hr)

$\mathrm{EF}_{\mathrm{PM10}}$	=	PM_{10} emission factor (kg//hr)
s	=	coal silt content (%)
M	=	coal moisture content (%)

The $PM_{2.5}$ emission factor was calculated from TSP using a fraction of 2.2% according to AP-42 Chapter 11.9.

A2.5 Material transfers and handling

Materials handling and transfers include truck loading, dumping, conveyor transfers and train load-out. These emission factors were calculated according to AP-42 Chapter 13.2.4 using the following equation:

$$\mathrm{EF} = k(0.0016)\left(\frac{U}{2.2}\right)^{1.3}\left(\frac{M}{2}\right)^{-1.4}$$

where:

EF	=	emission factor (kg/Mg)
k	=	particle size multiplier
U	=	mean wind speed (m/s)
M	=	material moisture content (%)

The particle size multiplier k varies with aerodynamic particle size range as follows:

$k = 0.74$	Particle size < 30 µm (TSP)
$k = 0.35$	Particle size < 10 µm (PM_{10})
$k = 0.053$	Particle size < 2.5 µm ($PM_{2.5}$)

A2.6 Grading

Emission factors for grading were calculated according to AP-42 Chapter 11.9. The TSP and PM_{10} emission factors are given by:

$$\mathrm{EF}_{\mathrm{TSP}} = 0.0034\,S^{2.5}$$

$$\mathrm{EF}_{\mathrm{PM10}} = 0.0034\,S^{2}$$

where:

$\mathrm{EF}_{\mathrm{TSP}}$	=	TSP emission factor (kg/VKT)
$\mathrm{EF}_{\mathrm{PM10}}$	=	PM_{10} emission factor (kg/VKT)
S	=	grader average speed (km/h)

The $PM_{2.5}$ emission factor was calculated from TSP using a fraction of 3.1% according to AP-42 Chapter 11.9.

A2.7 Wind erosion from active stockpiles

Emission factors for wind erosion of active stockpiles were calculated on an hourly basis using the emission factor for active storage piles from AP-42 Chapter 11.9. The TSP emission factor is given by:

$$\mathrm{EF}_{\mathrm{TSP}} = 1.8u$$

Where:

$\mathrm{EF}_{\mathrm{TSP}}$	=	TSP emission factor (kg/ha/hr)
u	=	hourly-average wind speed (m/s)

PM_{10} and $PM_{2.5}$ emission factors were calculated using fractions of 50% and 7.5%, respectively, according to AP-42 Chapter 11.9.

A2.8 Wind erosion from exposed areas

Emission factors for wind erosion of exposed areas were calculated on an hourly basis using the emission factor for exposed areas from AP-42 Chapter 11.9 and adapted to include a threshold for dust lift-off.

The default TSP emission factor of 0.85 Mg/ha/yr was used, with the annual emissions apportioned into hourly emissions according to the square of the hourly wind speed compared with the threshold of $(5.4\ \mathrm{m/s})^2$. This reflects the tendency for stronger winds to generate more dust lift-off (if above the threshold for lift-off) and yields worse emissions during hours of strong winds.

PM_{10} and $PM_{2.5}$ emission factors were calculated using fractions of 50% and 7.5%, respectively, according to AP-42 Chapter 11.9.

A2.9 Wheel-generated dust

Emission factors for wheel-generated dust on unpaved roads were calculated according to AP-42 Chapter 13.2.2 via the following equation:

$$\mathrm{EF} = k(281.9)\left(\frac{s}{12}\right)^{a}\left(\frac{W}{3}\right)^{b}$$

where

EF	=	emission factor (g/VKT)
k	=	particle size multiplier
s	=	surface material silt content (%)
W	=	mean vehicle weight (tons)
a, b	=	empirical constants

A factor of 1.10231 was used to convert the vehicle weights in Table A1 to imperial tons. The particle size multiplier and empirical constants vary with aerodynamic particle size range as defined in Table A2.

Table A2 Constants used in calculating emissions from wheel-generated dust

Constant	TSP (assumed from PM_{30})	PM_{10}	$PM_{2.5}$
k	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

A2.10 Crushing

Emission factors for the crushing of coal were calculated according to AP-42 Chapter 11.19.2. The default TSP and PM_{10} emission factors were used, equal to 0.0027 kg/tonne and 0.0012 kg/tonne of coal crushed, respectively. The $PM_{2.5}$ emission factor was calculated from TSP using a ratio of 8.33% according to AP-42 Chapter 11.19.2.

A2.11 Screening

Emission factors for the screening of coal were calculated according to AP-42 Chapter 11.19.2. The default TSP and PM_{10} emission factors were used, equal to 0.0125 kg/tonne and 0.0043 kg/tonne of coal screened, respectively. The $PM_{2.5}$ emission factor was calculated from TSP using a ratio of 2.27% according to AP-42 Chapter 11.19.2.

APPENDIX B METEOROLOGICAL AND DISPERSION MODELLING METHODOLOGY

B1 METEOROLOGY

The meteorological modelling methodology for the VS included the following steps:

- Selection of a representative year;
- TAPM modelling; and
- CALMET modelling.

The following sections describe each step of the meteorological modelling conducted for the VS.

B1.1 Selection of representative year

A representative year is required to be selected at the beginning of the meteorological modelling process. Using a representative year in the air quality assessment ensures that the conditions experienced at the VS site are reflected in the model.

Selection of a representative year has been done through statistical analysis of historical meteorological observations at BoM Moranbah Airport weather station. Meteorological observations from the past five years at Moranbah Airport were analysed in order to assess the inter-annual variability.

The annual frequency distributions of wind direction, wind speed and temperature for the period 2014 to 2018 were analysed and compared to the average distribution for the same five-year period. The analysis indicated that there was not a significant amount of variation in the distributions of wind direction, wind speed or temperature as illustrated graphically in Figure B1 to Figure B3, with the exception of Year 2016. Based on the analysis, the year 2018 was selected as the year for modelling as this year presented as the most recent year and also close to the 5-year average.

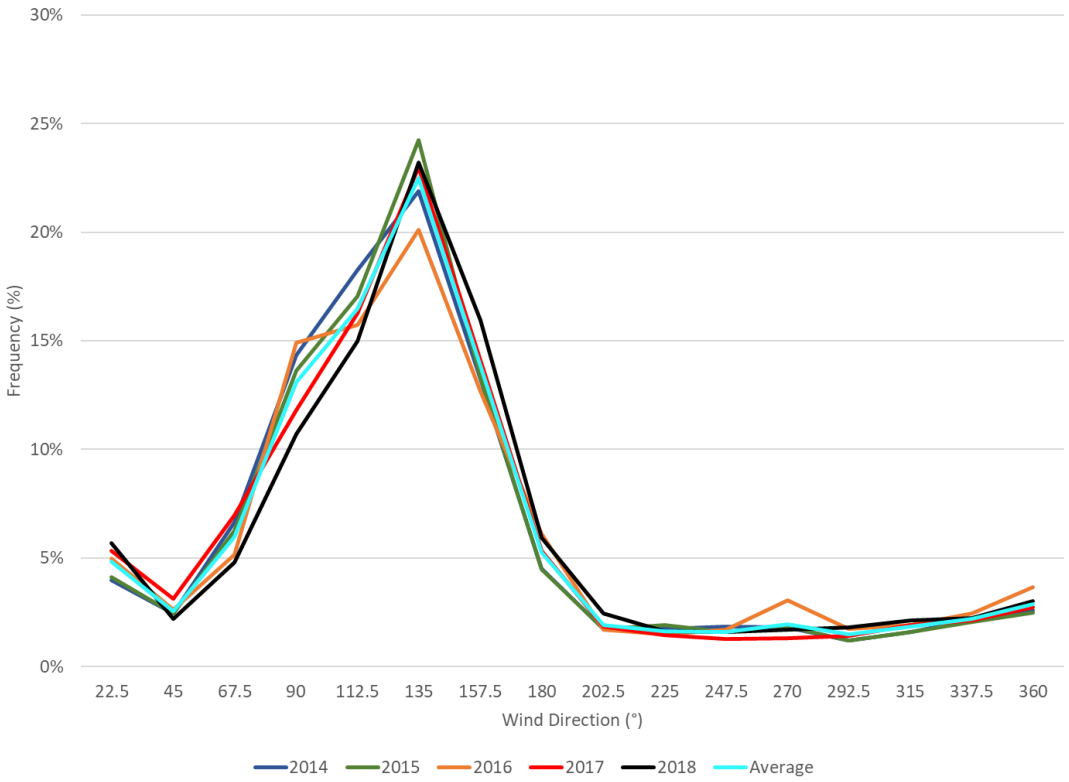

Figure B1 **Annual Wind Direction Frequency Distribution at Moranbah Airport**

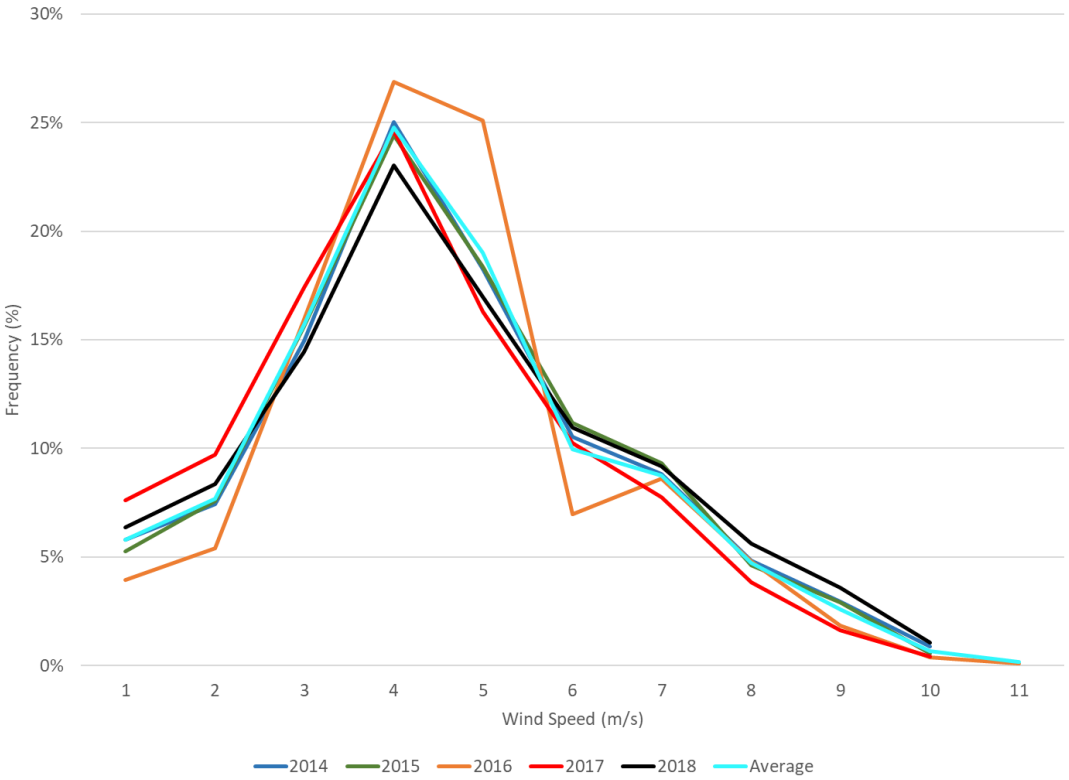

Figure B2 **Annual Wind Speed Frequency Distribution at Moranbah Airport**

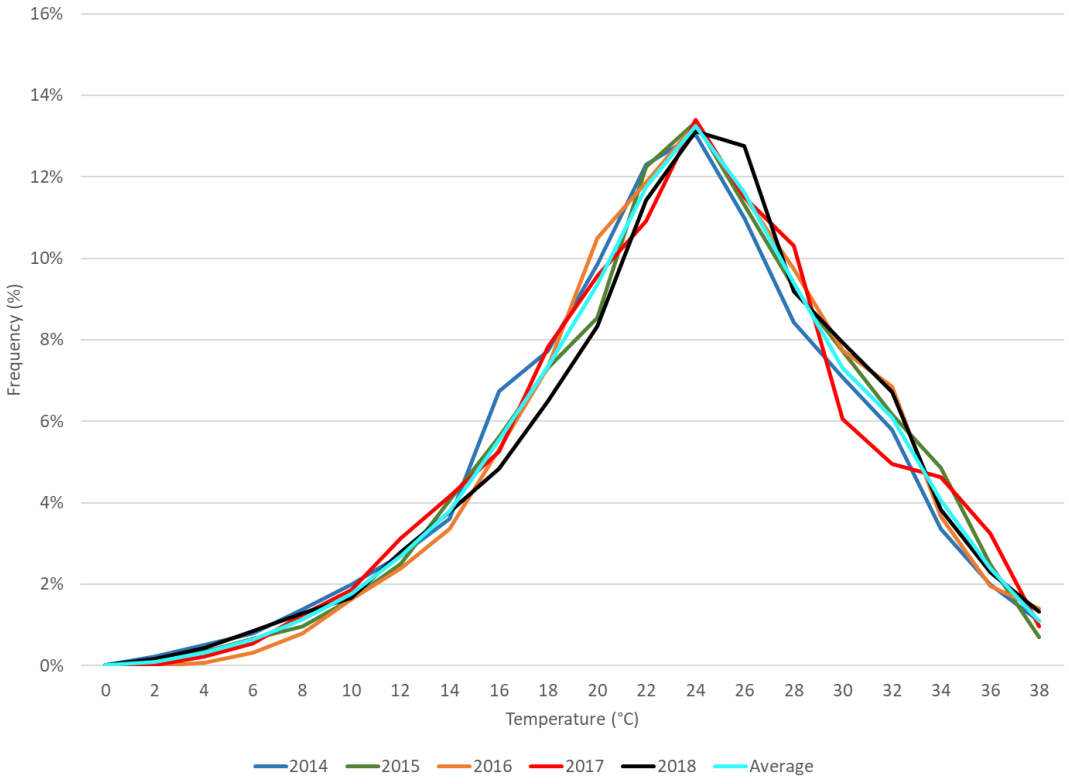

Figure B3 Annual Temperature Frequency Distribution at Moranbah Airport

B1.2 TAPM meteorology

The meteorological model, TAPM has been validated by the CSIRO, Katestone and others for many locations in Australia, in south-east Asia and in North America (CSIRO, 2008). Katestone has used the TAPM model throughout Australia as well as in parts of America, Bangladesh, New Caledonia and Vietnam. This model has performed well for simulating regional winds patterns. TAPM has proven to be a useful model for simulating meteorology in locations where monitoring data is unavailable.

TAPM is a prognostic meteorological model which predicts the flows important to regional and local scale meteorology, such as sea breezes and terrain-induced flows from the larger-scale meteorology provided by the synoptic analyses. TAPM solves the fundamental fluid dynamics equations to predict meteorology at a mesoscale (20 km to 200 km) and at a local scale (down to a few hundred metres (m)). TAPM includes parameterisations for cloud/rain micro-physical processes, urban/vegetation canopy and soil, and radiative fluxes.

TAPM requires synoptic meteorological information for the region. This information is generated by a global model similar to the large-scale models used to forecast the weather. The data were supplied on a grid resolution of approximately 75 km, and at elevations of 100 m to 5 km above the ground. TAPM uses this synoptic information, along with specific details of the location such as surrounding terrain, land-use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

Landcover data for TAPM are sourced from the US Geological Survey, Earth Resources Observation Systems (EROS) Data Center Distributed Active Archive Center (EDC DAAC) at 30-second (approximately 1 km) grid spacing.

TAPM was configured as follows:

- Modelling period for one year from 1 January to 31 December 2018;
- 30 x 30 grid point domain with an outer grid of 30 km and nesting grids of 10 km, 3 km and 1 km;
- 25 vertical levels;
- Grid centred near the VS (latitude –22° 21.0', longitude 148° 14.5');
- Geoscience Australia 9 second DEM terrain data;
- Land cover data based on TAPM's default land-use database and edited to match recent land-use imagery;
- Default options selected for advanced meteorological inputs; and
- No data assimilation.

B1.3 CALMET meteorological modelling

CALMET is an advanced non-steady-state diagnostic 3D meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF modelling system. CALMET can read hourly meteorological data as data assimilation from multiple sites within the modelling domain; it can also be initialised with the gridded three-dimensional prognostic output from other meteorological models such as TAPM. This can improve dispersion model output, particularly over complex terrain as the near surface meteorological conditions are calculated for each grid point.

CALMET (version 6.5) was used to simulate meteorological conditions in the region. The CALMET simulation was initialised with the gridded TAPM 3D wind field data from the 3 km grid. CALMET treats the prognostic model output as the initial guess field for the CALMET diagnostic model wind fields. The initial guess field is then adjusted for the kinematic effects of terrain, slope flows, blocking effects and 3D divergence minimisation.

Key features of CALMET used to generate the wind fields are as follows:

- Domain area of 81 by 81 grid points at 1 km spacing;
- Twelve vertical levels set at 20 m, 60 m, 100 m, 150 m, 200 m, 250 m, 350 m, 500 m, 800 m, 1600 m, 2600 m and 4600 m;
- 365 days (1 January to 31 December 2018);
- No observations mode, with prognostic wind fields generated by TAPM input as MM5/3D.dat at surface and upper air for "initial guess" field;
- Gridded cloud cover from prognostic relative humidity at all levels;
- No extrapolation of surface winds observations;
- All other wind field options set as default;
- Terrain radius of influence set at 20 kilometres;
- Mixing height parameters all set as default;
- 3D Relative humidity and temperature from prognostic data; and
- No data assimilation.

All other options and factors were set to default.

B2 DISPERSION MODELLING

CALPUFF simulates the dispersion of air pollutants to predict ground-level concentration and deposition rates across a network of receptors spaced at regular intervals, and at identified discrete locations. CALPUFF is a non-steady-state Lagrangian Gaussian puff model. CALPUFF employs the 3D meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal.

CALPUFF takes into account the geophysical features of the study area that affects dispersion of pollutants and ground-level concentrations of those pollutants in identified regions of interest. CALPUFF contains algorithms that can resolve near-source effects such as building downwash, transitional plume rise, partial plume penetration, sub-grid scale terrain interactions, as well as the long-range effects of removal, transformation, vertical wind shear, overwater transport and coastal interactions. Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of those sources within the modelling domain.

Key features of CALPUFF v7.2.1 used to simulate dispersion in the VS assessment include:

- Domain area of 81 km by 81 km equivalent to the domain defined in CALMET;
- 365 days modelled (1 January to 31 December 2018);
- Gridded 3D hourly-varying meteorological conditions generated by CALMET;
- Partial plume path adjustment and transitional plume rise modelled;
- No chemical transformation or wet removal modelled;
- PDF used for dispersion under convective conditions; and
- Dispersion coefficients calculated internally from sigma v and sigma w using micrometeorological variables.

All other options set to default.

B2.1 Source configuration

Characteristics for modelled sources are summarised in Table B1.

Emissions from all source types (haul roads, extraction and material handling, wind erosion and processing area) were modelled as area sources. Wind erosion was modelled as an hourly-varying emission source. Emissions from blasting were modelled to reflect daytime operations only from 6 am to 6 pm.

An additional control factor of 50% for TSP and 5% for PM_{10} has been applied to in-pit activities (drilling and blasting and material extraction/handling) to account for pit retention.

Table B1 Characteristics of modelled area sources

Source Type	Effective height	Initial vertical dispersion coefficient (σ_z)
	m	m
Haul roads	10	2.5
Pit activities (drilling and blasting)	8	2
All extraction and material handling activities	10	2.5
Wind erosion of exposed and rehabilitated areas	1	0.25
Processing area	10	2.5

Appendix B
Noise Impact Assessment

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Vulcan South

Noise Impact Assessment

Report: 197401.0210.R02V05

Prepared for:

Vitrinite Pty Ltd

11 October, 2022

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197401.0210.R02V04	13 May, 2022	Revision	Pubudu Jayawardana	Stephen Pugh
197401.0210.R02V05	11 October, 2022	Response to DES Request	Samuel Wong	Beau Weyers

Document Approval	
Approver Signature	
Name	Samuel Wong
Title	Environmental Manager

Contents

Appendices

1. Introduction

Trinity Consultants Australia T/A ASK Consulting Engineers was commissioned by Mining & Energy Technical Services Pty Ltd on behalf of Vitrinite Pty. Ltd., owner of Qld Coal Aust No.1 Pty. Ltd. and Queensland Coking Coal Pty. Ltd. (Vitrinite), to provide noise and vibration consultancy services for the proposed Vulcan South coal mine (the Project).

The proposed Project location is approximately 35 kilometres (km) south east from Moranbah as shown in **Figure 1.1**.

This report presents an assessment of the noise and vibration impacts associated with the proposed coal mine.

This report is based on the following tasks:

- Review the project and the associated potential noise emissions;
- Review existing noise monitoring data applicable to the project site;
- Model the noise emissions based on proposed activities using SoundPLAN to calculate noise levels at sensitive receptors and develop contours over the modelling area for typical operations;
- Analyse the results of noise modelling and compare modelling results with the relevant noise criteria selected to protect the acoustic environment;
- Assess blast information for vibration and airblast; and
- Provide recommendations on control measures, where required.

To aid in the understanding of the terms in this report a glossary is included in **Appendix A**.

Figure 1.1 Vulcan South Location (Image from QLD Globe)

2. Project Description

2.1 Overview

The Project is located between Dysart and Moranbah in Queensland's Bowen Basin (**Figure 1.1**). The Project lies to the immediate west of several established mining operations including BHP's Peak Downs and Saraji mines. The Vulcan Coal Mine (VCM) pit is proposed to the north-east of the Project.

The Vulcan hard coking coal target has been defined and selected for open cut development via 3 separate open cut pits that form the primary mining focus of the Project. The project will operate for approximately nine years, including primary rehabilitation works, following a 2 year construction period and will extract approximately 13.5 Mt of ROM coal consisting predominately of hard coking coal with an incidental thermal secondary product at a rate of up to 1.95 Mtpa. The Project will target the Alex and multiple Dysart Lower coal seams. Truck and shovel mining operations will be employed to develop the pits. A mine infrastructure area (MIA) will be established along with a modular coal handling and preparation plant (CHPP), rail loop and train load-out facility (TLO) at a location between the northern and central pits. The CHPP will include solid bowl centrifuges to maximise water recycling and to produce a dry tailings waste product for permanent storage within active waste rock dumps.

Out-of-pit waste rock dumps will be established prior to commencing in-pit dumping activities that will continue for the life of the operation. Ancillary infrastructure, including a Run of Mine (ROM) pad, offices, roads and surface water management infrastructure will be established to support the operation.

A realignment of the existing Saraji Road and services infrastructure to the eastern boundary of the proposed Mining Lease Application (MLA) area, adjacent to the existing rail easement, is also proposed in a number of locations. The re-alignment will occur within the MLA area.

In-pit dumping will fill the majority of the pit volumes during operations with the remaining final voids to be backfilled upon cessation of mining, resulting in the establishment of low waste rock dump landforms over the former pit areas. Following backfill of the final voids, the remaining material stored in the initial out-of-pit waste rock dumps will be rehabilitated in-situ.

The Project includes a small-scale highwall mining trial program in the north of the MLA. The trial will involve the establishment of 4 highwall mining benches across a number of hillsides to facilitate extraction of coal utilising a CAT HW300 highwall miner. The highwall mining trial will target up to 750 kt of coal which will be transported by truck to the Project CHPP via a dedicated haul road within the MLA area. The trial is scheduled to be completed within the first year of mining operations.

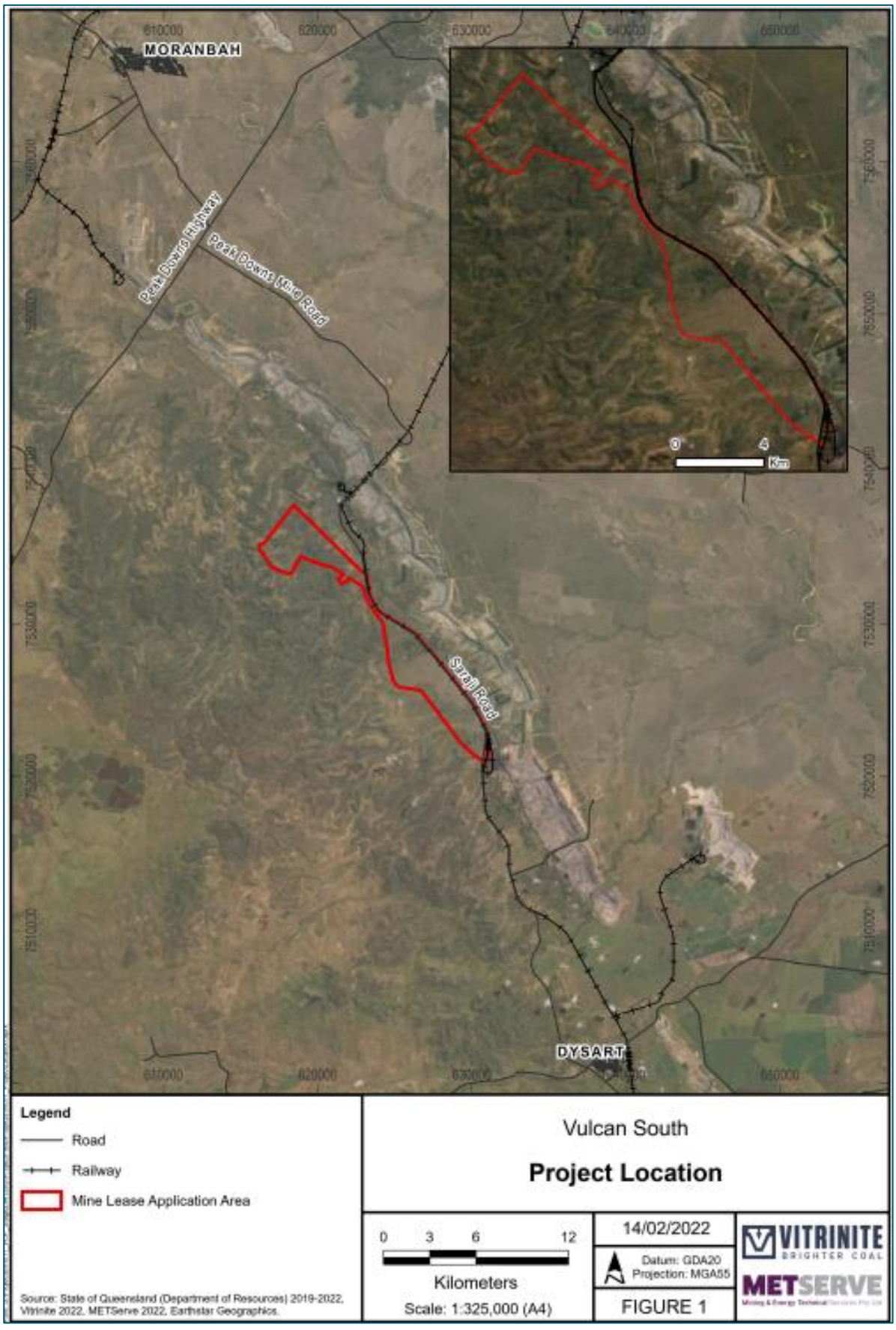


Figure 2.1 Vulcan South Maximum Disturbance Areas

2.2 Project Development Stages

The Project is a small scale mining operation, with coal extraction planned for approximately eight years, followed by completion of primary rehabilitation activities in year nine. Construction of infrastructure associated with the mining operation, including the CHPP and the rail loop, is expected to be completed within 2 years. Construction of the realigned Saraji Road sections will be completed intermittently as the Project progresses, as required. Ongoing establishment of internal road networks, surface water management infrastructure and other ancillary infrastructure will continue to be developed as the pits and in-pit dumps advance. Project stage plans for Years 3, 4 and 7 are presented **Figure 2.2** to **Figure 2.4**.

2.3 Mining Activities

2.3.1 Open Cut Mining

The open cut will extend to a depth of approximately 60 metres (m), following the seam as it dips eastwards. The footprint of the proposed three open cuts (Vulcan North, Vulcan Main and Vulcan South) are approximately 400 hectares (ha). Truck and shovel mining methods will be employed to extract waste rock and coal from the pit.

The open-cut operations are described as follows:

- Topsoil will be removed and hauled to the topsoil stockpile area;
- Drilling and blasting will be undertaken;
- Excavators will load trucks with overburden, which will then be hauled to the overburden dump;
- Dozers will push some overburden back into the pit;
- Excavators will load the mined coal into haul trucks to be transported from the pits to the run-of-mine (ROM) pad;
- Haul trucks will unload ROM coal at the ROM pad;
- The ROM coal will be crushed and screened;
- Rejects from the crushing and screening process will be stockpiled separately and placed within the relevant active dump.

2.3.2 High Wall Mining

The Project includes a small-scale highwall mining trial program in the north of the MLA. The trial will involve the establishment of 4 highwall mining benches across a series of hillsides to facilitate extraction of coal utilising a CAT HW300 highwall miner. The highwall mining trial will target up to 750 kt of coal within the first year of mining operations. Mined coal will be loaded by front-end-loader and transported by truck to the Project CHPP via a dedicated haul road within the MLA.

2.4 Production Rate and Schedule

The Vulcan South Project will commence operations at the Vulcan North and Vulcan Main pits, in close succession. Operations at the Vulcan Main pit will continue for the full 8 year mine life. Mining activities at the Vulcan North pit are anticipated to be completed after three years. Activities at the Vulcan South pit will commence in year 6 of operations and will conclude three years later in year 8. Throughout the project life, the average annual ROM coal production rate is less than 1.7 Mtpa. During peak production periods, the Project will produce up to 1.95 Mtpa. An indicative annual mining schedule is provided in **Table 2.1.**

Table 2.1 Indicative Mining Schedule

Production	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Total (t)
Highway Mining									
Topsoil (t)	622,557								622,557
Waste Rock (t)	6,246,343								6,246,343
ROM Coal (t)	750,000								750,000
Vulcan North Pit									
Topsoil (t)	58,734	313,019	40,004						411,757
Waste Rock (t)	4,001,234	24,117,467	1,616,789						29,735,489
ROM Coal (t)	26,137	1,202,385	585,592						1,814,114
Vulcan Main Pit									
Topsoil (t)	35,686	298,486	298,079	305,290	389,958	183,329	257,856	141,396	1,910,079
Waste Rock (t)	1,261,637	17,067,931	38,929,456	40,431,863	40,855,127	33,106,442	23,798,147	11,652,257	207,102,860
ROM Coal (t)		687,965	1,223,774	1,841,120	1,728,933	1,560,844	1,304,554	1,027,403	9,374,594
Vulcan South Pit									
Topsoil (t)						142,196	198,534	131,741	472,471
Waste Rock (t)						8,100,351	17,179,435	13,883,816	39,163,602
ROM Coal (t)						249,607	647,113	451,034	1,347,754
Annual Total									
Topsoil (t)	716,977	611,505	338,083	305,290	389,958	325,525	456,390	273,137	3,416,865
Waste Rock (t)	11,509,214	41,185,398	40,546,244	40,431,863	40,855,127	41,206,793	40,977,582	25,536,073	282,248,294
ROM Coal (t)	776,137	1,890,350	1,809,366	1,841,120	1,728,933	1,810,451	1,949,667	1,488,437	13,294,461

The following indicative mining equipment fleet is proposed for the Project:

Open cut operations:

- 1 x 400t class excavator
- 1 x 600t class excavator
- 2 x small coal clean-up excavators
- 4 x 90t mine trucks
- 5 x 180t mine trucks
- 4 x 200-220t mine trucks
- 2 x D10 dozers
- 2 x D11 dozers
- 3 x Graders
- 3 x Water trucks
- 2 x Drill rigs
- 2 x Service trucks.

Highwall mining trial:

- HW300 highwall mining system (low height cutter head)
- Push beams x 67 (400 m)
- Diesel generator
- Critical spares.

Highwall trenching and benching equipment:

- EX3600 Excavator
- ZX870
- CAT D11R
- 16M Grader
- CAT 775 Water Cart.

Highwall support equipment:

- 966H Loader (push beam handling)
- 988H Loader (Loading trucks, stockpile management)
- Loader attachments (forks, bucket)
- Stacker belt (stockpiling ROM coal)
- Off road haulage trucks (ROM coal to CHPP)
- Minor ancillary equipment.

2.5 Upset Conditions

Potential upset conditions and their effect on noise emissions are discussed as follows:

- If a piece of equipment malfunctions, this could result in an increased noise level for that item of equipment, although the overall effect on noise emissions from the whole site would likely be minor. When equipment malfunctions, it will be quickly taken out of operation, and adverse noise impacts are not expected to occur. In addition, all equipment will be maintained routinely, and malfunctions that increase noise levels are expected to be rare.
- Severe weather conditions could cause mining activity to reduce or stop. This would result in lower noise emission levels. Strong winds blowing from the mine towards sensitive receptors could increase

the mining noise levels but would also likely increase the background noise levels significantly such that mining noise would be masked.

Overall it is not expected that upset conditions pose a risk of additional noise impact, and further assessment of such cases is not considered to be warranted.

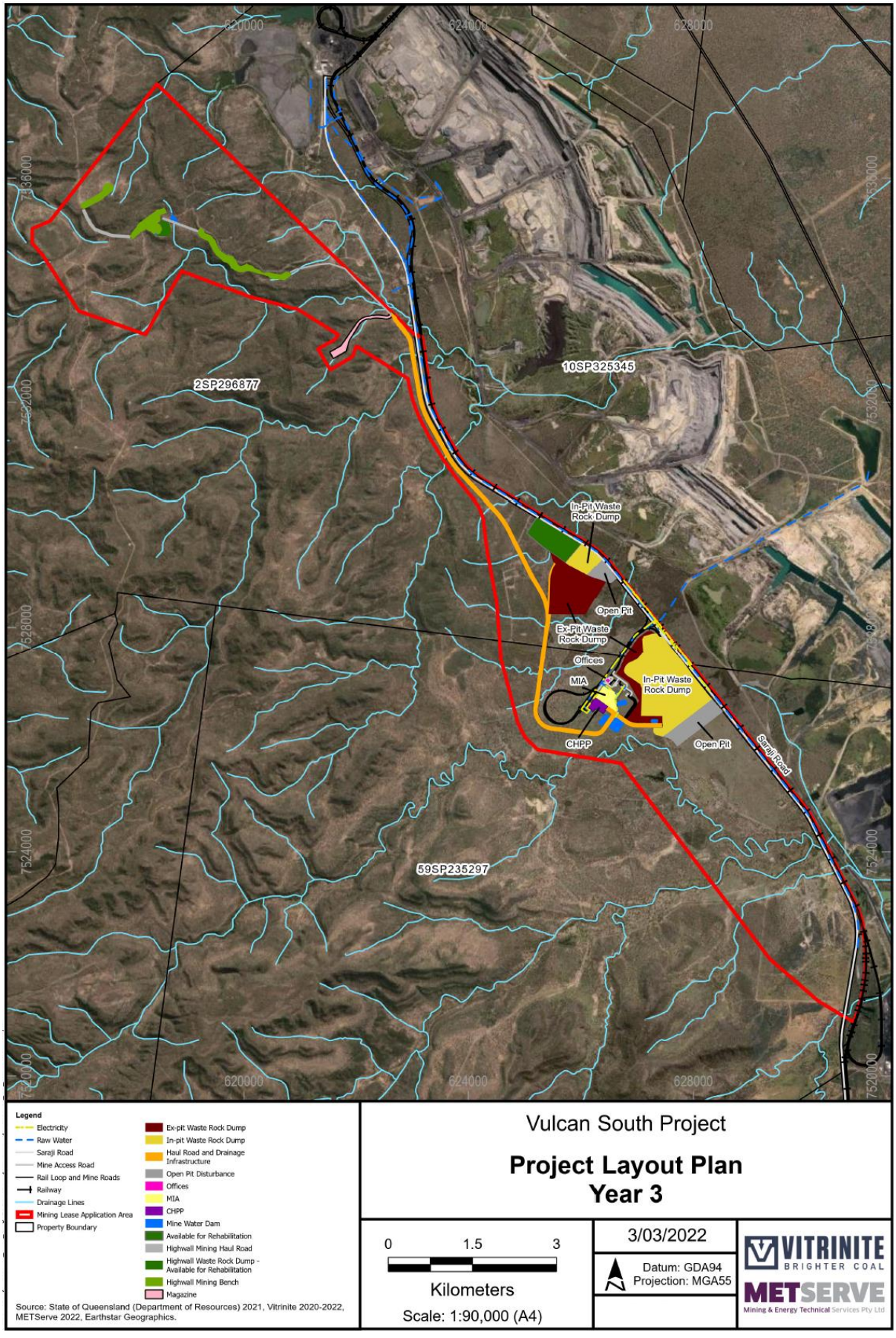


Figure 2.2 Year 3 Indicative Project Layout Plan

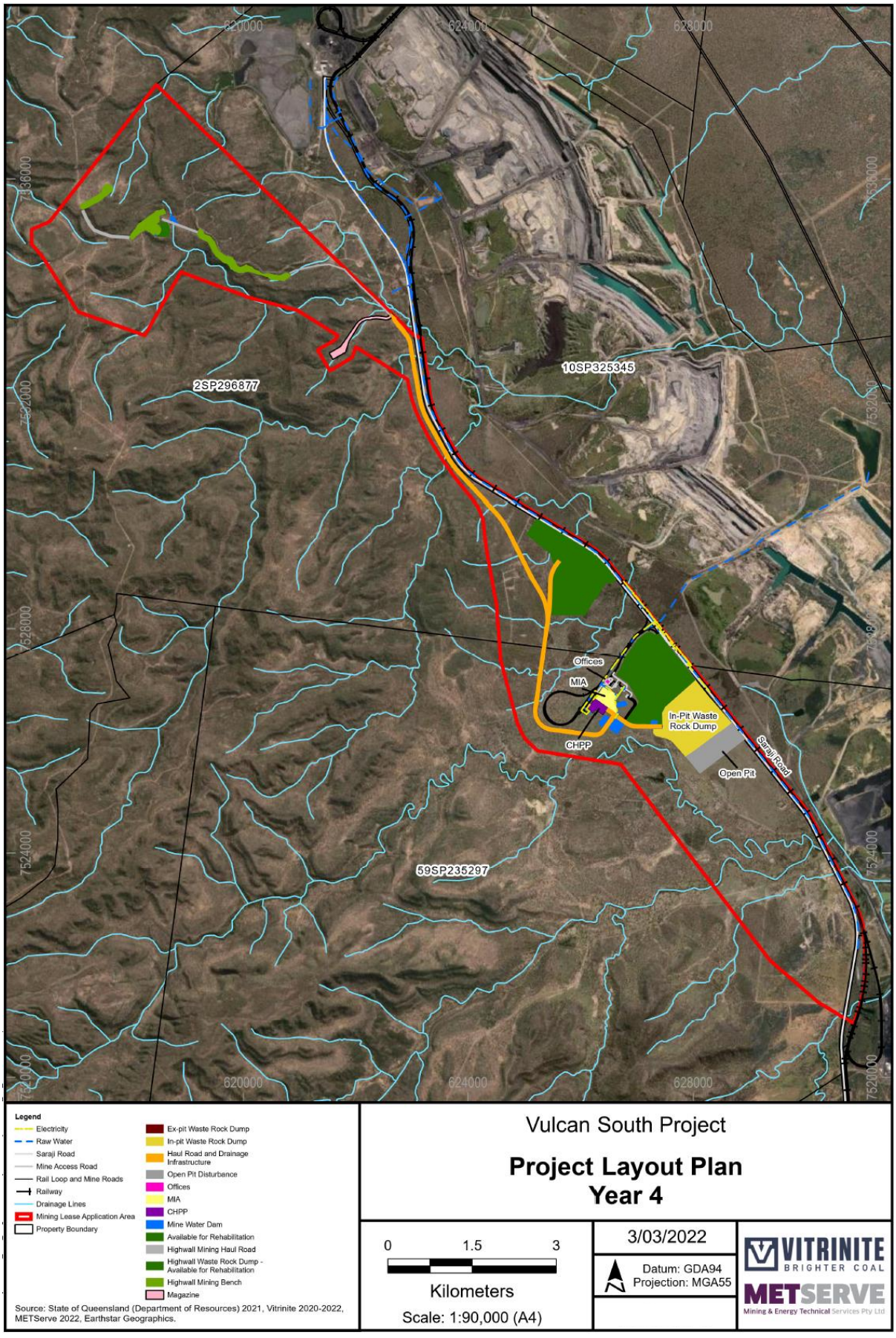


Figure 2.3 Year 4 Indicative Project Layout Plan

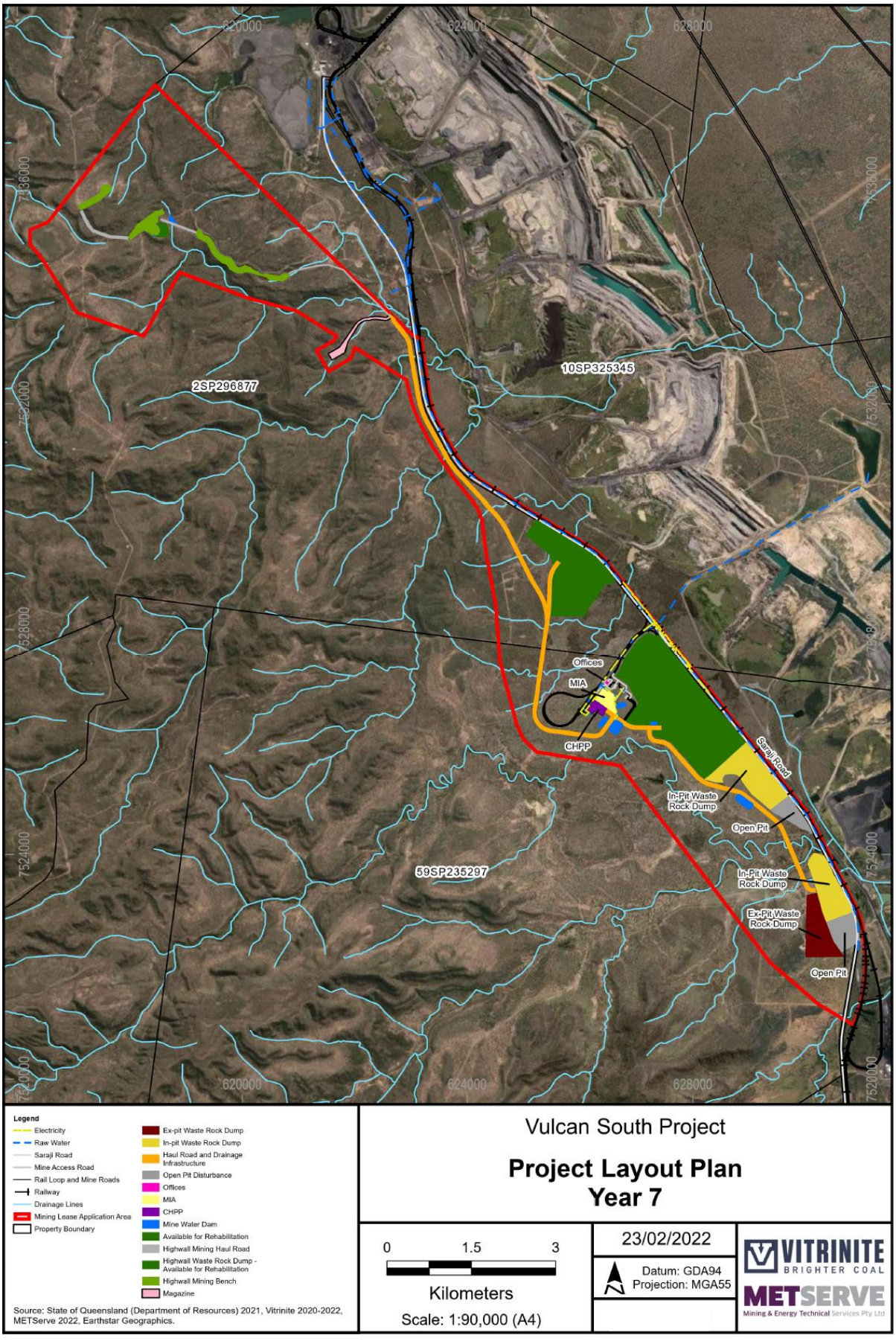


Figure 2.4 Year 7 Indicative Project Layout Plan

3. Study Area Description

3.1 Overview

The site is located in a rural area. The closest town is Moranbah which is located approximately 35 km north-west from the proposed site.

3.2 Receptors

The nearest receptors are summarised in **Table 3.1** including their locations (Latitude and Longitude) and are shown in **Figure 3.1**. The list includes commercial receptors and sensitive residential receptors, where the definition of a sensitive place required to be considered by operators of environmentally relevant activities is provided by the Department of Environment and Science (DES 2019). This definition is a place that could include but is not limited to:

- A dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises;
- A Motel, Hotel or Hostel;
- A Kindergarten, School, University or other Educational Institution;
- A Medical centre or Hospital;
- A protected area under the Nature Conservation Act 1992, the Marine Parks Act 2004 or a World Heritage Area;
- A Public park or garden; and
- A place used as a Workplace including an office for business or commercial purposes.

Table 3.1 Commercial and Sensitive Residential Receptors (Residential are Shaded Blue)

#	Receptor Name	Receptor Description	Location (Latitude and Longitude)	Distance (m) from nearest Project Disturbance Area	Direction from the Project	Distance (m) from nearest BHP Mine Operations
1	BMA Peak Downs	Commercial- Sustaining projects construction support and geological services buildings	-22.276062 148.177274	1,365	North to East	850
2	BMA Peak Downs	Commercial- Field workshop and field office/crib area	-22.27497 148.18670	1,850	North to East	Within existing operations (Adjacent to Goonyella System Rail (100m) and main haul road (400m)
3	BMA Peak Downs	Commercial- Field office/crib area	-22.27351 148.18567	2,020	North to East	Within existing operations (Adjacent to Goonyella System Rail (80m), hardstands (10m) and main haul road (350m)

#	Receptor Name	Receptor Description	Location (Latitude and Longitude)	Distance (m) from nearest Project Disturbance Area	Direction from the Project	Distance (m) from nearest BHP Mine Operations
4	BMA Peak Downs	Commercial- Main offices area and workshop area	-22.26044 148.17860	3,060	North to East	Within existing operations (400m from CHPP)
5	Property Manager Residence	Residential- Property managers residence	-22.390147 148.267067	Within MLA	Within MLA	410
6	Workers Residence	Residential- Workers residence	-22.394204 148.269578	Within MLA	Within MLA	480
7	BMA Saraji	Commercial- Main office area and workshop	-22.418965 148.277679	1,960	South	Within existing operations (300m from CHPP)
8	Saraji Station Residence	Residential	-22.42916 148.259057	2,970	South	-
9	Luxor Residence	Residential	-22.527639 148.122611	>15,000	South-west	-
10	Cheeseboro Residence	Residential	-22.427361 148.023250	>20,000	West	-

Note: All distances should be considered approximate.

It is noted that Receptors 5 and 6 are located on the MLA area. The commercial/industrial receptors are associated with BMA Peak Downs and those receptors are closer to the established BHP mine operations than the Project, and therefore would likely already be exposed to higher noise levels than produced by the Project.

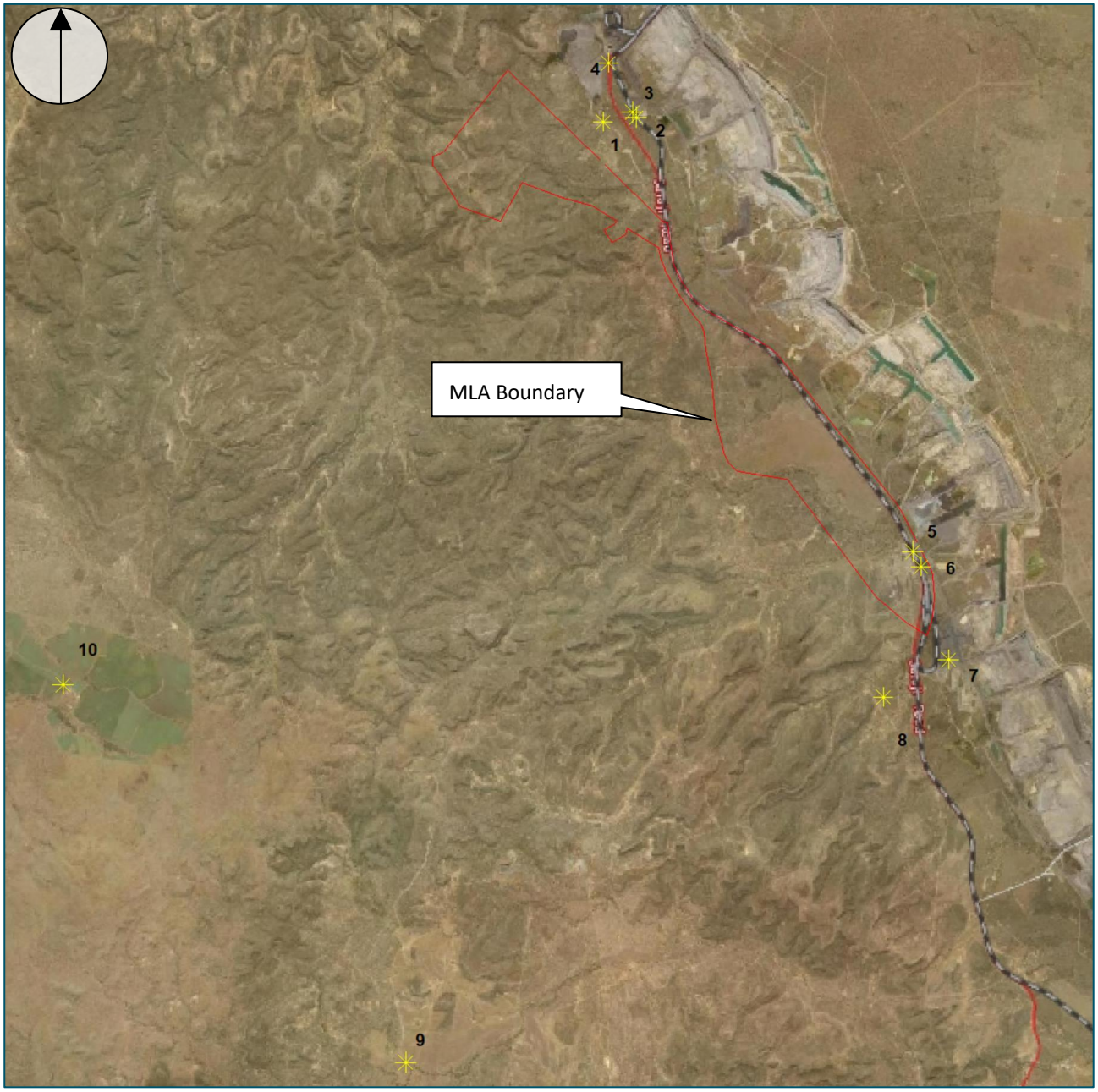


Figure 3.1 Location of MLA (Mine Lease Area) and Receptor Locations 1 to 10

4. Acoustic Criteria

4.1 Overview

Noise and vibration criteria are required to assess the potential impacts of the proposed mine operations on sensitive receptors.

The relevant Department of Environment and Science (DES) noise and vibration criteria have been considered and are listed as follows:

- Environmental Protection Act 1994;
- Environmental Protection (Noise) Policy 2019;
- Guideline "Planning For Noise Control", Department of Environment and Science;
- Guideline "Noise and Vibration from Blasting", Department of Environment and Science; and
- Guideline "Model Mining Conditions", Department of Environment and Science.

4.2 Environmental Protection Act

In Queensland, the environment is protected under the *Environmental Protection Act 1994* (EP Act).

Section 3 of the EP Act states that the object of the Act is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).

Section 12 of the EP Act defines noise as including *"vibration of any frequency, whether emitted through air or another medium"*.

Section 319 of the EP Act relates to General Environmental Duty and states that a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm.

Section 14(1) of the EP Act defines environmental harm as any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance.

Section 15 of the EP Act defines environmental nuisance as an unreasonable interference or likely interference with an environmental value caused by (a) noise.

The EP Act refers to the Environmental Protection Policies as being subordinate legislation to the Act.

4.3 Environmental Protection (Noise) Policy

4.3.1 Overview

With respect to the acoustic environment, the object of the EP Act is achieved by the Environmental Protection (Noise) Policy 2019 (EPP (Noise)). This policy identifies environmental values to be enhanced or protected, states acoustic quality objectives, and provides a framework for making decisions about the acoustic environment.

4.3.2 Acoustic Quality Objectives

The EPP (Noise) contains a range of acoustic quality objectives for a range of receptors. The objectives are in the form of noise levels, and are defined for various periods of the day, and use a number of acoustic parameters.

Schedule 1 of the EPP(Noise) includes the following acoustic quality objectives to be met at residential dwellings:

- Outdoors

  Daytime and Evening: 50 dBA $L_{Aeq,adj,1hr}$, 55 dBA $L_{A10,adj,1hr}$ and 65 dBA $L_{A1,adj,1hr}$
- Indoors

  Daytime and Evening: 35 dBA $L_{Aeq,adj,1hr}$, 40 dBA $L_{A10,adj,1hr}$ and 45 dBA $L_{A1,adj,1hr}$

  Night: 30 dBA $L_{Aeq,adj,1hr}$, 35 dBA $L_{A10,adj,1hr}$ and 40 dBA $L_{A1,adj,1hr}$

Based on a conservative 5 dBA façade reduction (5 dBA reduction in noise levels from outside a house to inside a house when windows are fully open), the indoor noise objectives noted above could be converted to the following external objectives (with windows open):

- Daytime and Evening: 40 dBA $L_{Aeq,adj,1hr}$, 45 dBA $L_{A10,adj,1hr}$ and 50 dBA $L_{A1,adj,1hr}$
- Night: 35 dBA $L_{Aeq,adj,1hr}$, 40 dBA $L_{A10,adj,1hr}$ and 45 dBA $L_{A1,adj,1hr}$

4.3.3 Background Creep

The current 2019 version of the EPP (Noise) no longer contains criteria for background creep, but states that background creep should be prevented or minimised, to the extent that it is reasonable to do so.

Background creep is defined as "a gradual increase in the total amount of background noise in the area or place as measured under the document called the 'Noise measurement manual' published on the department's website" (Section 9(4) of EPP Noise). This is understood to require consideration of cumulative impacts, including other developments.

4.4 Guideline – Planning for Noise Control

DES had previously published a guideline titled "Planning for Noise Control". The Planning for Noise Control guideline is currently listed as being "under review" according to the DES website. As such, it is not proposed to utilise the noise criteria contained within the document.

The document contains a method for determining the minimum background noise level using the lowest tenth percentile methodology.

4.5 Guideline – Noise & Vibration from Blasting

The DES Guideline "Noise and vibration from blasting" contains criteria and procedures that are applicable to noise and vibration emitted from blasting. It applies to activities such as mining, quarries, construction and other operations which involve the use of explosives for fragmenting rock.

The criteria are presented in **Table 4.1**. These criteria address human comfort and apply at residential and commercial receptors.

Table 4.1 Blasting Vibration and Airblast Criteria

Issue	Criteria
Airblast	Airblast overpressure of 115 dB (linear peak) for nine (9) out of ten (10) consecutive blasts initiated and not greater than 120 dB (linear peak) at any time.
Vibration	5 mm/s peak particle velocity for nine (9) out of ten (10) consecutive blasts and not greater than 10 mm/s peak particle velocity at any time.

It is noted that higher limits would typically be used for prevention of structural damage.

4.6 Guideline – Assessment of Low Frequency Noise

The DES Guideline "Assessment of Low Frequency Noise" contains methods and procedures that are applicable to low frequency noise emitted from industrial premises for planning purposes. Items such as boilers, pumps, transformers, cooling fans, compressors, oil and gas burners, foundries, wind farms, electrical installations, diesel engines, ventilation and air-conditioning equipment, wind turbulence and large chimney resonance may comprise sources of high level noise having frequency content less than 200 Hz. With regards to mining operations, processing plant including screens and crushers (also potentially associated with diesel engines) are a potential sources of low frequency noise.

These sources may exhibit an unbalanced frequency spectrum that characteristically shows a general increase in sound pressure level with decrease in frequency. Annoyance due to low frequency noise can be high even though the dBA level measured is relatively low. Typically, annoyance is experienced in the otherwise quiet environments of residences, offices and factories adjacent to or near low frequency noise sources. Generally, low level/low frequency noises become annoying when the masking effect of higher frequencies is absent. This loss of high frequency components may occur as a result of transmission through the fabric of a building, or in propagation over long distances.

Where a noise immission occurs exhibiting an unbalanced frequency spectrum, the overall sound pressure level inside residences should not exceed 50 dBZ to avoid complaints of low frequency noise annoyance. A spectrum is considered unbalanced when the un-weighted overall noise level is more than 15 dB higher than the A-weighted overall noise level.

4.7 Proposed Criteria

4.7.1 Noise Emissions

In accordance with the EPP (Noise) and based on the calculated external limits as discussed in **Section 4.3.2**, the resulting noise objectives for the site to protect the acoustic environment and to be proposed as noise limits for the operation are presented in **Table 4.2**.

Table 4.2 Proposed Noise Limits for Sensitive Receivers

Period	Noise Limit $L_{Aeq,adj,1hr}$ dBA
Day (7am to 6pm)	Outdoor 40 dBA $L_{Aeq,adj,1hr}$ and Indoor 50 dBZ $L_{eq,adj,1hr}$ (and dBZ-dBA > 15 dB)
Evening (6pm to 10pm)	Outdoor 40 dBA $L_{Aeq,adj,1hr}$ and Indoor 50 dBZ $L_{eq,adj,1hr}$ (and dBZ-dBA > 15 dB)
Night (10pm to 7am)	Outdoor 35 dBA $L_{Aeq,adj,1hr}$ and Indoor 50 dBZ $L_{eq,adj,1hr}$ (and dBZ-dBA > 15 dB)

4.7.2 Blasting

It is proposed to adopt the blasting criteria from the Guideline "Noise and vibration from blasting". The criteria are presented in **Table 4.3**.

Table 4.3 Proposed Blasting Vibration and Airblast Criteria for Sensitive Receivers

Issue	Criteria
Airblast	Airblast overpressure of 115 dB (linear peak) for nine (9) out of ten (10) consecutive blasts initiated and not greater than 120 dB (linear peak) at any time.
Vibration	5 mm/s peak particle velocity for nine (9) out of ten (10) consecutive blasts and not greater than 10 mm/s peak particle velocity at any time.

5. Existing Noise Environment

5.1 Overview and Location

Attended noise measurements and noise logging were undertaken at the following locations:

- Location A – Located back yard of the property (-22.394338, 148.269479). This is the adjacent sensitive receptor 6 in **Figure 5.1** and **Figure 3.1**.
- Location B – Located front yard of the property adjacent the fence (-22.527639, 148.122611). This is the adjacent sensitive receptor 9 in **Figure 5.1**.
- Location C – Located centre of the property under the trees (-22.427361, 148.023250). This is the adjacent sensitive receptor 10 in **Figure 5.1**.
- Location D – Located centre of the property (-22.429444, 148.259111). This is the adjacent sensitive receptor 8 in **Figure 5.1** and **Figure 3.1**.

The noise monitoring was undertaken in general accordance with Australian Standard AS1055 Acoustics – Description and measurement of environmental noise and the EHP Noise Measurement Manual 2013.

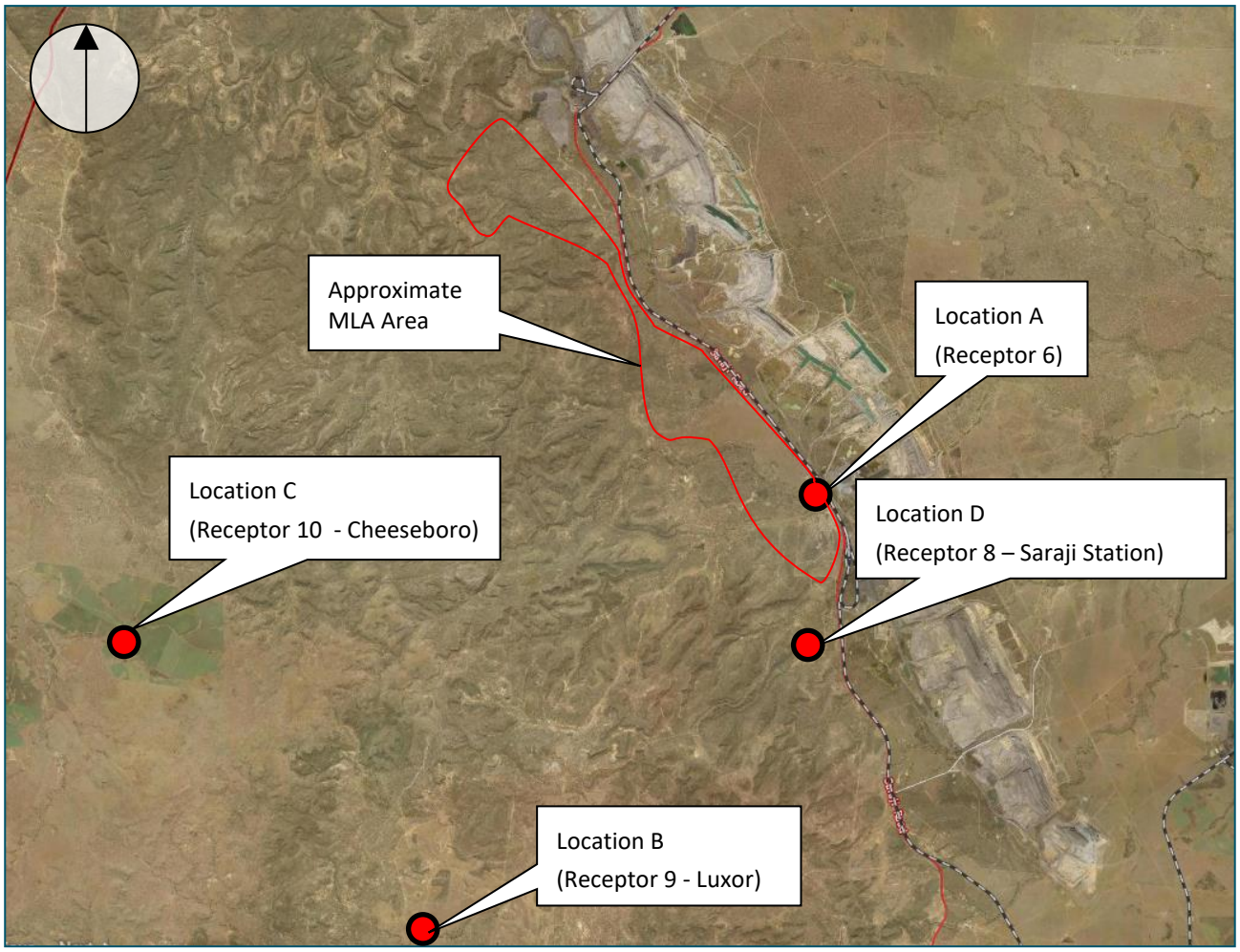


Figure 5.1 Aerial View of Monitoring Locations A to D.

5.2 Attended Noise Measurements

Attended noise measurements were undertaken at Locations A, B, C and D. The measurements were undertaken on 6th November 2019 over 15 minute periods using a field and laboratory calibrated Norsonic sound level meter. The microphone height was approximately 1.3 m above natural ground level and was located in the free field. Weather during the time of monitoring was generally moderate with a breeze in the daytime, and still at night. The conditions were as follows:

- Daytime: Approximately 30 °C to 35 °C with a 0 m/s to 1.5 m/s slight breeze and no cloud cover.
- Night time: Approximately 25 °C with calm and no cloud cover.

Noise measurements were only conducted at Locations A and D at night as they were expected to be affected by existing mine noise. Location B and C were expected to have low background noise levels which would be adequately demonstrated by noise logging. The measured noise levels are summarised in **Table 5.1**.

Table 5.1 Attended Noise Measurement Results

Location	Date & Time	Period (Minutes)	Results & Notes
Day			
A (Receptor 6)	02:12pm 06/11/19	15	Statistical noise levels: L_{10} 44 dBA, L_{eq} 42 dBA, L_{90} 34 dBA Road traffic 40 to d4 dBA Distance mine noise 32 to 43 dBA
B (Receptor 9)	04:39pm 06/11/19	15	Statistical noise levels: L_{10} 40 dBA, L_{eq} 45 dBA, L_{90} 26 dBA Birds 27 to 70 dBA
C (Receptor 10)	12:26pm 06/11/19	15	Statistical noise levels: L_{10} 44 dBA, L_{eq} 41 dBA, L_{90} 30 dBA People walking/talking 32 to 49 dBA Garden watering 35 to 36 dBA Distance weigh drop 36 to 39 dBA Wind through trees 38 to 51 dBA Birds 40 to 42 dBA
D (Receptor 8)	03:09pm 06/11/19	15	Statistical noise levels: L_{10} 38 dBA, L_{eq} 43 dBA, L_{90} 29 dBA Distance traffic 31 to 40 dBA Horse noise 41 to 71 dBA Workshop activities 41 to 46 dBA Birds 31 to 51 dBA
Night			
A (Receptor 6)	10:47pm 06/11/19	15	Statistical noise levels: L_{10} 43 dBA, L_{eq} 39 dBA, L_{90} 32 dBA Mine noise 32 to 49 dBA
D (Receptor 8)	10:08pm 06/11/19	15	Statistical noise levels: L_{10} 36 dBA, L_{eq} 35 dBA, L_{90} 32 dBA Mine noise 31 to 43 dBA

Note: * The reported noise levels, excluding the statistical noise levels, are the instantaneous levels read from the sound level meter, and generally represent the range in noise levels or maximum noise levels for a particular noise source.

5.3 Noise Logging

Noise logging was undertaken at Locations A, B, C and D. Logging was undertaken from Tuesday 5th to Tuesday 12th November 2019 using field and laboratory calibrated Larson Davis LD831 environmental noise loggers. Noise logging was undertaken in the free field.

Data from the Bureau of Meteorology (BoM) (Iffley) indicates that weather during the monitoring period was generally fine and warm. Overall, the noise monitoring data is considered acceptable for use in this report.

Photos of the noise monitoring locations are shown in **Figures B.1** to **B.2** in **Appendix B**.

The measured noise levels are shown graphically in **Figures C.1** to **C.8** in **Appendix C**. The statistical results from the noise logging have been summarised in **Tables C.1** to **C.4** in **Appendix C**.

The background noise levels at Locations A to D were calculated using the lowest tenth percentile method (as per **Section 4.4**) and the results for Locations A, C and D are shown in **Table 5.2**.

Table 5.2 Background Noise Levels at Locations A, C and D

Period	Background Noise Level L_{90} dBA		
	Location A (Receptor 6)	Location C (Receptor 10)	Location D (Receptor 8)
Day (7am to 6pm)	32	30	29
Evening (6pm to 10pm)	31	24	33
Night (10pm to 7am)	31	18	32

The background noise level at Location B (Receptor 9) was affected by insect noise. As the insect noise is likely a seasonal influence, the noise level data has been filtered to remove the insect noise. The resulting background noise levels calculated using the lowest tenth percentile method are shown in **Table 5.3**.

Table 5.3 Background Noise Levels at Location B (Receptor 9) - Measured and with Insect Noise Removed

Period	Measured Background Noise Level L_{90} dBA	Filtered (Less Insect Noise) Background Noise Level L_{90} dBA
Day (7am to 6pm)	24	24
Evening (6pm to 10pm)	28	18
Night (10pm to 7am)	17	15

From the results above, the following comments on background noise are made:

- Location A (Receptor 6): Continuous mine noise from nearby operating mines is audible at this location and road traffic noise from Saraji Road was audible at this location at day and night.
- Location B (Receptor 9) & Location C (Receptor 10): Overall, the measurement results indicate the area is very quiet, as is typical of a rural environment. The major noise sources are natural (birds, wind in trees) and farm related (farm machinery, livestock, dogs).
- Location D (Receptor 8): Continuous mine noise from nearby operating mines is audible at this location at night. Other noise sources are natural (birds, wind in trees), farm related (farm machinery, livestock, dogs) and distant road traffic.

5.4 Seasonal Variability

Ambient noise levels are affected by many noise sources including wind, rustling grass and leaves, distant highway traffic, insects, birds and other animals.

The noise monitoring was conducted in Spring (November) when insect noise levels can be relatively high. During colder months, the noise from insects will tend to be quieter. However, it is not normally necessary to conduct monitoring across warmer and cooler months as insect noise can be filtered from the noise data, as has occurred in **Section 5.3**. In this instance, significant insect noise was only identified at Location B and was removed accordingly as shown in **Table 5.3**.

6. Noise Assessment

6.1 Model Description

Noise modelling was carried out using the SoundPLAN v8.2 computer program using the CONCAWE algorithm, which are widely used and accepted for noise modelling and is approved by DES.

The SoundPLAN program was used to develop a three-dimensional digital terrain noise model of the Project and the surrounding area including the location of sensitive receptors. The model incorporates terrain data for the proposed Project and the surrounding natural topography.

6.2 Meteorology

The mining noise levels at residential receptors can vary significantly depending upon the meteorology and the mining activities. Meteorology has a significant effect on the noise levels, particularly due to wind speed and direction and vertical temperature gradients, which include temperature inversions.

It is possible to measure noise variations of the order of 15 to 20 dBA due to changes in meteorology. Assessment is required under worst-case meteorological conditions according to the Planning for Noise Control guideline.

The SoundPLAN model was setup to predict noise levels under neutral and adverse meteorological conditions. The conditions used in the noise model are shown in **Table 6.1**.

Table 6.1 Meteorological Scenarios

Parameter	Day Meteorological Scenarios		Night Meteorological Scenarios	
	Scenario D1	Scenario D2	Scenario N1	Scenario N2
Pasquill Stability Class	D	D	F	F
Temperature (°C)	25	25	10	10
Wind Speed (m/s)	0	2	0	2
Wind direction	-	Towards receivers	-	Towards receivers
Relative Humidity (%)	40	40	70	70

The neutral meteorological conditions are most likely to occur during the daytime and adverse conditions is most likely to occur during the night-time, particularly temperature inversions. It is noted that neutral conditions could occur during the night, and adverse conditions could occur to some extent during the day and evening.

These meteorological scenarios are presented to give an indication of the range of noise levels from neutral to adverse conditions and are assessed against the criteria corresponding to the periods when they will be most likely to occur. The most critical predictions are the night scenarios, since this assessed the highest predicted noise levels against the most stringent night-time criteria.

The SoundPLAN model assumes the wind direction is from the source to each receptor and thus modelling for multiple wind directions is not required.

6.3 Noise Source Data

The model uses the sound power level (L_w) of each noise source to predict noise emissions. The sound power levels used in the model were based on noise source data obtained from previous mining projects. The sound power levels for the mobile and fixed equipment proposed for the Project are presented in **Table 6.2**.

Table 6.2 Noise Source Sound Power Levels

Equipment	Data Source	Octave Band Sound Power Level $L_{W,eq}$ dBZ								Overall $L_{W,eq}$	
		63	125	250	500	1k	2k	4k	8k	dBZ	dBA
Excavator – 600t class	4	134	129	119	124	116	111	109	104	136	123
Excavator – 400t class	1,2,3	129	124	114	119	111	106	104	99	131	118
Excavator – 120t class	3,4	109	119	114	114	111	109	103	98	122	116
Excavator – EX3600	3,4	118	120	116	116	112	110	105	100	124	118
Dozer D10	3,4	85	103	108	116	113	115	106	92	120	119
Dozer D11	3,4	85	103	108	116	113	115	106	92	120	119
Dozer CATD11R	3,4	98	98	98	103	101	102	94	84	108	107
Drill	4	109	111	111	110	110	109	106	101	118	115
Pump	2,4	105	103	99	98	99	98	93	89	109	109
Crusher	1	125	122	116	114	108	110	104	98	127	117
Screen	4	80	91	97	104	107	110	106	99	114	114
Stacker Belt	3	114	118	112	109	104	100	92	83	121	111
Train loading	3	108	117	114	117	112	110	102	93	122	118
200-220t mine truck (793)	3,4	89	109	111	115	113	112	105	95	120	118
180t mine truck (789)	3,4	89	109	111	115	113	113	105	95	120	118
90t mine truck (777)	3,4	84	96	101	108	111	110	102	95	115	115
Grader	3,4	108	115	112	104	104	102	98	90	118	110
Water truck	3,4	110	112	110	111	111	109	101	96	119	115

The sources of data used to compile the sound power level data in **Table 6.2** are presented in **Table 6.3**.

Table 6.3 Source of Data for Equipment Sound Power Levels

Source #	Data Source
1	Data based on measurements undertaken by ASK at another coal mine.
2	Manufacturer's noise data.
3	ASK database, based on sound power level calculated from measurements at another coal mine for the same/similar equipment.
4	Data for these sources was extracted from another similar coal mine project. Generally this data is similar to noise data for similar equipment at other mine sites and is considered suitable for noise modelling purposes.

The equipment modelled has been chosen to closely reflect the anticipated mining fleet. However, there is potential for alternate makes and models of equipment to be used in the operating mine. If the equipment model is changed, the sound power level of the alternative model should be reviewed to determine if noise level increases are expected.

6.4 Modelling Scenario

Mining noise emissions from the Project have been predicted for year 3, 4 and 7 of mine life.

Modelling of the nominated mine scenarios have included mine ground elevations, equipment numbers and equipment locations based on information provided by Mining & Energy Technical Services Pty Ltd. Subsequent to this modelling, the ex-pit dump elevations have changed, but these changes are not considered to affect the modelling presented in this report.

The mobile equipment numbers and locations are presented in **Table 6.4** and the source locations and path of the mobile equipment are shown in **Appendix D**.

Table 6.4 Equipment Fleet and locations

Equipment	Map Reference
1 x Excavator – 600t class	South of open pit
1 x Excavator – 400t class	In-Pit dump
1 x Excavator – 120t class	Open pit
1 x Excavator – EX3600	In-Pit dump
2 x Dozer D10	In-Pit dump
2 x Dozer D11	In-Pit dump
1 x Dozer CATD11R	In-Pit dump
2 x Drill	South of open pit
3 x Pump	MIA, CHPP
Crusher. Screen, Stacker Belt	CHPP
Train loading	CHPP
5 x 200-220t mine truck (793)	Pre-strip waste to ex-pit waste dump
5 x 180t mine truck (789)	In-pit waste to in-pit dump
4 x 90t mine truck (777)	Open pit to ROM
2 x Grader	All roads
3 x Water truck	All roads

Based on the equipment fleet in **Table 6.4** and the individual equipment sound power levels in **Table 6.2**, the overall plant sound power level is calculated as per **Table 6.5**. The sound power levels are presented for mobile plant (i.e. trucks), fixed plant (i.e. everything but trucks) and all plant equipment combined.

Table 6.5 Overall Equipment Sound Power Level

Equipment	Octave Band Sound Power Level $L_{W,eq}$ dBZ								Overall $L_{W,eq}$	
	63	125	250	500	1k	2k	4k	8k	dBZ	dBA
Mobile	117	124	123	126	125	124	116	108	132	130
Fixed	136	132	126	128	124	124	117	111	139	130
All	136	133	128	130	127	127	120	112	139	133

From **Table 6.5** it can be seen that overall sound power level of the equipment is 133 dBA $L_{Aw,eq}$.

6.5 Predicted A-Weighted Noise Levels & Assessment

6.5.1 Noise from Project

The predicted noise levels at nearby sensitive receptors for the Year 3, 4 and 7 of the Project are presented in **Table 6.6**. The noise contours are presented in **Appendix E**.

The results at sensitive receptors are compared against the proposed noise limits of 35 dBA L_{eq} and 40 dBA L_{eq} for the night and daytime/evening respectively, as per **Table 4.2**. Where the result exceeds the limit, the cell is shaded pink in **Table 6.6**.

The predicted noise levels are also shown graphically as noise contours in **Appendix E**, as follows:

- **Figure E.1** Year 3 Scenario D2
- **Figure E.2** Year 4 Scenario D2
- **Figure E.3** Year 7 Scenario D2
- **Figure E.4** Year 3 Scenario N1
- **Figure E.5** Year 4 Scenario N1
- **Figure E.6** Year 7 Scenario N1

Note: Noise contours have not been prepared for the D1 and N2 scenarios, as they would have less noise impact than the results included in the figures (as shown by the tabulated results in **Table 6.6**).

Receptors 5 and 6 are presumed not to exist in the Year 7 scenario since these receptors will be in the open pit.

Based on the tabulated results, no exceedances are recorded during day/evening operations. Predicted night exceedances are listed in following:

- Year 3:
  Receptor 5: 5 dBA
  Receptor 6: 3 dBA
- Year 4:
  Receptor 5: 6 dBA
  Receptor 6: 4 dBA
- Year 7:
  Receptor 8: 5 dBA

It is proposed that a noise management plan be considered to determine the operational constraints for the mine to achieve the noise limits at receptors 5, 6 and 8. Refer to **Section 8** for a discussion on noise mitigation and management measures. More specifically, refer to **Section 8.3** on a recommended noise management to restrict certain equipment to achieve predicted compliance.

6.5.2 Noise at Commercial Receptors

The noise level at commercial receptors (1 to 4 and 7) are predicted to be 8 to 45 dBA L_{Aeq}. Given typical indoor office ambient noise levels are 40 to 45 dBA, an external noise level of up to 45 dBA is considered acceptable.

6.5.3 Cumulative Noise from the Project and Other Nearby Mines

Cumulative noise from this mine and other existing and proposed mining projects is difficult to accurately predict due to lack of information about the future of the other mining projects and the noise limits which may have been imposed/agreed on those other mining projects.

Cumulative noise is proposed to be considered where the predicted mining noise levels are within 3 dBA of the nominated noise limits, i.e. greater than 37 dBA in the day/evening and greater than 32 dBA in the night. A margin of 3 dBA has been selected as this would allow the noise contribution from other mines to be equal to the noise from the Project, i.e. 37 dBA from Vulcan South + 37 dBA from other mines = 40 dBA total = day/evening noise limit.

Therefore, cumulative noise is considered a concern for Receptors 5, 6 and 8. It is noted that exceedances are already predicted at these Receptors.

The existing mine noise levels at Locations A (Receptor 6) and Location D (Receptor 8) were measured at 39 dBA $L_{Aeq,15min}$ and 35 dBA $L_{Aeq,15min}$ respectively, which matches or exceeds the proposed night time limit of 35 dBA $L_{Aeq,1hr}$. Based on these measurement results it is possible that existing mine noise limits at these receptors are higher than the proposed limits in **Table 4.2**. It is proposed that the noise limits at Receptors 6 and 8 should be the higher of (i) the Trinity proposed limits in **Table 4.2**; and (ii) the existing mine noise limits contained in the Environmental Authorities of other nearby mine(s). If the existing mine noise limits for Receptors 6 and 8, as contained in the Environmental Authorities of other nearby mine(s), are the same as proposed in **Table 4.2**, then the target noise contribution from the Project at Receptors 6 and 8 is proposed to be 3 dB lower than the limits in **Table 4.2**.

It is proposed that a noise management plan be considered to determine the operational constraints for the mine to achieve reduced noise limits of 37 dBA in the day/evening and greater than 32 dBA in the night at receptors 5, 6 and 8.

6.6 Predicted Low Frequency Noise Emission Levels & Assessment

An assessment of low frequency noise emissions at residential receptors has been included in accordance with the guideline “Assessment of Low Frequency Noise criteria”.

The internal noise limit at a residence is an un-weighted noise level of 50 dBZ which is considered to correlate with an external noise limit of 57 dBZ, assuming a 7 dB reduction from outside to inside through a residential building with open windows. If the external noise level exceeds 57 dBZ and the difference between the un-weighted and A-weighted noise levels exceeds 15 dB, then the noise is considered to have unacceptable low frequency content and further assessment is required.

The predicted un-weighted (Z-weighted) noise levels are shown in **Table 6.7**.

From the results in **Table 6.7** it can be seen that there are no results exceeding 57 dBZ and with a dBZ-dBA difference of greater than 15 dB. Therefore, the predicted low frequency noise levels are acceptable.

Table 6.6 Predicted A-Weighted Mining Noise Levels

ID	Type	Sensitive Receptor Name	Predicted Noise Emission Levels, L_{eq} dBA											
			Year 3				Year 4				Year 7			
			D1	D2	N1	N2	D1	D2	N1	N2	D1	D2	N1	N2
1	Commercial	BMA Peak Downs	12	17	21	18	11	17	21	17	10	16	20	16
2	Commercial	BMA Peak Downs	12	18	22	19	12	18	22	18	10	16	21	17
3	Commercial	BMA Peak Downs	12	18	22	19	12	17	22	18	10	16	20	17
4	Commercial	BMA Peak Downs	10	16	20	16	10	15	20	16	8	14	19	15
5	Residential	Property Manager	31	37	40	39	33	39	41	41	-	-	-	-
6	Residential	Workers Accommodation	29	35	38	37	31	37	39	39	-	-	-	-
7	Commercial	BMA Saraji	20	26	30	28	21	27	31	29	37	43	45	45
8	Residential	O'Sullivan Residence	19	25	30	27	20	26	30	27	31	37	40	39
9	Residential	Luxor Residence	4	9	15	10	4	9	15	11	5	10	16	11
10	Residential	Cheeseboro Residence	2	8	14	9	2	8	14	9	2	8	14	9

Note: Residential receptors are shaded blue.

Potential exceedances are shaded red.

Receptors 5 and 6 are presumed not to exist in the Year 7 scenario since these receptors will be in the open pit.

Table 6.7 Predicted Z-Weighted Mining Noise Levels

ID	Type	Sensitive Receptor Name	Predicted L_{eq} dBZ and (dBZ-dBA difference)											
			Year 3				Year 4				Year 7			
			D1	D2	N1	N2	D1	D2	N1	N2	D1	D2	N1	N2
1	Commercial	BMA Peak Downs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Commercial	BMA Peak Downs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	Commercial	BMA Peak Downs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Commercial	BMA Peak Downs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	Residential	Property Manager	47 (16)	50 (13)	51 (11)	51 (12)	49 (16)	52 (13)	53 (11)	53 (12)	-	-	-	-
6	Residential	Workers Accommodation	46 (17)	49 (14)	50 (12)	49 (13)	47 (17)	50 (13)	51 (12)	51 (12)	-	-	-	-
7	Commercial	BMA Saraji	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	Residential	O'Sullivan Residence	38 (19)	42 (17)	43 (14)	43 (16)	39 (19)	42 (17)	43 (14)	43 (16)	48 (17)	51 (14)	52 (12)	51 (12)
9	Residential	Luxor Residence	21 (18)	27 (18)	31 (17)	30 (19)	22 (18)	27 (18)	31 (17)	30 (19)	23 (18)	28 (18)	32 (17)	31 (19)
10	Residential	Cheeseboro Residence	20 (18)	26 (18)	30 (17)	29 (19)	20 (18)	26 (18)	30 (16)	29 (19)	19 (18)	25 (18)	30 (16)	28 (19)

Note: Receptors 5 and 6 are presumed not to exist in the Year 7 scenario since these receptors will be in the open pit.

6.7 Haul Truck Noise Assessment

For a period of approximately 2 years, the transport of coal may potentially be from the Project MLA to an existing coal wash and load out facility along the Peak Downs Highway to the north as shown by the blue line in **Figure 6.1.** Each truck will transport approximately 60 t of coal, with an anticipated average of 80 truck movements per 24 hours each way (i.e. 3.3 trucks per hour).

The proposed haul truck route is on an existing public road (Peak Downs Mine Road and Saraji Road) and a Queensland Globe review indicates the majority of the route (from the existing mine to the Highway) is classified 'PBS 3A (Up to type 1 road trains) RT1' and therefore has been designed for road trains, such as proposed for this project.

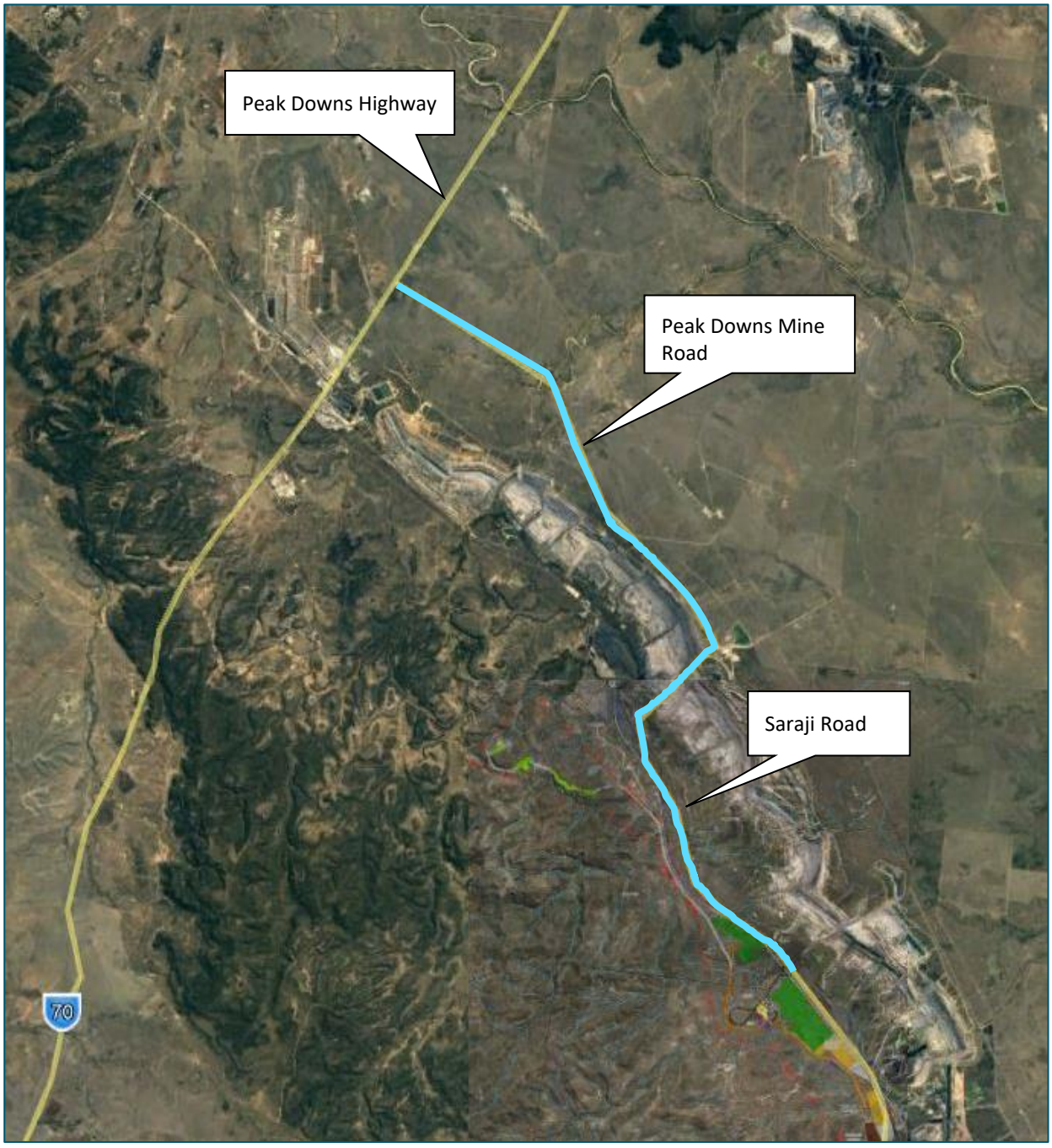


Figure 6.1 Haul Truck Route

The maximum (L_{max}) and average (L_{eq}) noise levels at locations adjacent the road can be calculated from the sound power level and using a standard moving point source calculation. From some recent ASK measurements, sound power level for the truck at higher speed offsite is 118 dBA.

The truck passby noise level would only affect the L_{10} noise level if the passby durations occurred for at least 10 percent of the measurement duration. For a 1 hour measurement, the L_{10} value is based on the noisiest 6 minutes in the hour. Given there are 3.3 trucks per hour, the $L_{10,1hour}$ value would only be affected where each truck passby occurred for a period of at least 1.8 minutes (i.e. 6 / 3.3). The $L_{10,1hour}$ value can thus be determined as the minimum noise level that occurs for the noisiest 1.8 minutes of a truck passby.

The calculated 1 hour L_{max}, L_{eq} and L_{10} noise levels from truck passbys (80 trucks per 24 hours) are shown in **Table 6.8**.

Table 6.8 Haul Truck Passby Noise Levels

Distance from Road, metres	Passby Noise Levels dBA		
	$L_{eq,1hour}$	$L_{10,1hour}$	$L_{max,1hour}$
50	57	50	76
100	52	50	70
200	48	50	64
400	45	49	58
800	41	48	52

From **Table 6.8** it can be seen that the L_{10} noise level is relatively constant due to the low number of truck movements resulting in the L_{10} noise level occurring when the truck is at approximately 1000 metres away from the residence, whereas the L_{eq} and L_{max} noise levels reduce at increased distances from the road.

From a review of Queensland Globe aerial photography, there does not appear to be any residents within 800 metres of the haul road, and thus traffic noise exposure would be less than the levels in **Table 6.8**. There is a residence approximately 200 metres from the Peak Downs Highway, near the intersection with Peak Downs Mine Road (Dysart Road) but it is considered reasonable to expect that this residence would be impacted by a higher number of existing cars and trucks compared to the number of trucks proposed for this project.

Noise levels from trucks on public roads are not assessed against the criteria and noise limits proposed for assessment of noise from mining operations. There is no specific Queensland noise limit for such a scenario, and so instead reference is made to the noise criteria from the Department of Transport and Main Roads (DTMR) Transport Noise Management Code of Practice, November 2013. This document proposes a noise criterion of 68 dBA $L_{A10,18hour}$ for an existing residence adjacent an existing road. Note: The $L_{A10,18hour}$ noise level is the arithmetic average of the $L_{A10,1hour}$ noise levels between 6am and midnight (i.e. 18 hours).

From the results in **Table 6.8** it can be seen that the hourly $L_{10,1hour}$ noise level adjacent the road would be well below the 68 dBA $L_{A10,18hour}$ noise criterion. It is simply the case that a low number of vehicle movements, i.e. 80 per 24 hours from this mine, would not be a sufficient number of vehicle passby events to result in a high $L_{A10,18hour}$ noise level.

Overall, based on the proposed haul truck route and truck numbers, the noise impacts are considered compliant.

7. Blasting Assessment

7.1 Overview

It is anticipated that the existing vibration levels around the mine site and at the location of sensitive receptors will generally be negligible, except at locations which are close (e.g. within 100m) to roads, rail lines or near major items of fixed plant (e.g. diesel generator).

The only vibration source of significance from the proposed mining activities would be blasting. Blasting activities within the pits have been assessed for both ground vibration and airblast. The relevant criteria for ground vibration and airblast have been presented and discussed in **Section 4.7.2**.

7.2 Predictions

Ground vibration and airblast levels caused by blasting activities have been predicted based on the formulas and methodology of Australian Standard AS2187.2 "Explosives - Storage Transport and Use - Use of Explosives", which predicts the peak particles velocity (PPV) in mm/s and the airblast over pressure (peak pressure) in dB.

7.2.1 Ground Vibration

In accordance with the criteria presented in **Section 4.7.2**, ground vibration levels are to achieve 5mm/s PPV for nine out of ten blasts and not greater than 10mm/s PPV at any time. Ground vibration can be calculated at various distances from a blast using the following formula from AS2187.2:

$$V = K (R / Q^{1/2})^{-B}$$

Where: V = ground vibration as peak particle velocity (PPV) (mm/s)
K = site constant
R = distance between charge and point of measurement (m)
Q = effective charge mass per delay or maximum instantaneous charge (kg)
B = site exponent or attenuation rate

Ground vibration from blasting generally increases with an increase in charge mass and reduces with distance.

The following site constants have been assumed in this calculation; however, seed hole analysis will be conducted within the Project to confirm site parameters:

- Site exponent (B) (attenuation rate) of 1.6; and
- Site constant (K) in the range 800 to 1600.

The maximum instantaneous charge mass will be 500 to 1000 kg as advised by Mining and Energy Technical Services Pty Ltd. **Table 7.1** contains the calculated ground vibration levels (mm/s) at various distances from the blast.

Table 7.1 Ground Vibration Levels at Various Distances from the Blast

Distance from Blast, km	Vibration Level mm/s	
	K = 800	K = 1600
1.0	3.2	6.4
1.5	1.7	3.3
2.0	1.1	2.1
2.5	0.7	1.5
3.0	0.5	1.1
3.5	0.4	0.9
4.0	0.3	0.7
4.5	0.3	0.6
5.0	0.2	0.5
5.5	0.2	0.4
6.0	0.2	0.4
6.5	0.2	0.3
7.0	0.1	0.3
7.5	0.1	0.3
8.0	0.1	0.2
8.5	0.1	0.2
9.0	0.1	0.2
9.5	0.1	0.2
10.0	0.1	0.2

Table 7.1 shows that the 10 mm/s PPV criterion would not be exceeded at distances greater than 1.0 kilometre from the blast. The 5 mm/s PPV criterion would not be exceeded at distances greater than 1.5 kilometres from the blast.

It is noted that the mine is expanding towards south and getting close the Receptors 5 and 6. When the distance between receptors and blasting site is less than 1.2km and 0.8km it is expected that the vibration levels will exceed the 5mm/s and 10mm/s, respectively. Other nearest residential receptor (Receptor 8) is at least 2km away from the nearest pit and vibration levels will be compliant with the nominated criteria.

Nearest Commercial Receptor 7 is approximately 1 kilometres away from the nearest pit within the proposed project area. Therefore, ground vibration due to blasting may exceed the 5mm/s limit.

Blast parameters will need to be reviewed to ensure that the nominated vibration criteria are met at all locations.

7.2.2 Airblast

In accordance with the criteria presented in **Section 4.7.2**, airblast pressure levels are to achieve 115 dBZ for nine out of ten blasts and not greater than 120 dBZ at any time. For blasting in an open-cut mine, the distance to the 120 dBZ L_{peak} contour line from the blast can be calculated using the following formula:

$$D_{120} = (k * h / \text{maximum } (B, S))^{2.5} * m^{1/3}$$

Where: D_{120} = distance to the 120 dBZ L_{peak} contour (m)
k = a site constant determined from the ratio S/B and S/h which requires local calibration
h = hole diameter (mm)
B = burden (mm)
S = stemming height (mm)
M = charge mass (kg)

The site constant, k, has been assumed to be equal to 180 based on ASK's experience with other mining projects.

The following blast information has been used for these calculations:

- Hole diameter (h) = 203mm to 251mm;
- Stemming height (S) = 5000 mm; and
- Burden (B) = 7000 mm.

Table 7.2 contains the separation distances and the reduction of noise levels due to distance.

Table 7.2 Airblast Noise Levels at Various Distances from the Blast

Distance from Blast, km	Airblast Level, dBZ
1.0	120.7
1.5	115.5
2.0	111.7
2.5	108.8
3.0	106.5
3.5	104.5
4.0	102.7
4.5	101.2
5.0	99.8
5.5	98.6
6.0	97.5
6.5	96.4
7.0	95.5
7.5	94.6
8.0	93.7
8.5	92.9
9.0	92.2
9.5	91.5
10.0	90.8

The distance to the 120 dBZ contour line is calculated to be 1,055 metres. The distance to the 115 dBZ contour line is calculated to be 1,550 metres. Therefore, the distance between receptors and blasting site is less than

1,055 metres and 1,550 metres it is expected that the airblast levels will exceed the 115 dBZ and 120 dBZ, respectively.

Nearest Commercial Receptors 7 is approximately 1 kilometres away from the nearest pit within the proposed project area. Therefore, airblast levels may exceed the 120 dBZ limit.

7.3 Assessment

Based on the blasting calculations presented within this section, the ground vibration and airblast levels from open cut operations may exceed the limits at some instances. The following recommendations are proposed when conducting the blasting activities.

- Receptor 5 and 6 will be most affected during the blasting operations and recommended minimum of distances in **Section 7.2.1** and **Section 7.2.2** should be maintained. However, it is noted that the Receptor 5 and 6 may be purchased in the future and may not be sensitive receptors in this project.
- Blast design and management of blast initiation will need to assess each blast and ensure that the vibration and airblast criteria are met.

8. Noise Management Plan

8.1 Overview

Noise modelling has predicted mine noise levels at sensitive receptors as outlined in **Section 6**. The predicted noise levels are therefore expected to result in noise levels exceeding the EPP (Noise) Acoustic Quality Objectives inside these receptors.

To achieve the Acoustic Quality Objectives inside the receptors, the following opportunities may be considered:

- Reducing machinery operations at times of the day that are predicted to result in exceedances.
- Reducing machinery operations under meteorological conditions that are predicted to result in exceedances.
- Moving mine equipment further from the receptors.
- Incorporating noise mitigation measures to equipment, particularly the mobile fleet.
- Providing acoustic or ventilation upgrades to the receptors.
- Relocating the receptors further from the mine.

The results in **Table 6.6** indicate there are no day/evening exceedances. Predicted night exceedances are listed in the following:

- Year 3:
  Receptor 5: 5 dBA
  Receptor 6: 3 dBA
- Year 4:
  Receptor 5: 6 dBA
  Receptor 6: 4 dBA
- Year 7:
  Receptor 8: 5 dBA

Additionally, as per **Section 6.5.3**, cumulative noise impacts are considered for Receptors 5, 6 and 8, which results in a noise level target 3 dBA less than the limits in **Table 4.2**, and thus will require additional operational constraints. It is noted that these constraints may not be required if the noise contribution from other mines is not significant.

8.2 Review of Noise Management Opportunities

8.2.1 Reducing Operational Equipment in Various Time Periods

Reducing operational machinery in particular time periods (e.g. night) can potentially be considered to reduce noise levels.

8.2.2 Reducing Operational Equipment under Particular Meteorological Conditions

From **Table 6.6,** it can be seen that modelled meteorological conditions affect the noise levels at the residence.

One consideration would be to set up real time noise monitors at highly affected receptors, so that the mine can alter operational equipment as required, and thus react to meteorological conditions. However, it is Trinity's experience that this form of reactive operation is difficult to plan.

8.2.3 Moving Mine Equipment Further from the Receptors

Moving noisy equipment away from the most affected sensitive receptors can be considered to minimise noise effects.

8.2.4 Noise Mitigation of Equipment

Noise mitigation measures can be applied to equipment, including all the mobile equipment which is located near to the receptors. The noise reductions can be of the order of 3 to 8 dBA, and the costs can be of the order of a $250,000 to $750,000 per item of equipment.

8.2.5 Noise Mitigation between Equipment and Receptors

Noise mitigation measures can include bunding constructed between equipment and the receptors. Noise bunding is generally most effective when constructed near the source, e.g. adjacent a haul road, or near the receptors. Noise reduction via this technique is likely to be limited to less than 5 dBA even with quite significant bunding heights and lengths.

8.3 Mitigation Scenarios

Based on the results discussed in **Section 6.5.1** noise affected receptors are 5, 6 and 8. Potential noise mitigation has focused on removing equipment from fleet operation during specific periods of predicted non-compliance. In summary, compliance with the noise criteria is predicted based on equipment restrictions being implemented as shown in **Table 8.1**.

Table 8.1 Equipment Fleet Restrictions

Equipment	Year 1 to 3		Year 4 and 5		Year to 6 to 8	
	Day/Eve	Night	Day/Eve	Night	Day/Eve	Night
1 x Excavator – 600t class	✓	✗	✗	✗	✓	✗
1 x Excavator – 400t class	✓	✗	✓	✗	✓	✗
1 x Excavator – 120t class	✓	✓	✓	✓	✓	✓
1 x Excavator – EX3600	✓	✓	✓	✓	✓	✓
4 x Dozer D10/11	✓	✓ (2)	✓ (3)	✓ (3)	✓	✓ (3)
1 x Dozer CATD11R	✓	✓	✓	✓	✓	✓
2 x Drill	✓	✓	✓	✓ (1)	✓	✓ (1)
5 x 200-220t mine truck (793)	✓	✓ (1)	✓	✗	✓	✓
5 x 180t mine truck (789)	✓	✓	✓	✓ (3)	✓	✓ (3)
5 x 200-220t mine truck (793)	✓	✓ (1)	✓	✗	✓	✓
4 x 90t mine truck (777)	✓	✓	✓	✓	✓	✓
2 x Grader	✓	✓	✓	✓	✓	✓
3 x Water truck	✓	✓	✓	✓	✓	✓

Note: Equipment restrictions are highlight in orange.

As shown in the above table and indicated in the predicted results in **Table 6.6**, there are no restrictions during the day (7 am to 6 pm) and evening (10 pm to 7 am) for Years 1 to 3 and Years 6 to 8. However, equipment restrictions apply to the night (10 pm to 7 am) for all operating years.

On-site procedures will need to be incorporated into the relevant site operational management plans to switch off equipment for the relevant time periods. It is noted that the restrictions only involve limiting certain types of equipment, and there are no circumstances where a complete shutdown of the site is required.

Table 8.2 Error! Reference source not found. presents the predicted noise levels with and without the above equipment operating. The results of the additional modelling demonstrate compliance with the noise limits.

Table 8.2 Mitigation - Predicted A-Weighted Mining Noise Levels

ID	Type	Sensitive Receptor Name	Predicted Noise Emission Levels, L_{eq} dBA			
			Year 3	Year 4		Year 7
			Night	Day	Night	Night
No Mitigation						
5	Residential	Property Manager	40	39	41	-
6	Residential	Workers Accommodation	38	37	39	-
8	Residential	O'Sullivan Residence	30	27	30	40
With Mitigation (Equipment Restrictions)						
5	Residential	Property Manager	32	37	32	-
6	Residential	Workers Accommodation	31	31	31	-
8	Residential	O'Sullivan Residence	21	20	23	32

Note: Residential receptors are shaded blue.

Potential exceedances of cumulative criteria are shaded red.

Receptors 5 and 6 are presumed not to exist in the Year 7 scenario since these receptors will be in the open pit.

The operating scenarios presented in **Table 8.1** should be considered examples only, and other acoustically equivalent scenarios could be developed if they are considered not appropriate.

8.4 Noise Monitoring

It is recommended that noise level compliance be confirmed by real time noise monitoring at the most noise affected receptor/s, and that monitoring be commenced prior to mine operation.

9. Conclusions

A noise and vibration impact assessment has been conducted for the proposed Vulcan South Project. The following comments are made regarding the assessment:

- Noise monitoring was conducted at four (4) sensitive receptor locations;
- A noise model has been developed for proposed mining activities for typical mining Year 3, 4 and 7 to predict noise emission levels at nearby receptors; and
- Calculations have also been made to predict vibration and airblast levels due to blasting.

From this assessment, the following conclusions are made:

- Noise criteria for the mine have been proposed in **Section 4.7.1**, which includes outdoor noise limits at sensitive receptors of 40 dBA $L_{Aeq,adj,1hr}$ in the day and evening and 35 dBA $L_{Aeq,adj,1hr}$ in the night; and an indoor noise limit at sensitive receptors of 50 dBZ $L_{eq,adj,1hr}$ (and dBZ-dBA > 15 dB).
- From the predicted noise levels in **Section 6.5**, no exceedances are predicted during the day/evening period, except the commercial Receptor 7. Further exceedances of up to 6 dBA are predicted at receptors 5, 6 and 8 during the night-time.
- Given there are exceedances predicted, noise mitigation measure scenarios have been developed as per **Section 8**. Potential noise mitigation has focused on removing equipment from fleet operation during specific periods of predicted non-compliance. For the purpose of noise management, the equipment restrictions detailed in **Section 8.3** are recommended (noting that alternative management approaches could be adopted).
- An assessment of low frequency noise impacts (**Section 6.6**) indicates that the low frequency noise criterion is compliant at all residential receptors.
- Noise from haul trucks on the public road network are considered compliant as per **Section 6.7**.
- Based on the blasting parameters and calculations in **Section 7**, the ground vibration and airblast levels from blasting are predicted to exceed at some receptors some instances and recommendations are discussed in **Section 7.3**.

References

AS1055: 2018 Acoustics – Description and measurement of environmental noise, Standards Australia.

Department of Environment and Heritage Protection Noise Measurement Manual 2013, The State of Queensland.

Environmental Protection Act 1994 (EP Act).

Model Mining Conditions Guideline 2017, Department of Environment and Science, The State of Queensland.

Noise and Vibration from Blasting Guideline 2016, Department of Environment and Science, The State of Queensland.

Transport Noise Management Code of Practice Volume 1 – Road Traffic Noise, November 2013, Department of Transport and Main Roads, The State of Queensland.

Appendix A Glossary

Parameter or Term	Description
dB	The decibel (dB) is the unit measure of sound. Most noises occur in a range of 20 dB (quiet rural area at night) to 120 dB (nightclub dance floor or concert).
dBA	Noise levels are most commonly expressed in terms of the 'A' weighted decibel scale, dBA. This scale closely approximates the response of the human ear, thus providing a measure of the subjective loudness of noise and enabling the intensity of noises with different frequency characteristics (e.g. pitch and tone) to be compared.
Frequency	The number of vibrations, or complete cycles, that take place in one second. Measured in hertz (Hz), where one Hz equals one cycle per second. A young person with normal hearing will be able to perceive frequencies between approximately 20 and 20,000 Hz. With increasing age, the upper frequency limit tends to decrease.
dB, dB(linear) or dBZ	Noise levels are sometimes expressed in terms of the linear, Z or un-weighted decibel scale – they all take the same meaning. The value has no weighting applied to it and is the same as the dB level.
Octave band	Ranges of frequencies where the highest frequency of the band is double the lowest frequency of the band. The band is usually specified by the centre frequency, i.e. 31.5, 63, 125, 250, 500 Hz, etc.
Day	The period between 7am and 6pm.
Evening	The period between 6pm and 10pm.
Night	The period between 10pm and 7am.
Free-field	The description of a noise receptor or source location which is away from any significantly reflective objects (e.g. buildings, walls).
Free-field	The description of a noise receptor or source location which is away from any significantly reflective objects (e.g. buildings, walls).
Noise sensitive receiver or Noise sensitive receptor	The definition can vary depending on the project type or location, but generally defines a building or land area which is sensitive to noise. Generally it includes residential dwellings (e.g. houses, units, caravans, marina), medical buildings (e.g. hospitals, health clinics, medical centres), educational facilities (e.g. schools, universities, colleges),
L_1	The noise level exceeded for 1% of the measurement period.
L_{10}	The noise level exceeded for 10% of the measurement period. It is sometimes referred to as the average maximum noise level.
L_{90}	The noise level exceeded for 90% of the measurement period. This is commonly referred to as the background noise level.
L_{eq}	The equivalent continuous sound level, which is the constant sound level over a given time period, which is equivalent in total sound energy to the time-varying sound level, measured over the same time period.
$L_{eq,1hour}$	As for L_{eq} except the measurement intervals are defined as 1 hour duration.
$L_{eq,adj,T}$	The L_{eq} adjusted for tonal or impulsive noise characteristics and with a measurement interval of 'T' duration (e.g. 15 minutes, 1 hour).
Sound power level (L_W)	The sound power level of a noise source is its inherent noise, which does not vary with distance from the noise source. It is not directly measured with a sound level meter, but rather is calculated from the measured noise level and the distance at which the measurement was undertaken.

Appendix B Noise Monitoring Photos

Figure B.1 Noise Logger setup at Receptor 6

Figure B.2 Noise Logger setup at Receptor 8 (Luxor)

Figure B.3 Noise Logger setup at Receptor 10 (Cheeseboro)

Figure B.4 Noise Logger setup at Receptor 8 (Saraji Station Residence)

Appendix C Noise Monitoring Results

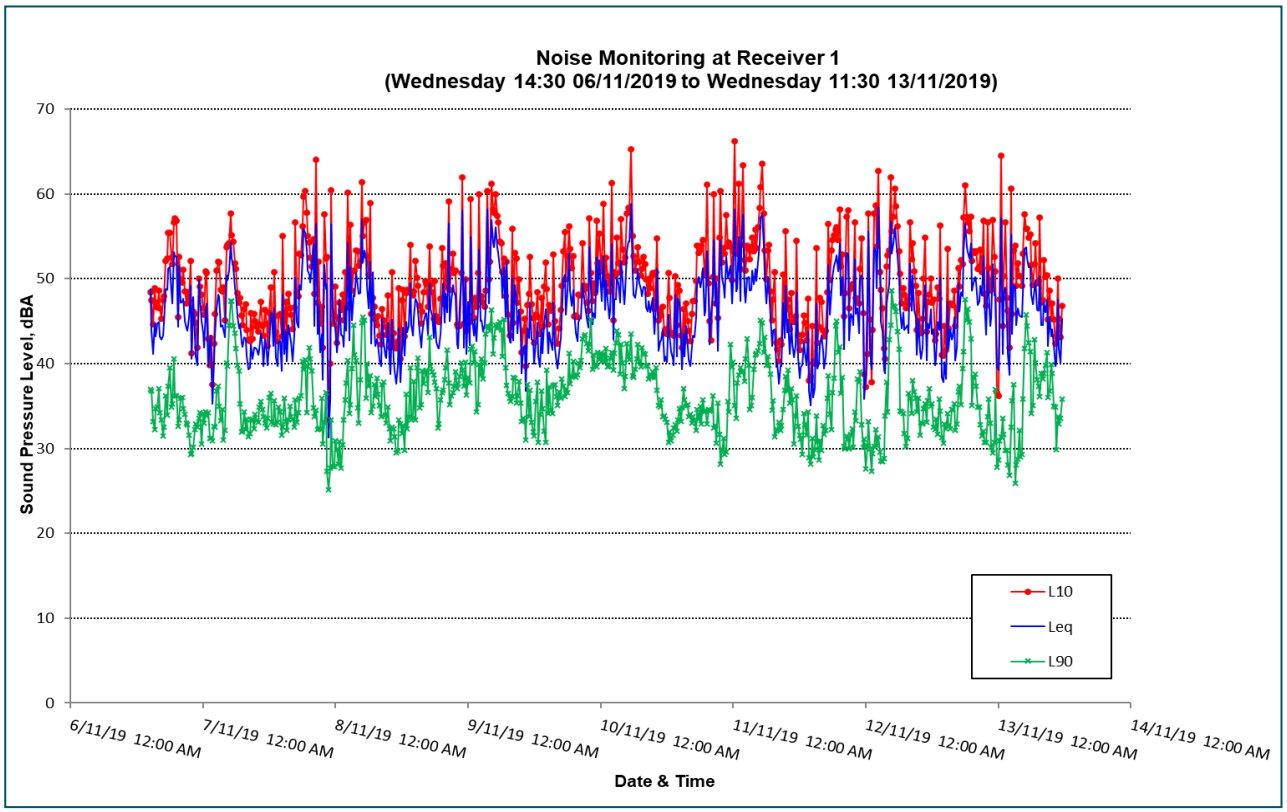


Figure C.1 Graph of Noise Logging Results at Receptor 6

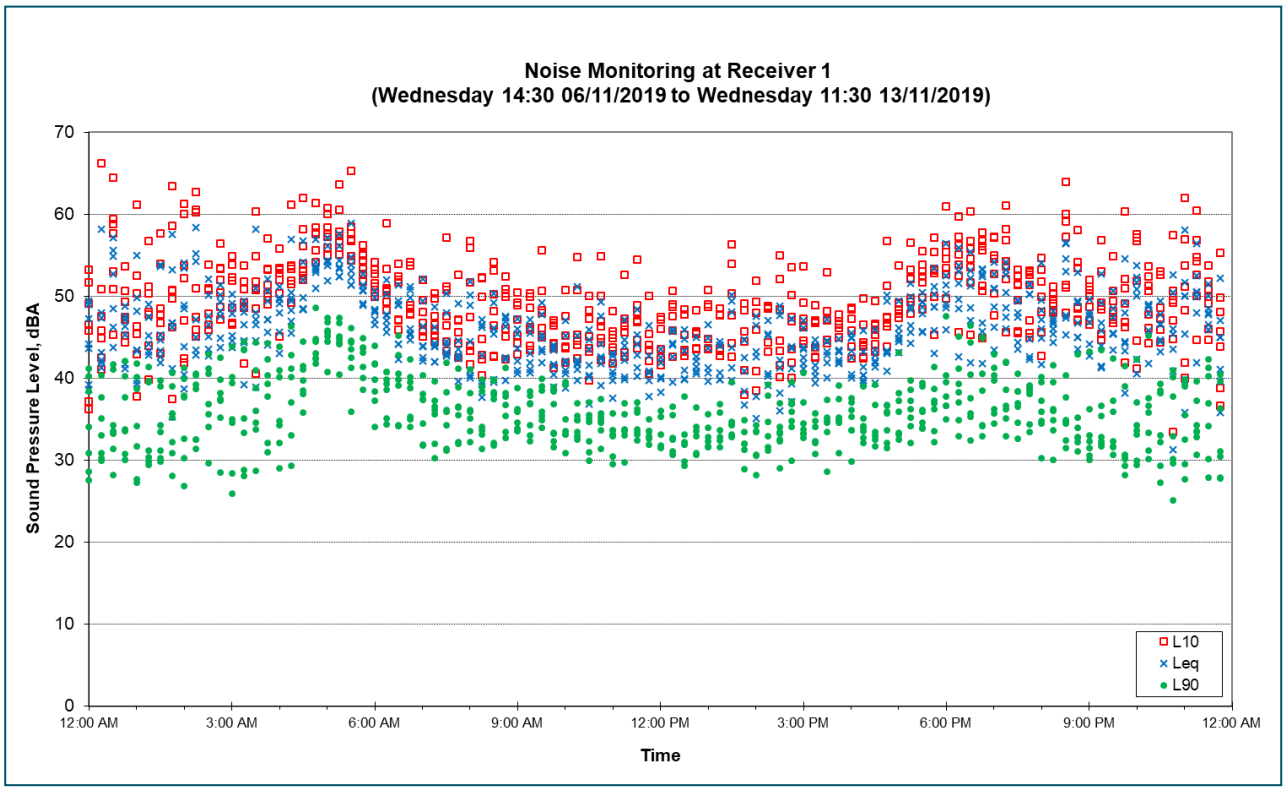


Figure C.2 24 Hour Noise Monitoring Results at Receptor 6

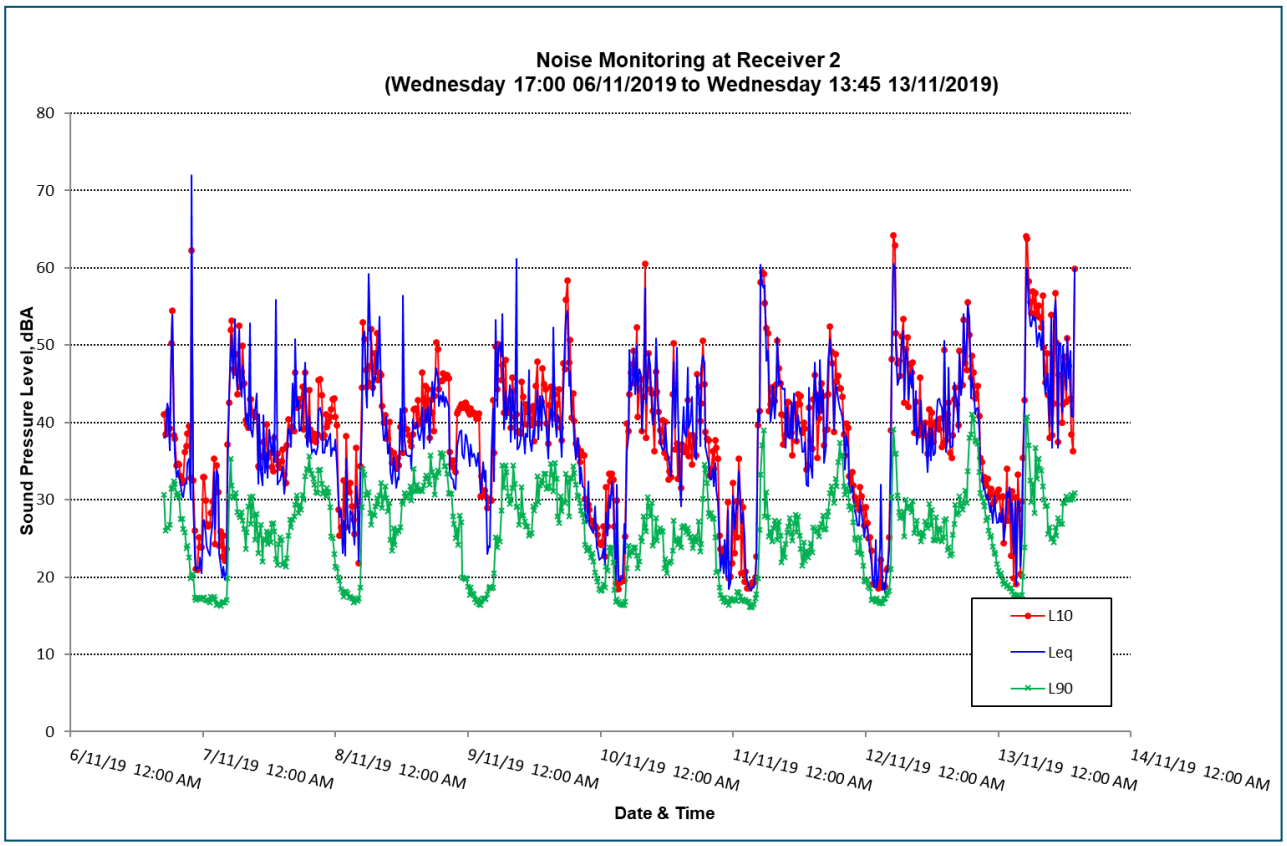


Figure C.3 Graph of Noise Logging Results at Receptor 9

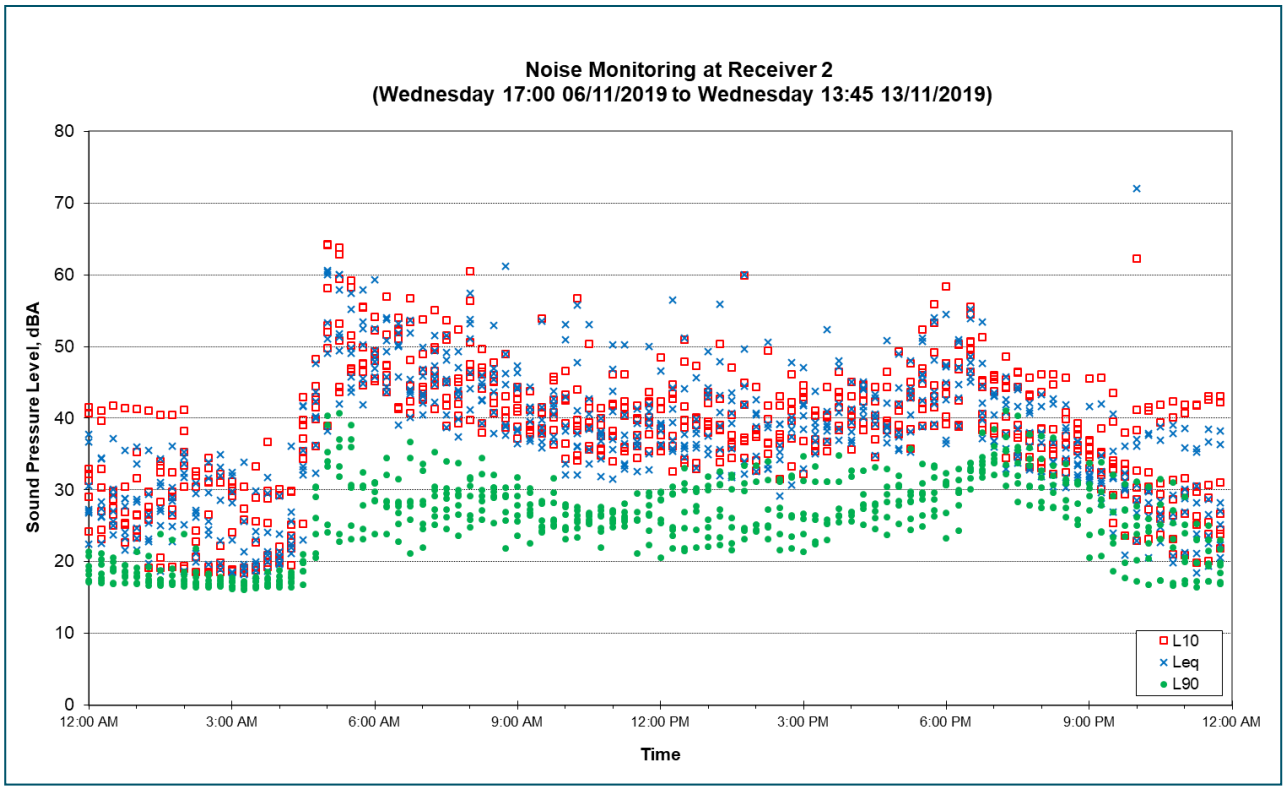


Figure C.4 24 Hour Noise Monitoring Results at Receptor 9

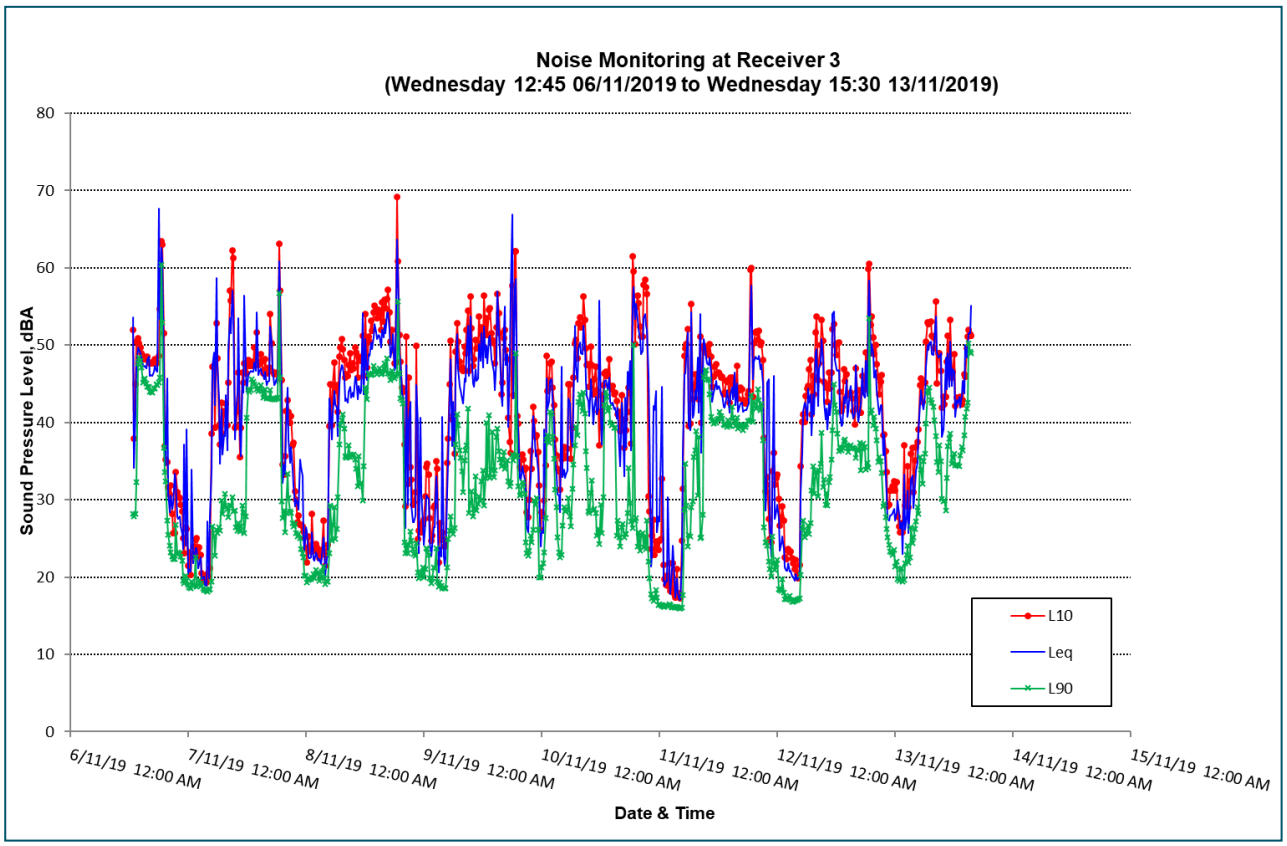


Figure C.5 Graph of Noise Logging Results at Receptor 10

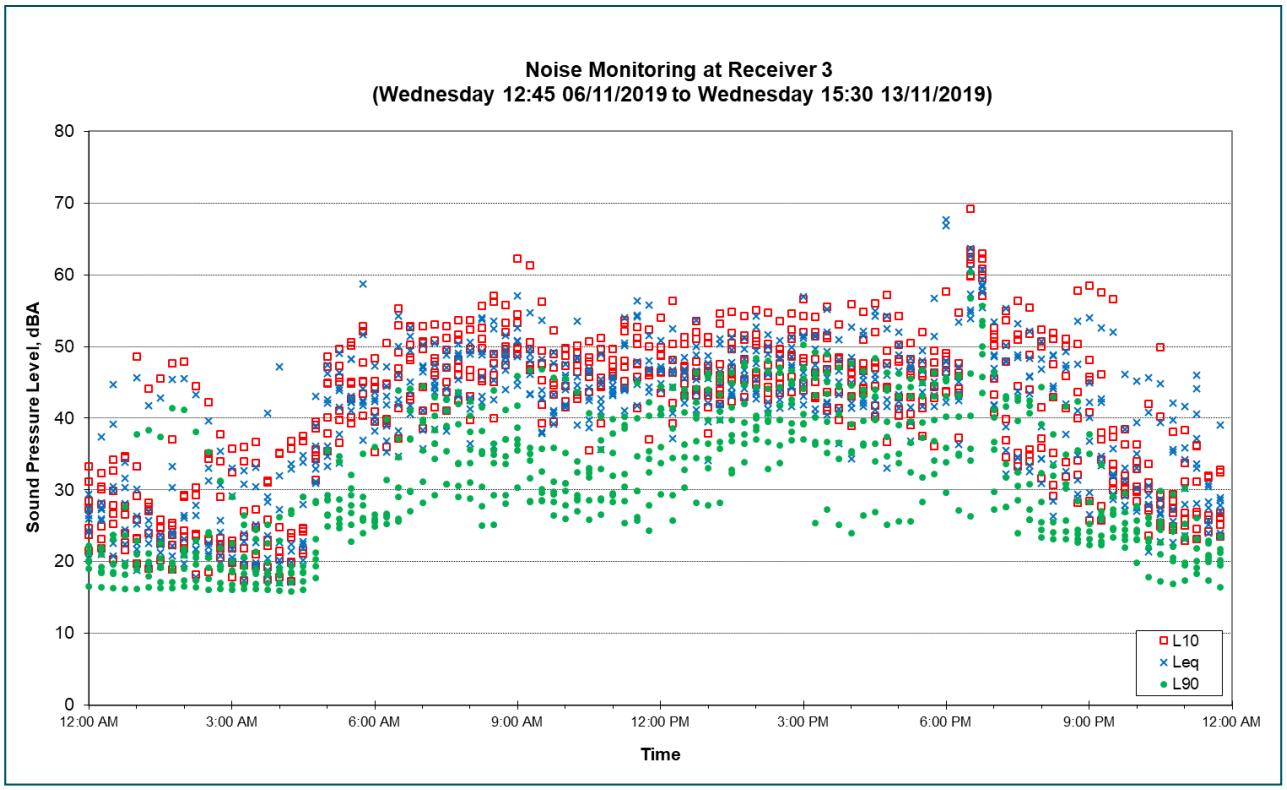


Figure C.6 24 Hour Noise Monitoring Results at Receptor 10

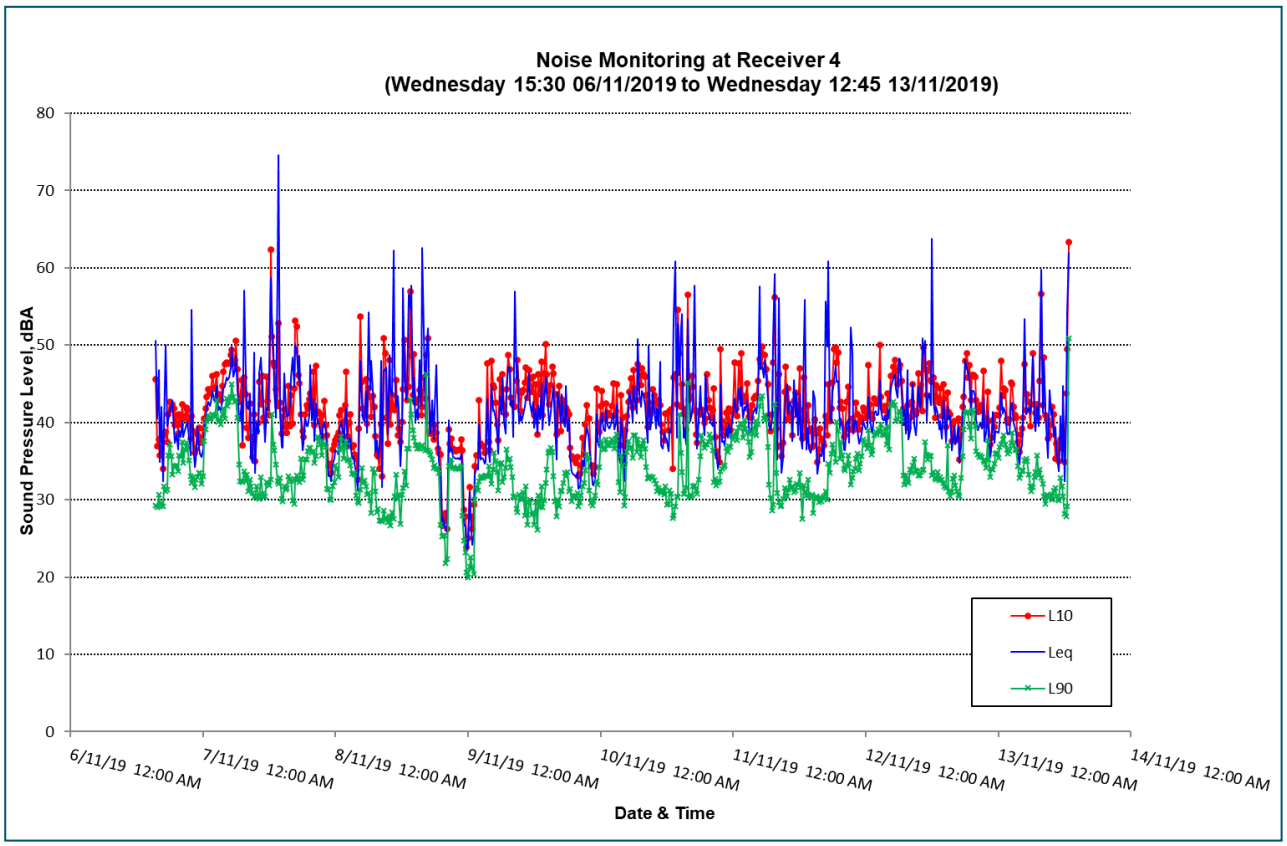


Figure C.7 Graph of Noise Logging Results at Receptor 8

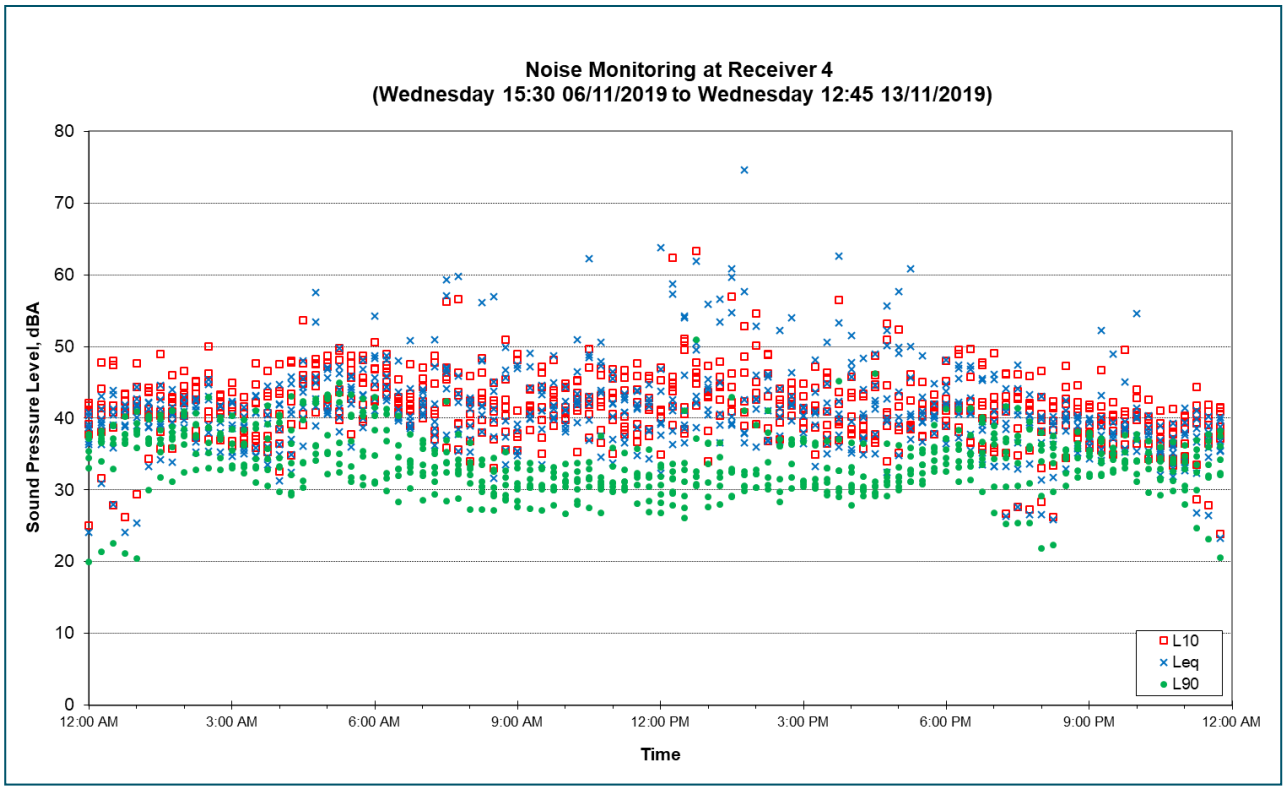


Figure C.8 24 Hour Noise Monitoring Results at Receptor 8

Table C.1 Statistical Noise Levels at Receptor 6

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	80-64-(58)-53-47	72-69-(63)-57-53	81-70-(63)-57-45
L_1	65-58-(53)-49-43	67-64-(58)-53-46	69-64-(58)-52-36
L_{10}	57-52-(47)-43-38	64-57-(52)-46-42	66-58-(51)-45-33
L_{eq}	53-49-(44)-40-35	57-53-(48)-43-38	59-54-(48)-42-31
L_{90}	43-39-(35)-32-28	48-42-(36)-32-28	49-44-(37)-30-25

Table C.2 Statistical Noise Levels at Receptor 9

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	92-74-(64)-53-47	79-69-(55)-41-29	92-74-(64)-53-47
L_1	73-61-(52)-44-36	68-59-(46)-36-25	73-61-(52)-44-36
L_{10}	61-48-(41)-36-32	58-48-(40)-33-24	61-48-(41)-36-32
L_{eq}	61-49-(41)-35-29	55-47-(38)-31-21	61-49-(41)-35-29
L_{90}	36-32-(28)-24-21	41-36-(31)-24-18	36-32-(28)-24-21

Table C.3 Statistical Noise Levels at Receptor 10

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	89-73-(64)-54-47	95-74-(61)-45-37	90-69-(53)-38-30
L_1	69-62-(54)-47-42	82-64-(50)-35-31	72-55-(38)-26-21
L_{10}	62-53-(47)-42-36	69-60-(45)-31-26	55-46-(32)-22-17
L_{eq}	57-52-(46)-41-33	68-57-(43)-29-26	59-45-(31)-20-17
L_{90}	50-46-(37)-28-24	60-46-(34)-23-22	44-30-(23)-17-16

Table C.4 Statistical Noise Levels at Receptor 8

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{max}	96-81-(66)-55-47	80-67-(55)-45-37	87-65-(55)-46-36
L_1	90-61-(53)-45-38	64-54-(45)-37-29	66-54-(46)-39-30
L_{10}	63-47-(42)-37-33	50-46-(40)-35-26	54-47-(41)-36-24
L_{eq}	75-51-(43)-37-32	52-45-(39)-33-26	58-46-(40)-35-23

Parameter	Noise Levels dBA [Maximum-Top 10%-(Average)-Bottom 10%-Minimum]		
	Day	Evening	Night
L_{90}	51-36-(32)-29-26	42-38-(35)-31-22	45-41-(36)-31-20

Appendix D Model Source Locations

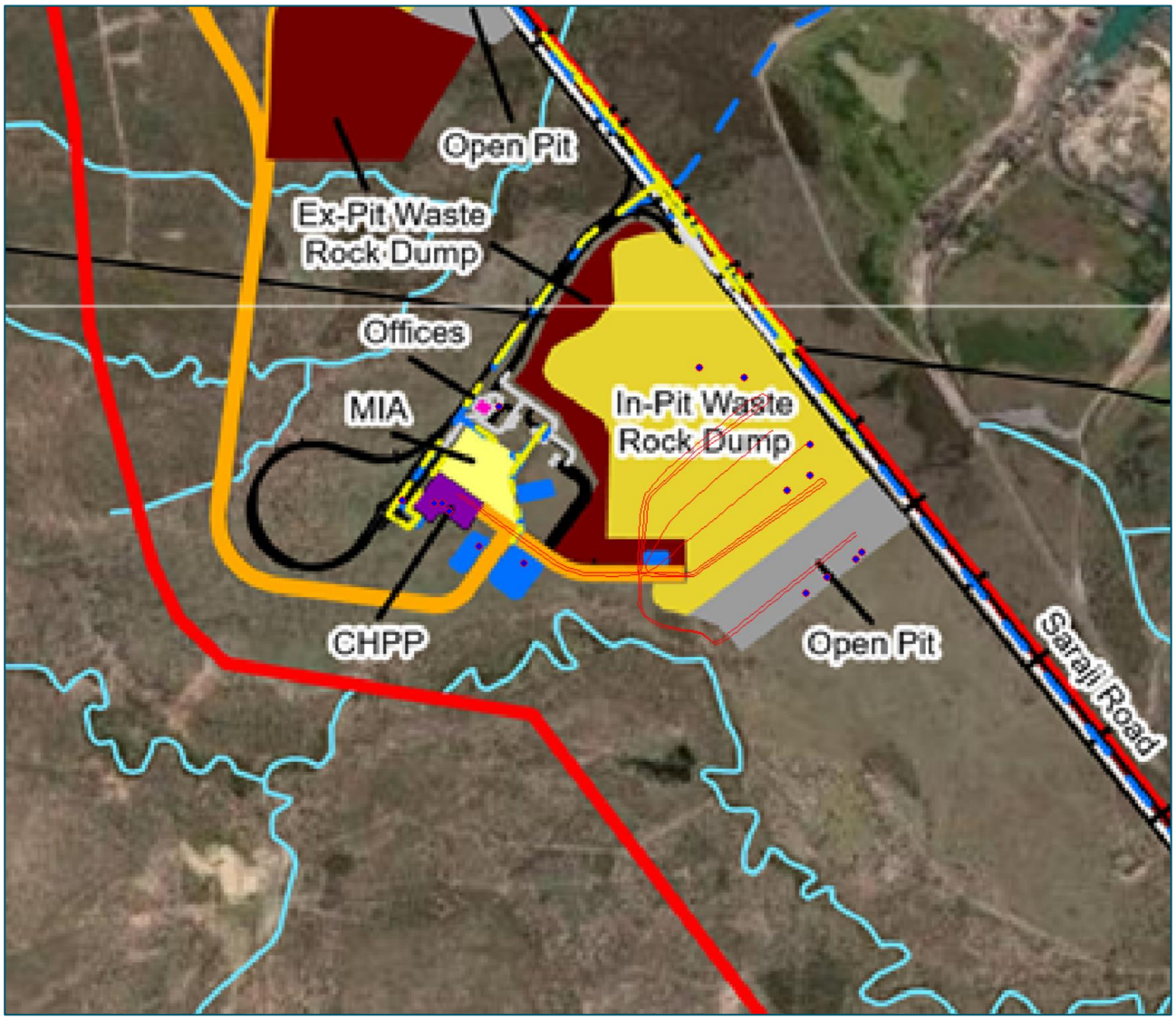


Figure D.1 Year 3 Equipment Locations in Noise Model (Note: Equipment shown as blue dots and truck paths shown as red lines)

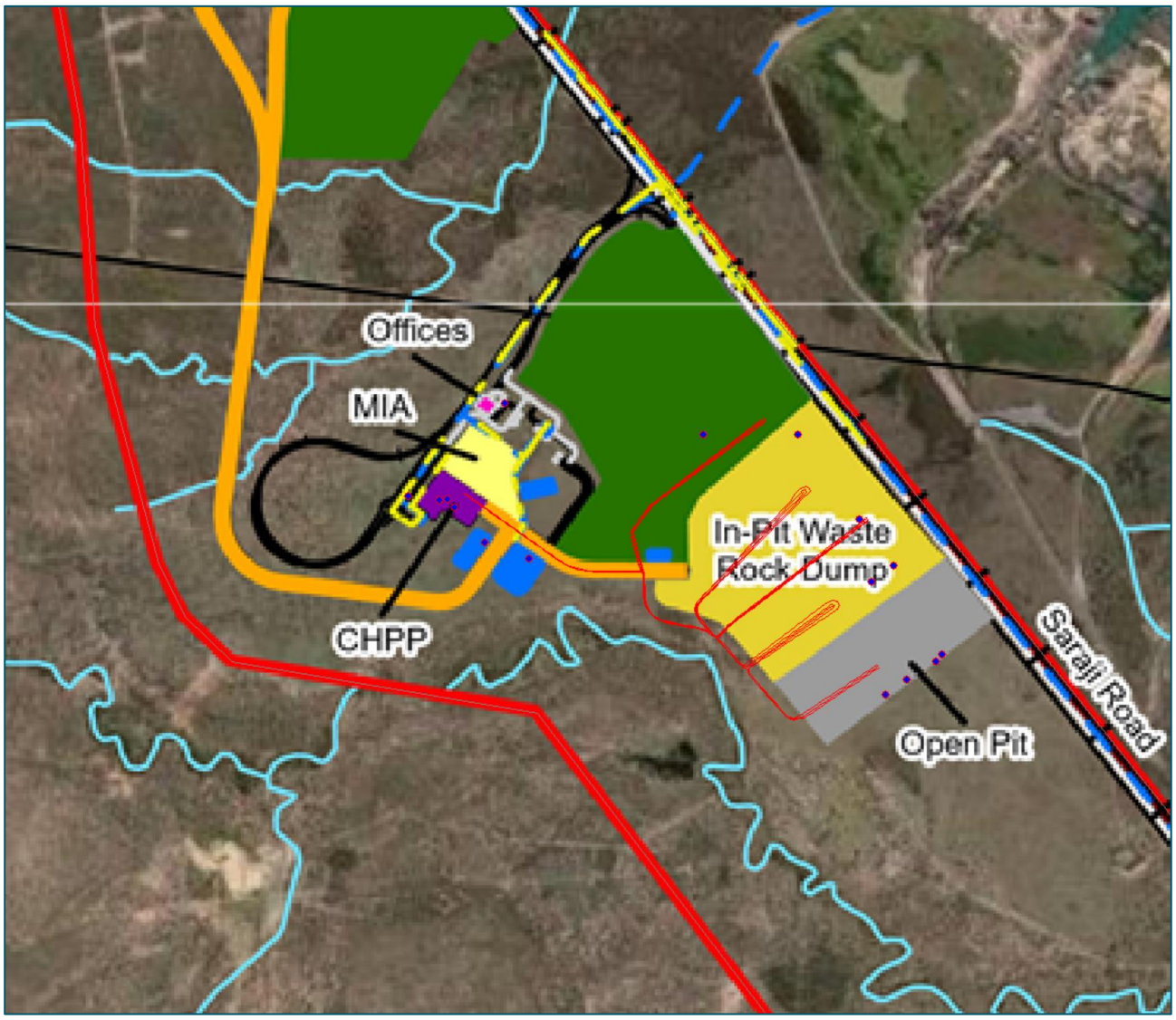


Figure D.2 Year 4 Equipment Locations in Noise Model (Note: Equipment shown as blue dots and truck paths shown as red lines)

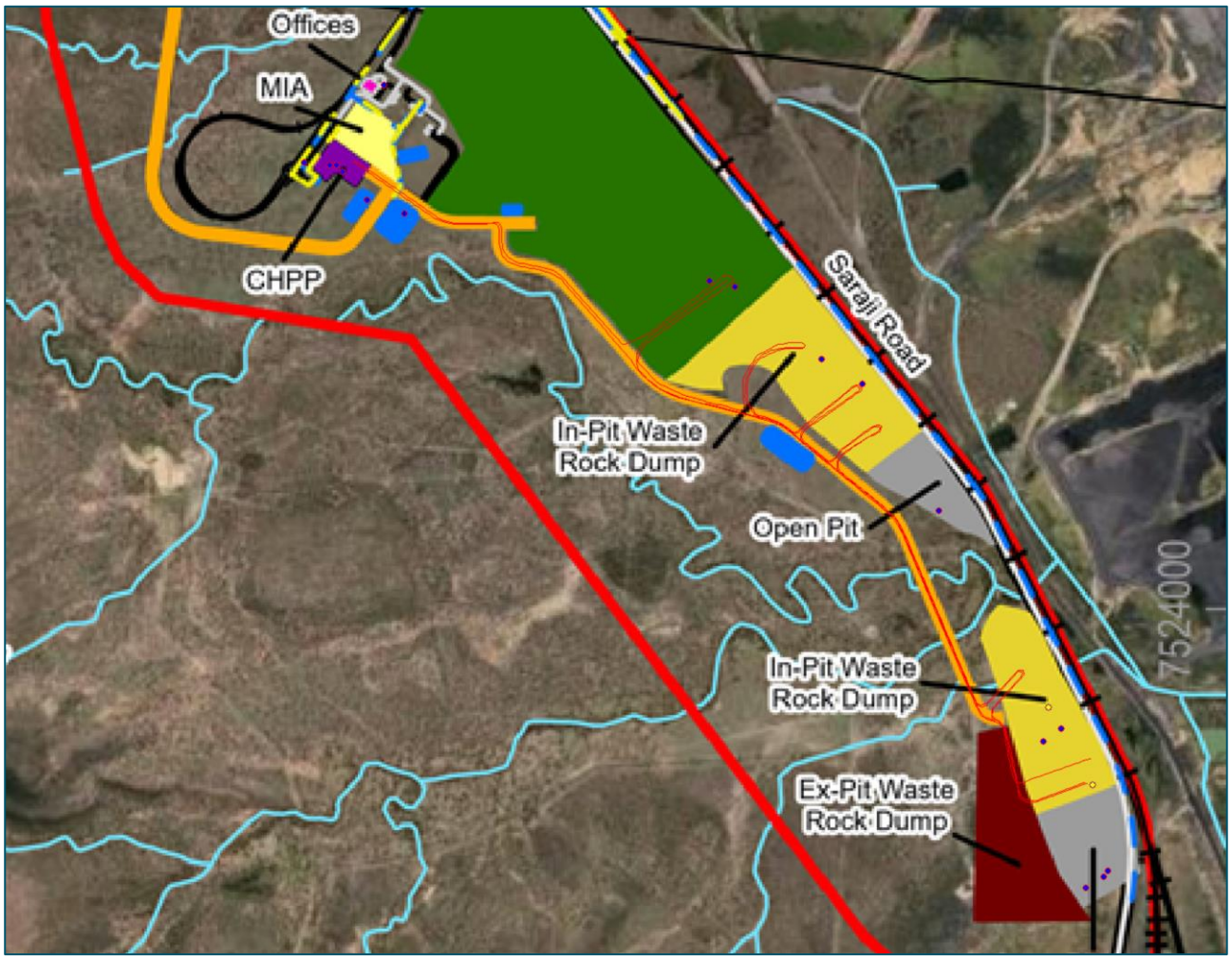
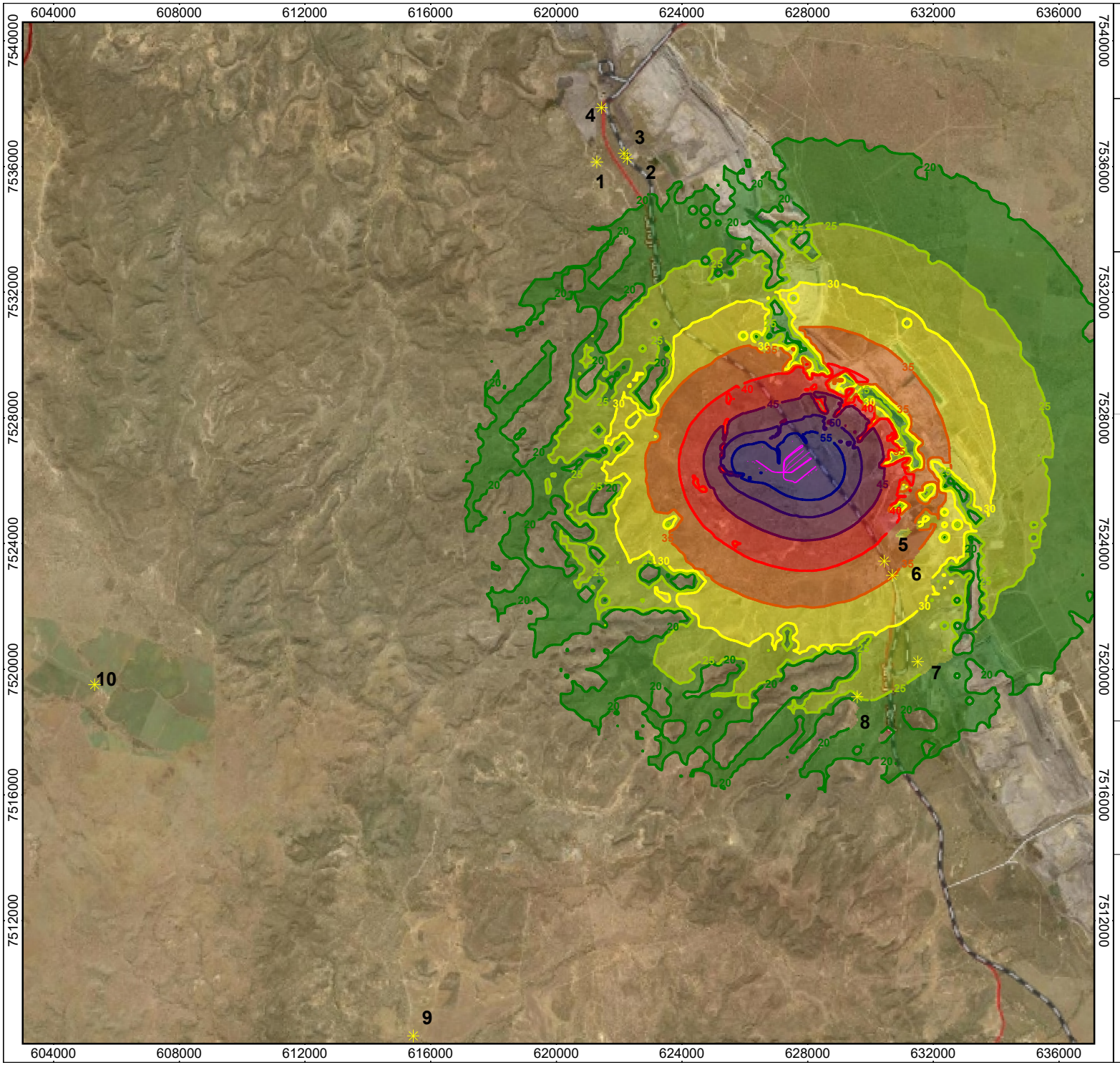


Figure D.3 Year 7 Equipment Locations in Noise Model (Note: Equipment shown as blue dots and truck paths shown as red lines)

Appendix E Predicted Noise Contours



Vulcan South
Project Number: 197401.0210

Figure

E.1

Year 3 Noise Contours Day - Scenario D2

Date: 7/04/2022
Drawn By: PJ
Prepared For: Mining & Energy Technical Services Pty Ltd

Noise Levels Leq (1hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

	=	20
	=	25
	=	30
	=	35
	=	40
	=	45
	=	50
	=	55

Signs and Symbols

- Point receiver
- Point source
- Line source

ask ACOUSTICS & AIR QUALITY
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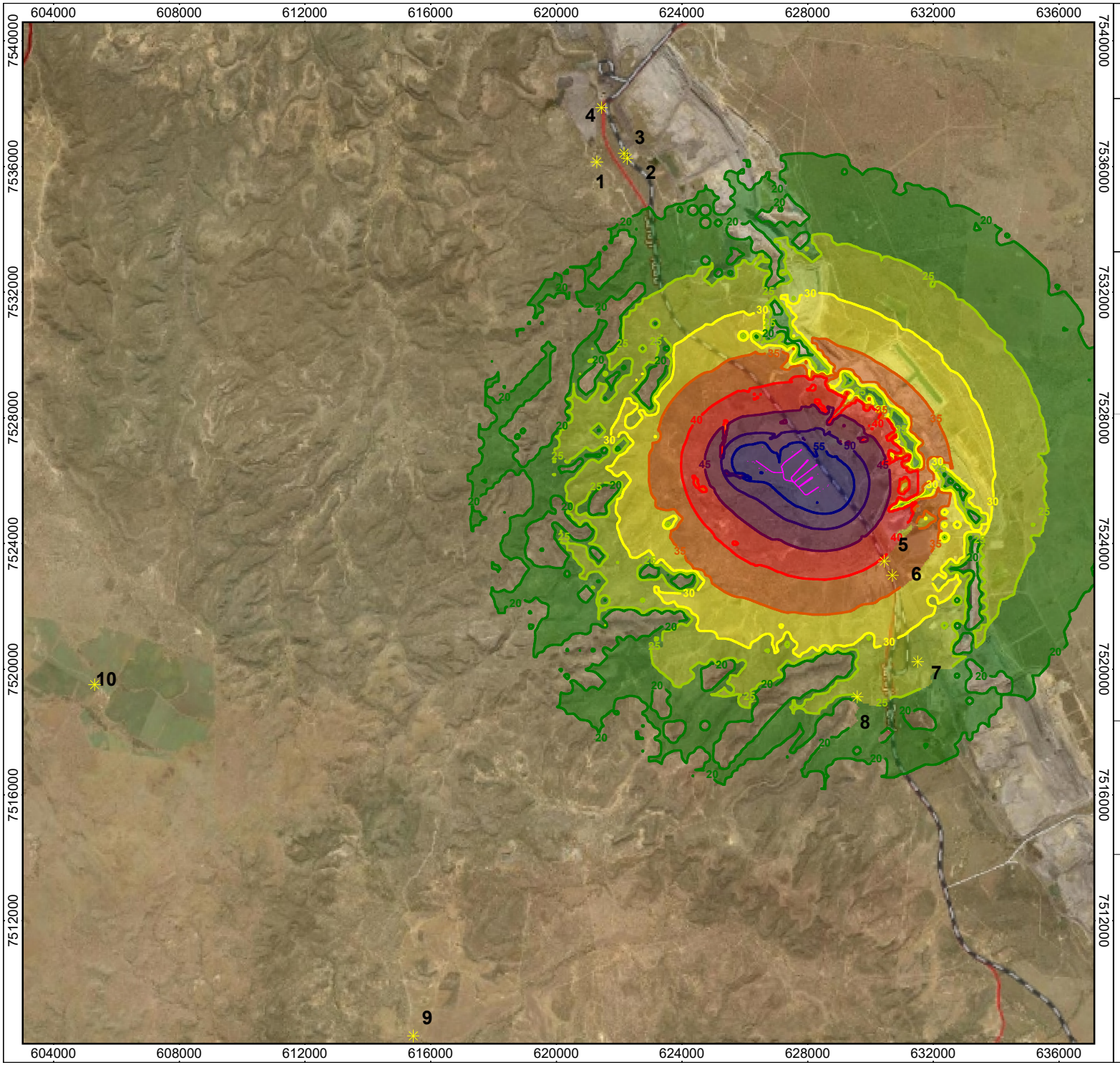

Vulcan South
Project Number: 197401.0210

Figure

E.2

Year 4 Noise Contours Day - Scenario D2

Date: 7/04/2022
Drawn By: PJ
Prepared For: Mining & Energy Technical Services Pty Ltd

Noise Levels Leq (1hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

=	20
=	25
=	30
=	35
=	40
=	45
=	50
=	55

Signs and Symbols

- Point receiver
- Point source
- Line source

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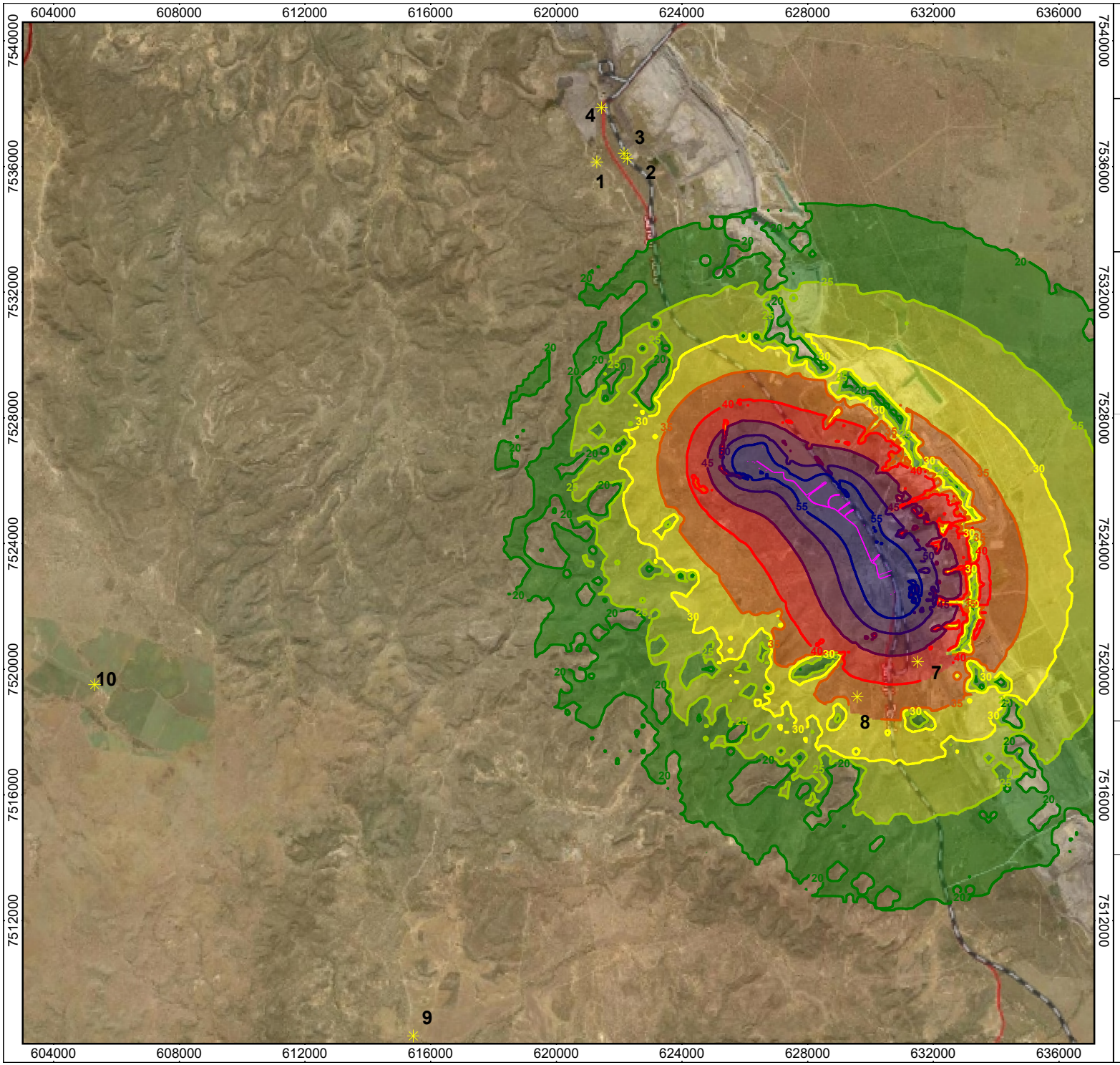

Vulcan South
Project Number: 197401.0210

Figure

E.3

Year 7 Noise Contours Day - Scenario D2

Date: 7/04/2022
Drawn By: PJ
Prepared For: Mining & Energy Technical Services Pty Ltd

Noise Levels Leq (1hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

	=	20
	=	25
	=	30
	=	35
	=	40
	=	45
	=	50
	=	55

Signs and Symbols

- Point receiver
- Point source
- Line source

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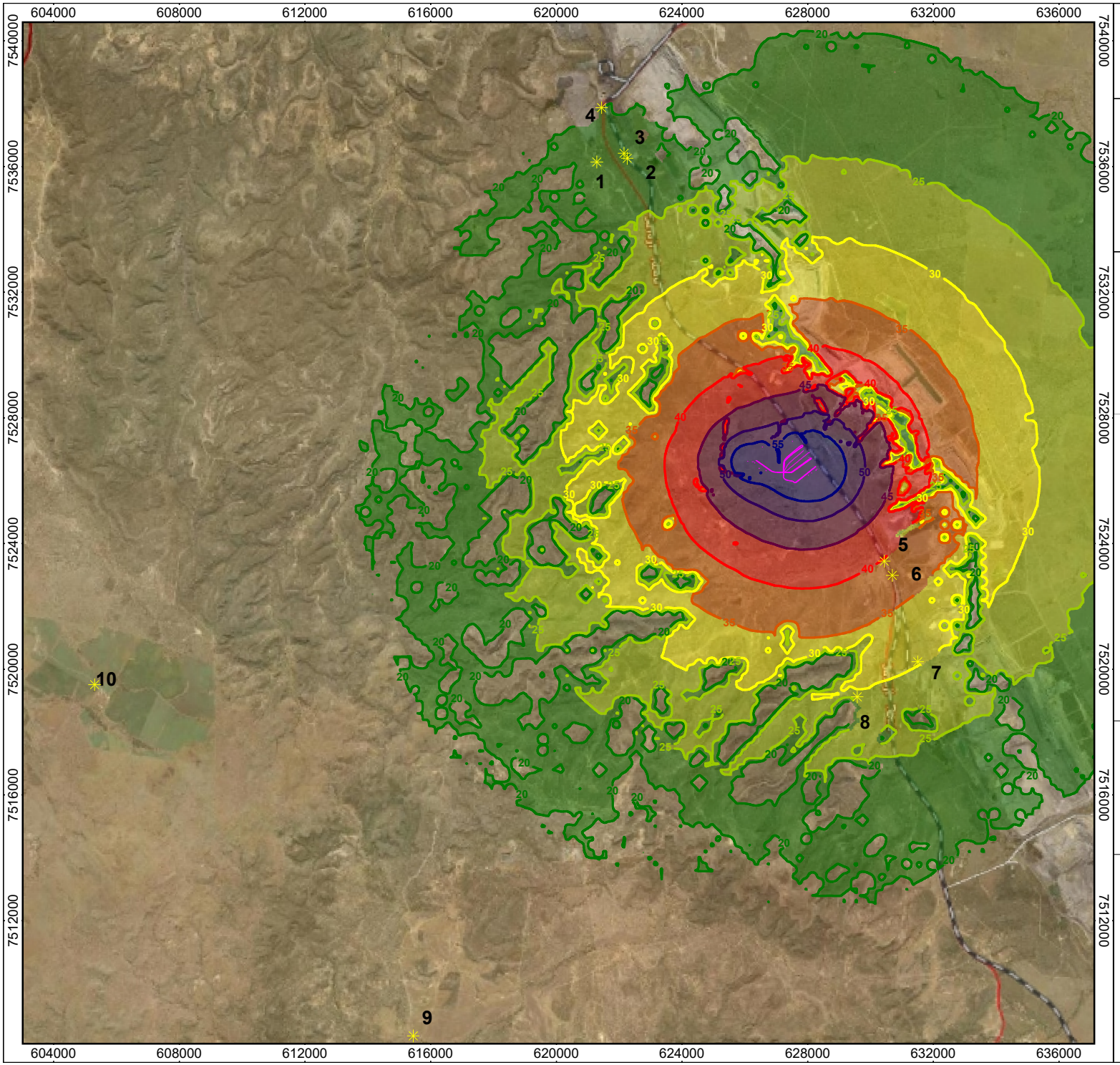

Vulcan South
Project Number: 197401.0210

Figure

E.4

Year 3 Noise Contours
Night - Scenario N1

Date: 7/04/2022
Drawn By: PJ
Prepared For: Mining & Energy Technical Services Pty Ltd

Noise Levels Leq (1hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

=	20
=	25
=	30
=	35
=	40
=	45
=	50
=	55

Signs and Symbols

- Point receiver
- Point source
- Line source

ask ACOUSTICS & AIR QUALITY
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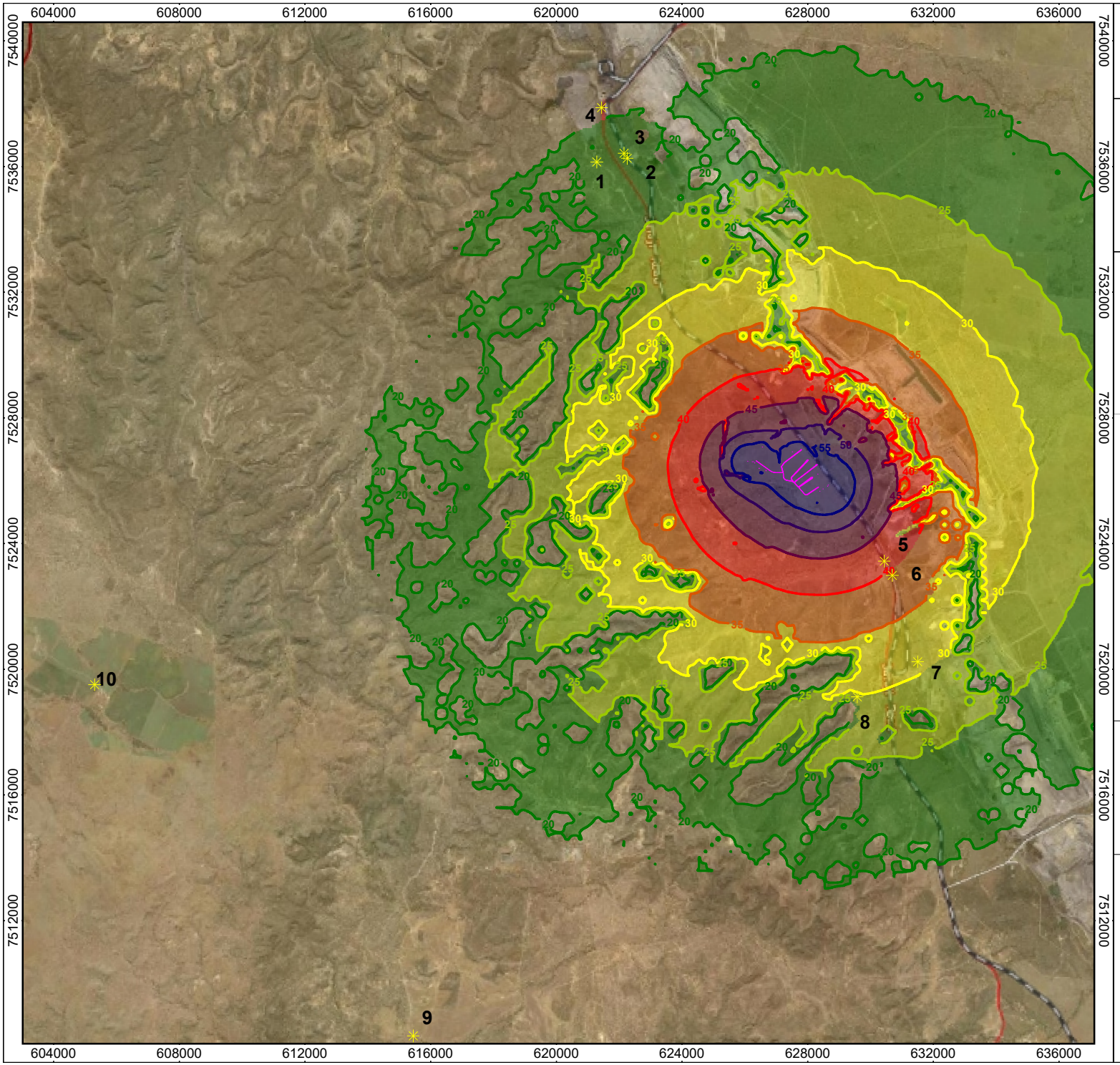

Vulcan South
Project Number: 197401.0210

Figure

E.5

Year 4 Noise Contours
Night - Scenario N1

Date: 7/04/2022
Drawn By: PJ
Prepared For: Mining & Energy Technical Services Pty Ltd

Noise Levels Leq (1hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

	=	20
	=	25
	=	30
	=	35
	=	40
	=	45
	=	50
	=	55

Signs and Symbols

- Point receiver
- Point source
- Line source

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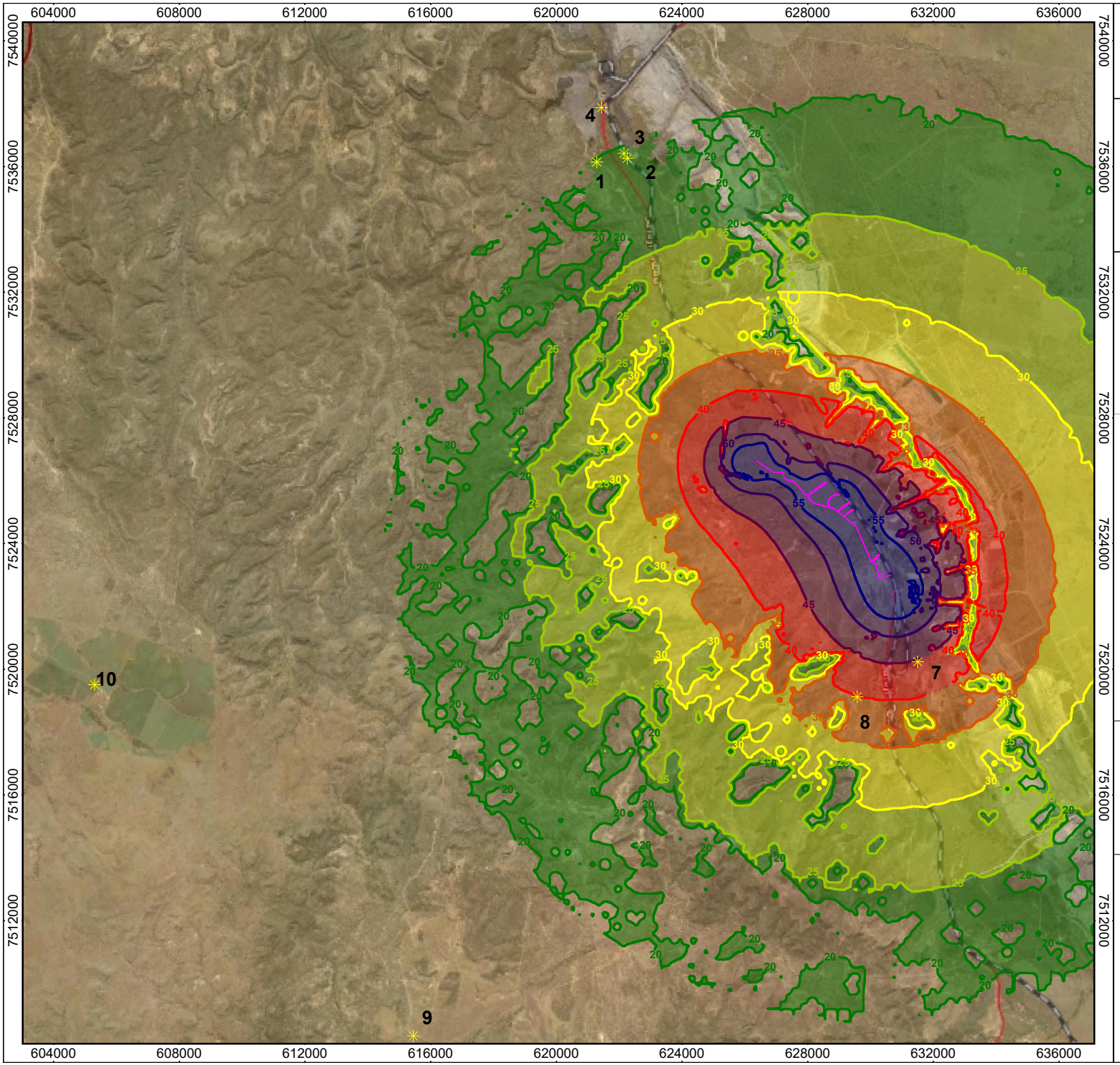

Vulcan South
Project Number: 197401.0210

Figure

E.6

Year 7 Noise Contours
Night - Scenario N1

Date: 7/04/2022
Drawn By: PJ
Prepared For: Mining & Energy Technical Services Pty Ltd

Noise Levels Leq (1hour)

Free Field dB(A)
Ground Contour Calculation Height = 1.8m

	=	20
	=	25
	=	30
	=	35
	=	40
	=	45
	=	50
	=	55

Signs and Symbols

- Point receiver
- Point source
- Line source

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Appendix C
The Groundwater Quality and Level Trigger Assessment

METSERVE
Mining & Energy Technical Services Pty Ltd

Groundwater Quality and Level Trigger Assessment

for Vulcan South

September 2022

This report has been prepared solely for the benefit of Vitrinite Pty Ltd. Mining and Energy Technical Services Pty Ltd (METServe) accepts no liability for the use or interpretation of any information contained in this report for any other purpose other than intended, or for its use by any party other than the above named Client.

Document History and Status

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1	1 (Draft)	Internal	1	13/09/2022	Emerson Pollard
2	2 (Draft)	Internal	1	21/09/2022	L. Morgan / D. Plucknett
3	3 (Final)	Vitrinite	1	21/09/2022	Emerson Pollard

MET Serve Project Delivery System

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Name of Organisation:	Vitrinite
Name of Project:	Vulcan South
Name of Document:	Groundwater Quality and Level Trigger Assessment
Document Version:	005
Project Number:	VI011

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Brisbane City
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TABLES

FIGURES

APPENDICES

1 INTRODUCTION

Mining & Energy Technical Services Pty Ltd (METServe) has been engaged by Vitrinite Pty Ltd to prepare a groundwater quality and level trigger assessment to support an Environmental Authority (EA) application for Vulcan South (the Project). The Project is proposed to be developed by Vitrinite Pty Ltd., owner of Queensland Coking Coal Pty Ltd and QLD Coal Aust No.1 Pty Ltd, the proponents of the Project and subsequent EA applicants.

1.1 BACKGROUND

The Project is located immediately south of Vitrinite's Vulcan Coal Mine (VCM), located on ML700060, 40 km south of Moranbah in Queensland. The proposed MLA boundary (the Project area) abuts ML700060; however, proposed activities for Vulcan South and VCM will be implemented separately. The Vulcan hard coking coal target has been defined and selected for open cut development via three separate open cut pits that form the primary mining focus of the Project (i.e. Vulcan North pit, Vulcan Main pit, and Vulcan South pit). The Project will operate for approximately nine years, including primary rehabilitation works, following a two-year construction period. The Project will extract approximately 13.5 million tonnes (Mt) of Run of Mine (ROM) coal consisting predominantly of hard coking coal with an incidental thermal secondary product at a rate of up to 1.95 million tonnes per annum (Mtpa). The Project will target the Alex and multiple Dysart Lower coal seams. Truck and shovel mining operations will be employed to develop the pits.

Ex-pit waste rock dumps will be established prior to commencing in-pit dumping activities that will continue for the life of the operation. Ancillary infrastructure, including a ROM pad, modular coal handling and preparation plant (CHPP), rail loop and train load-out facility (TLO), Mine Infrastructure Area (MIA), offices, roads and surface water management infrastructure will be established to support the operation. In-pit dumping will fill the majority of the pit volumes during operations with the remaining final voids to be backfilled upon cessation of mining, resulting in the establishment of low waste rock dump landforms over the former pit areas. The initial Ex-pit waste rock dump will be rehabilitated in-situ.

The Project includes a small-scale highwall mining trial program in the north of the Project area. The trial will involve the establishment of four highwall mining benches across several hillsides to facilitate extraction of coal utilising a highwall miner. The highwall mining trial will target up to 750 kilotonnes (kt) of coal which will be transported by truck to the CHPP via a dedicated haul road. The highwall mining trial is scheduled to be completed within the first year of mining operations.

A groundwater monitoring network was established across the Project area in June 2019 to support the collection of baseline data for Vulcan South. Vulcan South's groundwater monitoring network consists of eight monitoring bores, whereby water level and quality are periodically monitored (see section 2 for further details).

2 GROUNDWATER MONITORING NETWORK

The Project's groundwater monitoring network consists of eight monitoring bores across the Project area. Bore details are outlined in **Table 1** and locations shown in **Figure 1.**

Table 1 Vulcan South's Groundwater Monitoring Bore Construction Details

Monitoring location	Easting	Northing	Target formation	Casing height (m)	Casing elevation (mAHD)	Depth (mbgl)	Monitoring interval (mbgl)	Airlift yield (L/min)
MB01	625606	7529691	DLL coal seam	0.70	222.91	24.9	21.9 – 24.9	Dry
MB06	628119	7526476	Weathered Permian	0.70	214.61	24.6	21.6 – 24.6	Dry
MB07	628691	7526258	Weathered Permian	0.67	215.99	43.0	40.0 – 43.0	0.1
MB08	628092	7527015	Weathered Permian	0.70	212.24	24.0	21.0 – 24.0	Dry
MB09	629511	7525222	DLL coal seam	0.65	208.98	34.4	31.4 – 34.4	0.1
MB10	628123	7526469	DLL coal seam	0.70	214.60	40.3	37.3 – 40.3	< 0.1
MB11	627403	7527854	DLL coal seam	0.70	225.66	29.9	26.9 – 29.9	Dry
MB12	625251	7526409	Back Creek Group	0.66	241.43	38.2	32.2 – 38.2	1

Notes: *mAHD – meters Australian Height Datum*
mbgl – metres below ground level
L/min – litres per minute

Groundwater monitoring bores MB01, MB06, MB08, and MB11 have been consistently dry since installation in 2019. Owing to this, no groundwater quality or level trigger limits have been developed for these dry bores.

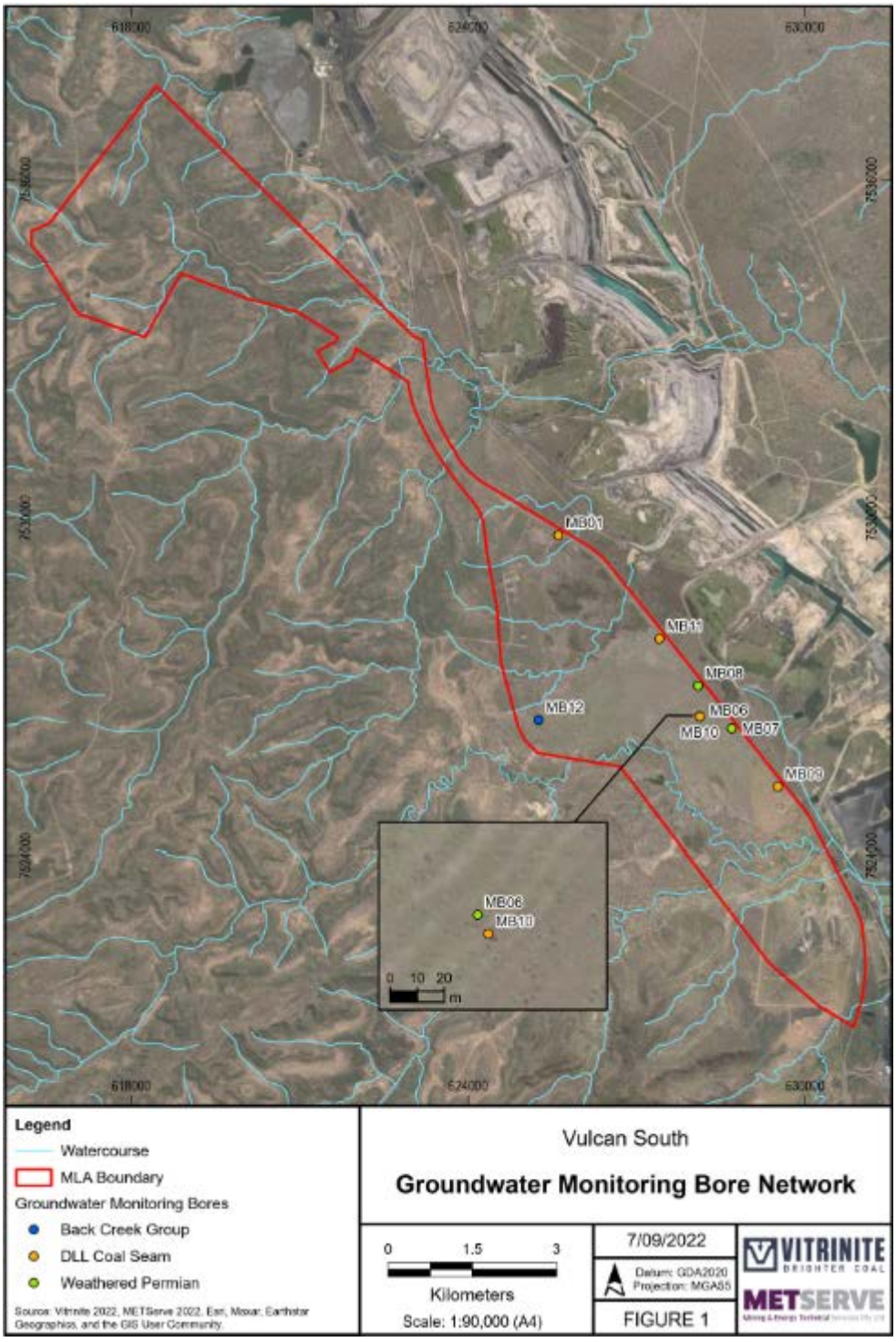

Figure 1 Vulcan South Groundwater Monitoring Network

3 GROUNDWATER LEVELS

3.1 METHODOLOGY

The methodology used to develop the proposed groundwater level trigger thresholds for Vulcan South included:

- determining the pre-mining baseline groundwater level for each monitoring bore;
- calculating the seasonal variation in groundwater levels for each monitoring bore; and
- extracting the predicted groundwater drawdown at the monitoring bore location for the bore's monitored formation from the numerical flow model (developed by hydrogeologist.com.au).

The pre-mining baseline for each monitoring bore was determined as the groundwater level seen in the latest groundwater level measurements collected in June 2022. The seasonal variation in groundwater levels recorded at each bore were also calculated using the variation between minimum and maximum measurements recorded over the pre-mining data collection period (June 2019 to June 2022).

Using the numerical model developed for the Project, predicted drawdowns within the bore's monitored geologic formation were extracted at each bore location (hydrogeologist.com.au, 2022). If a formation's predicted drawdown was to be limited / negligible at the monitoring bore's location, a conservative drawdown value of 0.2 m was applied (hydrogeologist.com.au, 2021). The numerical model indicates the largest maximum drawdown within the shallowest layer is the weathered Permian formation at MB07, followed by the DLL coal seam at both MB09 and MB10. The groundwater level trigger values were then calculated as the pre-mining baseline level minus the seasonal variation and predicted drawdown (see **Table 2** for values used in calculation).

3.2 PROPOSED GROUNDWATER LEVEL TRIGGER VALUES

The proposed groundwater level trigger thresholds are listed in **Table 2** below.

Table 2 Proposed Groundwater Level Trigger Values

Monitoring location	Target formation	Pre-mining baseline level (mAHD)	Predicted formation drawdown (m)	Seasonal variation (m)	Groundwater level trigger threshold (mAHD)
MB07	Weathered Permian	180.01	10.96	0.91	168.14
MB09	DLL coal seam	181.38	5.23	0.53	175.63
MB10	DLL coal seam	182.66	6.47	0.52	175.67
MB12	Back Creek Group	215.83	0.2[1]	2.49	213.14

Notes: mAHD – meters Australian Height Datum

[1] No drawdown predicted by the numerical model, hence 0.2 m drawdown value used.

4 GROUNDWATER QUALITY

4.1 METHODOLOGY

The methodology to determine the proposed groundwater quality trigger levels included:

- collating the available groundwater quality data from the groundwater monitoring bores;
- analysing the available groundwater data and developing summary statistics for each individual monitoring bore, and each geological formation monitored by the groundwater monitoring bores;
- comparing the summary statistics to ANZG (2018) guidelines and any published groundwater quality objectives associated with the local groundwater regime; and
- developing groundwater quality triggers that address the environmental protection requirements of an EA condition.

The following sections provide additional information on the methodology used to develop the proposed groundwater quality trigger values.

4.1.1 Data collation and statistical analysis

Vulcan South's groundwater monitoring network consists of eight monitoring bores; four of which have remained dry since installation in 2019 and have not been addressed in this assessment. In-line with the groundwater monitoring regime at the VCM, monthly water quality sampling was completed for the first four months post-install, decreasing to quarterly sampling thereafter. A total of 17 – 18 monitoring events have occurred at the Project's monitoring bores since June 2019.

Each groundwater sample collected was measured for field parameters in-situ (e.g pH, EC), as well as laboratory analysis which included major ion and metals (dissolved and totals) analysis. Total Recoverable Hydrocarbons (TRH) was added to the sample suite in December 2020.

Although duplicate samples were collected during each monitoring event, such samples have been removed from the dataset prior to statistical analysis. Where groundwater quality concentrations were measured to be below the laboratories limit of reporting (LOR), a value of half the LOR was substituted to enable statistical analysis. LOR results detailed in **Appendix A** – Groundwater Quality and Level Data are coloured red and are in italics.

Summary statistics for each analyte per monitoring bore are shown in **Appendix B** – Groundwater Quality Statistics Summary aligning with DES' guideline *Using monitoring data to assess groundwater quality and potential environmental impacts'* (2021).

Appendix C illustrates box and whisker plots as well as long-term trends of each analyte (per bore) which are considered a contaminant of concern. Box and whisker plots represent the 25th to 75th percentile (edges of boxes) and medians of the data, while the whiskers represent the minimum or maximum value that falls within 1.5 times the interquartile range (75th percentile minus the 25th percentile).

4.1.2 Review of applicable water quality objectives

The *Environmental Protection Act* (EP Act) establishes an Environmental Protection Policy (EPP) for water. The Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (Qld) (EPP Water) provides a framework for the protection of environmental values (e.g surface water uses) associated with Queensland rivers, streams, wetlands, lakes, aquifer, estuaries and coastal areas. Under this framework, environmental values for specific catchments and drainage basins have been formalised through a process of statutory declaration. Environmental values formalised in this way are listed in Schedule 1 of the EPP Water.

The published groundwater environmental values for the Isaac River sub-basin include aquatic ecosystems, recreational use, agriculture (irrigation, farm supply, stock water), drinking water supply and cultural values.

The EPP Water provides groundwater quality objectives for the protection of high ecological value groundwater ecosystems and drinking water. However, it should be noted that there are no high ecological value groundwater ecosystems present within the vicinity of the project.

While the Project is located outside the extent of the Fitzroy Basin groundwater zones and any subsequent sub-basin plans, box and whisker plots developed from the site-specific dataset includes water quality objectives (WQOs) for the nearest local government groundwater zone, zone 34 within the Dawson River sub-basin plan. 20th, 50th and 80th percentile values for Zone 34 are illustrated on the box and whisker plot as a comparison to the regional groundwater chemistry (see **Appendix C** for plots). Zone 34 'deep' values were considered the most relevant to the Project's groundwater monitoring bores, as majority of the bores are greater than 30 m in depth.

Overall, groundwater within the Project area measured at the Project's monitoring bores are consistently more acidic than that of the relevant regional values. Hence, the application of Zone 34's regional groundwater quality objectives to the Project's groundwater monitoring network is not considered appropriate.

4.1.3 Development of groundwater quality triggers

Reference bores were not considered when determining the compliance approach for groundwater quality triggers, as pre-mining baseline data is not available for multiple bores within every aquifer across the Project area. Additionally, the ionic composition between bores, both within the same aquifer and between different aquifers, varies. For these reasons, comparison between compliance and reference bores is not considered appropriate. Instead, the recommended compliance approach outlined in the DES (2021) guideline *Using monitoring data to assess groundwater quality and potential environmental impacts* was followed, developing a single compliance limit from the 95th percentile of site-specific data.

Groundwater quality trigger values were not developed for MB01, MB06, MB08 or MB11 due to these monitoring bores being consistently dry since installation. Proposed groundwater quality trigger values for MB07, MB09, MB10 and MB12 were developed for the following analytes: field pH, field EC, sulphate, aluminium, arsenic, iron, lead, mercury, molybdenum, selenium, and TRH (both TRH C6-C10 and TPH C10-C40). Dissolved fractions were used when developing trigger values for metalloid analytes. Analytes such as major cations (sodium, potassium, calcium, magnesium) and major anions (chloride, bicarbonate, carbonate) did not have triggers developed as they are not considered a contaminant of concern. Such analytes are monitored for interpretive purposes only.

4.2. Groundwater Quality Characteristics and Proposed Groundwater Quality Trigger Values

The groundwater quality characteristics measured at the Project's monitoring bores is illustrated in Figure 2. The Piper plot indicates that groundwater is generally of a sodium-chloride type. No distinct relationship between the aquifer and groundwater quality is apparent, with each bore plotting in different locations on the Piper plot, **Figure 2.**

Monitoring bores MB09 and MB10, which both monitor the DLL coal seam, show differing groundwater characteristics. This indicates a low degree of connectivity between bores screened within the same aquifer, and the spatial differences in water chemistry across the Project area.

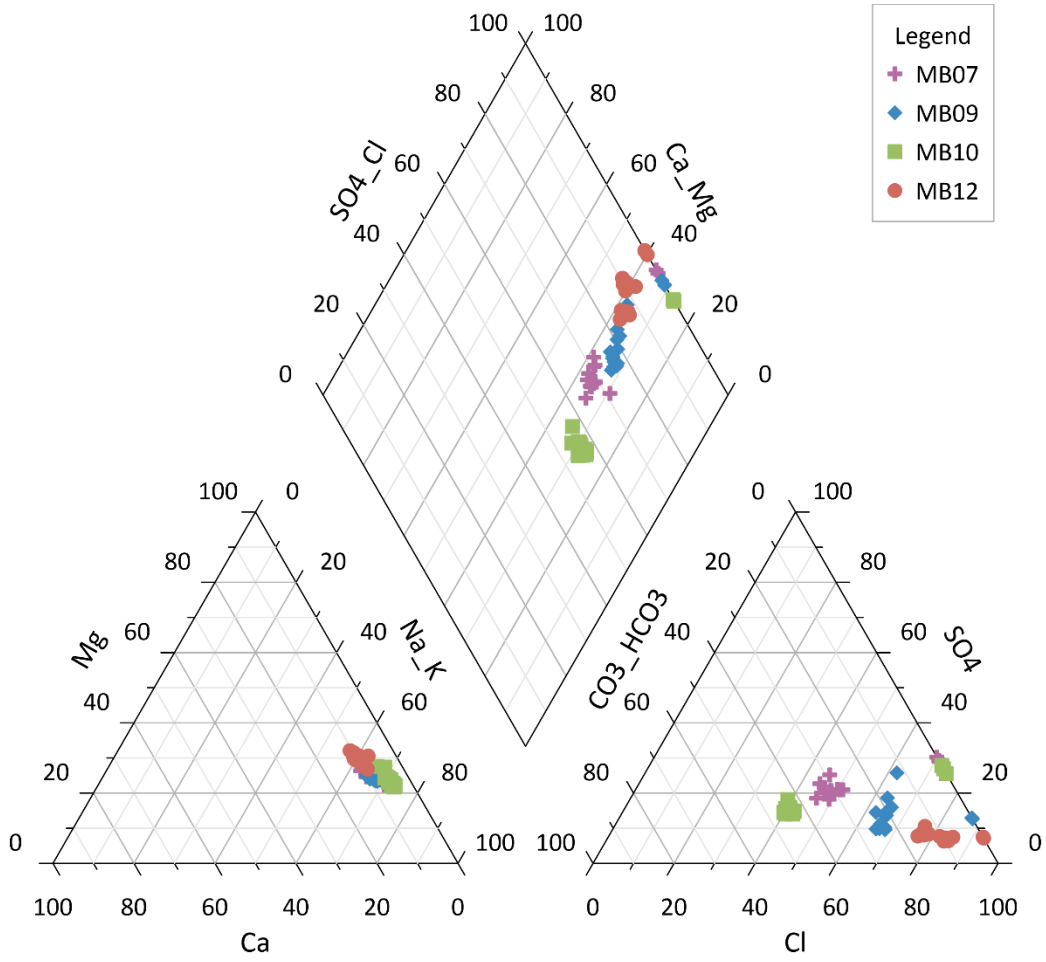

Figure 2 **Piper Plot for Vulcan South Groundwater Monitoring Bores**

The proposed groundwater quality triggers were developed from site-specific data collected between June 2019 and June 2022, consisting of 18 monitoring events. The 95th percentile for each analyte per monitoring bore were calculated and compared to the corresponding ANZG (2018) default guideline.

Since monitoring began in June 2019, several metalloid analytes have consistently recorded concentrations below the limit of reporting (LOR). In this case, the ANZG (2018) guideline values for the 95% level of species protection have been applied rather than a 95th percentile derived trigger owing to the numerous records below LOR. For TRH (both C6-C10 and C10-C40), the LOR has also been applied as the proposed trigger value, due to the ANZG (2018) guideline value for TRH being significantly lower than LOR. It is recommended that if several results are recorded above the LOR for aluminium, arsenic, lead, mercury, molybdenum, selenium and TRH, site specific trigger values should then be calculated. Proposed groundwater quality trigger values for Vulcan South are presented in **Table 3** below.

Table 3 Proposed Groundwater Quality Trigger Values

Parameter	Unit	Bores	Limit	Comment
pH (field)	**pH unit**	**All bores**	**5.5 - 8.0**	**ANZG (2018)**
Electrical Conductivity (field)	µS/cm	MB07	5,834	Site-specific 95th percentile
		MB09	15,095	Site-specific 95th percentile
		MB10	4,836	Site-specific 95th percentile
		MB12	23,160	Site-specific 95th percentile
Sulphate	mg/L	MB07	786	Site-specific 95th percentile
		MB09	1,917	Site-specific 95th percentile
		MB10	518	Site-specific 95th percentile
		MB12	938	Site-specific 95th percentile
Metals and Metalloids				
Aluminium	mg/L	All bores	0.050	ANZG (2018)
Arsenic	mg/L	All bores	0.013	ANZG (2018)
Iron	mg/L	MB07	0.600	Site-specific 95th percentile
		MB09	0.7	Site-specific 95th percentile
		MB10	0.2	Site-specific 95th percentile
		MB12	4.6	Site-specific 95th percentile
Lead	mg/L	All bores	0.004	ANZG (2018)
Mercury	mg/L	All bores	0.0006	ANZG (2018)
Molybdenum	mg/L	All bores	0.034	ANZG (2018)
Selenium	mg/L	All bores	0.005	ANZG (2018)
TRH (C6-C10)	ug/L	All bores	< 20	LOR
TRH (C10-40)	ug/L	All bores	< 50	LOR
Major Ions				
Bicarbonate	mg/L	All bores	For interpretation purposes only	
Carbonate				
Calcium				
Chloride				
Magnesium				
Potassium				
Sodium				

5 GROUNDWATER TRIGGERS SUITABILITY FOR MINE CLOSURE

The proposed groundwater quality triggers are designed to detect changes in groundwater quality that has the potential to impact the environmental values associated with surrounding groundwater in the region. As the proposed triggers are based on data collected prior to mining activity commencing, the proposed triggers are representative of baseline groundwater quality within the Project area. Assuming there are no impacts to groundwater quality during the life of the Project, the proposed groundwater triggers for quality and level are considered suitable to apply in mine closure.

However, groundwater triggers should be routinely reviewed, as future sampling may indicate changes in groundwater quality that require the proposed trigger values to be amended as required. The installation or addition of new bores to the groundwater monitoring network at Vulcan South would also prompt a review of the proposed groundwater trigger values.

6 CONCLUSION

The proposed groundwater quality and level trigger values for Vulcan South are based upon a long-term dataset collected across the existing groundwater monitoring network. The proposed trigger values are robust, technically justifiable and have been derived in consideration of government guidelines (DES, 2021).

Adoption of the proposed groundwater trigger values for quality and level will:

- allow for the detection of changes in groundwater quality which are not consistent with long-term trends;
- identify abnormal groundwater levels or unexpected drawdowns which are inconsistent with the numerical flow model predictions;
- assessed and investigated groundwater quality or level changes in accordance with the Project's EA conditions; and
- prevent and reduce the frequency of groundwater quality or levels which are consistent with long-term trends from exceeding default trigger values (false positives) which are unrepresentative of the Project's groundwater system.

7 REFERENCES

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Appendix D
Groundwater Monitoring Data

VITRINITE
BRIGHTER COAL

METSERVE
Mining & Energy Technical Services Pty Ltd

Appendix A – Groundwater Quality & Level Data

Appendix A - Groundwater Quality and Level Data

MB07	LOR	Units	6/06/2019	14/07/2019	11/08/2019	23/09/2019	24/10/2019	2/12/2019		4/06/2020	6/08/2020	4/10/2020	3/12/2020	26/02/2021	10/05/2021	12/07/2021	12/09/2021	16/12/2021	22/03/2022	18/06/2022
pH	0.01	pH units	8.31	7.73	7.48	7.43	7.57	7.48		7.48	7.79	7.32	7.98	7.75	7.95	7.9	8.11	7.62	7.63	8.16
EC	1	µS/cm	5430	5430	5630	5620	5890	5820		5420	5260	5420	5530	5320	5150	5430	5440	5200	5590	5290
SO_4	1	mg/L	819	778	665	754	733	722		722	592	682	666	684	671	675	691	653	687	657
Aluminium (dissolved)	0.01	mg/L	0.02	*0.005*	*0.005*	*0.005*	0.02	*0.005*		*0.005*	*0.005*	*0.005*	*0.005*	0.02	*0.005*	*0.005*	*0.005*	*0.005*	0.01	*0.0025*
Arsenic (dissolved)	0.001	mg/L	0.001	0.002	*0.0005*	*0.0005*	*0.0005*	*0.0005*		0.003	0.001	0.003	0.002	0.003	0.003	0.002	0.003	0.002	*0.0029*	0.0015
Lead (dissolved)	0.001	mg/L	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*		*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*
Iron (dissolved)	0.05	mg/L	*0.025*	*0.025*	*0.025*	*0.025*	0.07	*0.025*	No sample	0.98	0.33	0.34	0.37	*0.025*	0.53	0.38	0.37	0.4	0.283	0.13
Mercury (dissolved)	0.0001	mg/L	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*		*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*		
Molybdenum (dissolved)	0.001	mg/L	0.007	0.006	*0.00005*	*0.00005*	0.001	0.001		*0.00005*	0.001	0.001	*0.00005*	0.001	0.004	*0.00005*	*0.00005*	0.002	0.0016	0.001
Selenium (dissolved)	0.0002	mg/L	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*		*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*
TRH (C6-C9)	20	µg/L	*10*	*10*	*10*	*10*	*10*	*10*		*10*	*10*	*10*	*10*	40	*10*	*10*	*10*	*10*	*10*	*10*
TRH (C10-C36)	50	µg/L	*25*	*25*	*25*	*25*	*25*	*25*		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	60	200	*25*
Standing Water Level	-	mAHD	-	207	207.06	207.08	206.93	207.23		206.41	207.21	207.16	207.2	207.28	207.2	207.25	207.32	207.31	207.3	207.3

MB09	LOR	Units	6/06/2019	14/07/2019	12/08/2019	24/09/2019	26/10/2019	3/12/2019	22/03/2020	4/06/2020	6/08/2020	4/10/2020	3/12/2020	26/02/2021	10/05/2021	12/07/2021	12/09/2021	16/12/2021	23/03/2022	18/06/2022
pH	0.01	pH units	7.59	7.65	7.64	7.47	7.53	7.58	7.99	7.51	7.81	7.28	7.93	7.53	7.76	7.56	7.97	8.09	8.13	7.95
EC	1	µS/cm	16200	12500	14900	13500	13300	11500	11400	12000	12100	12100	12000	11600	11500	12100	12200	12000	11600	11200
SO_4	1	mg/L	2580	1020	1800	1400	1210	934	708	808	700	748	716	745	746	729	751	718	744	703
Aluminium (dissolved)	0.01	mg/L	0.01	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Arsenic (dissolved)	0.001	mg/L	0.001	*0.0005*	0.001	*0.0005*	0.002	0.001	0.001	0.001	*0.0005*	0.001	*0.0005*	0.001	0.001	*0.0005*	0.001	*0.0005*	0.0008	*0.0005*
Lead (dissolved)	0.001	mg/L	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*
Iron (dissolved)	0.05	mg/L	*0.025*	*0.025*	*0.025*	*0.025*	0.89	0.63	0.66	0.65	0.29	0.29	0.08	0.09	0.42	0.24	0.3	0.13	0.137	0.083
Mercury (dissolved)	0.0001	mg/L	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*		
Molybdenum (dissolved)	0.001	mg/L	0.003	0.002	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	0.002	*0.0005*	*0.00005*
Selenium (dissolved)	0.0002	mg/L	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*
TRH (C6-C10)	20	µg/L	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	20	*10*	*10*	*10*	*10*	*10*	*10*
TRH (C10-C40)	50	µg/L	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	70	*25*	*25*
Standing Water Level	-	mAHD	-	215.64	215.66	215.69	215.46	215.81	215.73	215.53	215.54	215.28	215.59	215.65	215.63	215.62	215.73	215.76	215.76	215.68

MB10	LOR	Units		14/07/2019	12/08/2019	24/09/2019	24/10/2019	2/12/2019	22/03/2020	4/06/2020	8/08/2020	4/10/2020	3/12/2020	1/03/2021	11/05/2021	12/07/2021	13/09/2021	16/12/2021	22/03/2022	18/06/2022
pH	0.01	pH units		7.62	7.54	7.67	7.64	7.51	7.42	7.57	7.97	7.37	8.08	7.59	8.02	8.01	8.2	7.55	7.94	8.14
EC	1	µS/cm		5060	4780	4140	4280	4000	4000	4080	4110	3960	3970	3790	3720	3800	3830	3810	3760	3660
SO_4	1	mg/L		628	491	458	445	420	414	435	396	395	381	386	378	367	375	372	383	388
Aluminium (dissolved)	0.01	mg/L		*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	0.01	0.007	*0.005*
Arsenic (dissolved)	0.001	mg/L		*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	0.001	0.001	0.001	0.001	*0.0005*	*0.0005*	0.001	*0.0005*	*0.0005*	*0.0005*	0.001	0.0007
Lead (dissolved)	0.001	mg/L		*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*
Iron (dissolved)	0.05	mg/L	No sample	*0.025*	0.07	*0.025*	*0.025*	*0.025*	0.29	0.18	0.12	0.11	0.08	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	0.03
Mercury (dissolved)	0.0001	mg/L		*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	-	-
Molybdenum (dissolved)	0.001	mg/L		0.003	0.002	0.002	0.003	0.003	0.002	0.002	0.003	0.003	0.002	0.004	0.003	0.002	0.002	0.007	0.003	0.0024
Selenium (dissolved)	0.0002	mg/L		*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*
TRH (C6-C10)	20	µg/L		*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
TRH (C10-C40)	50	µg/L		*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*
Standing Water Level	-	mAHD		210.83	210.88	210.97	211.02	211.06	210.98	216.08	211.17	211.18	211.23	211.28	211.24	211.29	211.33	211.35	211.34	211.32

Appendix A - Groundwater Quality and Level Data

MB12	LOR	Units	6/06/2019	14/07/2019	11/08/2019	23/09/2019	26/10/2019	2/12/2019	22/03/2020	4/06/2020	6/08/2020	3/10/2020	3/12/2020	26/02/2021	10/05/2021	12/07/2021	13/09/2021	16/12/2021	22/03/2022	18/06/2022
pH	0.01	pH units	7.81	7.61	7.36	7.33	7.19	7.28	7.18	7.08	7.65	7.07	7.64	7.5	7.75	7.77	7.89	7.36	7.52	7.9
EC	1	µS/cm	21600	17300	17400	16900	20900	17000	14800	22200	23100	21900	23500	21900	22000	22500	22400	21800	21800	20000
SO_4	1	mg/L	908	804	852	1090	808	785	682	911	781	842	830	861	847	842	822	817	861	824
Aluminium (dissolved)	0.01	mg/L	0.04	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	0.08	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Arsenic (dissolved)	0.001	mg/L	0.002	0.002	0.004	0.009	*0.0005*	*0.0005*	*0.0005*	0.001	0.001	0.002	*0.0005*	0.001	0.002	0.001	0.002	0.001	0.0018	*0.0005*
Lead (dissolved)	0.001	mg/L	0.001	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*
Iron (dissolved)	0.05	mg/L	0.025	0.47	0.77	1.2	0.43	1.04	2.41	4.85	4.5	3.53	2.7	2.41	3.2	3.58	3.08	3.03	3.84	1.37
Mercury (dissolved)	0.0001	mg/L	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	-	-
Molybdenum (dissolved)	0.001	mg/L	0.003	0.004	0.004	0.002	0.002	0.004	0.001	*0.00005*	*0.00005*	0.001	*0.00005*	0.004	0.002	0.001	0.001	0.001	0.0011	0.0003
Selenium (dissolved)	0.0002	mg/L	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*
TRH (C6-C10)	20	µg/L	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
TRH (C10-C40)	50	µg/L	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	*25*	180	220	*25*
Standing Water Level	-	mAHD	-	218.07	218.26	218.51	219.19	218.15	218.03	216.9	218.4	218.41	218.38	217.7	217.45	217.46	216.7	217.29	217.68	216.86

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Appendix B – Groundwater Quality Statistics Summary

Appendix B - Groundwater Quality Statistics Summary

MB07	Unit	LOR	n	Min	5th percentile	20th percentile	50th percentile	Mean	80th percentile	95th percentile	Max	Std Dev
pH - Field		0.01	17	6.53	6.682	6.754	6.91	7.00	7.072	7.598	8.31	0.40
EC - Field	µS/cm	1		4040	4235.2	5186.4	5383	5365.76	5803	6099.2	6132	545.04
Ca	mg/L	1		84	86.4	95.6	102	105.12	114.2	129	129	13.56
Mg	mg/L	1		161	165.8	173.2	182	181.71	190	202.8	210	12.43
Na	mg/L	1		759	781.4	800	845	844.24	866.4	914.6	997	53.06
K	mg/L	1		6	6	6	7	7.82	7	11.4	25	4.48
HCO3	mg/L	1		752.74	609.695	638.792	671	671.09	699.792	731.329	752.74	41.80
SO4	mg/L	1		592	640.8	665.2	684	697.12	730.8	786.2	819	53.31
Cl	mg/L	1		1080	1096	1132	1190	1198.82	1272	1320	1320	77.37
Al (dissolved)	mg/L	0.01		0.0025	0.0045	0.005	0.005	0.008	0.009	0.02	0.02	0.01
As (dissolved)	mg/L	0.001		0.0005	0.0005	0.0006	0.002	0.002	0.003	0.003	0.003	0.00
Fe (dissolved)	mg/L	0.05		0.025	0.025	0.025	0.283	0.255	0.378	0.62	0.98	0.26
Pb (dissolved)	mg/L	0.0001		0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00
Hg (dissolved)	mg/L	0.0001		0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00
Mo (dissolved)	mg/L	0.0001		0.00005	0.00005	0.00005	0.001	0.002	0.00192	0.0062	0.007	0.00
Se (dissolved)	mg/L	0.0002		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.00
TRH (C6-C10)	µg/L	20		10	10	10	10	13.75	10	29.5	40	10.61
TRH (C10-C40)	µg/L	50		25	25	25	25	51.25	46	151	200	61.34

Appendix B - Groundwater Quality Statistics Summary

MB09	Unit	LOR	n	Min	5th percentile	20th percentile	50th percentile	Mean	80th percentile	95th percentile	Max	Std Dev
pH - Field		0.01	18	6.64	6.6995	6.816	6.92	7.01	7.158	7.576	7.95	0.32
EC - Field	µS/cm	1		6332	10642.35	11643.2	11961	12267.17	13543.6	15290.5	16200	1995.11
Ca	mg/L	1		184	194.2	206.4	220	232.50	251.2	305.25	369	43.18
Mg	mg/L	1		312	324.75	350.4	364.5	398.50	422.6	570.75	694	90.71
Na	mg/L	1		1600	1736	1864	1930	1977.78	2050	2318.5	2820	250.10
K	mg/L	1		44	44.85	47.4	49.5	50.72	52	58.55	73	6.29
HCO3	mg/L	1		771.04	861.564	1017.724	1065.06	1039.28	1106.052	1131.184	1151.68	95.84
SO4	mg/L	1		700	702.55	716.8	747	986.67	1134	1917	2580	496.85
Cl	mg/L	1		3250	3301	3470	3610	3706.11	3814	4530.5	4590	379.23
Al (dissolved)	mg/L	0.01		0.0025	0.0025	0.005	0.005	0.005	0.005	0.00575	0.01	0.00
As (dissolved)	mg/L	0.001		0.0001	0.00044	0.0005	0.001	0.001	0.001	0.00115	0.002	0.00
Fe (dissolved)	mg/L	0.05		0.025	0.025	0.047	0.1885	0.277	0.546	0.6945	0.89	0.27
Pb (dissolved)	mg/L	0.0001		0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00
Hg (dissolved)	mg/L	0.0001		0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00
Mo (dissolved)	mg/L	0.0001		0.00005	0.00005	0.00005	0.00005	0.000	0.00032	0.00215	0.003	0.00
Se (dissolved)	mg/L	0.0002		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.00
TRH (C6-C10)	µg/L	20		10	10	10	10	11.25	10	16.5	20	3.54
TRH (C10-C40)	µg/L	50		25	25	25	25	30.625	25	54.25	70	15.91

Appendix B - Groundwater Quality Statistics Summary

MB10	Unit	LOR	n	Min	5th percentile	20th percentile	50th percentile	Mean	80th percentile	95th percentile	Max	Std Dev
pH - Field		0.01	17	6.7	6.748	6.82	6.91	6.96	7.062	7.318	7.43	0.19
EC - Field	µS/cm	1		3742	3758	3808.4	3980	4121.82	4291.6	5024.8	5668	489.80
Ca	mg/L	1		33	33.8	37.4	42	42.82	46.8	55	67	8.05
Mg	mg/L	1		96	100.8	104.2	116	120.53	128.6	163.4	177	20.96
Na	mg/L	1		605	629.8	648	673	685.65	729.6	762.4	177	51.06
K	mg/L	1		2	2.8	3	3	3.00	3	3.2	4	0.35
HCO3	mg/L	1		690.52	696.071	719.068	751.52	778.80	801.54	968.619	1013.82	92.63
SO4	mg/L	1		367	371	378.6	395	418.35	443	518.4	628	64.11
Cl	mg/L	1		742	763.6	786	813	831.24	833.6	1008.4	1050	79.43
Al (dissolved)	mg/L	0.01		0.0025	0.0045	0.005	0.005	0.005	0.005	0.0076	0.01	0.00
As (dissolved)	mg/L	0.001		0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.00
Fe (dissolved)	mg/L	0.05		0.015	0.023	0.025	0.025	0.001	0.104	0.202	0.29	0.07
Pb (dissolved)	mg/L	0.0001		0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00
Hg (dissolved)	mg/L	0.0001		0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00
Mo (dissolved)	mg/L	0.0001		0.002	0.002	0.002	0.003	0.003	0.003	0.0046	0.007	0.00
Se (dissolved)	mg/L	0.0002		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.00
TRH (C6-C10)	µg/L	20		10	10	10	10	10	10	10	10	0.00
TRH (C10-C40)	µg/L	50		25	25	25	25	25	25	25	25	0.00

Appendix B - Groundwater Quality Statistics Summary

MB12	Unit	LOR	n	Min	5th percentile	20th percentile	50th percentile	Mean	80th percentile	95th percentile	Max	Std Dev
pH - Field		0.01	18	6.22	6.3475	6.57	6.69	6.76	6.99	7.1895	7.81	0.36
EC - Field	µS/cm	1		14000	14340	16927.4	21625	19907.89	22337.6	22841.65	22851	3078.20
Ca	mg/L	1		230	290.35	350.6	483	436.06	502.4	523.55	538	88.89
Mg	mg/L	1		555	573.7	633.6	857.5	808.00	925.6	947.5	956	139.71
Na	mg/L	1		2330	2372.5	2694	3195	3038.89	3276	3464.5	3490	362.83
K	mg/L	1		13	13	14	18	16.89	19	20	20	2.49
HCO3	mg/L	1		570.96	668.316	742.248	762.5	777.95	841.068	904.02	946.72	84.92
SO4	mg/L	1		682	766.15	805.6	836	842.61	861	937.85	1090	79.75
Cl	mg/L	1		4940	5203.5	5920	7665	7099.44	7936	8098	8200	1101.17
Al (dissolved)	mg/L	0.01		0.0025	0.0025	0.005	0.005	0.011	0.005	0.046	0.08	0.02
As (dissolved)	mg/L	0.001		0.0005	0.0005	0.001	0.0019	0.002	0.0032	0.0056	0.009	0.00
Fe (dissolved)	mg/L	0.05		0.025	0.36925	0.878	2.555	2.358	3.56	4.5525	4.85	1.47
Pb (dissolved)	mg/L	0.0001		0.00005	0.00005	0.00005	0.00005	0.0001	0.00005	0.0001925	0.001	0.00
Hg (dissolved)	mg/L	0.0001		0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00
Mo (dissolved)	mg/L	0.0001		0.00005	0.00005	0.00058	0.00105	0.002	0.0036	0.004	0.004	0.00
Se (dissolved)	mg/L	0.0002		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.00
TRH (C6-C10)	µg/L	20		10	10	10	10	10	10	10	10	0.00
TRH (C10-C40)	µg/L	50		25	25	25	25	68.75	118	206	220	81.71

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Appendix C – Groundwater Quality Trends

Appendix C – Groundwater Quality Trends

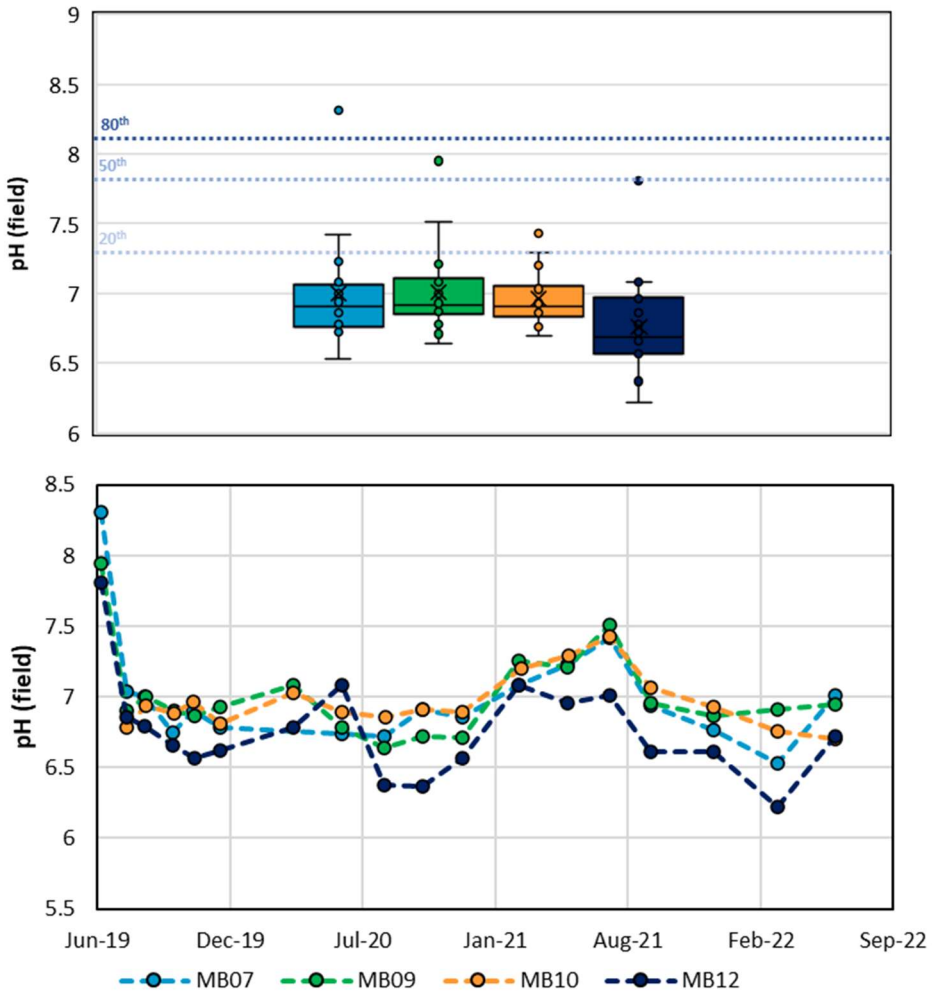


Plate 1 – Field pH

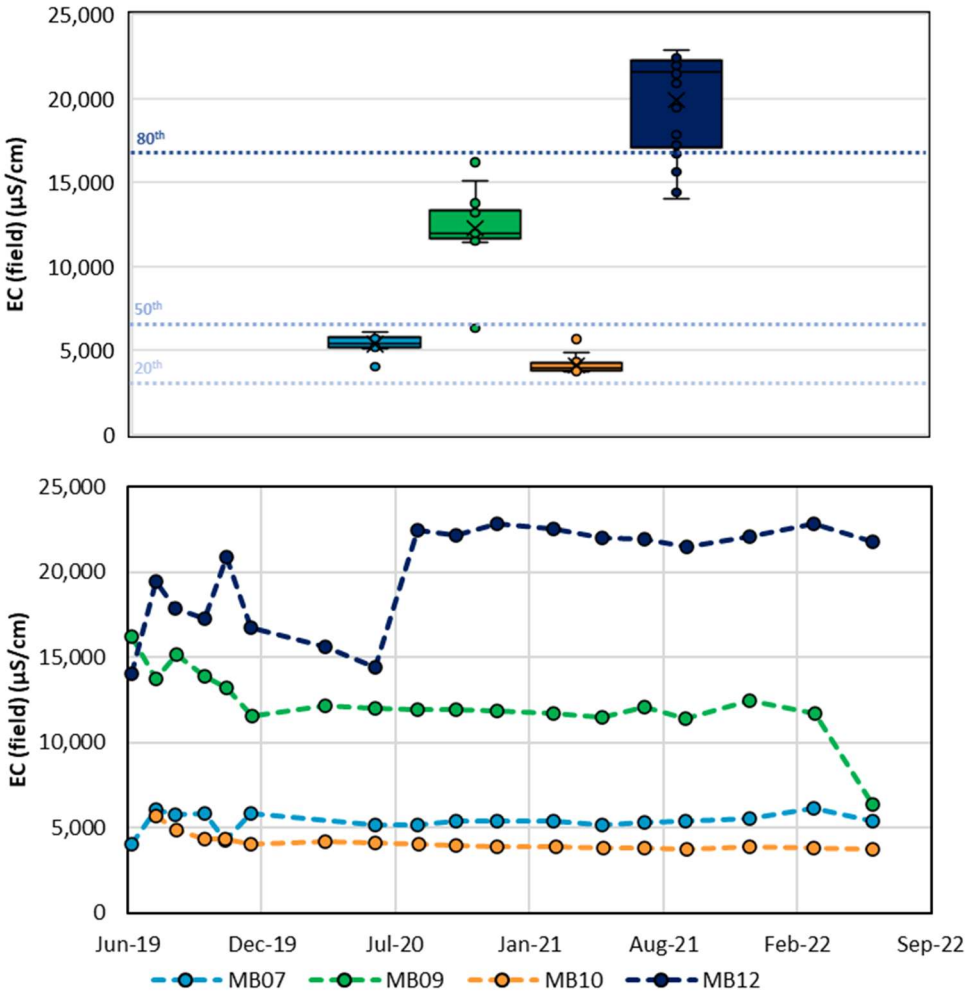


Plate 2 – Field Electrical Conductivity

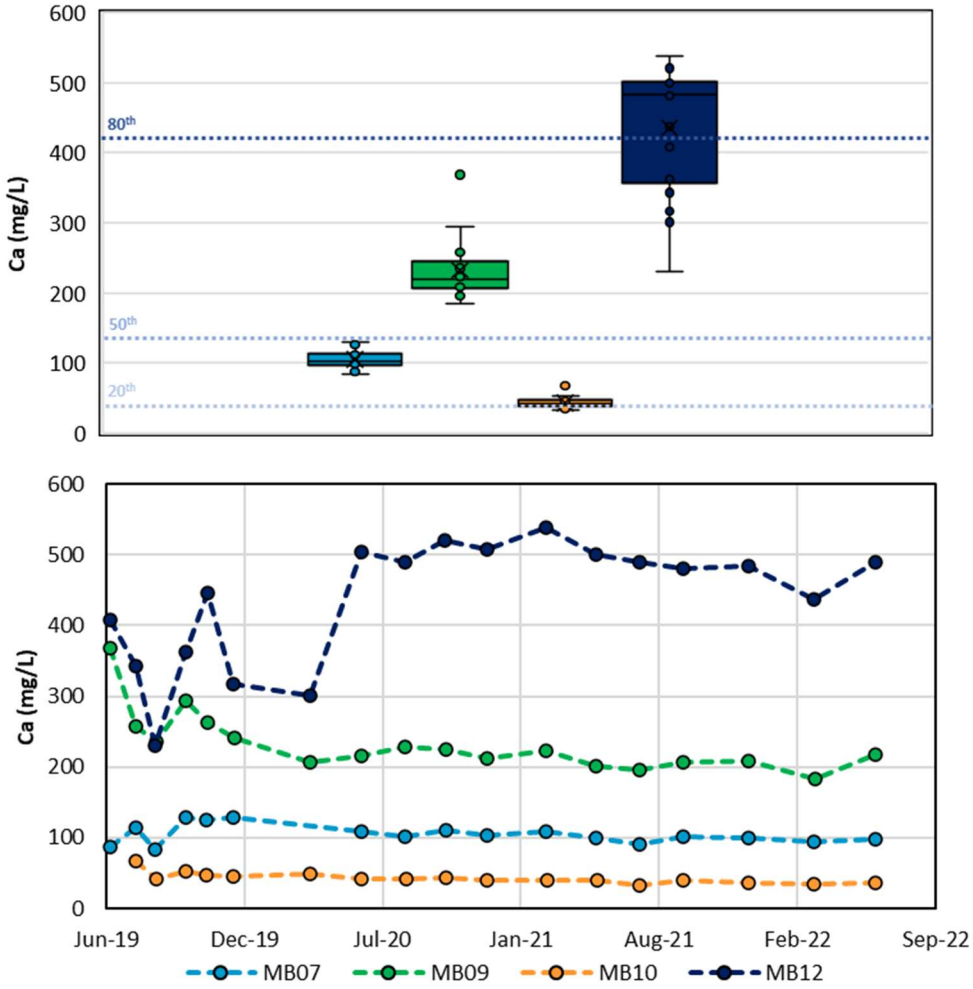


Plate 3 – Calcium (Ca^{2+})

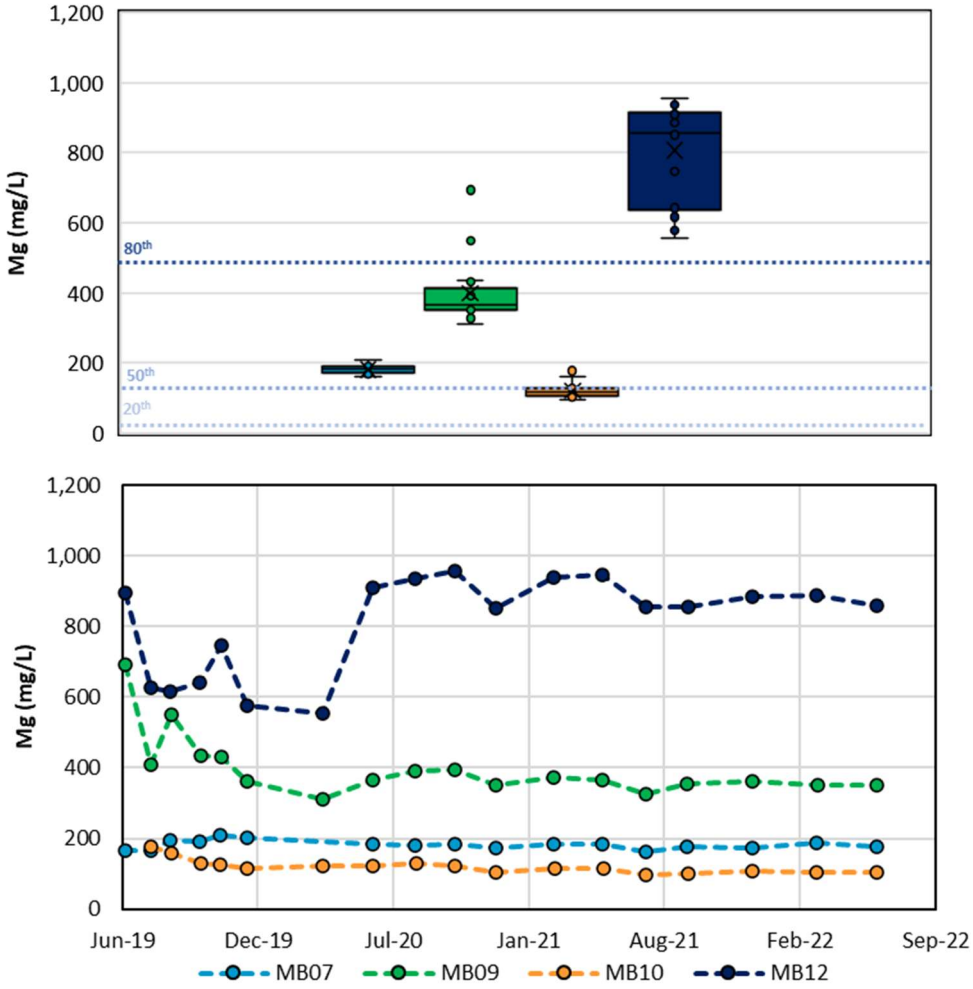


Plate 4 – Magnesium (Mg^{2+})

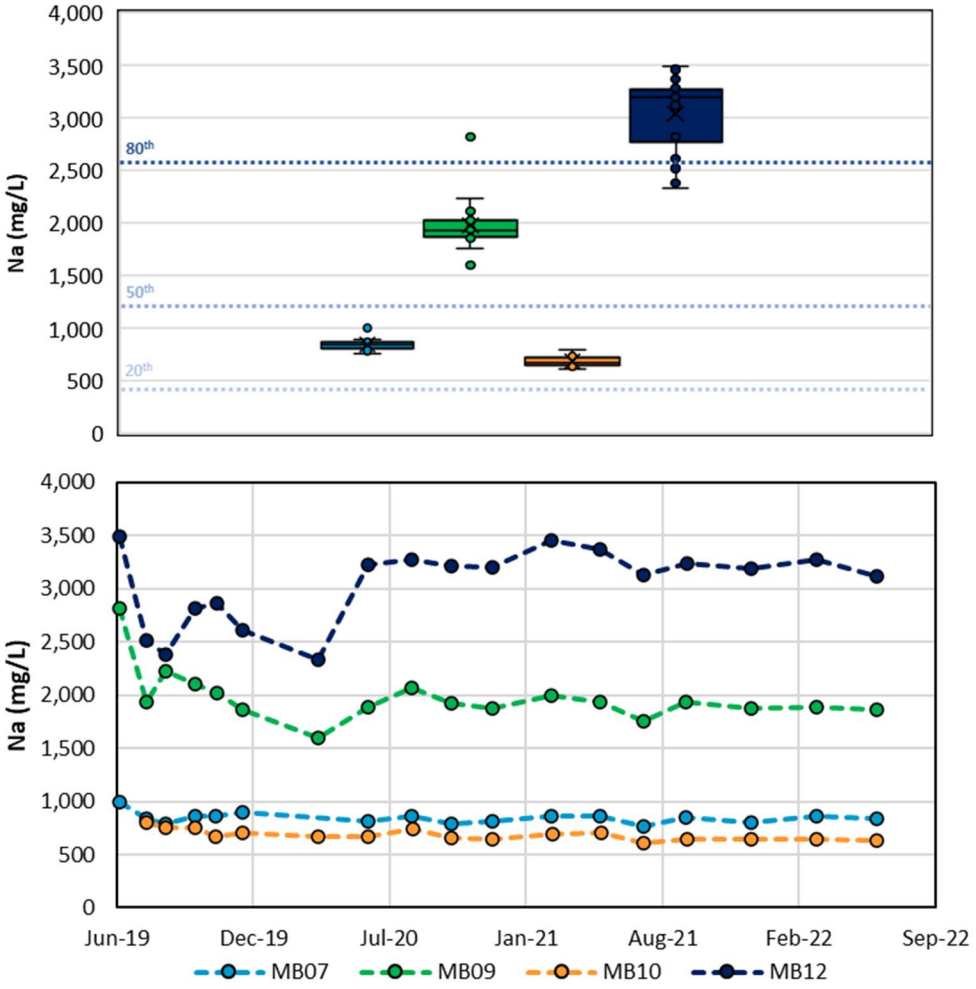


Plate 5 – Sodium (Na^+)

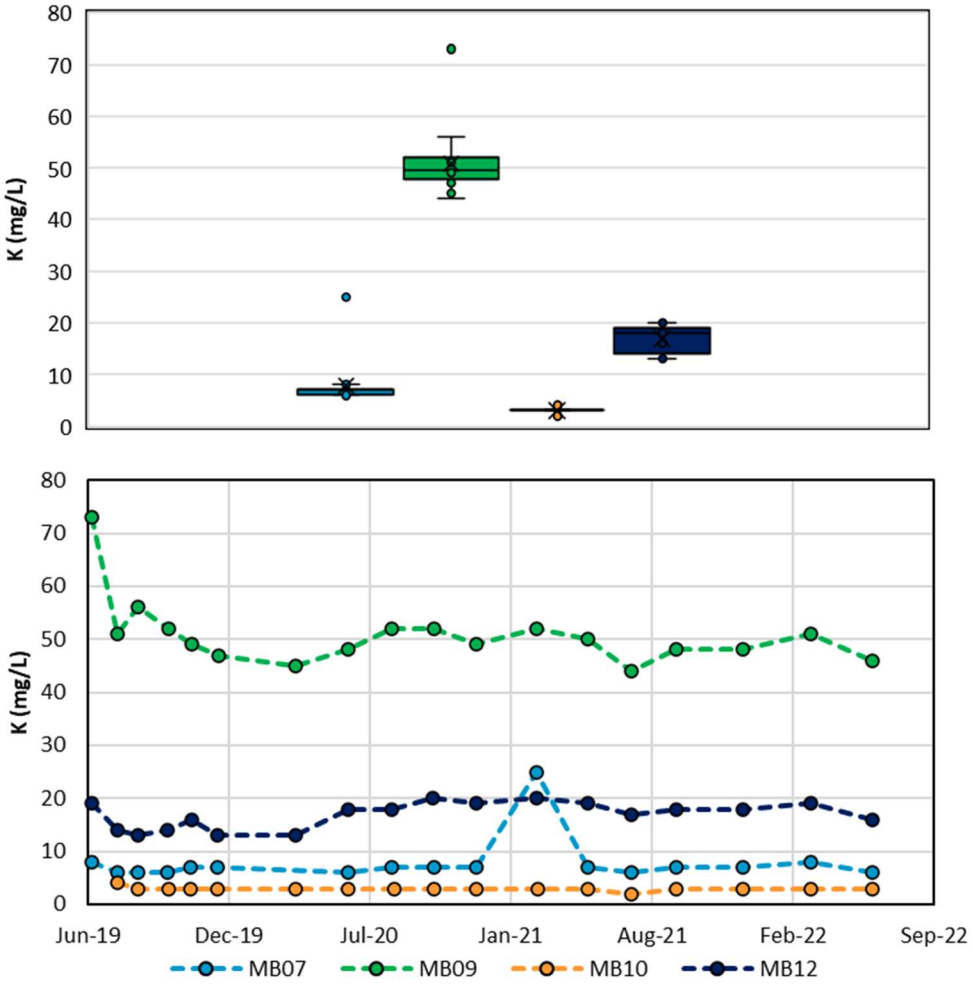


Plate 6 – Potassium (K^+)

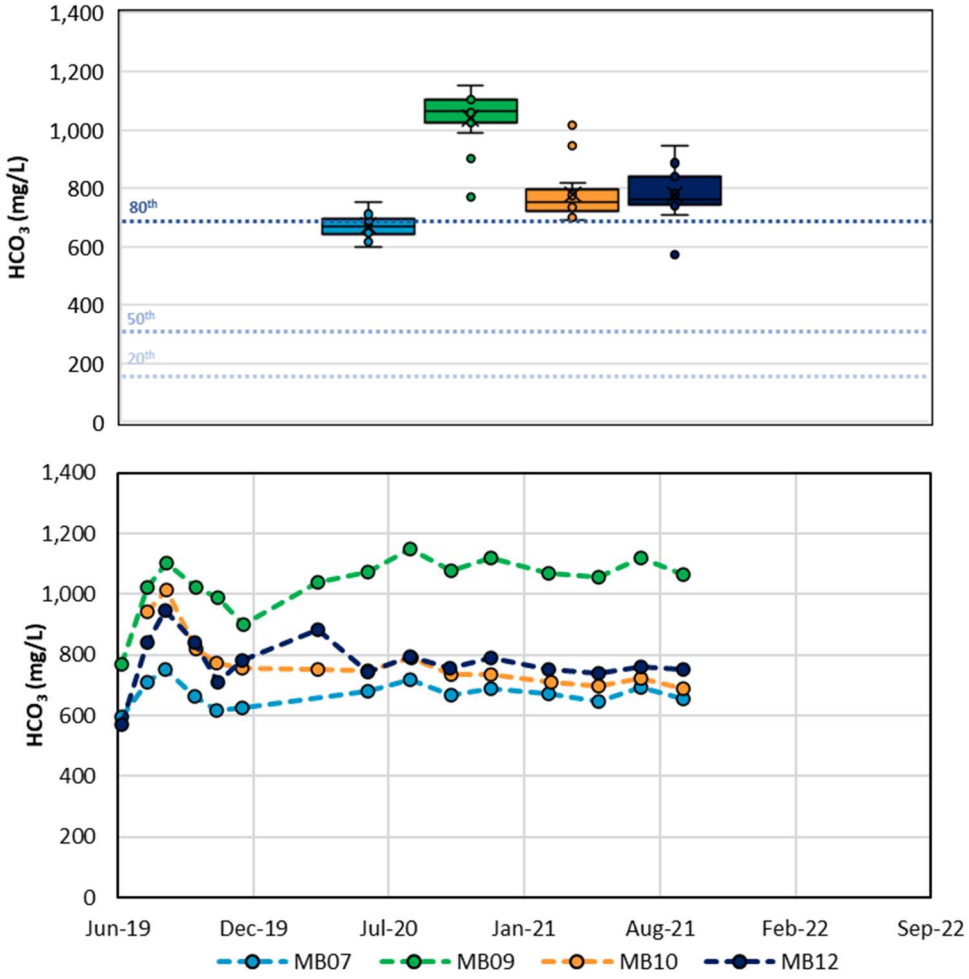


Plate 7 – Bicarbonate (HCO_3^-)

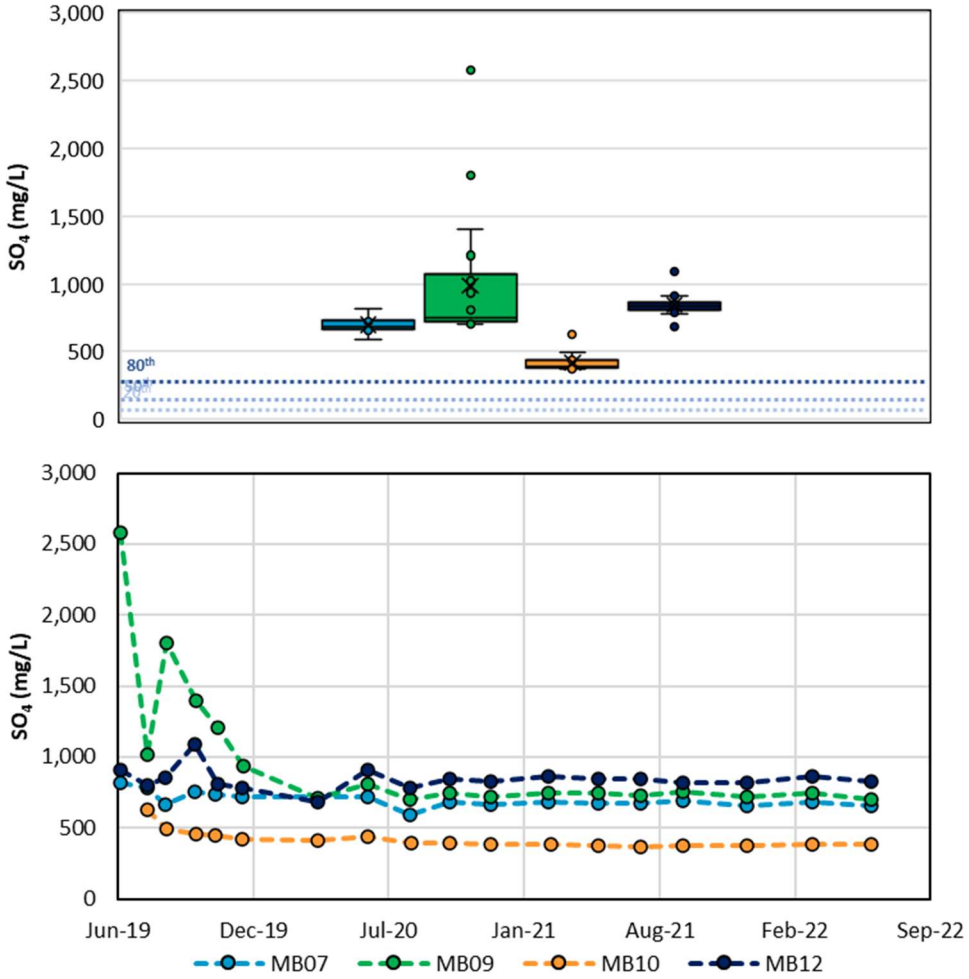


Plate 8 – Sulphate (SO_4^{2-})

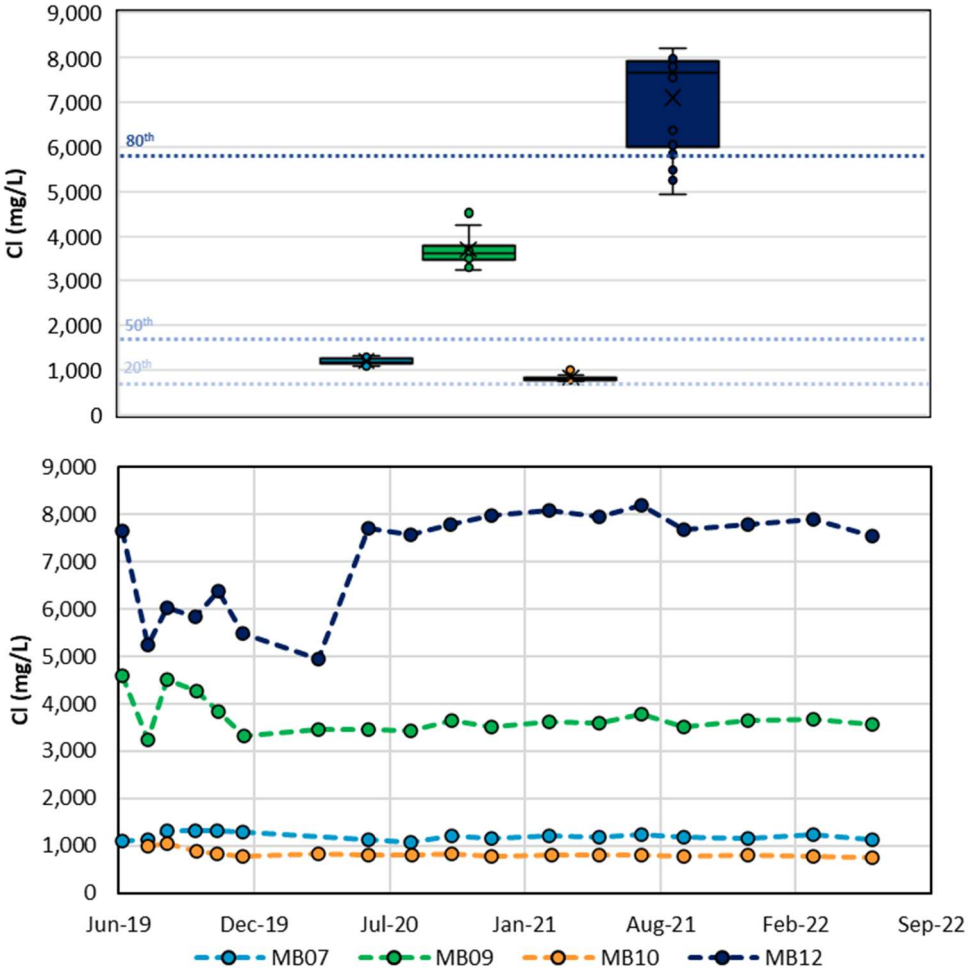


Plate 9 – Chloride (Cl^-)

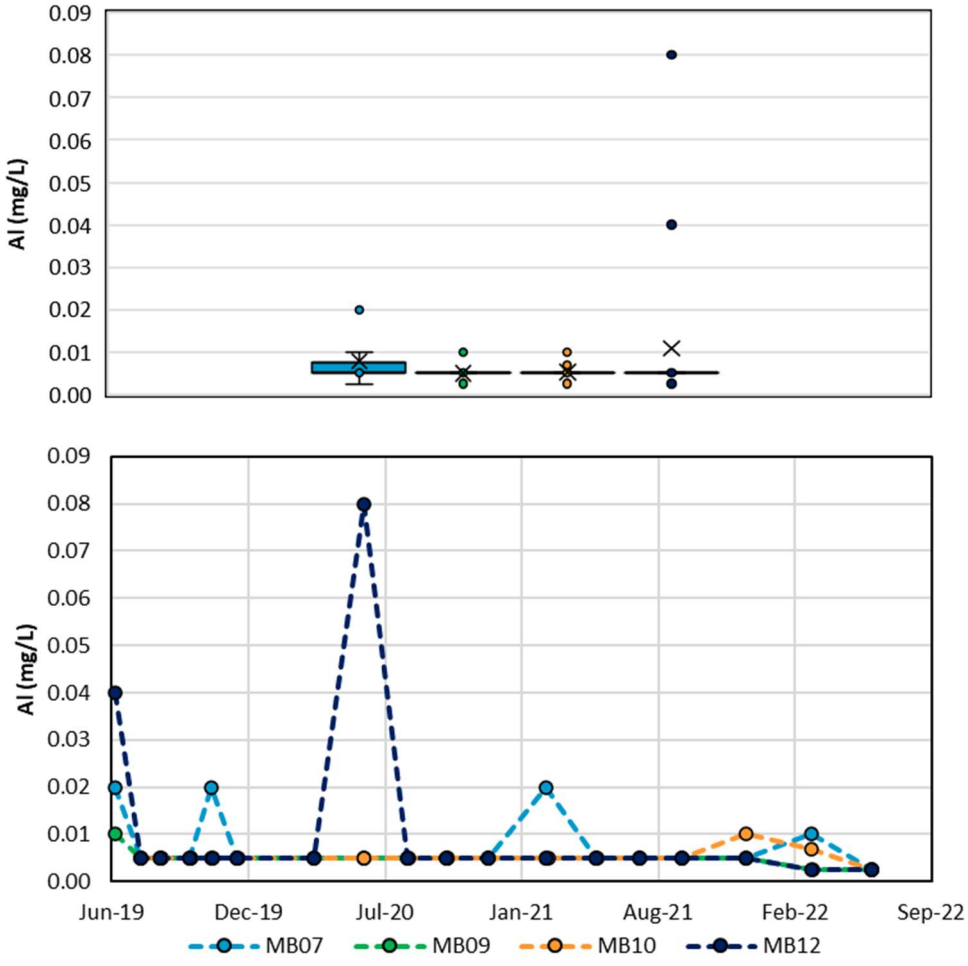


Plate 10 – Dissolved Aluminium (Al)

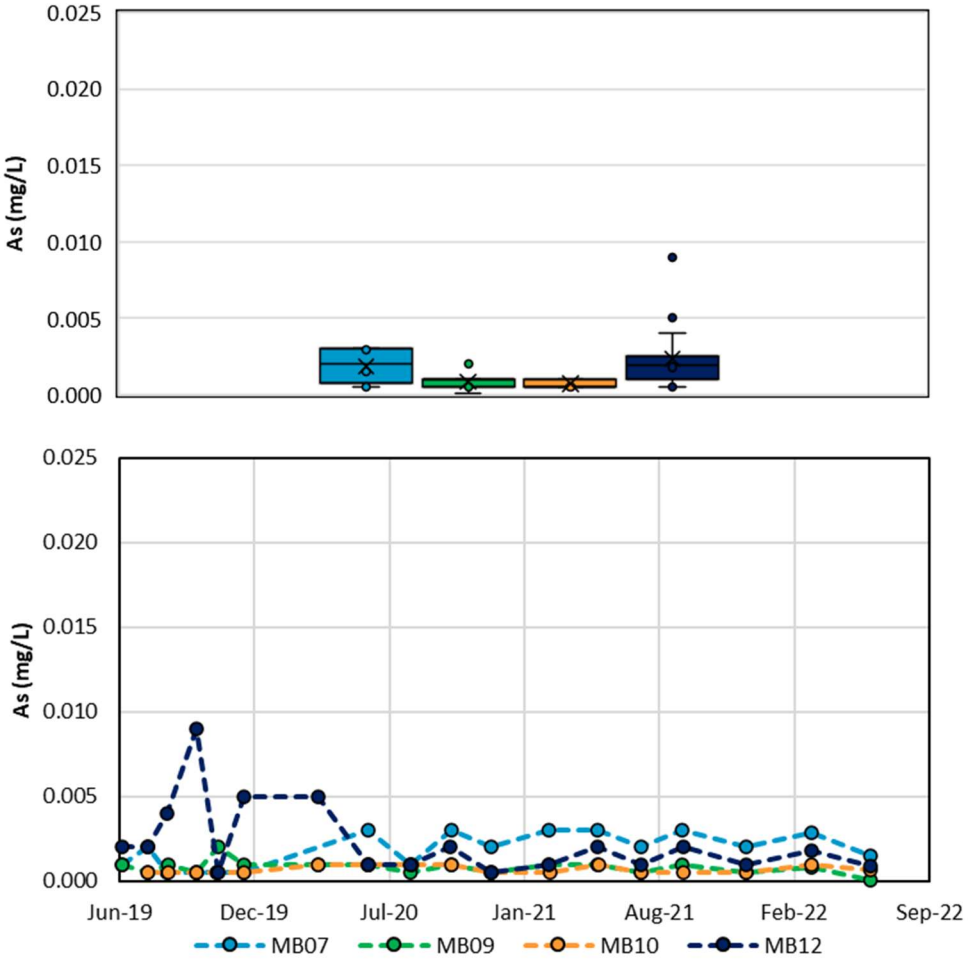


Plate 10 – Dissolved Arsenic (As)

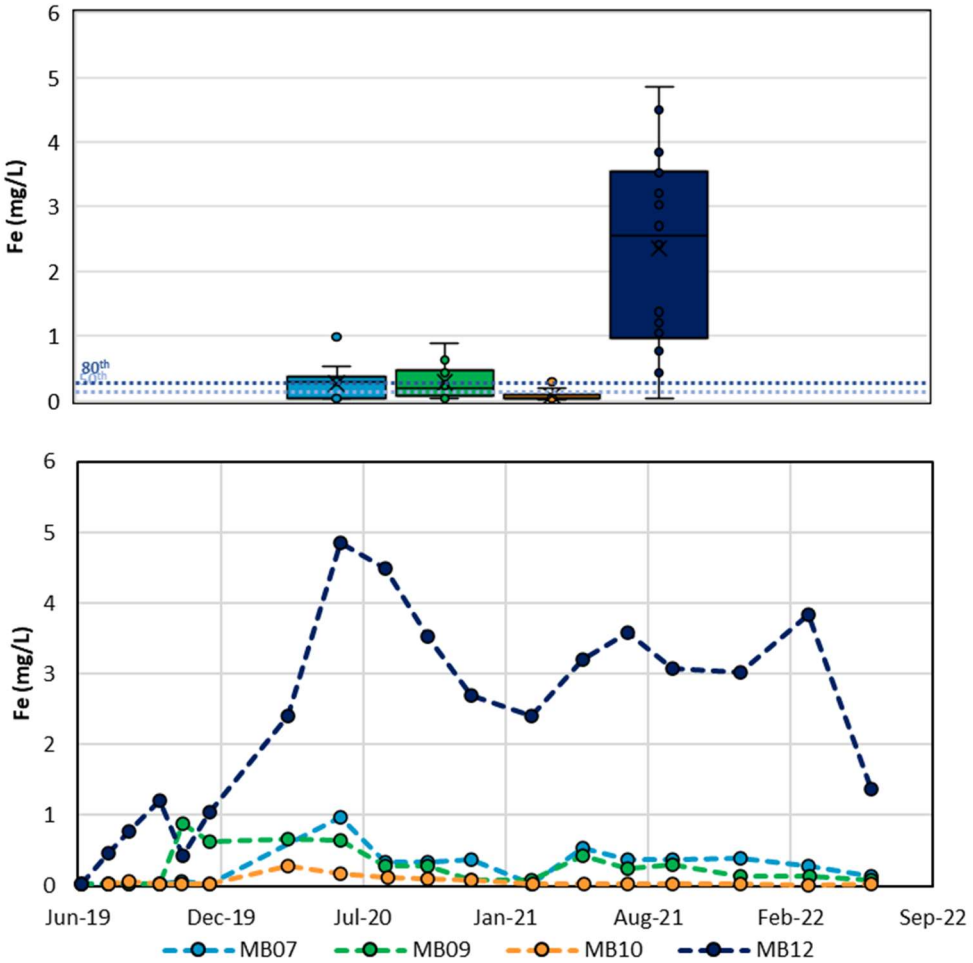


Plate 11 – Dissolved Iron (Fe)

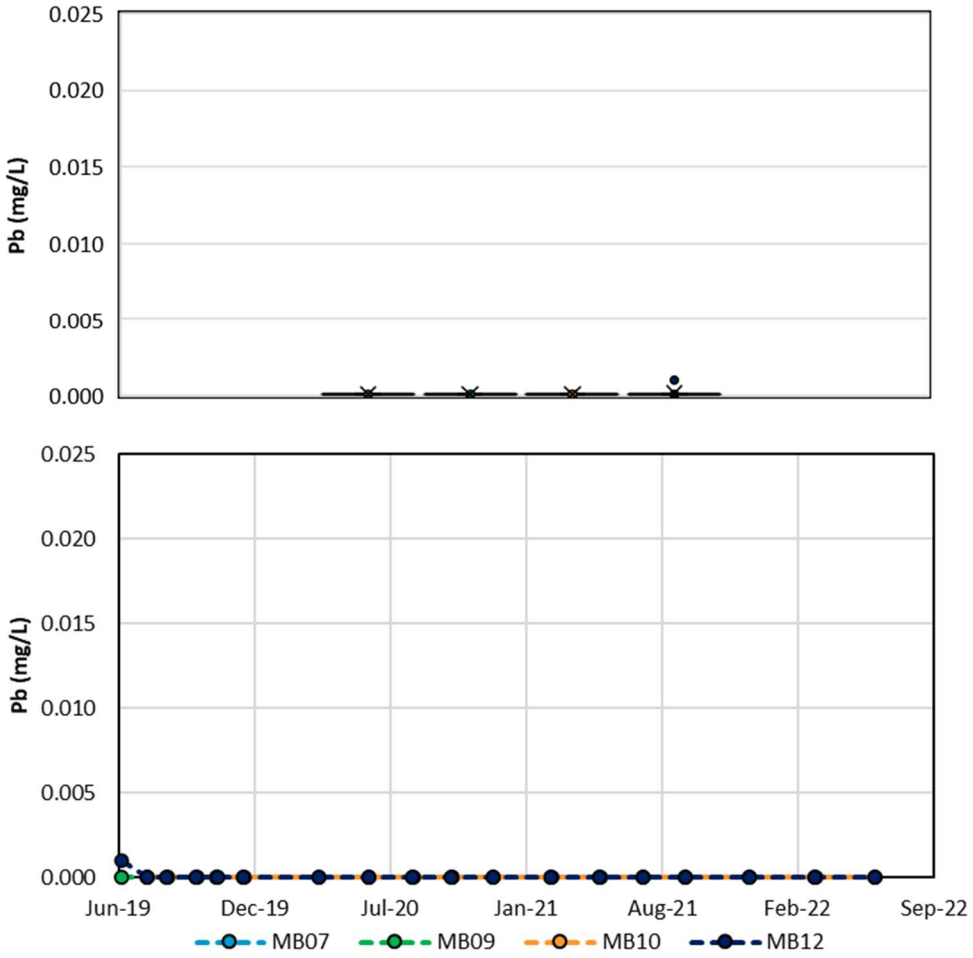


Plate 12 – Dissolved Lead (Pb)

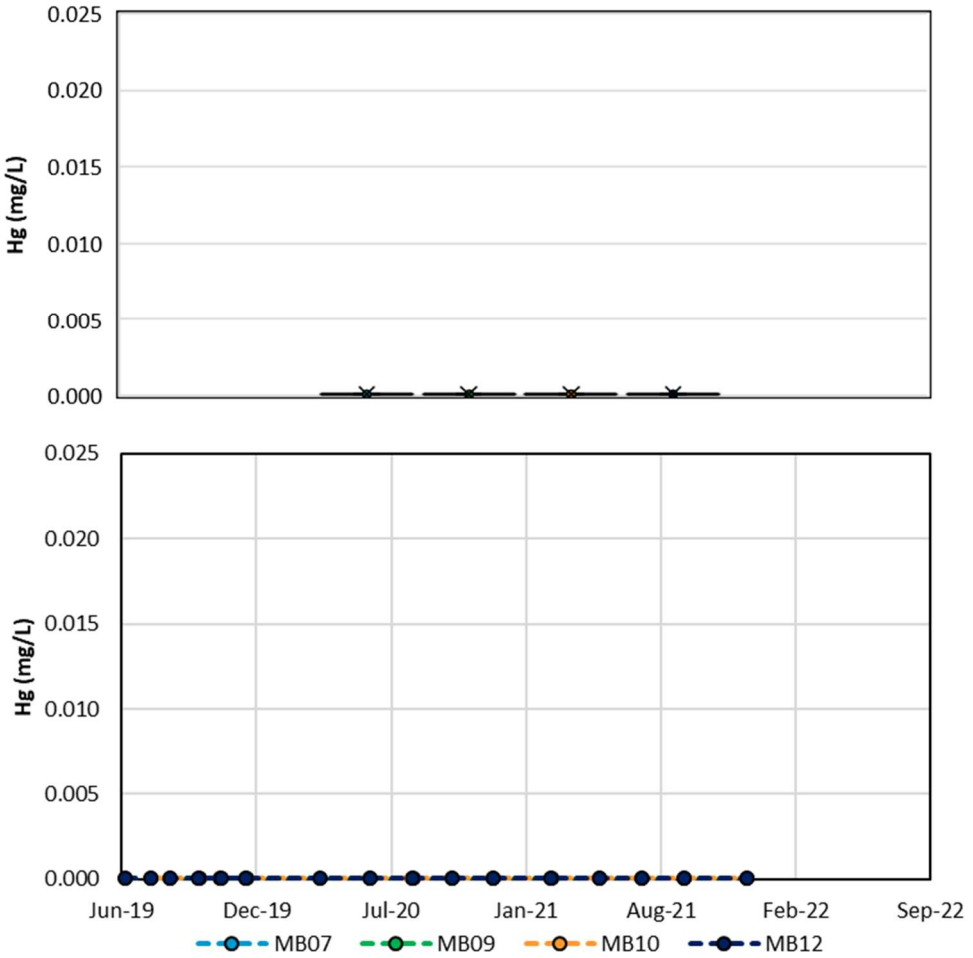


Plate 13 – Dissolved Mercury (Hg)

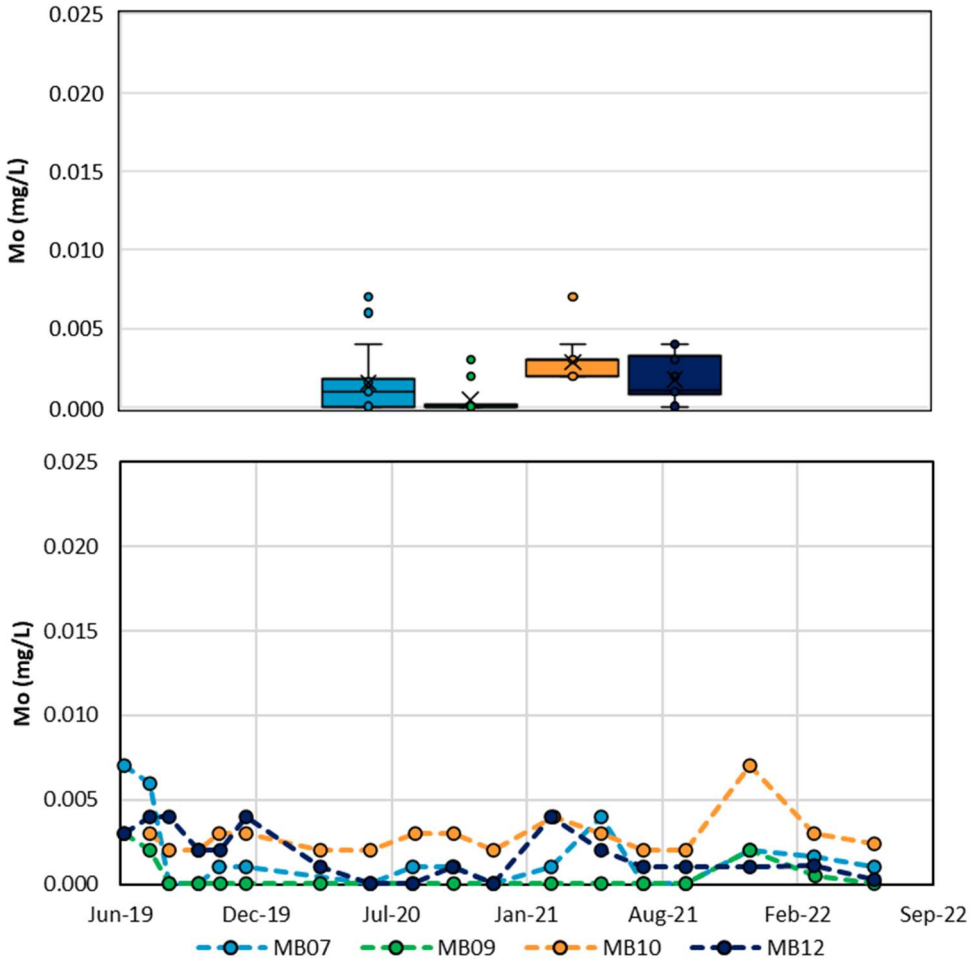


Plate 14 – Dissolved Molybdenum (Mo)

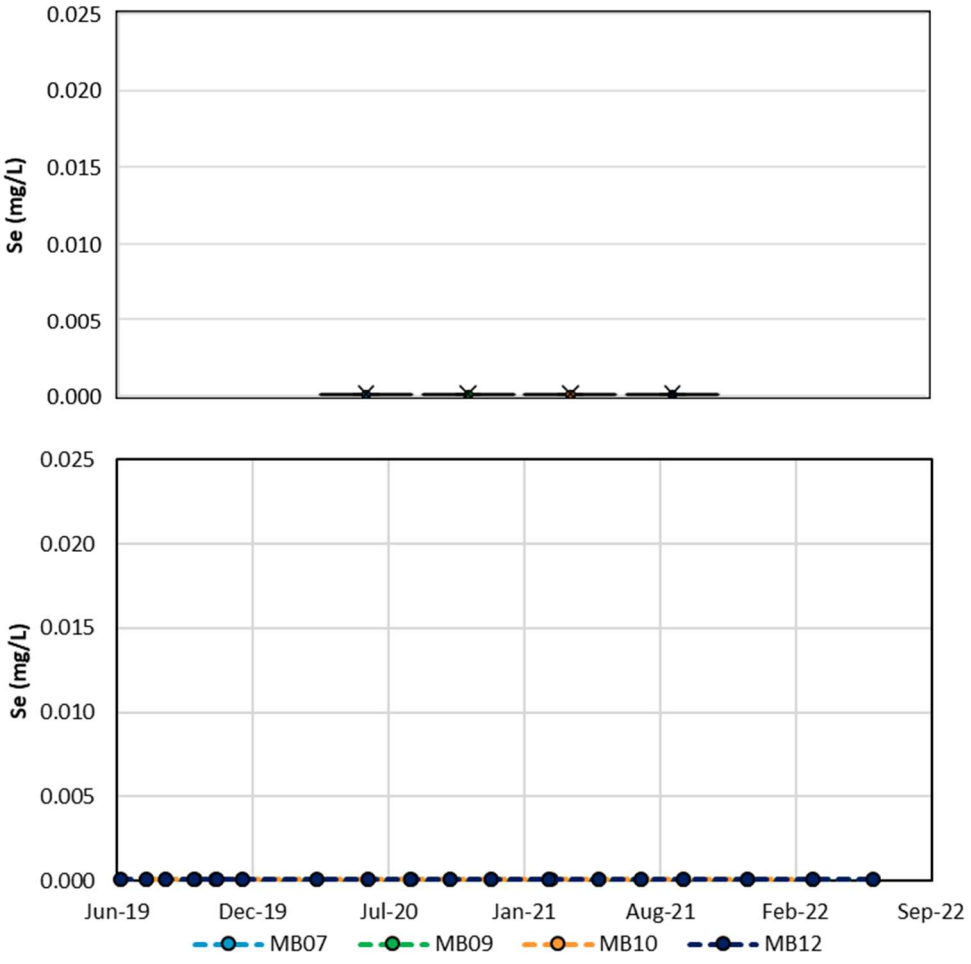


Plate 15 – Dissolved Selenium (Se)

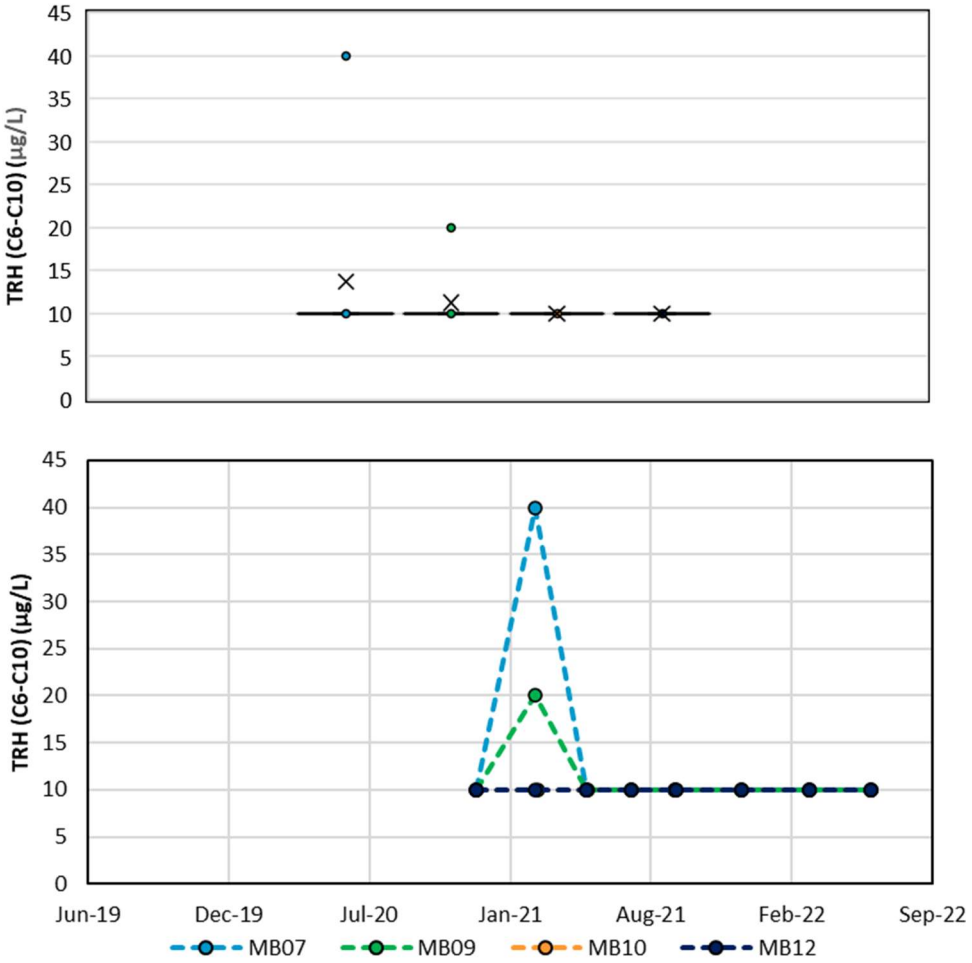


Plate 16 – Total Recoverable Hydrocarbons (TRH) C6 – C10 fraction

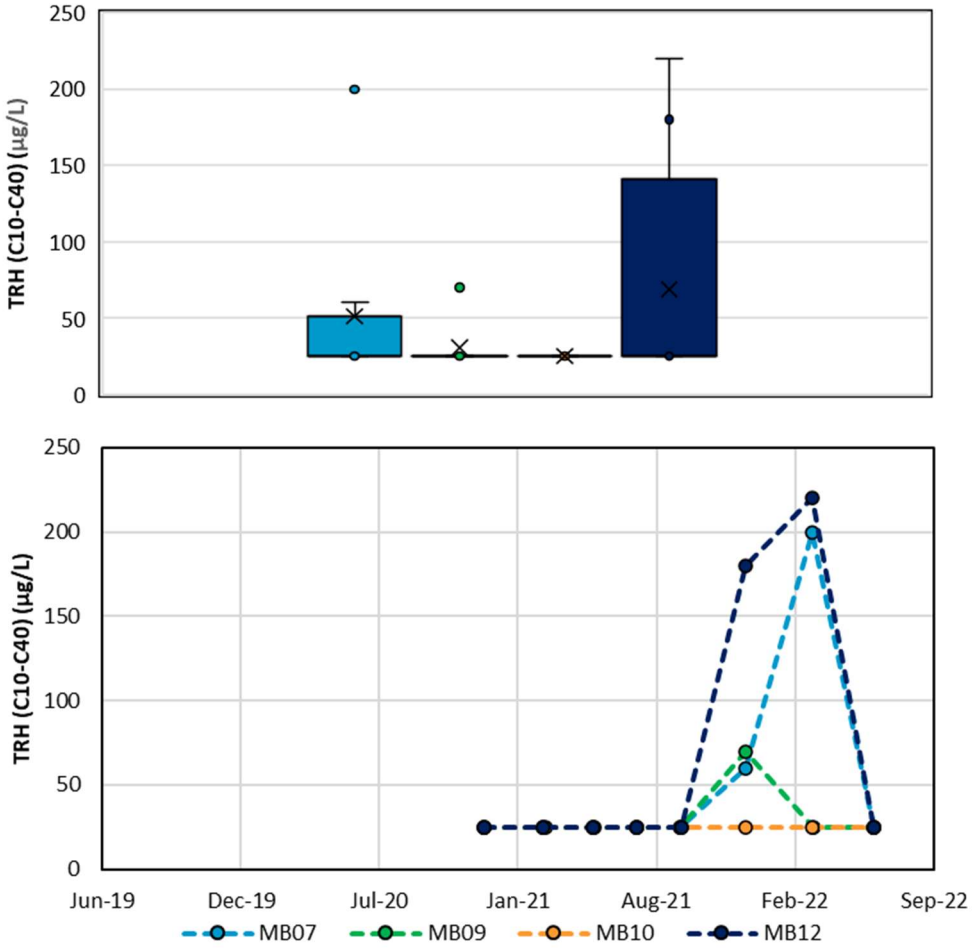


Plate 17 – Total Recoverable Hydrocarbons (TRH) C10 – C40 fraction

Appendix E
Connectivity Assessment

IMPACTS OF VULCAN SOUTH ON CONNECTIVITY

According to the *Queensland Environmental Offsets Policy Significant Residual Impact Guideline*, a development impact on connectivity areas is determined to be significant if either of the following are true:

1. The change in the core remnant ecosystem extent at the local scale (post impact) is greater than a threshold determined by the level of fragmentation at the regional scale (as per Table 1); or
2. Any core area that is greater than or equal to one hectare is lost or reduced to patch fragments (core to noncore).

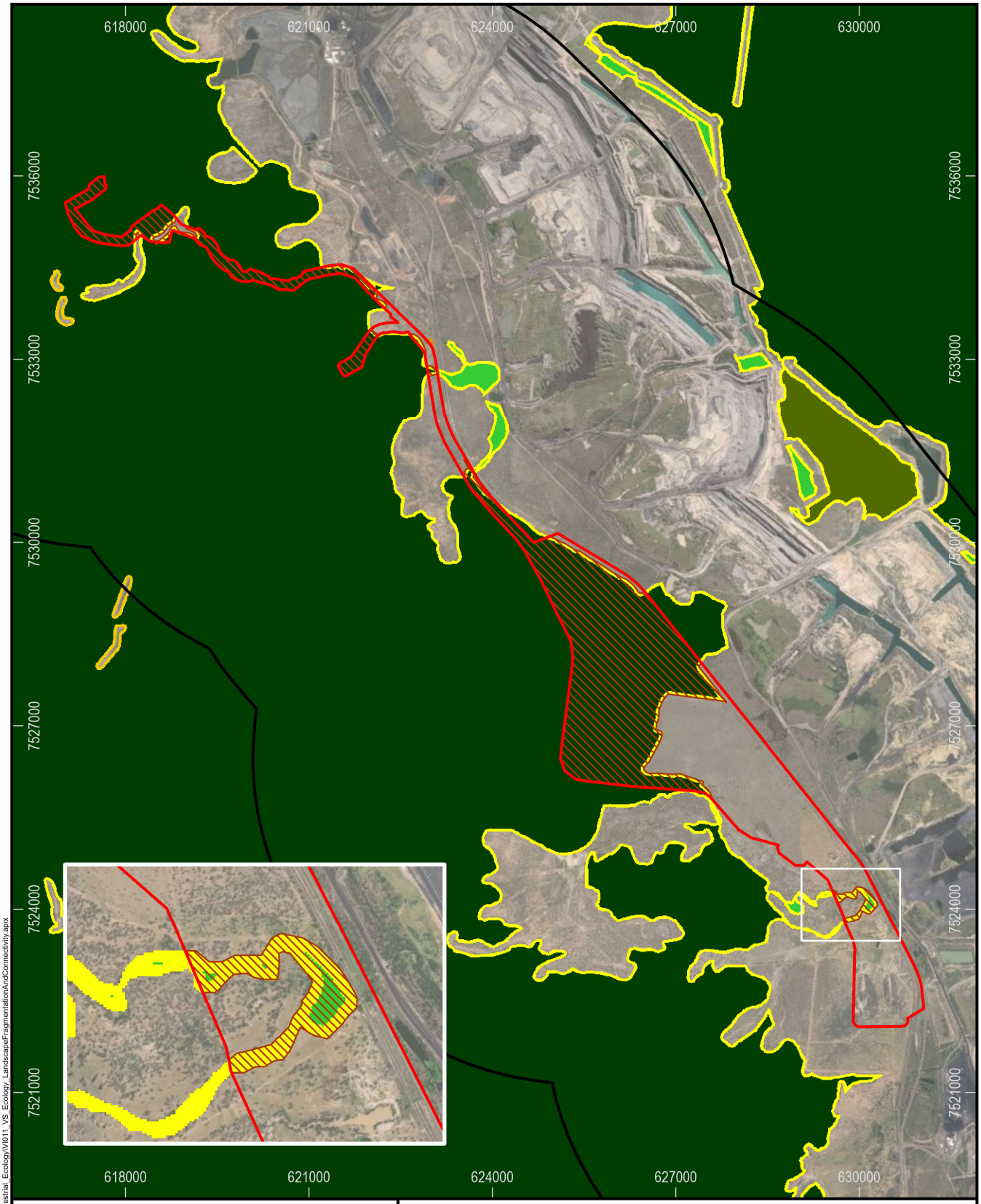
Table 1 Significant impact threshold for loss of core habitat on a local scale

Regional scale extent of core remnant ecosystem (%)	Change threshold for local core scale remnant ecosystem (%)
>90	50
70-90	30
50-70	20
30-50	10
10-30	5
<10	2

The Landscape Fragmentation and Connectivity Tool determined that the extent of core remnant ecosystem at the regional scale was 54.5%. At the local scale, the project will reduce the extent of core remnant ecosystem by 5.5%, which is well below the 20% threshold for a significant impact. Vulcan South therefore does not trigger the first significant impact criterion.

The second criterion is triggered by Vulcan South on the grounds that a single 1.9-ha patch of core remnant ecosystem along Hughes Creek will be removed (**Figure 1**). All other core remnant vegetation to be removed for Vulcan South will reduce the size of core patches, but will not reduce the number.

As a matter of state significance, impacts to connectivity will require offsets. For connectivity, an appropriate offset site must be a non-remnant ecosystem and in the same subregion.



Legend

- Impact site
- Cleared regulated vegetation (Cat. B)
- Impact site local buffer (5km)

Regional fragmentation pre impact

- patch
- edge
- perforated
- core (< 100 hectares)
- core (100-500 hectares)
- core (> 500 hectares)
- other

Source: State of Queensland (Department of Resources) 2022, Vitrinite 2022, METServe 2020-2022, Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\VI011_VS_Ecology_LandscapeFragmentationAndConnectivity.aprx

Vulcan South

Landscape Fragmentation and Connectivity Assessment - Pre-Disturbance

0 1.5 3

Kilometers

Scale: 1:90,000 (A4)

16/08/2022

Datum: GDA2020
Projection: MGA55

FIGURE 1

VITRINITE BRIGHTER COAL

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