Section 6

Assessment and Management of Key Environmental Issues

PREAMBLE

This section describes the environmental setting within and surrounding the Project Site. Emphasis is placed in the initial subsection upon providing information about the environmental setting and the features that would contribute to or influence the assessment of a wide range of other environmental parameters. Information is provided on the regional and local topography and meteorology. Information in relation to local and regional communities, surrounding land uses, land ownership and residences, natural and built features and key risks and hazards are identified in Section 2.2.

Key environmental issues were identified and prioritised based on:

- *the results of the analysis of environmental risk presented in Appendix 3;*
- *feedback received during community and agency consultation (see Section 5.2);*
- *the results of the specialist consultant studies; and*
- *the experience of R.W. Corkery & Co. Pty Limited in preparing EIS and related documentation in the Central West of NSW for over 40 years.*

This section assesses each of the identified key environmental issues in turn. Information is provided on: existing conditions; potential impacts, relevant assessment criteria, where appropriate; the proposed management and mitigation measures to minimise or avoid the identified impacts; the assessment of residual impacts; and proposed monitoring strategies. The proposed management and mitigation measures for each of the following subsections have been collated and are presented in ***Appendix 18****.*

Given the absence of any other substantive active mining operations in the vicinity of the Project Site, negligible opportunities would occur whereby cumulative impacts need to be addressed. As development consent for the existing operations within the TGO Mine Site forms a component of the current application, these have been assessed as Project-related impacts. The Peak Hill Gold Mine, held by Alkane and located approximately 16km south of Tomingley, is currently in care and maintenance and as a result, cumulative impacts of that operation would be negligible.

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6.1 Environmental Setting

6.1.1 Introduction

The assessment of the environmental impacts of the Project in this section is reliant upon background information common to many environmental issues. Key features of the Project Site and surrounding area and region, including community, surrounding land uses, land ownership, natural and built features, risks and hazards are described in Section 2.2. In this subsection, background information is provided on the topography, drainage and climate. Additional detail in relation to surface water drainage is presented in Section 6.6.1.

6.1.2 Topography and Drainage

6.1.2.1 Regional Topography and Drainage

The Project Site is located to the northwest of the Herveys Range on the western slopes of the Great Dividing Range (**Figure 6.1.1**). The Herveys Range forms a north/south orientated range with maximum slopes of approximately 1:1 (V:H). The highest points of the range are a number of unnamed peaks located to the east of Peak Hill, approximately 15km to the southeast of the Project Site, with elevations of up to 775m AHD.

To the east of the Herveys Range, undulating topography varies in elevation from 500m AHD to 1 250m AHD. In contrast, the western side of the range is characterised by generally flat plains with elevations between 220m AHD and 400m AHD and average slopes of approximately 1:300 (V:H).

The Project Site is located within the catchment of the Bogan River (**Figure 6.1.1**). Poorly defined ephemeral drainages on the western side of the Herveys Range flow to the Bogan River located approximately 11km to the southwest of the Project Site. Similar drainages to the northeast of the range direct runoff to the Macquarie River, located approximately 37km to the north of the Project Site. Both the Bogan and Macquarie Rivers flow in a generally northwesterly direction before merging with the Darling River approximately 340km northwest of the Project Site.

6.1.2.2 Local Topography and Drainage

The topography surrounding the Project Site is presented on **Figure 6.1.2**. The most prominent topographic feature in the vicinity of the Project Site, with an elevation of approximately 450m AHD, is an isolated hill located approximately 4km to the east of the Project Site. Maximum slopes associated with this hill are up to approximately 1:2 (V:H).

Typically, the area to the east and southeast of the Project Site is undulating, with low hills with elevations of up to approximately 373m AHD and slopes typically between 1:5 (V:H) and 1:50 (V:H). To the north, west and south of the Project Site, the topography is typically flat to very gently undulating, with elevations between approximately 250m AHD and 260m AHD and slopes of approximately 1:200 (V:H) or less.

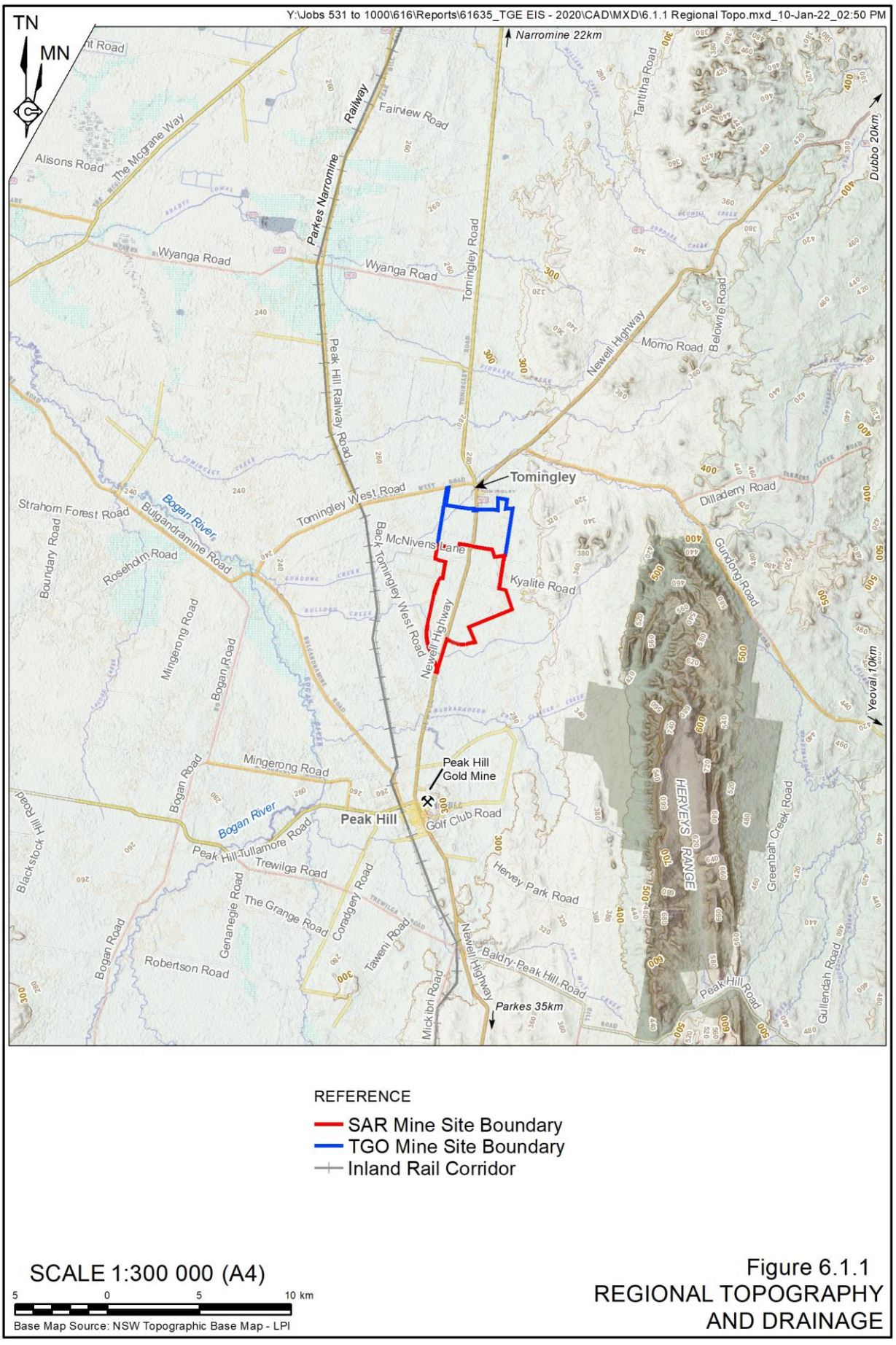
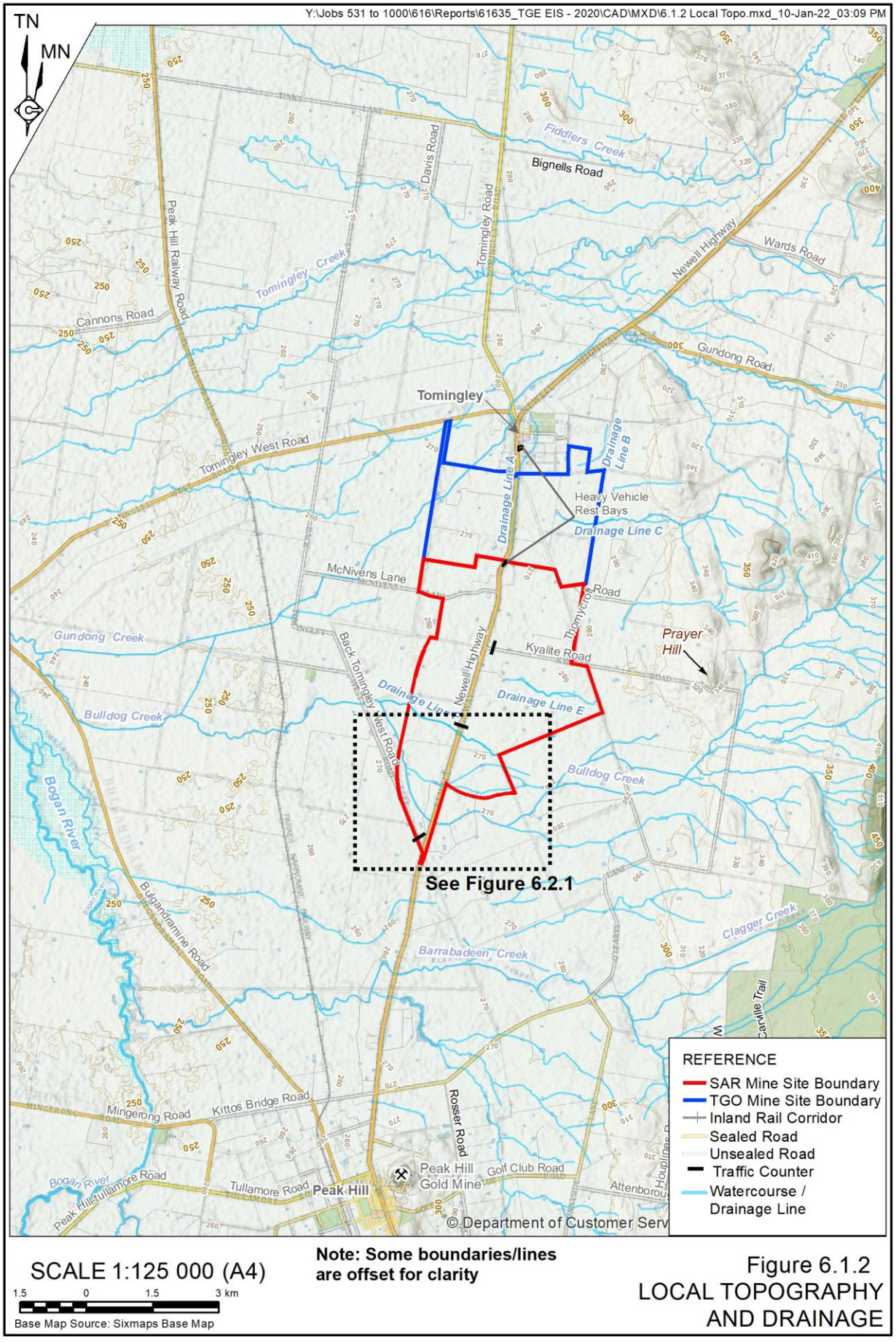


Figure 6.1.1
REGIONAL TOPOGRAPHY AND DRAINAGE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TN
MN
Tomingley
Heavy Vehicle Rest Bays
Drainage Line A
Drainage Line B
Drainage Line C
Drainage Line E
See Figure 6.2.1
Prayer Hill
Peak Hill
Peak Hill Gold Mine
Bignells Road
Fiddlers Creek
Davis Road
Tomingley Road
Peak Hill Railway Road
Tomingley Creek
Cannons Road
Newell Highway
Wards Road
Gundong Road
Tomingley West Road
McNivens Lane
Thornyvale Road
Kyalite Road
Back Tomingley West Road
Gundong Creek
Bulldog Creek
Bogan River
Barrabadeen Creek
Clagger Creek
Carville Trail
Bulgandramine Road
Mingerong Road
Kittos Bridge Road
Rosser Road
Golf Club Road
Tullamore Road
Peak Hill-Tullamore Road
Attenborough
© Department of Customer Serv
REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
Inland Rail Corridor
Sealed Road
Unsealed Road
Traffic Counter
Watercourse / Drainage Line
SCALE 1:125 000 (A4)
1.5 0 1.5 3 km
Base Map Source: Sixmaps Base Map
Note: Some boundaries/lines are offset for clarity
Figure 6.1.2
LOCAL TOPOGRAPHY AND DRAINAGE

Watercourses surrounding the Project Site are typically indistinct, ephemeral and flow westwards to the Bogan River (**Figure 6.1.2**). Gundong Creek flows west and southwest, rising east of Tomingley, before passing through the northwestern section of the TGO Mine Site. Bulldog Creek is an indistinct watercourse that flows to the west, rising in the Herveys Ranges, before flowing through the southern section of the SAR Mine Site, passing under the existing Newell Highway, before turning north and crossing Back Tomingley West Road to the west of the SAR Mine Site. Between these named Creeks are a series of unnamed watercourses, referred to for the purpose of this document as Drainage Lines A to F. **Figure 6.1.2** presents the location of each of these watercourses, with the exception of Drainage Line D which does not appear on the NSW Hydro Line Dataset[1] used to generate that figure. Drainage Line D is presented on **Figure 6.6.3** in Section 6.6.2.2.

6.1.3 Climate

6.1.3.1 Temperature

Table 6.1.1 presents data drawn from the Bureau of Meteorology-operated Peak Hill Post Office weather station (Station Number 050031) located approximately 11km south of the Project Site at an elevation of 285m. This station provides continuous temperature data for the period July 1965 to present. On average, January is the hottest month, with a mean maximum temperature of 33.4ºC and a mean minimum temperature of 19.5ºC, while July is the coldest month, with a mean maximum temperature of 15.4ºC and a mean minimum temperature of 4.8ºC.

Table 6.1.1
Monthly Temperature Statistics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Maximum (°C)	33.4	32.6	29.5	25.1	20.1	16.3	15.4	17.1	20.8	25.0	28.5	31.6	24.6
Mean Minimum (°C)	19.5	19.3	16.4	12.4	8.7	6.1	4.8	5.6	7.9	11.6	14.6	17.4	12.0
Note 1: Based on records from July 1065 to November 2021.													
Source: http://www.bom.gov.au/climate/averages/tables/cw_050031_All.shtml - accessed 11 November 2021													

6.1.3.2 Rainfall

Table 6.1.2 presents rainfall and evaporation data for the area surrounding the Project Site. Rainfall data was derived through a combination of climate data from the TGO Automatic Weather Station, operated by the Applicant since October 2013, and from the Queensland Government's online SILO database. Whilst the TGO AWS presents the most accurate and site-specific meteorological data, data collection began in 2013 and is therefore unlikely to represent long-term climate trends. The SILO data was extracted for the now closed Tomingley weather station (Bureau of Meteorology station # 050091) for a period between 1970 and April 2021.

In summary, rainfall is reasonably evenly distributed throughout the year, with marginally more rainfall in the warmer months than in winter. Mean annual rainfall since 2013 from the TGO Automated Weather Station is 603mm, while the SILO database estimates a mean annual rainfall since 1971 of 562mm. Evaporation exceeds rainfall in all months by between 13mm and 179mm based on data from the TGO Automated Weather Station.

[1] https://www.industry.nsw.gov.au/water/licensing-trade/hydroline-spatial-data

Table 6.1.2
Mean Monthly Rainfall and Evaporation – SILO and TGO AWS

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
TGO Automatic Weather Station (October 2013 to April 2021)													
Mean monthly rainfall (mm)	65	35	85	46	37	40	44	37	42	46	61	65	603
Mean monthly pan evaporation (mm)	244	207	165	118	81	53	69	95	127	171	204	229	1 762
Rainfall deficit[1] (mm)	179	171	80	72	45	13	24	58	85	125	143	165	1 158
SILO Calculated Data (1970 to April 2021)													
Mean monthly rainfall (mm)	59	50	51	41	44	37	44	39	42	45	53	56	562
Mean monthly pan evaporation (mm)	278	221	189	120	73	48	53	77	114	172	218	272	1 833
Rainfall deficit[1] (mm)	219	171	137	79	29	11	8	38	72	127	164	216	1 271
Note 1: Calculated by subtracting pan evaporation from rainfall													
Source: Jacobs (2021b) – after Table 3.1													

6.1.3.3 Wind

Figure 6.1.3 presents annual wind roses sourced from the TGO Automatic Weather Station for the period 2016 to 2020. In summary, winds are predominantly from the east-northeast, with winds from the southwest also observed. Winds from other directions occur less frequently.

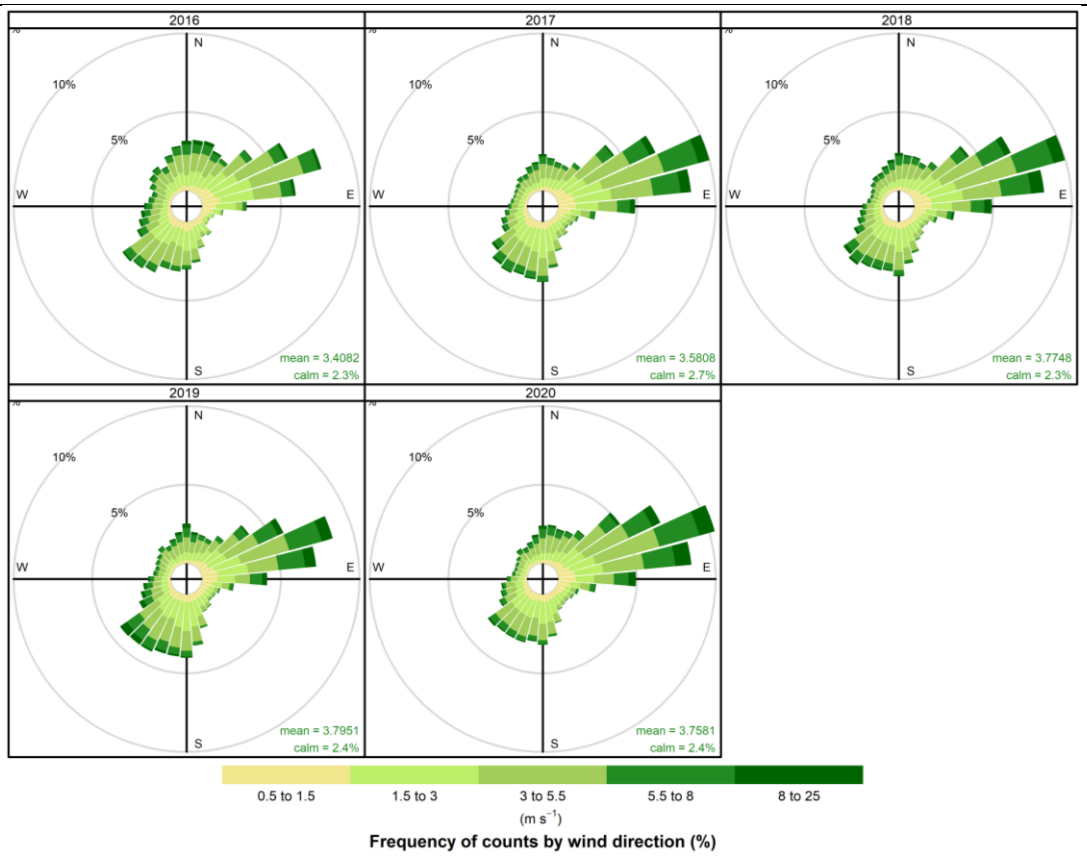


Figure 6.1.3
Annual TGO AWS Wind Roses – All Hours

Source: Northstar (2021) – after Figure 8

6.2 Traffic and Transportation

6.2.1 Introduction

The assessment of environmental risk undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in adverse traffic and transportation-related impacts. Risk sources with an assessed risk of "medium" or above after the adoption of standard mitigation measures are as follows.

- Realigned public roads fail to comply with required design standards (medium risk).
- Realigned public roads fail to comply with required construction standards, thereby requiring additional maintenance compared with the existing road network (medium risk).
- Realigned public roads result in additional travel time for motorists compared with the existing road network (medium risk).
- Temporary intersections and traffic control operations result in increased safety risks (medium risk).
- Disruption to motorists as a result of construction operations (high risk).
- Additional operational traffic results in increased safety risks for motorists (medium risk).

In addition, the SEARs issued for the Project identified "traffic and transport" as a key issue requiring assessment, including assessment of the following.

- The likely traffic and transport impacts of the development on the capacity, condition, safety and efficiency of the road network, including cumulative impacts.
- The site access routes and intersections in accordance with the *Roads Act 1993*.
- A description of the measures that would be implemented to mitigate and/or manage potential traffic impacts including a schedule of all required road upgrades, road maintenance contributions, management of oversized and over mass traffic and other traffic control measures, developed in consultation with the relevant road authority.
- Details of design requirements for the realignment of the Newell Highway and Kyalite Road, including associated plans and proposed flood protection of the realigned roads.

The assessment requirements of Transport for NSW (TfNSW) and Narromine Shire Council were also considered. A summary of the SEARs and the requirements of the TfNSW and Narromine Shire Council are listed within **Appendix 2**, together with a record of where each requirement is addressed in the EIS.

Constructive Solutions Pty Ltd prepared the *Integrated Transport Assessment* for the Project. The resulting report, referred to hereafter as Constructive Solutions (2021b), is presented as Part 1 of the *Specialist Consultant Studies Compendium*. The following subsection draws on information presented in that report and describes the existing road network and traffic environment, predicted changes to the traffic environment as a result of the Project, the proposed management and mitigation measures and an assessment of traffic and transportation-related impacts.

6.2.2 Existing Environment

6.2.2.1 TGO Site Access Road

The TGO Mine Site is currently accessed via an unsealed, two lane private road from Tomingley West Road (see **Figure 3.1.2**). The road has a sign posted speed limit of 40km/h and is maintained by the Applicant as an all-weather access. The TGO Site Access Road includes a culvert crossing over Gundong Creek.

6.2.2.2 Surrounding Roads

Newell Highway

Newell Highway (**Figure 6.1.2**) is a State road that runs the length of NSW, from Tocumwal at the Victorian boarder to Goondiwindi at the Queensland border, forming a major interstate transport connection for freight and passengers. Narromine Shire Council is the roads authority, with Transport for NSW responsible for management and funding of the road. In the vicinity of the Project Site, the Newell Highway consists of long straight sections of two-lane, two-way sealed road with approximately 3.5m wide travel lanes and sealed shoulders. Two overtaking lanes are present, approximately 1 500m long, with one in each direction. The posted speed limit is 110km/h except for the northern and southern approaches to Tomingley village where the posted speed limit reduces to 80km/h before reducing to 50km/h within the village. The pavement is generally in good condition. The road is approved for restricted access vehicles including 25m and 26m long B-doubles, and double road trains. Two truck parking/rest areas exist, one within Tomingley village and one to the south Tomingley in the vicinity of the former McPhail Mine.

Tomingley Road

Tomingley Road (**Figure 6.1.2**) is a Regional road that links Tomingley and Narromine and provides access to Tomingley West Road as well as numerous rural properties. Narromine Shire Council is the roads authority, with Council and Transport for NSW jointly responsible for management of the road. The section of Tomingley Road joining the Newell Highway to Tomingley West Road consists of a two-lane sealed road with pavement in relatively good condition, with approximately 3.1m wide travel lanes and approximately 1m wide sealed shoulders. The posted speed limit is 80km/h. Delineation consists of guideposts, centre and edge line markings.

Tomingley West Road

Tomingley West Road is a Local road, with Narromine Shire Council as the road authority. The TGO Site Access Road is located approximately 1.5km from the intersection of Tomingley Road and Tomingley West Road. This section of Tomingley West Road was upgraded by the Applicant in 2013 and consists of a two-lane sealed road with 3.5m wide travel lanes and 0.5m wide sealed shoulders. The pavement is in relatively good condition and delineation consists of guideposts, centre and edge line markings, some of which are faded in places. The posted speed limit is 80km/h. The remaining section of Tomingley West Road west of the TGO Site Access Road is 9.2km consisting of an approximately 3.4m wide sealed road with unsealed shoulders between 1m and 1.5m wide and caters for two-way traffic. The pavement is in relatively good condition with no guideposts for delineation at night.

A Planning Agreement with Narromine Shire Council provides for maintenance of the section of this road between Tomingley Road and the TOG Site Access Road.

Back Tomingley West Road

Back Tomingley West Road is a Local road providing rural property access with Narromine Shire Council as the road authority. The road caters for two-way traffic and is unsealed with an average pavement width of 6m. The pavement is in fair to reasonable condition with several soft spots due to poor drainage provisions. There are no guideposts for delineation at night and there is no posted speed limit.

McNivens Lane

McNivens Lane is a Local road with Narromine Shire Council as the road authority. It is an unsealed road with an average pavement width of 3.5m, catering for two way traffic. The pavement is in fair to reasonable condition, with several soft spots, and there are no guideposts for delineation at night. There is no posted speed limit. Gundong Creek where it crosses McNivens Lane flows along the Lane for distance of approximately 750m. Standing water over the road pavement in this section of the Lane is common. In times of high-flow, this section of the Lane can become unsuitable for non-4WD vehicles.

Kyalite Road

Kyalite Road is a Local road with Narromine Shire Council as the road authority. Traveling in an east-west direction, it is located to the east of the Newell Highway and provides access to numerous rural properties and O'Learys Lane. Kyalite Road is unsealed with a width of approximately 6m, catering for two-way traffic. The pavement is in reasonable condition however there are no guideposts for delineation at night. There is no posted speed limit on Kyalite Road. A crest to the east of the intersection with Thornycroft Road limits the sight distance for road users. There is no crest signage in place.

Thornycroft Road

Thornycroft Road is a Local road that provides access to numerous rural properties with Narromine Shire Council as the road authority. It is an unsealed road with an average pavement width of 4.5m, catering for two way traffic. The pavement is in reasonable condition and there are no guideposts for delineation at night. There is no posted speed limit on Thornycroft Road.

6.2.2.3 Surrounding Intersections

Tomingley West Road and the Existing TGO Mine Site Access

The intersection of Tomingley West Road and the existing TGO Site Access Road caters for two way traffic movements. Tomingley West Road is the priority road, with stop control in place for the TGO Site Access Road. A sightboard is located opposite the TGO Site Access Road approach to the intersection. The pavement is in relatively good condition and delineation is provided in the form of guideposts and line markings. There is a 40km/h speed limit for the TGO Site Access Road and the posted speed limit for Tomingley West Road in the vicinity of the intersection is 80km/h.

Tomingley Road and Tomingley West Road

The intersection of Tomingley Road and Tomingley West Road was upgraded by the Applicant in 2013 and comprises a T-intersection inclusive of a Basic Right (BAR) turn treatment on Tomingley Road. Tomingley Road is the priority road with give way control (no signposts) in place for Tomingley West Road. A sightboard is located opposite the Tomingley West Road approach to the intersection and is equipped with street lights. The pavement is in relatively good condition and delineation is provided in the form of guideposts and line markings. The posted speed limit is 80km/h for all legs of the intersection.

A Planning Agreement with Narromine Shire Council provides for maintenance of this intersection.

Newell Highway and Tomingley Road

The intersection of the Newell Highway and Tomingley Road is a T-intersection inclusive of an Auxiliary Right (AUR) and Auxiliary Left (AUL) turn treatments on the Newell Highway. The Newell Highway is the priority road and signposted give way control is in place for Tomingley Road, inclusive of a sightboard located opposite the Tomingley Road approach to the intersection. In addition, a median island is in place along the centre line of Tomingley Road to prevent vehicles cutting the corner when undertaking right turn manoeuvres. The pavement is in relatively good condition and delineation is provided in the form of guideposts and line markings, retroreflective raised pavement markers and overhead street lighting. The posted speed limit is 80km/h for all legs of the intersection.

Tomingley West Road and Back Tomingley West Road

The intersection of Tomingley West Road and Back Tomingley West Road is a 4-way intersection. Tomingley West Road is the priority road with signposted give way control in place for Back Tomingley West Road to the south and Lovers Lane to the north. The speed limit is presumed to be 100km/h for all legs of the intersection.

Back Tomingley West Road and McNivens Lane

The intersection of Back Tomingley West Road and McNivens Lane is a basic rural T-intersection with all legs consisting of an unsealed gravel pavement. Back Tomingley West Road is the priority road with give way control (no sign posts) in place for McNivens Lane. There is no sightboard located opposite the McNivens Lane approach to the intersection and no delineation.

Newell Highway and Back Tomingley West Road

The intersection of the Newell Highway and back Tomingley West Road is a T-intersection with the Newell Highway as the priority road. Signposted give way control is in place for Back Tomingley West Road inclusive of a sightboard located opposite the Back Tomingley West Road approach to the intersection. The posted speed limit for Newell Highway is 110km/h and includes a 1.0m wide centre line treatment. The sight distance in both directions along Newell Highway is greater than 300m and there are no turn treatments in place on Newell Highway. The pavement is in relatively good condition and delineation is provided in the form of guideposts, retroreflective raised pavement markers and line marking.

Newell Highway and Kyalite Road

The intersection of Newell Highway and Kyalite Road is a T-intersection with the Newell Highway as the priority road. Signposted give way control is in place for Kyalite Road inclusive of a sightboard located opposite the Kyalite Road approach to the intersection. The posted speed limit for the Newell Highway is 110km/h and the sight distance in both directions along Newell Highway is greater than 300m. There are no turn treatments in place along Newell Highway. The pavement is in relatively good condition and delineation is provided in the form of guideposts, retroreflective raised pavement markers and line marking.

Newell Highway and McNivens Lane

The intersection of Newell Highway and McNivens Lane is a T-intersection with the Newell Highway as the priority road. Signposted give way control is in place for McNivens Lane inclusive of a sightboard located opposite the McNivens Lane approach to the intersection. The posted speed limit for the Newell Highway is 110km/h and the sight distance in both directions along Newell Highway is greater than 300m. There are no turn treatments in place along Newell Highway. The pavement is in relatively good condition and delineation is provided in the form of guideposts, retroreflective raised pavement markers and line marking.

Kyalite Road and Thornycroft Road

The intersection of Kyalite Road and Thornycroft Road is a basic rural T-intersection with all legs consisting of an unsealed gravel pavement. Kyalite Road is the priority road with give way control (no sign posts) in place for Thornycroft Road. There is no sightboard located opposite the Thornycroft Road approach to the intersection and no delineation. A crest located on Kyalite Road immediately to the west of the intersection limits sight distance for users of the intersection.

6.2.2.4 Traffic Volumes

Traffic counts were commissioned by Constructive Solutions (2021b) in the vicinity of the Project Site as part of the traffic assessment to establish annual average daily traffic (AADT) volumes and vehicle types using the existing road network. Traffic counts were conducted during two periods as follows with the location of the traffic counters displayed on **Figure 6.1.2**.

- Traffic counts were recorded over a thirteen-week period between 1 November 2019 to 24 January 2020 on Kyalite Road.
- Traffic counts were recorded over a two-week period between 24 August 2020 to 6 September 2020 on Newell Highway and on Back Tomingley West Road.

Table 6.2.1 presents the traffic volumes using these roads assessed for the Project.

Constructive Solutions (2021b) notes that the traffic count data indicates that peak traffic times on Newell Highway occur between 8:00am and 9:00am, with 325 vehicles per hour (vph), and between 3:30pm and 4:30pm with 348vph. Heavy vehicles represent 45% of total movements on Newell Highway.

Table 6.2.1
Existing Traffic Volumes

Road	Traffic Counter Location	Existing Traffic (2020)	
		AADT	Heavy Vehicle (%)
Newell Highway[1]	Between Kyalite Road and Back Tomingley West Road	4 448	44.8
Back Tomingley West Road[1]	Approximately 100m on the approach to Newell Highway	34	9.8
Kyalite Road[2]	Approximately 100m on the approach to Newell Highway	22	41.3
McNivens Lane[3]	-	15	10
Note 1: 2 week period from 24 August 2020 to 6 September 2020 Note 2: 13 week period from 1 November 2019 to 24 January 2020. Note 3: Assumed existing traffic volume given traffic is considered to be less than Kyalite Road as evidenced by its length and the number of properties serviced.			
Source: Constructive Solutions (2021b) – modified after Table 5, Section 2.4.1			

6.2.2.5 Public Transport and School Bus Services

Table 6.2.2 provides details of the number of school bus services on roads surrounding the Project Site, and the names of the service providers.

Table 6.2.2
School Bus Services

Road	Number of Services	Service Providers
Newell Highway	AM X 3 PM X 3	Tony Witts Dubbo Buslines GJ & AF Parker
Tomingley Road	AM X 2 PM X 2	Tony Witts GJ & AF Parker
Tomingley West Road	AM X 2 PM X 2	Tony Witts GJ & AF Parker
Back Tomingley West Road	AM X 1 PM X 1	GJ & AF Parker
Kyalite Road	AM X 1 PM X 1	GJ & AF Parker
Source: Constructive Solutions (2021b) – modified after Table 6, Section 2.5		

TfNSW provides six coach services per week between Cootamundra and Dubbo, operating every day except Friday. The stop location is the Tomingley Coach Stop within Tomingley village, with the coach travelling along the Newell Highway.

6.2.2.6 Pedestrian and Cyclist Activity

No pedestrians or cyclists were observed during the inspections on the local roads. A small number of pedestrians were observed on Newell Highway within Tomingley village in the 50km/h speed zone.

6.2.2.7 Crash History

Crash data was obtained from TfNSW to assess the crash history in the vicinity of the Project Site. Four crashes have been reported on the Newell Highway in the vicinity of the Project Site between 2016 and 2019. No crashes have been recorded on the other roads described by Constructive Solutions (2021b).

The number of crashes reported in the vicinity of the Project Site is minor, given the traffic volume on Newell Highway. No repetitive or re-occurring accident patterns were identified therefore the reported crash history in the vicinity of the Project Site does not indicate any areas of concern within the road network.

Five road-side memorials occur adjacent to the Newell Highway (**Figure 6.2.1**). None would be removed as a result of the Project, however, all would be located adjacent to the southern section of the existing Highway that would be decommissioned. The Applicant would facilitate access to those memorials on request.

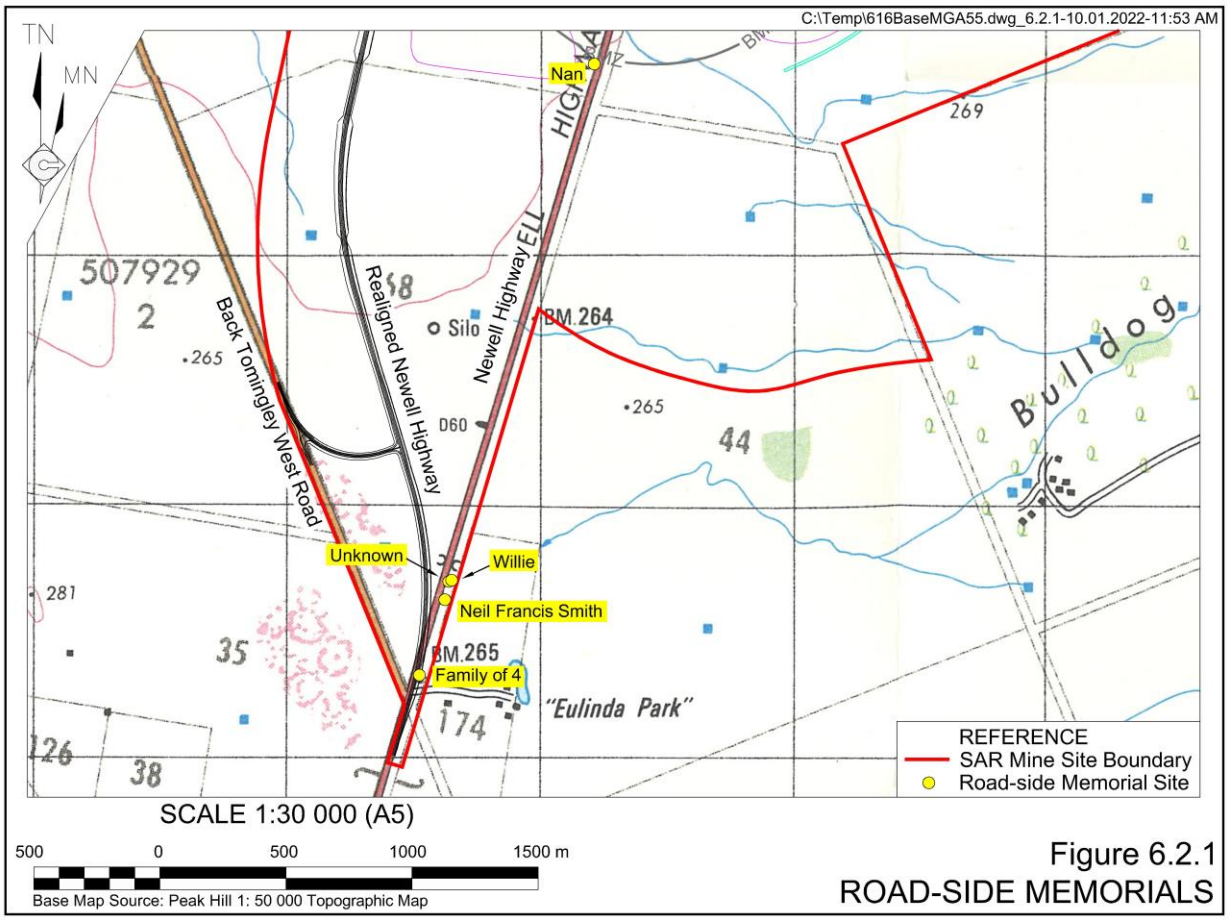


Figure 6.2.1
ROAD-SIDE MEMORIALS

6.2.3 Predicted Changes to the Traffic Environment

6.2.3.1 Introduction

For the purpose of discussing the predicted changes to the traffic environment, Constructive Solutions (2021b) identified three phases of Project activities as follows.

- Road construction phase

- SAR Mine Site construction phase
- SAR and TGO operational phase

Road realignment construction activities described in Section 3.4 are anticipated to commence in 2022 and take 9 to 12 months to complete. SAR Mine Site construction is also anticipated to commence in 2022 and take a similar time to complete, with 9 months allowed for construction operations. The SAR Mine Site construction activities would take place in parallel with the road construction activities. East of the existing Newell Highway, separate construction site compounds would service the Kyalite Road and the SAR Mine Site construction operations. West of the existing Newell Highway, a single construction site compound would be constructed within the "Kenilworth" property (see **Figure 3.5.8**).

The SAR Mine operational phase is expected to begin from the commissioning of the realigned Newell Highway and Kyalite Road and associated decommissioning of the existing sections of those roads. This is expected to take place during Financial Year 2024 with mining operations anticipated to conclude by December 2032.

6.2.3.2 Road and SAR Mine Site Construction Phase

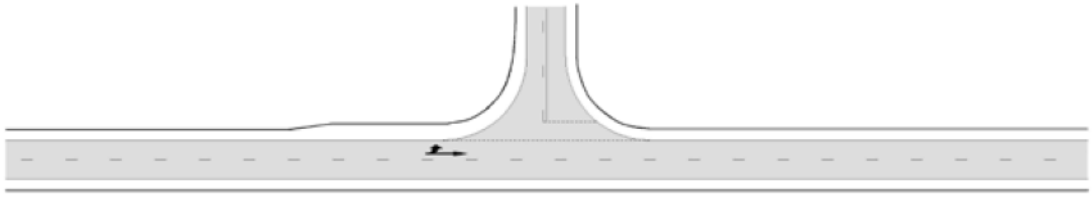
Construction Compound Accesses

The proposed Highway construction laydown area, located west of the existing Newell Highway (see **Figure 3.5.8**) would be accessed via the existing "Kenilworth" property access on Newell Highway. This access would be temporarily upgraded to include a Channelised Right (CHR) turn treatment on the Newell Highway for vehicles travelling from the north and a Basic Left (BAL) turn treatment for vehicles travelling from the south (**Figure 6.2.2**). All vehicles accessing the Newell Highway construction area between Back Tomingley West Road and McNivens Lane would do so via this entrance.

Vehicles leaving the Newell Highway construction area would do so via temporary site access points onto McNivens Lane and Back Tomingley West Road. Vehicles would then use the existing intersections of these roads with the Newell Highway. Light vehicles would also exit the Newell Highway construction area via the upgraded "Kenilworth" intersection. These vehicles would exit in both directions after giving way to Highway traffic.

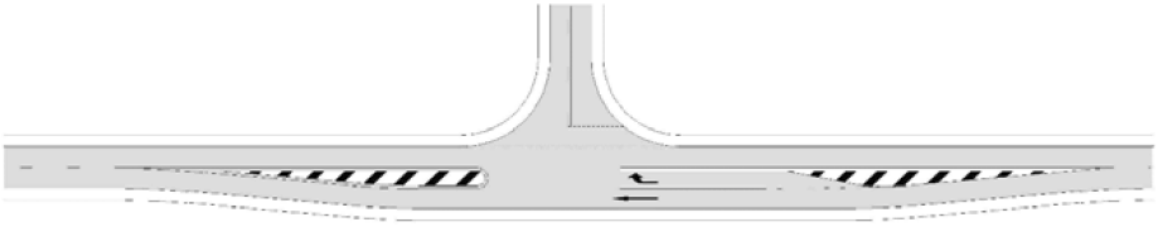
The Kyalite Road construction laydown area and SAR Mine Site construction compound within the SAR Administration Area would be accessed via a temporary intersection from Kyalite Road. Construction traffic travelling from the south would not be permitted to turn right into Kyalite Road. Rather, those vehicles would travel past the Kyalite Road intersection and turn right into the Tomingley South Heavy Vehicle Rest Bay, approximately 2km to the north, before exiting the Rest Bay and turning left into Kyalite Road. Vehicles exiting Kyalite Road onto the Newell Highway would exit in both directions after giving way to Highway traffic.

On completion of the realignments of Newell Highway and Kyalite Road (including the overpass) and the associated closure of existing roads, vehicles associated with ongoing SAR Mine Site construction activities would use the new realigned sections of Newell Highway and Kyalite Road and the new SAR Mine Site access road.



Basic left turn (BAL)
on the major road

BAL Turn treatment



Channelised right turn (CHR)
on the major road

CHR Turn treatments

Figure 6.2.2
Intersection Treatments

Source: Constructive Solutions (2021b) – modified after Figures 8 to 10

Proposed Traffic Levels

It is anticipated that approximately 80% of construction traffic would approach the construction site compound areas from the north (Dubbo and Narromine) and approximately 20% would originate from the south (Peak Hill and Parkes). **Table 6.2.3** presents the anticipated construction-related traffic levels.

Table 6.2.3
Anticipated Construction-related Traffic Levels

	Light Vehicles[2]	Heavy Vehicles[3]
Road Construction Site Compound		
Typical Daily Movements[1]	100	6
Estimated Maximum Daily Movements[1]	120	120
Estimated Peak Hour Movements[1]	48	48
SAR Mine Site Construction Site Compound		
Typical Daily Movements[1]	120	6
Estimated Maximum Daily Movements[1]	170	60
Estimated Peak Hour Movements[1]	68	24
Note 1: Two vehicle movements = one return trip Note 2: Light Vehicles – Class 1 or 2 vehicles Note 3: Heavy vehicles – Class 3 to 10 vehicles		
Source: Tomingley Gold Operations Pty Ltd		

6.2.3.3 SAR Mine Site Operational Phase

Project Site Access

During the operational phase at the SAR Mine Site, the majority of personnel, consumables and equipment would access the SAR Mine Site via Newell Highway, the realigned Kyalite Road and the proposed SAR Mine Site Access Road. Parking for approximately 75 vehicles would be provided within the SAR Administration Area.

Access to the TGO Mine Site would be unchanged as a result of the Project, with vehicles access the TGO Mine Site via the TGO Site Access Road and Tomingley West Road.

The proposed Haul Road and Services Road would permit transportation between the SAR and TGO Mine Sites and, as a result, there would be no requirement for off-site haulage of ore or waste rock.

Proposed Traffic Levels

Operational and administrative staff are expected to travel to the SAR Mine Site in private light vehicles during normal operations. It is anticipated that approximately 80% of operational and administrative traffic would approach from the north (Dubbo and Narromine) and approximately 20% would originate from the south (Peak Hill and Parkes).

It is expected that the operational traffic associated with the ongoing operations at the TGO Mine Site would remain largely unchanged from existing traffic levels. **Table 6.2.4** presents the anticipated operational-related traffic levels.

Table 6.2.4
Anticipated Operational Traffic Levels

	Light Vehicles	Heavy Vehicles
SAR Mine Site Vehicle Movements		
Average Daily Movements[1, 2]	100	6
Maximum Daily Movements[1, 3] (Indicative only)	240	8
Peak Hour Movements[1]	96	4
TGO Mine Site Vehicle Movements		
Daily Movements[1]	156	12
Note 1: Two vehicle movements = one return trip.		
Note 2: An "Average Day" would be representative of operations during FY27 when anticipated direct employment levels would be approximately 155 people, plus contractors.		
Note 3: A "Maximum Day" would be representative of operations during FY25 when anticipated employment levels would be approximately 235 people, plus contractors.		
Source: Constructive Solutions (2021b) – modified after tables 9, 10 and 14		

6.2.3.4 Measured and Forecast Background Traffic Volumes

Constructive Solutions (2021b) estimated AADT volumes for all roads during the Project construction phase, indicatively Calendar Year (CY) 2022 and at end of Project life in CY 2032 assuming an average annual growth rate of 1%.

Table 6.2.5 presents the measured and forecast AADT background traffic volumes for roads in the vicinity of the Project Site.

Table 6.2.5
Measured and Forecast Background Traffic Volumes

Road	Location	Background Traffic (CY2020)		Forecast Traffic (CY2022)		Forecast Traffic (CY2032)	
		AADT	HV%[1]	AADT	HV%[1]	AADT	HV%[1]
Newell Highway	Kyalite Road intersection	4 448	45	4 537	45	5 012	45
Kyalite Road	East of Newell Highway	22	44	22	44	25	44
McNivens Lane	West of Newell Highway	15	10	15	10	17	10
Back Tomingley West Road	West of Newell Highway	34	10	35	10	38	10
Note 1: HV – Heavy Vehicle							
Source: Constructive Solutions (2021b) – modified after Table 11, Section 3.3.1.							

6.2.3.5 Peak Hour Traffic Volumes

Table 6.2.6 presents the anticipated peak hour traffic volumes determined by Constructive Solutions (2021b) for key intersections during the construction phase of the Project.

Table 6.2.6
Peak Hour Traffic Volumes - Construction

Activity	Calendar Year	Newell Highway Southbound (vph)	Newell Highway Northbound (vph)	Subsidiary Road	Proposed Construction Traffic (vph)		
					HV[1]	LV[1]	Total
Newell Highway and "Kenilworth" Property Access Intersection							
Construction	2022	172	168	0	48	48	96
Newell Highway and Kyalite Road Intersection							
Construction	2022	172	168	5	24	68	97
Note 1: HV – Heavy Vehicle, LV = Light Vehicle Note 2: vph = vehicles per hour							
Source: Constructive Solutions (2021b) – modified after Tables 12 and 13							

Table 6.2.7 presents the anticipated peak hour traffic volumes determined by Constructive Solutions (2021b) for key intersections on the realigned Newell Highway during the operational phase of the Project.

Table 6.2.7
Peak Hour Traffic Volumes - Operations

Year	Newell Highway Southbound (vph)	Newell Highway Northbound (vph)	Subsidiary Road (vph)	Proposed Operational Traffic (vph)		
				HV[1]	LV[1]	Total
Newell Highway and Kyalite Road Intersection						
2023	174	170	5	4	96	105
2024	176	172	5	4	96	105
2025	178	173	5	4	96	105
2026	179	175	5	4	96	105
2027	181	177	5	4	96	105
2028	183	179	5	4	96	105
2029	185	180	5	4	96	105
2030	187	182	5	4	96	105
2031	189	184	5	4	96	105
2032	190	186	5	4	96	105
Newell Highway and McNivens Lane Intersection						
2032	190	186	5	-	-	-
Newell Highway and Back Tomingley West Road Intersection						
2032	190	186	5	-	-	-

Note 1: HV – Heavy Vehicle, LV = Light Vehicle

Note 2: vph = vehicles per hour

Source: Constructive Solutions (2021b) – modified after Tables 14, 15 and 16

6.2.4 Avoidance, Management and Mitigation Measures

6.2.4.1 Introduction

The Applicant, in conjunction with Constructive Solutions, has identified a range of measures to minimise traffic and transportation-related impacts likely to be experienced by motorists using the public road network. This has involved a detailed consultation and review of the proposed road design.

Traffic associated with the TGO Mine Site is managed in accordance with the existing and approved *Traffic Management Plan*. The following subsections provide an overview of the management and mitigation measures that would be implemented by the Applicant as part of a revised *Traffic Management Plan* for the Project in consideration of the results and recommendations of Constructive Solutions (2021b).

6.2.4.2 Avoidance and Mitigation through Project Design

The realigned Newell Highway and Kyalite Road and associated intersections, including the temporary intersections to be used during construction operations, have been designed following consultation with the community, road users and the road authorities (Transport for NSW and Narromine Shire Council). The proposed designs are consistent with the *Austroads Guide to Road Design* and have been subjected multiple rounds of review and comment.

6.2.4.3 Operational Management and Mitigation Measures

The Applicant would implement the following traffic management and mitigation measures to ensure that any traffic and transportation impacts associated with the Project are minimised.

- Obtain all necessary approvals from TfNSW and Council for all proposed road upgrade works prior to commencing these works.
- Prepare and implement a *Public Road Construction Environmental Management Plan* that addresses all relevant construction-related environmental management measures to be implemented during construction of the realigned Newell Highway and Kyalite Road and associated intersections.
- Commission the infrastructure upgrade and road improvement works identified in Section 3.4 in accordance with the requirements of the *Roads Act 1993* prior to the commencement of mining operations within the SAR Mine Site.
- Decommission redundant sections of the Newell Highway, McNivens Lane and Kyalite Road and redundant property access points in accordance with the requirements of the *Roads Act 1993*.
- Prepare and implement an *Operational Traffic Management Plan* for the operational phase of the Project, including a Driver's Code of Conduct that outlines the Applicant's expectations in relation to driver behaviour including driving in a courteous manner, adherence to all relevant road rules, and sharing the road space.
- Decommission the Kyalite Road overpass and Newell Highway underpass prior to Mining Lease relinquishment in consultation with Narromine Shire Council and TfNSW.

6.2.5 Assessment of Impacts

6.2.5.1 Introduction

The following presents an overview of the assessment of traffic and transportation-related impacts determined by Constructive Solutions (2021b) based on the above.

6.2.5.2 Heavy Vehicle Impacts

Heavy vehicle movements required for the construction operations would be largely limited to delivery of road construction materials via the Newell Highway. No construction-related heavy vehicle movements are expected on local roads other than short sections of Back Tomingley West Road, McNivens Lane and Kyalite Road. Heavy vehicles would also cross the existing alignment of Kyalite Road in the vicinity of the proposed Haul Road and Services Road. Until that section of Kyalite Road is decommissioned, heavy vehicle access would be controlled by stop signs for Project-related vehicles in accordance with the *Construction Traffic Management Plan.*

Heavy vehicle movements during the operational phase of the project would be limited to deliveries of consumables, including diesel, reagents and other products. These movements would be limited to the sections of:

- Tomingley West Road between Tomingley Road and the TGO Site Access Road; and
- The realigned Kyalite Road between the Newell Highway and the SAR Site Access Road.

There would be no haulage of ore or waste rock on public roads. As a result, Project-related heavy vehicle impacts would be minimised and would not trigger the requirement for road maintenance contributions.

Over-size and overweight vehicles would be limited to transportation of:

- components of the proposed ball mill at the TGO Mine Site;
- bridge elements for the Kyalite Road Overpass;
- mobilisation and demobilisation of mining equipment; and
- delivery of large tyres and other parts.

Relevant permits would be obtained for each over size and overweight vehicle movement.

In light of the above, the proposed realigned roads and intersections would meet the relevant standards and no significant heavy vehicle impacts are anticipated.

6.2.5.3 Road Realignments

The following roads and intersections would be realigned and upgraded as described in Section 3.4.

- Newell Highway
- Kyalite Road
- Back Tomingley West Road
- Intersection of the Newell Highway and McNivens Lane
- Intersection of the Newell Highway and Kyalite Road
- Intersection of the Newell Highway and Back Tomingley West Road

In each case, the proposed roads and intersections would be constructed to the requirements of the relevant roads authority, namely TfNSW and Narromine Shire Council, in a manner that is consistent with the *AustRoads Guide to Road Design*. As a result, the proposed realigned roads and intersections would meet the relevant standards and no significant design or construction impacts are expected.

6.2.5.4 Travel Time and Distance

Table 6.2.8 presents the changes in travel distances and time for motorists using Kyalite Road and the Newell Highway. In summary, motorists using the realigned Kyalite Road would experience the following changes in travel distance and time.

- Intersection of Thornycroft Road to Tomingley – a reduced distance of approximately 60m and an increased travel time of approximately 2 seconds, largely as a result of the reduced travel distance on the Newell Highway with a 110km/h speed limit .
- Intersection of Thornycroft Road to Peak Hill – an increased distance of approximately 1.67km and associated increased travel time of approximately 59 seconds.

Table 6.2.8
Changes in Travel Distance and Time

Road Name	Travel Distance[1]			Travel Time[1]		
	Existing	Proposed	Change	Existing	Proposed	Change
Kyalite Road – Thornycroft Rd to Newell Highway	2.02km	2.62km	+0.60km	1:21 min[2]	1:45 min[2]	+0:24 min
Newell Highway – Kyalite Road to Tomingley[4]	4.17km	3.51km	-0.66km	2:22 min[3]	2:00 min[3]	-0:22 min
Newell Highway – Kyalite Road to Peak Hill[4]	11.95km	13.02km	+1.07km	6:38 min[3]	7:13 min[3]	+0:35 min
Newell Highway Tomingley to Peak Hill	16.12km	16.53km	0.41km	9:00 min[3]	9:13 min[3]	+0:13 min
Note 1: Approximate Lengths and Travel Times with no waiting at intersections. Note 2: Based on an average speed of 90km/h for Kyalite Road. Note 3: Based on the posted speed limits of 110km/h and 80km/h for the Newell Highway. Note 4: To the start of the 50km/h speed zone on HW17.						
Source: Constructive Solutions (2021b) – modified after Table 18						

Motorists using the realigned Newell Highway between Tomingley and Peak Hill would experience an increased travel distance of 0.41km and travel time of 13 seconds.

Changes in travel distance and time for residents living on Back Tomingley West Road and McNivens Lane would be negligible.

The Applicant contends that taking into consideration the following, that the proposed increased travel distance and time for some motorists would not result in significant impacts for the following reasons.

- The realigned Newell Highway would be constructed on a like-for-like basis with the same length of overtaking lanes and similar pavement design as the existing Highway.
- The realigned Newell Highway would include a range of improved safety measures, including:
  - additional wire-rope barriers;
  - 1m wide centreline;

- improved curve radii;
- improved intersections at Back Tomingley West Road, Kyalite Road and McNivens Lane, including channelised right turn lanes and either a channelised left turn lane on Kyalite Road or Basic Auxiliary Left treatments on Back Tomingley West Road and McNivens Lane; and
- reduced flood risk, from flooding during 25% Annual Exceedance Probability (AEP) rainfall events, flood protection under a 1% AEP rainfall event.[2]

In light of the above, it is concluded that the proposed additional travel time and distance for some motorists would not result in unacceptable impacts for the potentially affected motorists.

6.2.5.5 Other Local Roads

It is anticipated that there will be up to 10 additional light vehicle movements per day using the road network between the TGO Mine Site and the SAR Mine Site. These additional light vehicle traffic movements are anticipated to be spread out across a normal working day and would have a negligible impact on the peak traffic flows. As a result, no upgrades are considered necessary for the existing TGO Mine Site Access, Tomingley West Road, Tomingley Road and associated intersections and no significant impacts are anticipated.

As Project-related traffic would not use Thornycroft Road or McNivens Lane, no further upgrades are required and no significant impacts are anticipated.

A realignment of approximately 600m of Back Tomingley West Road and a new intersection with the Newell Highway is proposed. The new intersection would be located to the north of the existing intersection to ensure minimum sight distances are met. Elevation of the intersection would be increased to improve flood immunity. The existing intersection with the Newell Highway would be closed and a cul-de-sac provided on the redundant section of Back Tomingley West Road. As Project-related traffic would not use Back Tomingley West Road and the proposed works would be in accordance with the *Austroads Guide to Road Design*, no unacceptable impacts are anticipated.

6.2.5.6 Intersections – Construction Phase

Four intersections would be used during construction as follows (see Section 3.4.3).

- A temporary intersection on the Newell Highway at the entrance to "Kenilworth" property to permit light and heavy vehicles to enter and light vehicles only to exit.
- Temporary intersections onto Back Tomingley West Road and McNivens Lane to permit heavy vehicles to exit. Such vehicles would then use the existing intersections of these roads with the Newell Highway.

[2] The Annual Exceedance Probability (AEP) is the probability of a rainfall event occurring in a particular 12-month period. For example a 1% AEP rainfall event would have a 1% or 1 in 100 change of occurring in any one year. Such a rainfall event is commonly referred to as a 1 in 100 year rainfall event.

- A temporary intersection onto Kyalite Road to permit light and heavy vehicles to enter and exit. All construction-related traffic movements would turn left into Kyalite Road. Construction-related traffic approaching from the south would be required to travel to the existing South Tomingley Rest Area to complete a U-turn before returning to Kyalite Road.

Constructive Solutions (2021b) undertook an analysis of the peak hour vehicle movements for each of the above intersections and determined that the following intersections upgrades would be required for the road construction phase of the Project.

- Newell Highway and "Kenilworth" property access ..... temporary CHR / BAL
- Newell Highway and Kyalite Road.....temporary BAL
- Newell Highway and Back Tomingley West Road .....no works required
- Newell Highway and McNivens Lane .....no works required

The Applicant has accepted these recommendations and, as a result, no unacceptable impacts are anticipated.

In the event that tracking of mud and sediment onto the Newell Highway becomes an issue, the Applicant would implement measures on its own land to ensure that sediment is removed from the wheels of exiting vehicles.

6.2.5.7 Intersections – Operational Phase

Three intersections would be used during operations as follows. Constructive Solutions (2021b) undertook an analysis of the peak hour vehicle movements for each intersection and determined that the following intersection standards would be required (see Section 3.4.2.3 and **Figure 3.4.5**).

- Newell Highway and McNivens Lane .....BAL / BAR
- Newell Highway and Kyalite Road.....CHR / AUL (short)
- Newell Highway and Back Tomingley West Road .....BAL / BAR

Notwithstanding the above, the Applicant has agreed with Transport for NSW to provide CHR / AUL treatments to each of these intersections. This treatment would involve a dedicated right-hand turn lane and left hand turn deceleration lane. The proposed intersection designs exceed the minimum requirements and provide substantial benefit to users of the proposed intersections into the future. As a result, no unacceptable impacts are anticipated.

6.2.5.8 Intersections – SAR and TGO Site Access Roads

Constructive Solutions (2021b) determined that the following intersection treatments would be required for the following intersections.

- SAR Mine Site Access (construction phase).....standard rural property access
- SAR Mine Site Access (operational phase) .....BAL
- TGO Site Access Road.....no upgrade required

In addition, Constructive Solutions (2021b) recommended truck warning signs be installed on Kyalite Road at each side of the intersection with the SAR Mine Site Access Road. The Applicant has accepted these recommendations and, as a result, no unacceptable impacts are anticipated.

6.2.5.9 Bus Services, Pedestrians and Cyclists

Several school and passenger bus services use the surrounding road network in the vicinity of the Project Site. There are no formal bus stops on the local roads and the school bus services using these roads pick up students, as required. Bus services using the Newell Highway use designated stops within the 50km/h speed zone in Tomingley village.

Worker shift changeover times during both the construction phase and operational phase of the Project would occur outside the morning and afternoon school bus travel times. Whilst there would be a minor increase in traffic volumes during peak morning and afternoon times as workers enter and leave the SAR Mine Site, it is unlikely the construction and operation of the Project would impact on school bus services.

The Project is unlikely to impact pedestrians and/or cyclists due to the surrounding rural environment and distance from Tomingley village.

6.2.5.10 Rail Services

The existing Parkes to Narromine rail line has been upgraded to form part of the Inland Rail network and is located approximately 4km west of the Project Site. As there is no rail infrastructure within the vicinity of the Project Site, the Project would have no impact on rail infrastructure, the rail corridor or rail services.

6.2.5.11 Cumulative Impacts

There are no other known traffic generating developments or proposed developments in close proximity to the Project Site. As the construction of the Newell Highway realignment would be off line and the existing Newell Highway alignment unimpeded during the construction phase (except for the construction of the tie ins of the new alignment to the existing alignment) there would be no cumulative traffic impact on the road network as a result of the Project.

6.2.6 Conclusion

The principal Project-related traffic and transportation impacts would be associated with the realignment of the Newell Highway, Kyalite Road and associated intersections. As the proposed road designs are consistent with the *Austroads Guide to Road Design* and would be approved by the relevant roads authority, there would be no unacceptable road design or operational impacts.

Additional traffic generated by the Project would principally comprise light vehicles used to transport personnel to work. Heavy vehicles use of the public road network would not be a significant feature of the Project.

Notwithstanding the above, the Project would result in minor additional travel time for users of the Newell Highway and residents along Kyalite Road travelling to the south. This would, however, be offset by substantial safety and intersection improvements. As a result, on balance the Applicant contends that the Project would not result in unacceptable adverse traffic and transportation-related impacts.

6.3 Visibility

6.3.1 Introduction

The risk assessment undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in adverse impacts to visibility. These risk sources and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Amenity impacts through the operation of machinery within sections of the Project Site visible from nearby privately-owned residences and the local public road network (medium risk).
- Amenity impacts through the temporary and permanent change in content and composition of views from nearby privately-owned residences and the local public road network (high risk).
- Distraction of motorists using the Newell Highway and Kyalite Road and resulting road accident (medium risk).

The SEARs for the Project require the EIS to include an assessment of the following potential impacts of the Project on visual amenity, including the existing light and sky glow environment.

- The likely visual and landscape impacts of the development on private land in the vicinity of the development and key vantage points in the public domain, paying particular attention to any temporary and permanent modification of the landscape (e.g. overburden emplacements, bunds, tailings facilities).
- The lighting impacts of the development, including impacts on Siding Spring Observatory in accordance with the *Dark Sky Planning Guideline.*

The assessment requirements of Narromine Shire Council were also considered during the preparation of the visibility assessment. A summary of the SEARs and the requirements of Narromine Shire Council are listed in **Appendix 2** together with a record of where each requirement is addressed in the EIS.

An assessment of daytime visual impact was undertaken by RWC and is presented in full in the following subsections of this EIS.

A *Light and Sky Glow Assessment* was undertaken by Lighting, Art and Science Pty Limited (LAAS). The full *Light and Sky Glow Assessment* is presented in Part 2 of the Specialist Consultant Studies Compendium and is hereafter referred to as LAAS (2021).

It is noted at the outset that the value placed upon changes in visual amenity will vary from person to person and from location to location. As a result, a visual amenity assessment is, by its nature, somewhat subjective. As a result, during the visual amenity assessment emphasis has been placed on providing a description of the existing visual amenity and visibility surrounding the Project Site and the measures that would be undertaken by the Applicant to minimise potential visual amenity and visibility-related impacts on surrounding residents and others. It particular, it is noted that landforms and activities within the TGO Mine Site are a component of the existing visual landscape. As a result, emphasis has been placed on assessing changes to the visual landscape as a result of proposed landforms and activities within the SAR Mine Site.

Finally, it is acknowledged that a change in the visual landscape that one person would find acceptable, may not be acceptable to another. As a result, the Applicant has consulted extensively with neighbours surrounding the SAR Mine Site, with the results of that consultation presented in Section 5.2.2.

6.3.2 Existing Environment

6.3.2.1 Daytime Visual Setting

Introduction

A description of the topographic, natural and built features within the area in the vicinity of the Project Site is provided in Sections 6.1.2 and 2.2.4, respectively. The following subsections provide an overview of the key features of the surrounding environment that influence the view compositions and visual character of the local landscape.

Principal Landscape Setting and Features

Regionally, the Project Site is located at the interface between the foothills of the Herveys Range east of the Project Site and the flatter plains each side of the Bogan River (**Figure 6.1.1**). The forested slopes of the Herveys Range and the Goobang National Park dominate the eastern skyline, while the lower foothills and plains are a typical rural matrix of agricultural fields and areas of remnant and managed native vegetation in variable condition. The Newell Highway and associated moving vehicles is also a ubiquitous component of the visual landscape.

Locally, the Project Site is bordered to the north and south side by the ephemeral waterways of Gundong Creek and Bulldog Creek (respectively) (**Figure 6.1.1**). These watercourses, together with a series of unnamed watercourses, form a network of natural and modified channels and overland flow with periodic riparian vegetation across a landscape heavily modified by land clearance and agricultural practices.

The influence of historic mining activity is prevalent across the local landscape, including the following.

- Former mining operations within Tomingley village and the McPhail's Mine located immediately to the south of the TGO Mine Site (see **Figure 3.3.3**).
- The McPhail Tailings Dam constructed during reprocessing of historic tailings in the 1990s (see **Figure 3.3.3**).
- Views to the south of the Project Site include the vegetated slopes of Peak Hill and the Peak Hill Gold Mine (see **Figure 6.1.2**).
- Within the TGO Mine Site, the rehabilitated Waste Rock Emplacements 2 and 3 are dominant features of the skyline. Other sections of the TGO Mine Site are partly or largely obscured from surrounding land and the Newell Highway by vegetated screens and bunds.

The proposed SAR Mine Site is located in a relatively flat area. The highest point within the SAR Mine Site is associated with a series of low rises with a maximum elevation of approximately 295m AHD immediately to the west of Thornycroft Road.

Additional elevated areas exist approximately 1.5km and 3.2km to the east of Thornycroft Road with elevations of approximately 310m AHD (Kyalite Road crest) and 373m AHD (Prayer Hill) respectively (see **Figure 3.3.3**). These areas of relatively higher elevation have views across the SAR Mine Site, with existing views dominated by agricultural activities and native vegetation, as well as the Newell Highway and associated traffic.

Existing views of the SAR Mine Site from selected surrounding residences and publicly accessible vantage points are presented in Section 6.3.5.3.

6.3.2.2 Night-time Visual Setting

The Project Site is located in a rural area. The dominant night-time visual features include the following.

- Lights from vehicles using the Newell Highway and surrounding local roads.
- Lights associated with rural residences and street and other lighting within Tomingley village.
- Lights associated with fixed and mobile plant within the TGO Mine Site. The TGO Mine Site is largely screened from surrounding land by Amenity Bunds, Waste Rock Emplacements 2 and 3 and planted and pre-existing native vegetation.

In addition, the Project Site is located approximately 162km from the Siding Spring Observatory and falls within the Observatory's Dark Sky Region (**Figure 6.3.1**). This region comprises the land within a 200km radius of the Siding Spring Observatory near Coonabarabran established under the *Dark Sky Planning Guideline* (DPE, 2016) to ensure lighting impacts from significant developments do not unreasonably disrupt the operation of the Observatory. **Figure 6.3.2** presents a cross-section of the topography between the Project Site and Siding Spring Observatory. The line of sight for an observer at the Observatory would, as a result of intervening topography, namely Needle Mountain, be approximately 870m above the Project Site.

In addition, in accordance with *AS/NZS4282:2019*[3] *Control of the obtrusive effects of outdoor lighting* (Lighting Standard), LAAS (2021) identified a number of additional significant amateur or private observatories which are required to be taken into account for an assessment of potential sky glow impacts. **Figure 6.3.1** presents the location of the closest observatories to the Project Site. Each of these observatories have intervening topography between them and the Project Site that would prevent direct observations of lighting within the Project Site.

[3] The SEARs for the Project specified AS4282-1997 *Control of the obtrusive effects of outdoor lighting*, however this was updated in 2019 and therefore this assessment is in accordance with the most recent version of this standard.

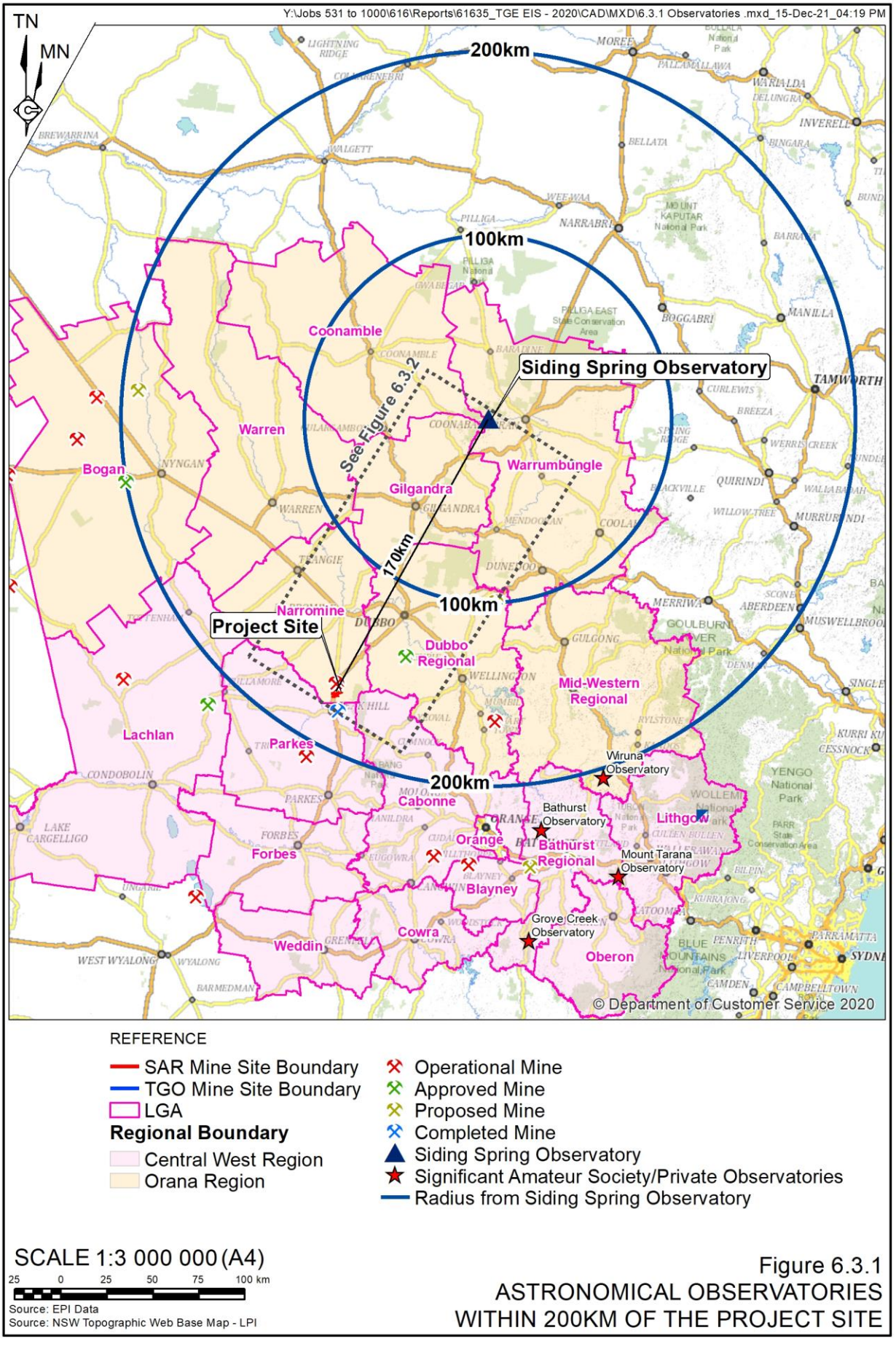
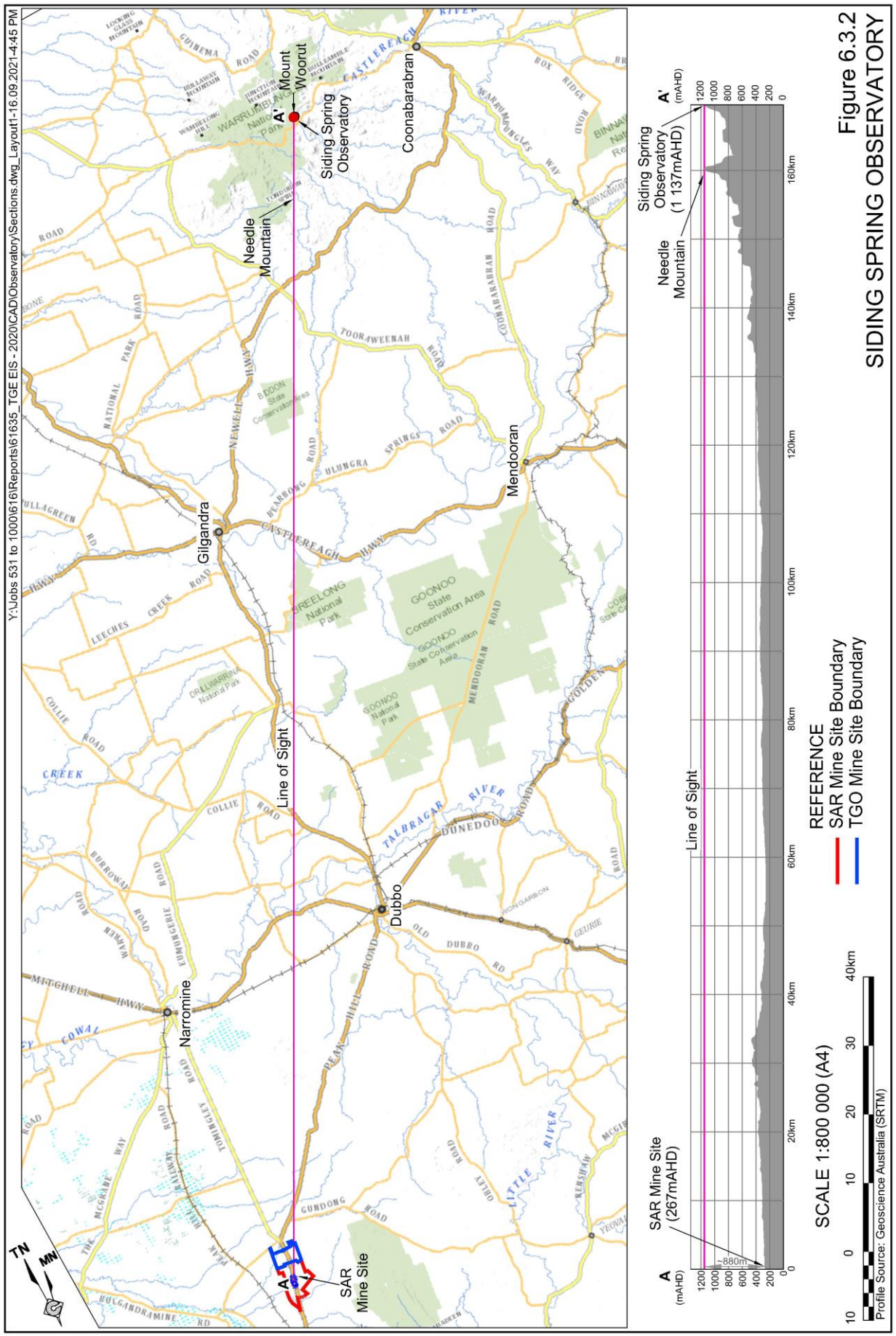


Figure 6.3.1
ASTRONOMICAL OBSERVATORIES WITHIN 200KM OF THE PROJECT SITE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A
A'
Mount Woorut
Siding Spring Observatory
Coonabarabran
Needle Mountain
Gilgandra
Mendooran
Dubbo
Narromine
Line of Sight
SAR Mine Site
TN
MN
SIDING SPRING OBSERVATORY
Figure 6.3.2
Siding Spring Observatory (1 137mAHD)
Needle Mountain
SAR Mine Site (267mAHD)
~880m
REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
SCALE 1:800 000 (A4)
Profile Source: Geoscience Australia (SRTM)

6.3.3 Potential Visual Impacts

6.3.3.1 Day-time Potential Impacts

Site Establishment and Construction Stage

The potential additional visual impacts associated with the Project during the site establishment and construction stage are as follows.

- Earthmoving and roadmaking equipment would be visible to road users and surrounding residents along the existing alignment of the Newell Highway during the construction of the realigned Newell Highway and Kyalite Road.
- Earthmoving equipment within the SAR Mine Site would be visible from the existing and proposed alignment of the Newell Highway, particularly, prior to and during construction of the SAR Amenity Bund and the outer wall of the SAR Waste Rock Emplacement. Whilst these design elements are intended to provide visual protection in the medium to long term, they would themselves be discernible until they are sufficiently vegetated.
- It is anticipated that most, if not all site establishment and construction operations would be visible from elevated areas to the east of the Project Site where local terrain and vegetation allow a direct line of sight.

Operational Stage

The potential additional visual impacts generated by the Project during the operational stage are as follows.

- The movement and placement of waste rock and ore, as far as practicable, would be obscured by the SAR Amenity Bund and the rising outer wall of the SAR Waste Rock Emplacement from areas to the south, west and north of the SAR Mine Site, including the Newell Highway. Activities on the outer faces of these structures would, however, be visible from those locations.

  Views of activities within the SAR Mine Site would, however, be visible from elevated sections of Kyalite Road, including the proposed Kyalite Road Overpass.
- The progressive construction of the SAR Waste Rock Emplacement would be visible throughout the Project life, with the key areas that would be visible being the exposed and progressively rehabilitated outer face.
- Views of activities within the SAR Mine Site would be available from elevated areas to the east of the Project Site where local terrain and vegetation allow a direct line of sight.

Post-operational Period

The proposed final landform and anticipated rehabilitation operations are outlined in Section 3.14 and shown in **Figure 3.14.1** and **3.14.3**. The potential visual impacts generated by the Project during the post-operational period include the movement of heavy machinery and equipment involved with the decommissioning of fixed plant and landform shaping within the Project Site, particularly in elevated sections of the Project Site, would be visible from a range of locations.

However, once the majority of the Project Site is within the latter stages of rehabilitation (i.e. Ecosystem Development and Ecosystem Sustainability) (see Section 3.14), the nature and scale of rehabilitation activities are considered to be relatively minor in regard to potential impacts on visual amenity.

6.3.3.2 Night-time Potential Impacts

Project Lighting Environment

The additional lighting that would potentially be used during mining operations within the Project Site includes:

- headlights and other lighting from mobile equipment during the development and construction of the proposed Newell Highway and Kyalite Road realignments and associated intersections;
- headlights from mobile equipment operating within the SAR Open Cut and on internal roads; and
- lighting towers within the SAR Open Cut, SAR and Caloma Waste Rock Emplacements, SAR Administration Area and other operational areas.

The type of additional lighting impacts after dusk would depend upon:

- the type of lighting used, i.e. the colour temperature and luminance level of lighting;
- the quantity and disposition of the lighting used within the Project Site;
- the presence of natural or human-made amenity barriers either on or off site, i.e. intervening topography, light shields etc.; and
- the presence or absence of fog, low cloud cover and/or airborne dust particles.

Lighting impacts could potentially occur in one of three ways.

- Direct Impacts – where light is directed towards a viewer.
- Indirect Impacts – where the source of light is not directed at a viewer but the spread of light is observable.
- Sky Glow – where light from one or more sources is reflected in the atmosphere. The extent of sky glow is a function of the presence or absence of fog, low cloud and/or airborne dust particles.

In addition to the above, the proposed upgrades to the TGO Processing Plant would include minor upgrades to the existing lighting. The additional lighting sources were included in the modelling conducted by LAAS (2021) for the light and sky glow assessment.

Potential Lighting Impacts

The potential lighting impacts during all stages of the Project are as follows.

- Direct impacts from Project-related lighting on users of the Newell Highway. Risk of impacts to road users would be greatest where road alignment may allow for a direct line of sight to Project-related lighting, such as headlights from trucks on the proposed Haul Road and SAR Waste Rock Emplacement access ramp.

- Direct impacts from Project-related lighting on surrounding receptors where Project lighting may be positioned in a direction facing the receptors location.
- Indirect impacts of increased sky-glow on occupants of surrounding residences.
- Project-related impacts of increased sky-glow on the operation of astronomical observatories.

6.3.4 Avoidance, Management and Mitigation Measures

6.3.4.1 Introduction

The Applicant has identified a range of measures to minimise the changes in visual amenity likely to be experienced at surrounding residences and from publicly available vantage points, including the realigned Newell Highway and Kyalite Road. This subsection provides an overview of the management and mitigation measures that would be implemented by the Applicant to address Project-related visual amenity and visibility-related matters.

6.3.4.2 Avoidance and Mitigation through Project Design

Key infrastructure within the Project Site has been designed in consideration of visual amenity and visibility mitigation opportunities. In particular, the Applicant would implement the following.

- Construct the SAR Amenity Bund in a manner that would prevent views of the principal operational areas of the SAR Mine Site, excluding the SAR Waste Rock Emplacement, from the west of the SAR Mine Site, including the realigned Newell Highway. In particular, ensure to the extent practicable that headlights from vehicles using the Haul Road are not visible from the realigned Newell Highway.
- Progressively construct the outer faces of the SAR Waste Rock Emplacement in a series of lifts to provide an amenity bund to screen operations behind the bund from surrounding vantage points. Shape, stabilise and rehabilitate each successive lift as soon as practicable following construction.
- Maintain existing and establish additional vegetation screens, including adjacent to Back Tomingley West Road in the vicinity of Residence R43.
- Construct built infrastructure using non-reflective, neutral coloured materials or outer coatings.
- Ensure to the extent practicable that lights with diffusing covers or with visible bare lamps that emit light above the horizontal plane are not be used on the outside of buildings or structures.

6.3.4.3 Operational Management and Mitigation Measures

The Applicant would implement the following visual amenity and visibility-related operational management and mitigation measures throughout the life of the Project.

- Limit to the extent practicable, operation of mobile plant on the outer faces of the SAR Amenity Bund and SAR Waste Rock Emplacement to daylight hours.

- Manage dust emissions and blasting to limit the potential for dust clouds or blast fume to be visible from outside active sections of the Project Site.
- Ensure, to the extent practicable, that the light from all mobile lighting towers is directed away from surrounding residences and public roads.
- Construct the SAR Waste Rock Emplacement access ramp in consideration of the direction and intensity of lighting from Project-related vehicles on users of the Newell Highway.
- Turn off external lighting in non-operational or non-active sections of the Project Site.
- Consider any reasonable request by a potentially affected resident for assistance to create a visual screen between a residence and the SAR Mine Site through planting of fast-growing vegetation and/or landscaping, where such a screen would effectively reduce the visual impact of the Project.

6.3.5 Assessment of Impacts

6.3.5.1 Introduction

The following subsections present an overview of the visual amenity and visibility impact assessment methodology and results. In particular, the following subsections identify those areas surrounding the Project Site from where an observer could potentially see Project-related activities. In addition, a range of photographs were used to create photomontages from vantage points on private and public land are provided, as well as a summary of the assessment of night-time impacts prepared by LAAS (2021).

6.3.5.2 Seen Area Analysis

Visibility tools of ArcGIS were used to assess the areas surrounding the Project Site that, in the absence of vegetation or other factors, could potentially have daytime views of the SAR Waste Rock Emplacement. That analysis took into consideration the following.

- Topographic and point cloud data from LiDAR surveys for the area surrounding the Project Site was downloaded from the ELVIS data portal on 20/12/2010 and 22/03/2011 in a digital elevation model with 5m resolution.
- Topographic data within the Project Site was captured as part of a site survey on 19/01/2021 and incorporated to account for mining-related changes within the Project Area since 2012.
- The datasets were mosaiced and converted into a digital surface model which represents the surface elevation with vegetation cover and building structures in 3D format.
- Details of the approved and proposed Project Site layout and final landform were then embedded into the digital surface model which was then converted into the format required for analysis using ArcGIS.

- Areas that have a potential view of the uppermost section of the SAR Waste Rock Emplacement were then identified.

This assessment methodology is likely to overestimate visual amenity and visibility impacts for the following reasons.

- Vegetation, particularly mature vegetation associated with road reserves, tree lines and visual screens will tend to obscure distant objects in a largely flat landscape such as that surrounding the Project Site.
- This assessment methodology does not account for distance from the proposed SAR Waste Rock Emplacement. For example, while a location 4km from the peak of the proposed SAR Waste Rock Emplacement may occur within the "seen area", the Waste Rock Emplacement itself, at approximately 70m high, would occupy only 1º of an observer's vertical field of view at that distance.

Figure 6.3.3 presents the areas surrounding the Project Site that may have views of the uppermost section of the SAR Waste Rock Emplacement. In summary, substantial areas surrounding the Project Site would potentially have views of the Waste Rock Emplacement.

6.3.5.3 Daytime Visual Analysis

Assessment Locations

In undertaking the daytime visual analysis, the existing visual amenity of the land surrounding the Project Site was assessed by RWC following an extensive inspection of the local area during which observations were made from the public road network and all private properties and residences sharing a boundary with the SAR Mine Site.

In addition, during community consultation (see Section 5.2.2) with all residents surrounding the SAR Mine Site, RWC was able to establish particular concerns and sensitivities in relation to which sections of the SAR Mine Site would be directly visible, partially visible or not visible from key residences and areas of private land.

As a result, eight viewing locations, three from private land and five from the publicly accessible vantage points were selected for detailed visual analysis (**Figure 6.3.3** and **Table 6.3.1**).

Assessment Methodology

A series of photographs were taken from each assessment location using an SLR Camera with a focal length of approximately 50mm. A 50mm focal length captures images representative of that perceived by the human eye. The photographs taken typically covered a field of view of approximately 180º, with approximately 50% overlap between each photograph. The photographs from each assessment location were then stitched together using Photoshop software. The precise location and the field of view of stitched photographs of each assessment location were determined by field survey using a hand-held GPS and/or high-resolution aerial photograph interpretation.

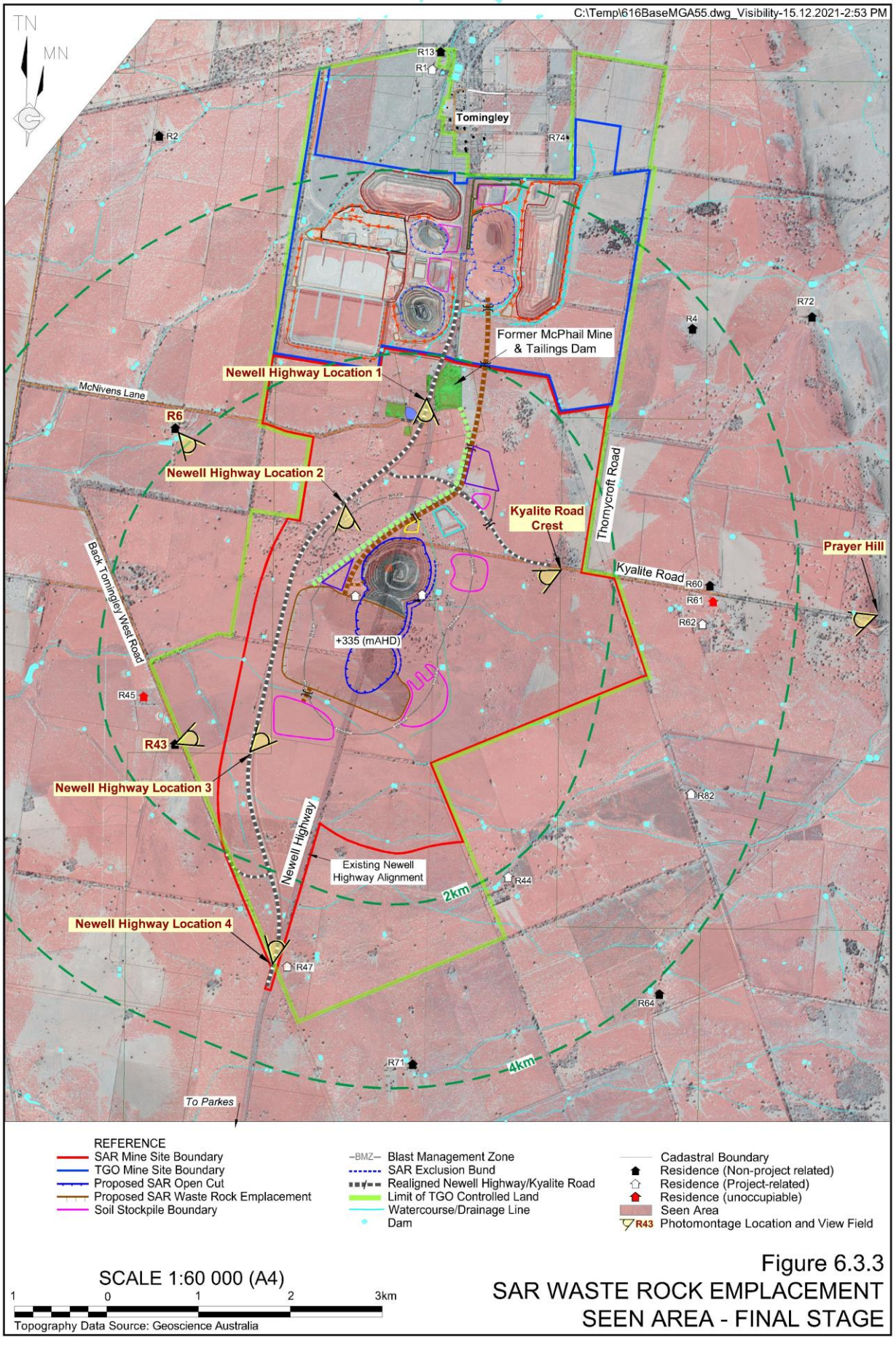


Figure 6.3.3
SAR WASTE ROCK EMPLACEMENT
SEEN AREA - FINAL STAGE

Table 6.3.1
Visual Impact Assessment Receptors Locations

Receptor	Description and Significance	View Aspect for Impact Assessment
R6	Residence with existing views to the southeast across the SAR Mine Site towards the Herveys Range. The residents advised that views of the Ranges from their kitchen window are important to them. The photographs used to create the photomontage were taken from outside the kitchen window.	Southeast
R43	Residence with existing views to the northeast and east across the SAR Mine Site towards the Herveys Range. The resident advised that views of the Ranges from the front veranda are important to them. The SAR Waste Rock Emplacement would not be visible from that location, or anywhere else within the residence. As a result, the photographs used to create the photomontage were taken from the gate onto Back Tomingley West Road.	Northeast
Prayer Hill	This location was identified as a significant location within private land by the residents of Residences 60, 63 and 70. The photographs used to create the photomontage were taken from a position on the ridgeline approximately 100m south of the most elevated position because mature eucalypts located on the western slopes of the hill obscured views of the SAR Mine Site from most of the ridgeline.	West-southwest
Newell Highway 1	This location is representative of the northern section of the proposed realigned Newell Highway. Road users, and drivers of south-bound vehicles in particular, would have views straight ahead of the SAR Waste Rock Emplacement.	South
Newell Highway 2	This location is representative of the central section of the proposed realigned Newell Highway closest to the SAR Waste Rock Emplacement and Amenity Bund. Road users, and drivers of south-bound vehicles in particular, would have views as 45º angle of the SAR Waste Rock Emplacement.	South southeast
Newell Highway 3	This location is representative of the central section of the proposed realigned Newell Highway closest to the SAR Waste Rock Emplacement. Road users, and drivers of north-bound vehicles in particular, would have views as 45º angle of the SAR Waste Rock Emplacement.	North northeast
Newell Highway 4	This location is representative of the southern section of the proposed realigned Newell Highway. Road users, and drivers of north-bound vehicles in particular, would have views straight ahead of the SAR Waste Rock Emplacement.	North
Kyalite Road Crest	This location is a crest on Kyalite Road immediately west of the intersection with Thornycroft Road. Roadside vegetation obscured views of the SAR Mine Site from the road. As a result, photographs used to create the photomontage were taken from adjacent to the southern boundary of the road reserve.	Southwest

A 3D model of the Project Site was also established using the previously described topographic data, with embedded proposed Project Site infrastructure components incorporated in AutoCAD Civil 3D software. Two designs for the SAR Waste Rock Emplacement were incorporated into the model, namely the anticipated design at the end of Scenario 3 in June 2025 before the commencement of in-pit waste rock placement in the SAR Open Cut South and Central Pits (see Section 3.5.4.3) and at the end of Project life. That model was then manipulated in the form of perspective views in ArcScene software to achieve a viewpoint 2m above the ground surface at each of the assessment locations.

The photomontage and 3D model images were then overlayed using a minimum of three features in both images. In particular features such as trees, power poles and buildings with known heights were incorporated into the 3D model and these were used to ensure accurate correlation between the photomontage and the 3D model. In one case, a photomontage from Residence 64, an absence of identifiable features in the foreground prevented correlation of the photomontage and 3D model and that assessment location was not considered further.

Once the adequate correlation between individual photomontages and the 3D model had been established, the extents of the Scenario 3 and final SAR Waste Rock Emplacement were digitally added to the photomontages using Photoshop. The images were rendered using features from other sections of the photomontages or images from the Peak Hill Gold Mine rehabilitated Waste Rock Emplacement.

This assessment methodology provides a robust and defensible assessment of the anticipated views of the proposed Scenario 3 and the final landform. It is, however, acknowledged that the following limitations with this methodology exist.

- The final landform may not achieve vegetation cover exactly like the surrounding land and may therefore be more obvious or have a greater visual contrast that that shown.
- The size and bulk of the proposed SAR Waste Rock Emplacement presented is a function of the accuracy of the correlation of the photomontage and the 3D model. It is possible that the final SAR Waste Rock Emplacement may be slightly larger or smaller than that shown.

Assessment Results

Residence R6

Figures 6.3.4 and **6.3.5** present views to the southeast from outside the kitchen window of Residence R6.

Existing views are dominated by native and non-native vegetation and agricultural areas. In the medium distance, traffic using the Newell Highway is visible. The Herveys Range are a prominent feature of the skyline. The residents of Residence R6 maintain vegetation in the vicinity of the residence to maintain their views of the ranges.

The SAR Waste Rock Emplacement under Scenario 3 would largely not be visible, with intervening vegetation obscuring the emplacement. The final landform would, however, be visible from this location, with the southern section of the Herveys Range obscured.

Vehicles using the realigned Newell Highway would continue to be visible from Residence R6, albeit at a distance of approximately 1 800m or approximately 740m closer than is currently the case.

The Applicant has planted vegetation along the property boundary between this property and its own land which will in time further obscure views of the SAR Mine Site.

The Applicant presented the results of the visual assessment to the residents of Residence R6 who expressed satisfaction with the assessment. The Applicant has committed to work with the residents to manage vegetation screens including on the residents' land to minimise Project-related visual amenity impacts.

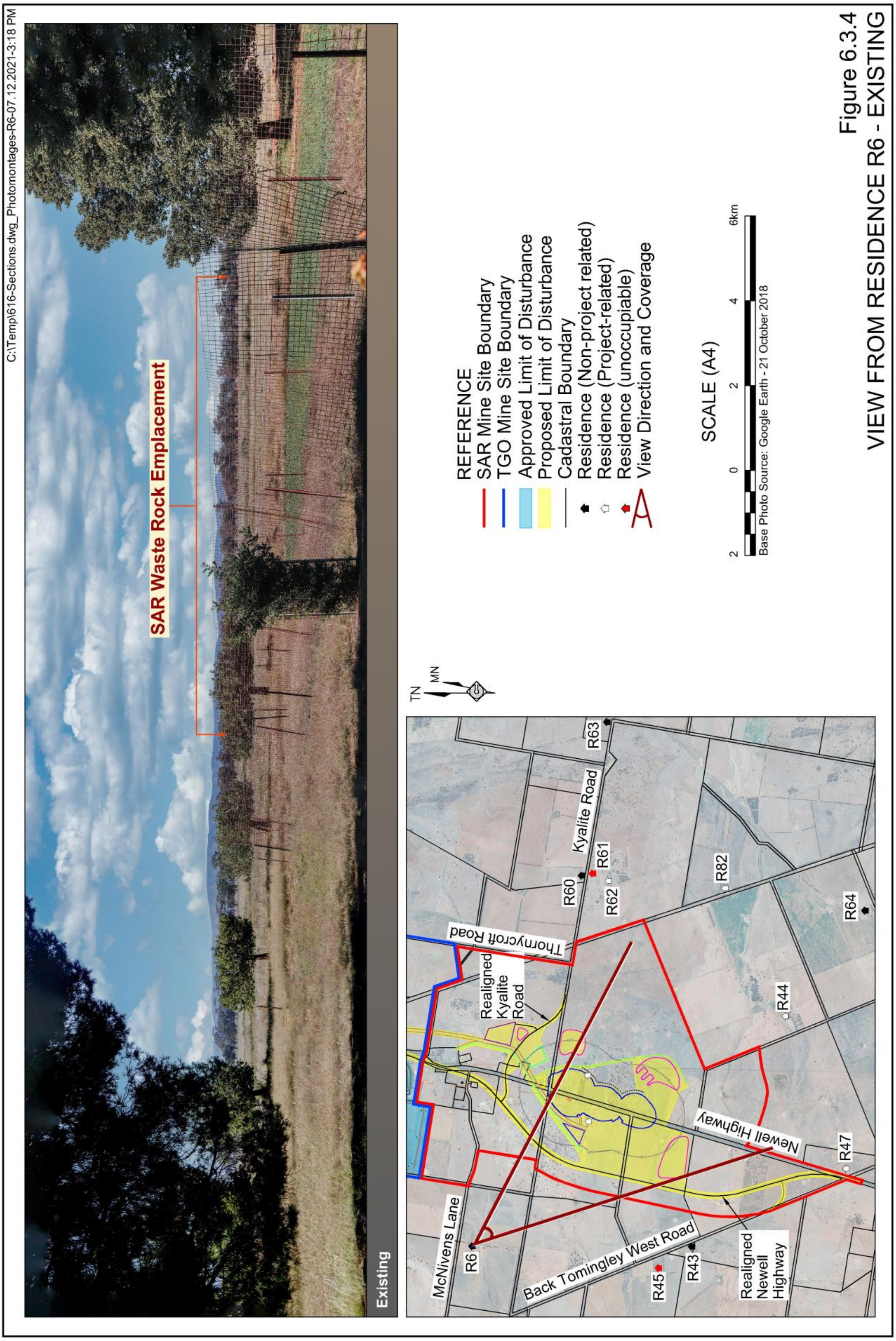


Figure 6.3.4
VIEW FROM RESIDENCE R6 - EXISTING

Figure 6.3.5
VIEW FROM RESIDENCE R6 - SCENARIO 3 AND POST MINING

Residence R43

Figures 6.3.6 and **6.3.7** present views to the northeast from the access gate from Back Tomingley West Road to Residence R43. The resident advised that their primary concern was views from the front veranda. As views of the SAR Waste Rock Emplacement from the veranda would be blocked by established vegetation adjacent to the residence and within the Back Tomingley West Road reserve, an alternative location was selected.

Existing views from the front gate are dominated by agricultural areas with scattered native vegetation. In the medium distance, traffic using the Newell Highway is visible. The Herveys Range is a prominent feature of the skyline.

The SAR Waste Rock Emplacement under Scenario 3 would obscure the northern section of the Herveys Range, with the final landform further obscuring the ranges.

Vehicles using the realigned Newell Highway would continue to be visible, albeit at a distance of approximately 800m, or approximately 900m closer than is currently the case. It is noted that the residence itself is set back from Back Tomingley West Road and the existing and proposed Newell Highway are not visible from the residence.

The Applicant presented the results of the visual assessment to the resident of Residence R43 who expressed satisfaction with the assessment. The Applicant proposes to establish additional vegetation within its own land adjacent to Back Tomingley West Road to ensure that visual amenity is not adversely impacted in the event of the death or removal of existing vegetation adjacent to Residence R43 or within the Back Tomingley West Road reserve.

Prayer Hill

Figures 6.3.8 and **6.3.9** present views to the southwest from a location referred to by residents of Residences R60, 63 and 70 as "Prayer Hill." The location was selected by the residents as a significant site for their family.

Existing views are dominated by established native vegetation in the foreground, with mature eucalypts obscuring views of the SAR Mine Site from many locations on the ridgeline. In the middle distance, views are dominated by native vegetation associated with Kyalite Road, as well as agricultural fields. Distant views are dominated by the flat plains associated with the Bogan River and associated native vegetation and agricultural lands.

The SAR Waste Rock Emplacement under Scenario 3 would be visible from a distance but would not obscure the skyline because of the elevated location of "Prayer Hill." It is noted that the eastern face of the SAR Waste Rock Emplacement prior to the completion of backfilling of the SAR Open Cut South and Central Pits would be grey coloured rock, with this face not available for shaping and final rehabilitation operations until the pits are backfilled.

The final landform would be visible from "Prayer Hill" but would not obscure the skyline.

The Applicant presented the results of the visual assessment to the resident of Residence R60 who expressed satisfaction with the assessment.

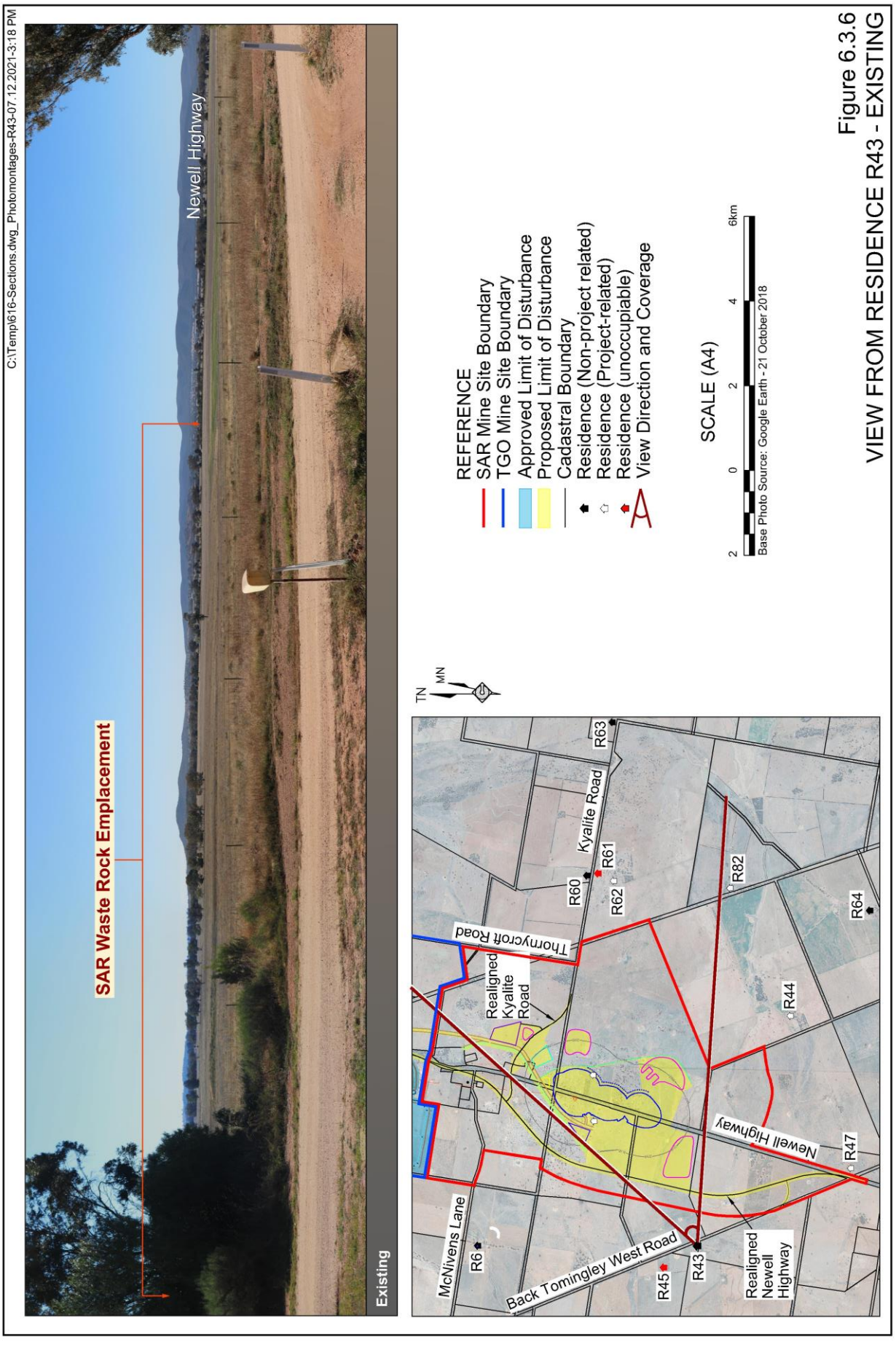


Figure 6.3.6
VIEW FROM RESIDENCE R43 - EXISTING

Figure 6.3.7
VIEW FROM RESIDENCE R43 - SCENARIO 3 AND POST MINING

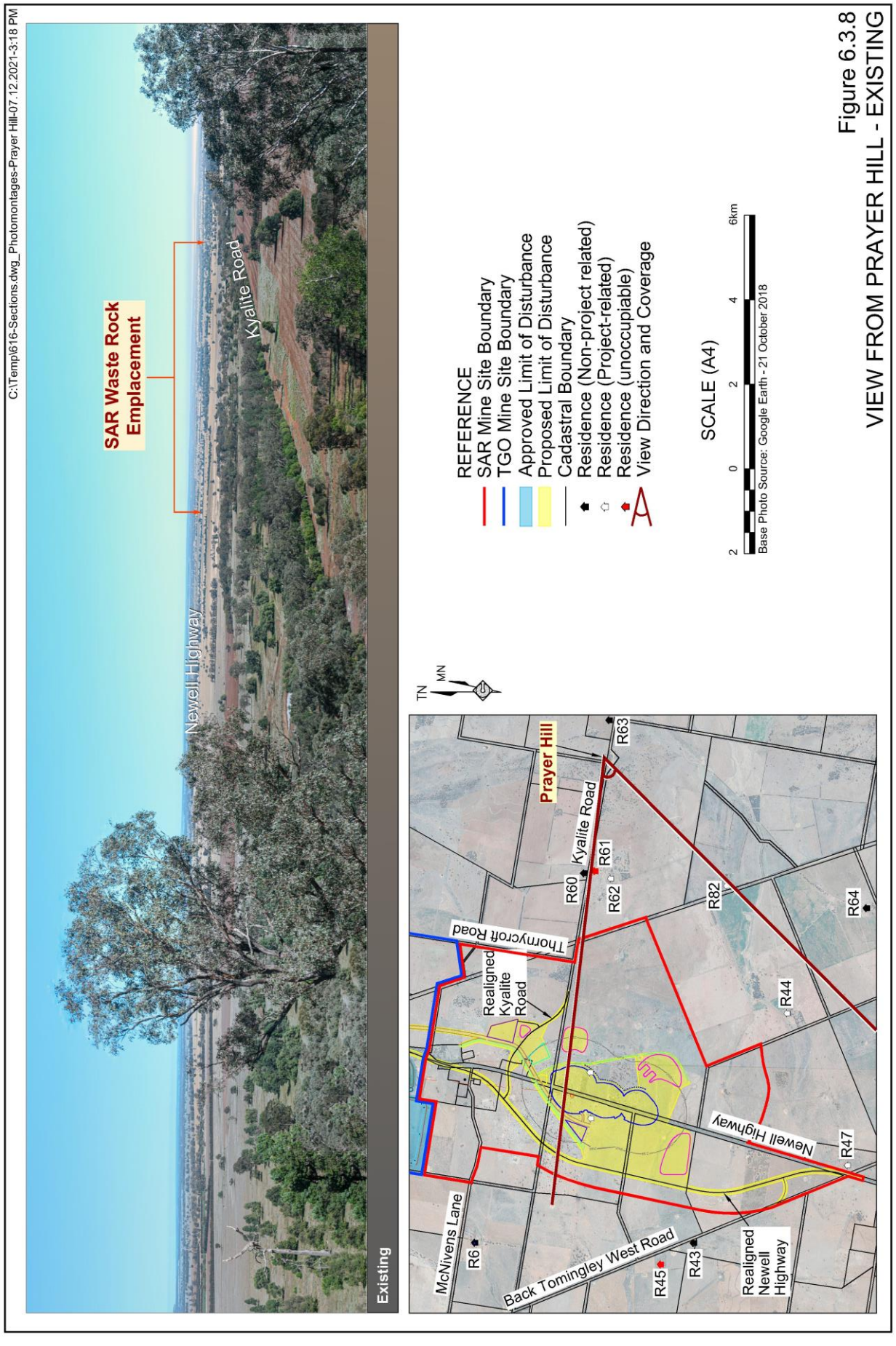


Figure 6.3.8
VIEW FROM PRAYER HILL - EXISTING

Figure 6.3.9
VIEW FROM PRAYER HILL - SCENARIO 3 AND POST MINING

Newell Highway

Figures 6.3.10 to **6.3.17** present views of the SAR Mine Site from the realigned Newell Highway.

Existing views are dominated by a mixture of native vegetation and agricultural fields. Where gaps in the roadside vegetation exist, distant views of the Herveys Range to the east are available.

The SAR Waste Rock Emplacement would be visible for drivers and their passengers from the Highway. Distant views from approximately 3km away would be available in the drivers' line of sight, i.e. straight ahead. Closer views would be available to the side as vehicles approach and pass by the Waste Rock Emplacement.

As described in Section 3.6.5, the Applicant would construct the outer face of the SAR Waste Rock Emplacement during daylight hours initially in approximately 10m lifts, with each lift being shaped, topsoiled and revegetated progressively. As a result, drivers and their passengers would only see mobile plant operating on the Waste Rock Emplacement during construction, shaping and rehabilitation operations. The remainder of the time, the emplacement would simply be a static landform in the landscape. The Applicant contends that the impacts of the proposed landform would not adversely impact on the visual amenity nor provide a distraction to drivers that is any greater than existing distractions, including agricultural machinery operating in paddocks.

In addition, **Figures 6.3.12** and **6.3.13** present views of the SAR Mine Site, including the SAR Amenity Bund. By comparing the existing and proposed views, it can be seen that existing agricultural buildings, which are approximately the same height as the largest mobile plant likely to be used, would no longer be visible once the SAR Amenity Bund has been constructed. As a result, the Applicant contends that the SAR Amenity Bund would prevent views from the Newell Highway of mobile plant using the Haul Road, as well as other ground-level activities within the SAR Mine Site.

Kyalite Road Crest

Figures 6.3.18 and **6.3.19** present views of the SAR Mine Site from the crest on the existing Kyalite Road immediately to the west of the intersection with Thornycroft Road. It is noted that the photomontages were prepared from photographs taken from the southern boundary of the road reserve as roadside vegetation prevented views of the SAR Mine Site from the road itself.

Existing views are dominated by agricultural fields with scattered native vegetation and distant vegetated areas, including vegetation to the east of the SAR Waste Rock Emplacement and vegetation within the Newell Highway road reserve.

The Scenario 3 SAR Waste Rock Emplacement would be largely obscured by existing vegetation. As noted previously, the eastern face of the Waste Rock Emplacement would be grey coloured rock prior. As a result of the dark colour of the emplacement, it would be likely to blend in with vegetation between the emplacement and Kyalite Road.

The final landform would be visible from Kyalite Road and would obscure the skyline. However, as noted previously, drivers or their passengers using Kyalite Road would be unlikely to see the SAR Waste Rock Emplacement as a result of intervening roadside vegetation.

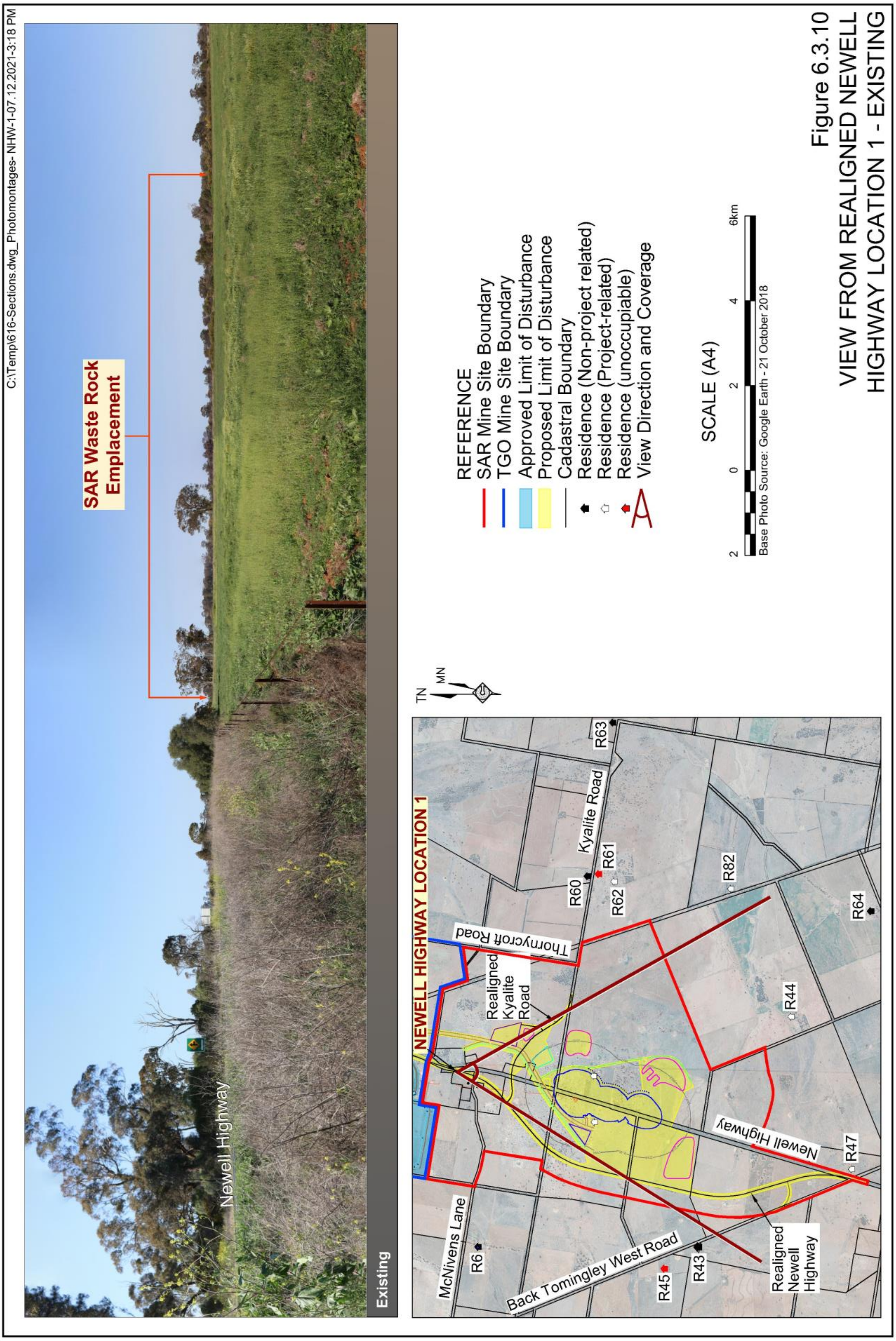


Figure 6.3.10
VIEW FROM REALIGNED NEWELL HIGHWAY LOCATION 1 - EXISTING

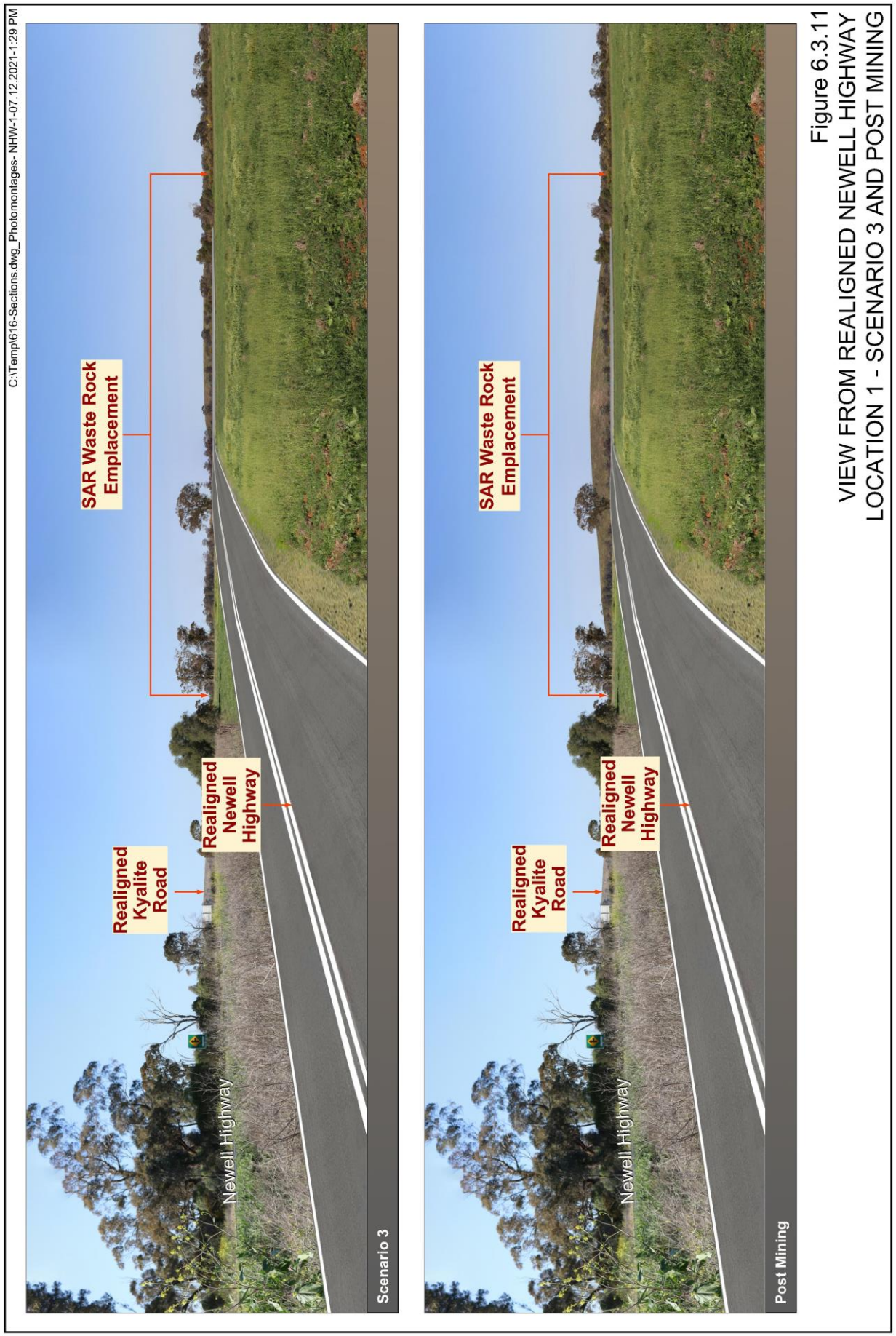


Figure 6.3.11
VIEW FROM REALIGNED NEWELL HIGHWAY
LOCATION 1 - SCENARIO 3 AND POST MINING

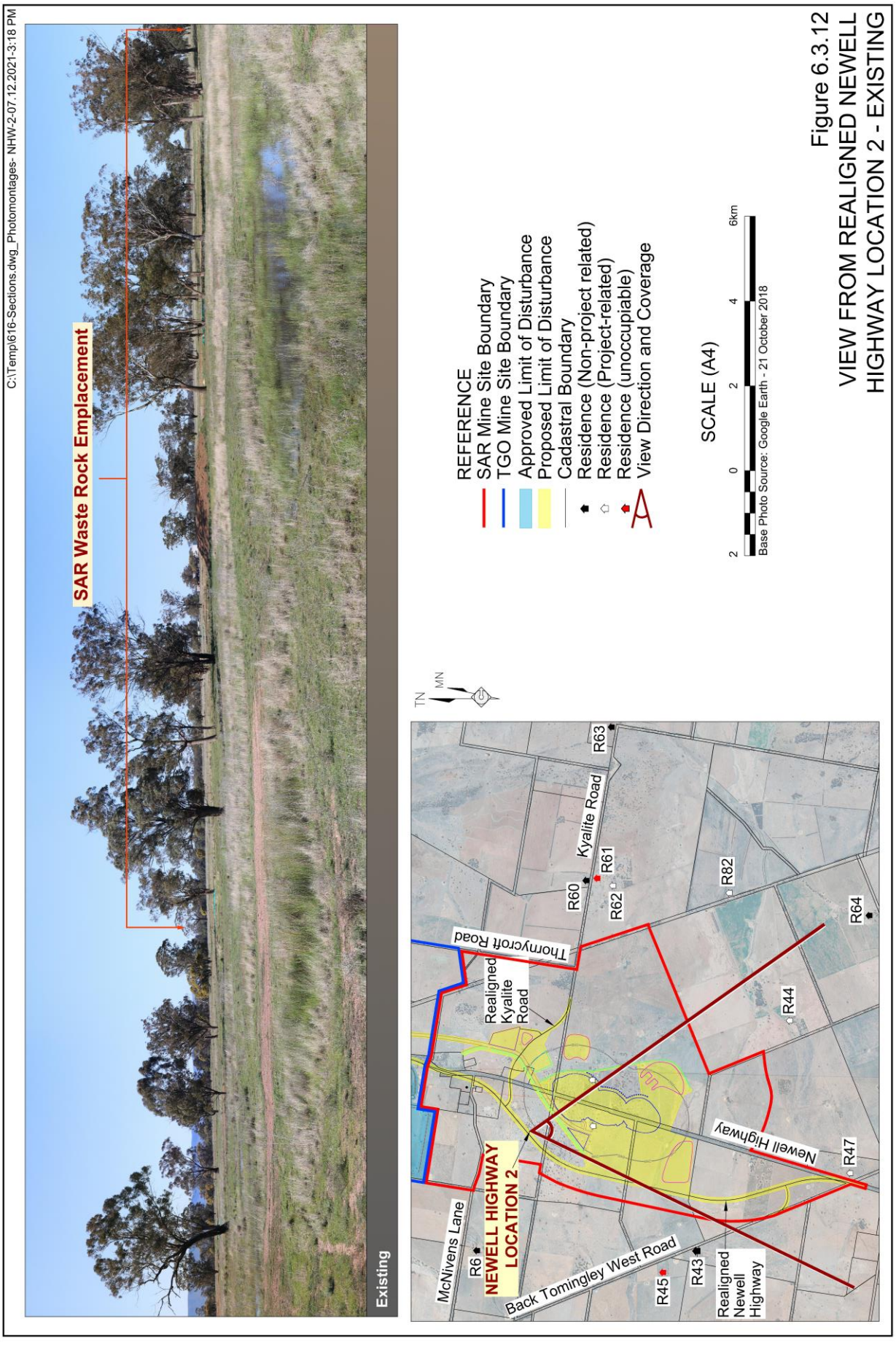


Figure 6.3.12
VIEW FROM REALIGNED NEWELL HIGHWAY LOCATION 2 - EXISTING

Figure 6.3.13
VIEW FROM REALIGNED NEWELL HIGHWAY
LOCATION 2 - SCENARIO 3 AND POST MINING

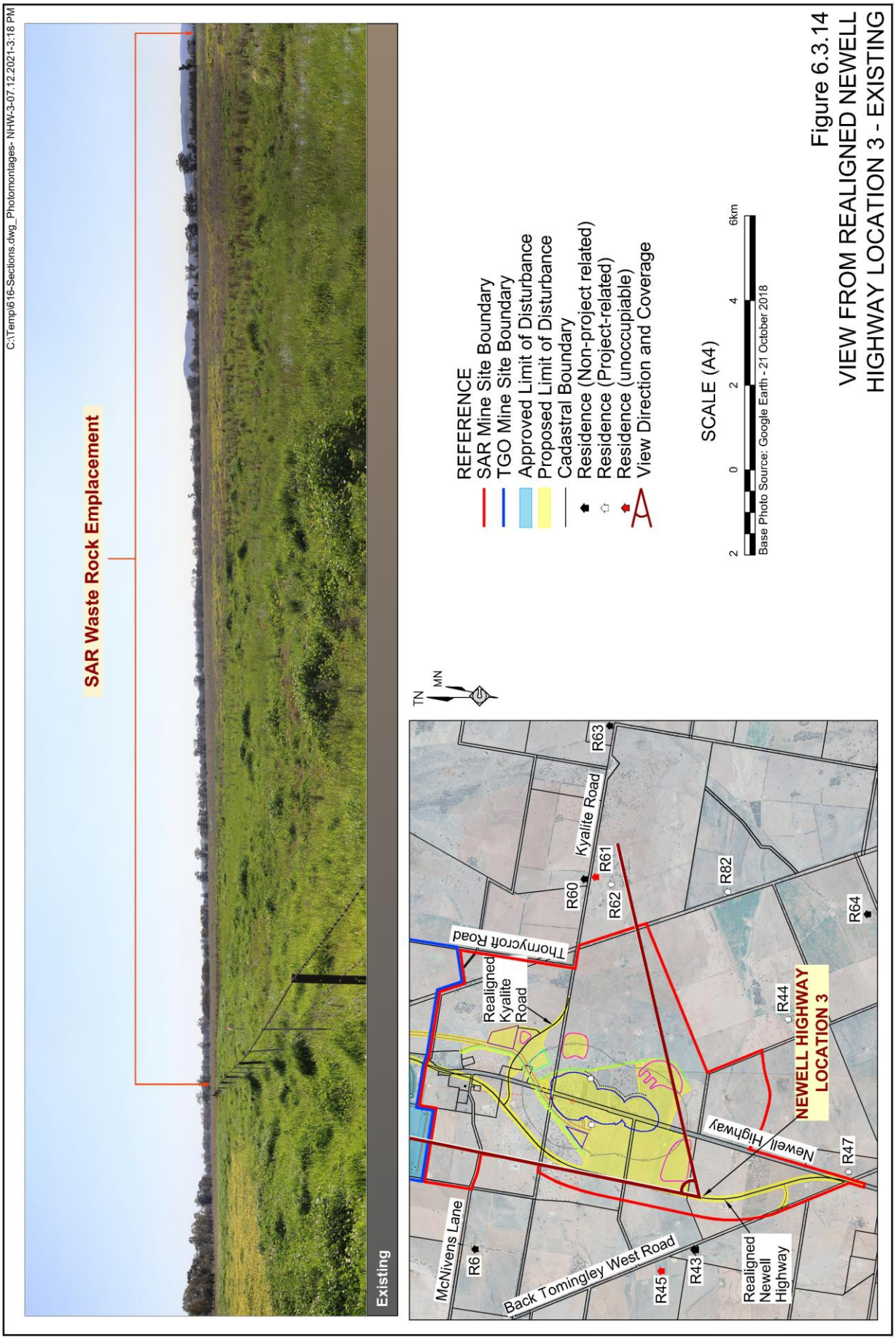


Figure 6.3.14
VIEW FROM REALIGNED NEWELL HIGHWAY LOCATION 3 - EXISTING

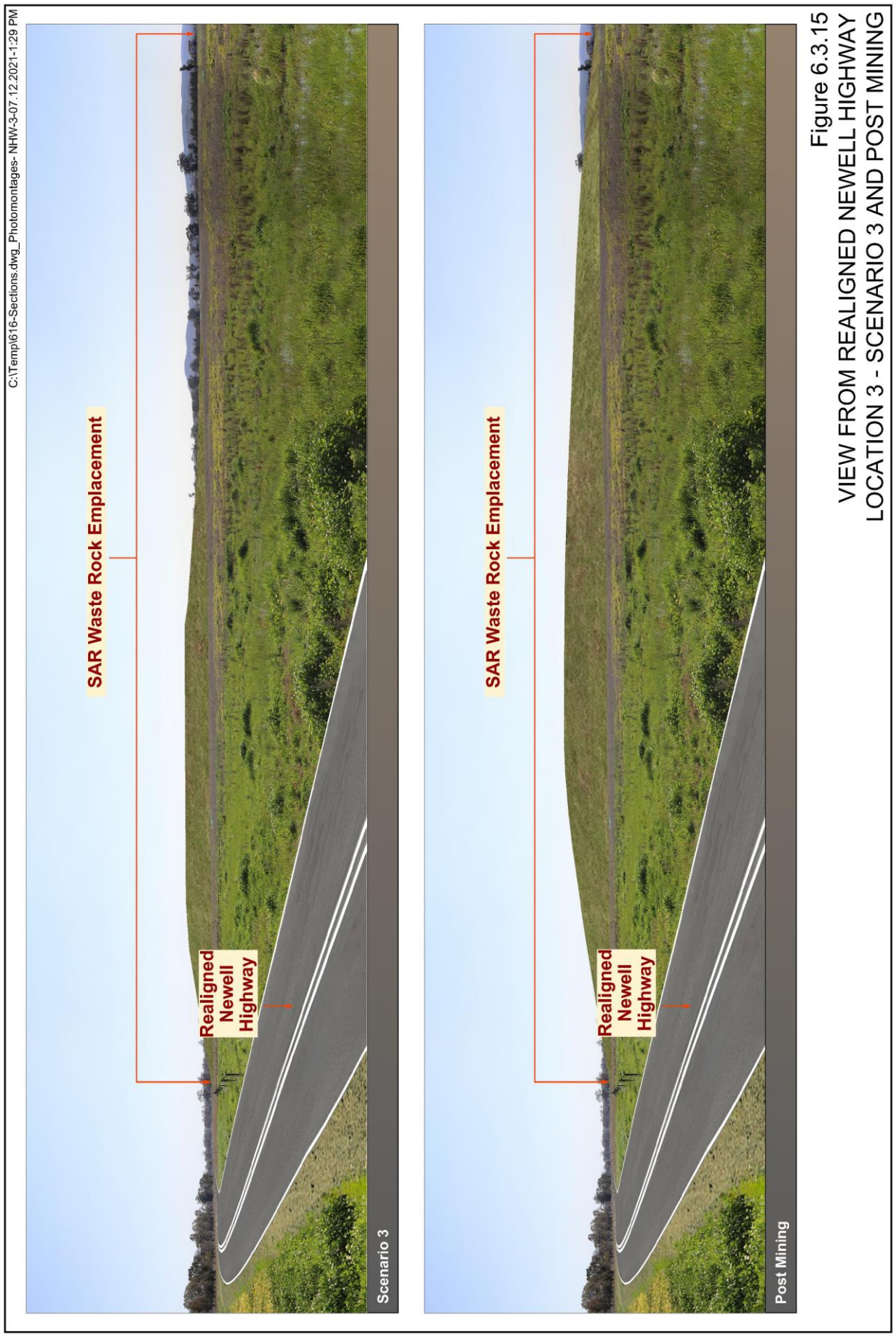
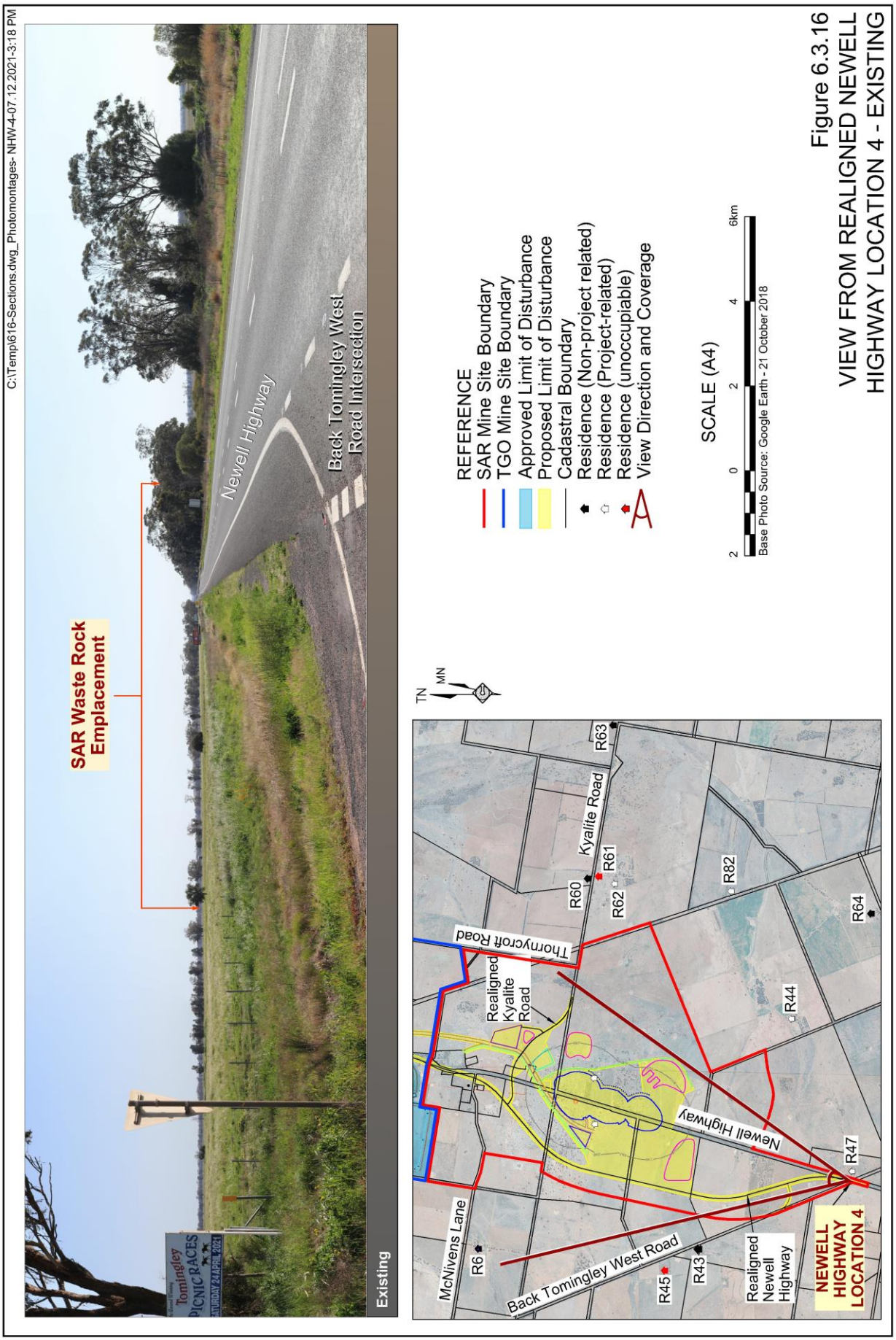


Figure 6.3.15
VIEW FROM REALIGNED NEWELL HIGHWAY
LOCATION 3 - SCENARIO 3 AND POST MINING


C:\Temp\616-Sections.dwg_Photomontages- NHW4-07.12.2021-3:18 PM
SAR Waste Rock Emplacement
Newell Highway
Back Tomingley West Road Intersection
Existing
Tomingley PICNIC RACES
SATURDAY 24 APRIL 2021
TN
MN
R63
Kyalite Road
R61
R60
R62
R82
R64
Thornycroft Road
Realigned Kyalite Road
R44
Newell Highway
R47
McNivens Lane
R6
Back Tomingley West Road
R45
R43
Realigned Newell Highway
NEWELL HIGHWAY LOCATION 4
REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
Approved Limit of Disturbance
Proposed Limit of Disturbance
Cadastral Boundary
Residence (Non-project related)
Residence (Project-related)
Residence (unoccupiable)
View Direction and Coverage
A
SCALE (A4)
2 0 2 4 6km
Base Photo Source: Google Earth - 21 October 2018
Figure 6.3.16
VIEW FROM REALIGNED NEWELL HIGHWAY LOCATION 4 - EXISTING

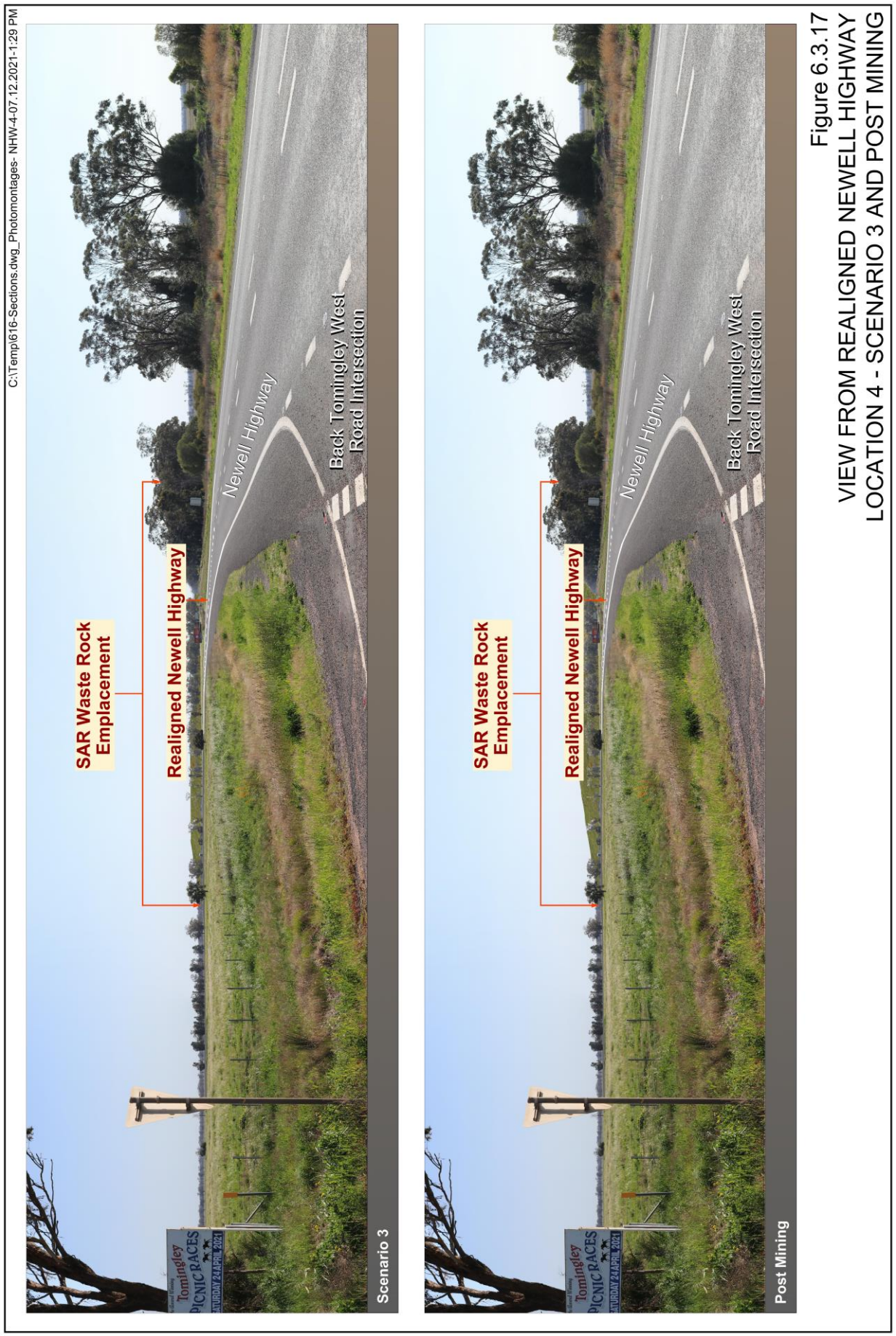


Figure 6.3.17
VIEW FROM REALIGNED NEWELL HIGHWAY
LOCATION 4 - SCENARIO 3 AND POST MINING

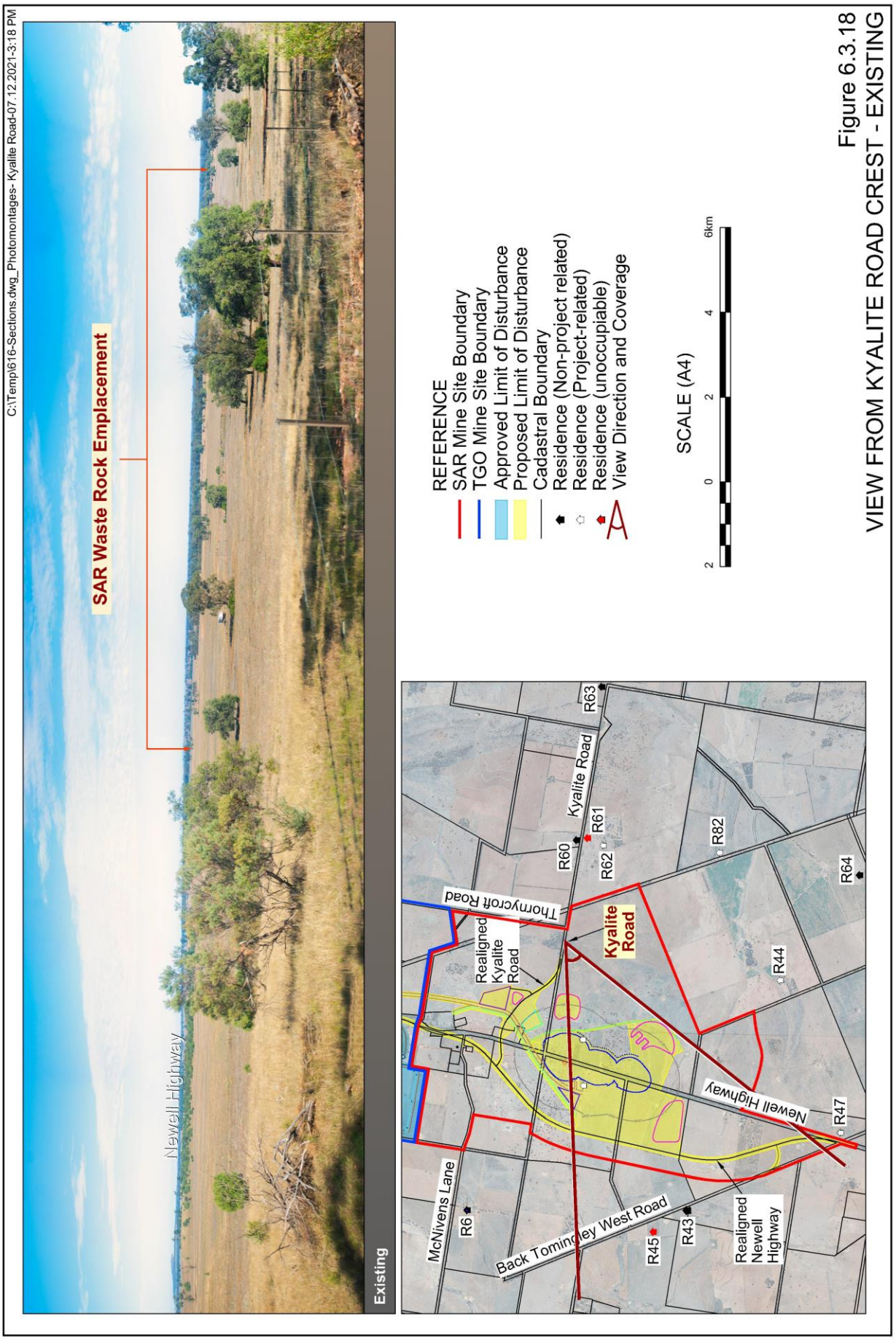


Figure 6.3.18
VIEW FROM KYALITE ROAD CREST - EXISTING

Figure 6.3.19
VIEW FROM KYALITE ROAD CREST - SCENARIO 3 AND POST MINING

Views of the SAR Mine Site would be available from the realigned section of Kyalite Road until roadside vegetation becomes established. In particular, views would be available for drivers and passengers using the Kyalite Road overpass. However, the Applicant would establish a visual screen similar to the visual screen on the Newell Highway underpass.

In assessing the visual amenity and visibility-related impacts, distinction is made between changes to the existing view compositions and character from selected sensitive locations and those where changes in the local landscape may provide a distraction to users of the road network.

View Compositions

With the adoption of the mitigation measures outlined in Section 6.3.4, the extent of visual impacts can be ascertained for each of the assessment locations both during and after the Project life. In summary, the construction of the SAR Waste Rock Emplacement would represent the most significant change to the existing views of the local area. Direct views of less substantial infrastructure and landscape elements within the SAR Mine Site would largely be reduced or prevented due to either low viewing angles, existing vegetation or the SAR Amenity Bund.

The proposed progressive rehabilitation of the SAR Waste Rock Emplacement would substantially reduce visual impacts when compared with an unrehabilitated Waste Rock Emplacement.

In light of the above, the Applicant contends that the Project would mitigate the inevitable change in view composition as a result of construction of the SAR Waste Rock Emplacement to the maximum extent possible. As a result, and in consideration of discussions held with all surrounding residents, the Applicant contends that the proposed changes to view compositions surrounding the SAR Mine Site are acceptable.

Finally, the Applicant contends that construction of Stages 3 to 9 of Residue Storage Facility 2 would merely extend aspects of the existing view composition from locations to the south and west of the TGO Mine Site and that such impacts would be negligible.

Driver Distraction

The principal risk for driver distraction would be during the early stages of construction during land clearing and preparation activities within the SAR Mine Site prior to the construction of the SAR Amenity Bund and the first stages of the SAR Waste Rock Emplacement. While driver distraction is a serious risk, the proposed road construction activities are considered unlikely to be a novel activity for most users of the local road network and therefore are unlikely to require specific management and mitigation measures.

The proposed site development and construction activities within the SAR Mine Site similarly represent operations that already occur within the TGO Mine Site. Notwithstanding the above, the proposed scheduling of site development activities (i.e. the construction of visual amenity barriers and the planting of vegetation screens) has been designed in consideration of the requirement for visual impact mitigation.

Scenic Character and Quality

There would be a high level of change to the scenic character of the SAR Mine Site as a result of the removal of vegetation, the development of the SAR Open Cut and the progressive construction of other landforms. Whilst it is planned to construct the SAR Waste Rock Emplacement with a more natural appearance compared to the existing Waste Rock

Emplacements 2 and 3, it would retain a manufactured and engineered structure in a natural landscape. The Applicant contends, however, that the change in scenic character and quality would be small in the context of the sub-regional and regional landscapes and the scale of the existing TGO operations.

Post-Project Views

The approach by the Applicant in designing the final SAR Waste Rock Emplacement landform and its revegetation would achieve an acceptable long-term impact. Other SAR Mine Site infrastructure would largely not be visible from outside the SAR Mine Site.

6.3.5.4 Night-time Visual Analysis

Introduction

LAAS prepared the *Light and Sky Glow Assessment* for the Project. That report is presented as Part 2 of the *Specialist Consultant Studies Compendium* and is hereafter referred to as LAAS (2021). The assessment primarily focused on Project-related impacts on the night-time observational operations of the Siding Spring Observatory, together with compliance with relevant lighting criteria at surrounding residences. As mining operations within the TGO Mine Site are an approved activity, LAAS (2021) assessed the impacts of additional lighting associated with proposed activities within the SAR Mine Site. The assessment was prepared in accordance with the Lighting Standard.

The assessment of lighting impacts under the Lighting Standard is based upon the classification of a given area into one of more of 11 different 'Environmental Zones', with each Zone having specific lighting impact criteria levels. Tables 1 and 2 of LAAS (2021) present the Environmental Zones and associated maximum impact criteria (respectively) of the Lighting Standard. In summary, the Project Site and surrounding area (excluding Tomingley village) is classified as an A2 Environmental Zone under the Lighting Standard. This area comprising of sparsely inhabited rural and semi-rural areas. Lighting criteria under the Lighting Standard includes a 'curfew' period between the hours of 11pm and 6am where lower limits are set.

Light and Sky Glow Modelling Methodology

The potential light and sky glow impacts of the Project were modelled by LAAS (2021) using AGi32 Version 20.4 software.

The lighting model developed by LAAS (2021) was based on the following assumptions.

- The operational surfaces of the Caloma and SAR Waste Rock Emplacements would be lit using mobile lighting towers with a maximum height of 7.5m.
- A maximum of 10 mobile lighting towers would be in use at any given time within the operational areas of the Project Site.
- The direction of the mobile lighting towers would be facing towards the centre of the operational surface of the waste rock emplacements or into the open cut wall.
- The beam width and degree of upcast would vary depending on the setup and position of the mobile lighting towers and the respective light fittings.

- The operational surface of the Caloma and SAR Waste Rock Emplacements would rise progressively, with a maximum height of 38m[4] and 70m, respectively.
- The outer Waste Rock Emplacement amenity bund walls were **not** included in the model to allow for a conservative 'maximum impact' scenario to be assessed.

The lighting model assessed the following criteria.

- Illuminance – the amount of light that falls on a surface or plane, measured in Lux. Illuminance decreases proportionally to the square of the distance between two points, and therefore rapidly declines with increasing distance.
- Luminous Intensity – the amount of luminous flux leaving the light source in a given direction, measured as Lumens.
- Upward Light Ratio - the proportion of the flux of a light fitting and/or installation that is emitted at or above the horizontal, excluding reflected light.
- Threshold Increment – the measure of the disability glare caused by lighting to road users outside of the Project Site.
- Reflectance - the proportion of light that is reflected, transmitted or absorbed by a surface.
- Sky glow - the brightening of the night sky that results from the reflection of radiation (visible and non-visible), scattered by the air in the direction of observation. It comprises two separate components.
  - Natural sky-glow - that part of the sky-glow which is attributable to radiation from celestial sources and luminescent processes in the Earth's upper atmosphere.
  - Man-made sky-glow - that part of the sky-glow which is attributable to man-made sources of light (e.g. artificial outdoor lighting), including light that is emitted directly upwards and light that is reflected from surfaces.

The effect of the elevation on the potential impact of the mobile lighting towers was also modelled by LAAS (2021). The Caloma and SAR WREs were each modelled at four different heights ranging from 0m to 40m[4] and 0m to 70m, respectively. Further information on the approach used in the lighting model is provided in Section 6.6 of LAAS (2021).

In accordance with the Lighting Standard, the maximum total Upward Light Ratio for the lighting of the Project Site within an A2 Environmental Zone is 1% of the total light emitted. The Upward Light Ratio used by LAAS (2021) was based on the existing and proposed lighting environment of the Project Site.

The potential impacts of the Project on the relevant astronomical observatories was assessed by LAAS (2021) by calculating the expected total increase in sky glow from the Project Site. This was calculated based on the modelled Project lighting environment, including the Upward Light Ratio and reflectance values of the material within the SAR Mine Site.

[4] At the time of assessment, the Caloma WRE was anticipated to reach a maximum height of approximately 38m above the natural ground level, compared to the currently proposed maximum height of 2m to 3m above the natural ground surface. As a result, the light and sky glow modelling is likely to overestimate Project-related impacts.

LAAS (2021) states that for the purposes of the assessment of the potential impacts of the Project on the Siding Spring Observatory, only the significant fixed lighting that would be installed within the SAR Administration Area and the proposed extension to the TGO Processing Plant has been assessed. The potential influence of the mine-related mobile plant have been excluded based on the following.

- The impacts of the existing vehicle fleet were assessed as part of the original assessment for the TGO Mine Site and are already approved.
- All vehicles would be fitted with standard headlights and light fittings.
- From the Siding Spring Observatory, the influence of the Project-related vehicles on the total sky glow would be indistinguishable from that of the existing non-Project related vehicles on the nearby Newell Highway.

Table 6.3.2 presents the total additional Total Flux that would be emitted from the Project Site.

The inherent properties of waste rock and ore can influence the degree of reflectance of the material in question and therefore the overall amount of light that would be reflected into the sky. Based on analysis of drill core samples, LAAS (2021) states that the average reflectance value of material from the proposed SAR Mine Site is 0.37.

Table 6.3.2
Anticipated Additional Project-related Lighting

Light Source	Quantity	Wattage	Luminous Flux (lumens)[1]	Total Flux (lumens)
Existing Assessed Source				
Mobile Lighting Towers	10	2 400	336 000	3 360 000
Additional Source to be Assessed				
SAR Mine Site Administration Area				
Small Area Lights	4	70	14 000	56 000
Large Area Lights	4	400	56 000	224 000
External Fixed Lighting	10	150	21 000	210 000
TGO Mine Site Mill Extension				
External Fixed Lighting	20	17	2 380	47 600
Total Additional Flux				537 600
Note 1: Total values are used where multiple light fittings would be installed on a single light tower or source.				
Source: LAAS (2021) – modified after Table 5				

Light and Sky Glow Modelling Results

Impact on Observatories

Table 6.3.3 presents the predicted total Project-related increase in sky glow. These results are based on the assumption that all lighting to be used as part of the Project would either be pre-existing or would be designed in consideration with the relevant requirements of Lighting Standard. In summary, LAAS (2021) states that the Project would have no significant light or sky glow impacts on the surrounding environment, including Siding Spring Observatory.

Table 6.3.3
Project-related Increased Sky Glow

Project Lighting Characteristic	Total Flux (lumens)
Increased Total Flux from Project Site	537 600
Maximum Upward Light Ratio Flux (1% of Total Flux)[1]	5 376
Maximum Reflectance of SAR Mine Site Material (approximately 37% of Total Flux)[2]	196 922
Total Upward Lumens	202 300
Note 1: Maximum Flux emitted for lighting within A2 Environmental Zone where lighting is in accordance with *AS/NZS4282:2019*. Note 2: Arithmetic differences due to rounding	
Source: LAAS (2021) – modified after Table 5 and Section 6.5	

The results of the Light and Sky Glow assessment were provided to the Director of the Siding Spring Observatory for consultation who did not raise any objection or comment regarding the potential impact of the Project on the operation of Siding Spring Observatory. LAAS (2021) states that as no impacts are anticipated on the operation of Siding Spring Observatory, no impacts would occur at any other observatory identified by the Lighting Standard.

Impact on surrounding Residences

Potential impacts from Project-related lighting on surrounding Residences were assessed by LAAS (2021) based on modelled light emissions and calculated the front face of private Residences R3, R6, R43 and R45, and Project-related Residences R44, R62 and R82. To allow for a conservative estimate of potential impacts, modelled impacts were measured at the boundary of the Project Site in the direction of the Residences.

Sections 6.6.1 to 6.6.3 of LAAS (2021) present the predicted lighting impacts of the Project at the assessed receptors locations. **Table 6.3.4** presents the results of the analysis. In summary, the Project would conform to all relevant criteria identified by the Lighting Standard. In addition, LAAS (2021) states that even if lighting towers were directed at Residences, the Project would still comply with the Lighting Standard.

Table 6.3.4
Conformance Impact on Receptors and Compliance with Lighting Standard

Receptor	Parameter		Compliant
	Vertical Illuminance (Criterion = 1 Lux)[1]	Luminous Intensity (Criterion - 1000 cd)[1]	
Residence R3	0.0016 lux	95 cd	Yes
Residence R6	0.0000 lux	118 cd	Yes
Residence R43	0.0000 lux	116 cd	Yes
Residence R44[2]	0.0000 lux	47 cd	Yes
Residence R45	0.0000 lux	123 cd	Yes
Residence R62[2]	0.0000 lux	116 cd	Yes
Residence R82[2]	0.0000 lux	47 cd	Yes
Note 1: As defined by *AS/NZS4282:2019* for A2 Environmental Zone during the Curfew period (11pm to 6am). Note 2: Project-related.			
Source: LAAS (2021) – modified after Table 9			

Impact on Road Users

LAAS (2021) states that lighting from within the Project Site would not likely result in a significant disability glare for vehicle users outside of the Project Site based on the anticipated locations of Project-related lighting and the presence of the SAR Amenity Bund.

6.3.5.5 Conclusion

Management of potential visual impacts during the site establishment and operation of the Project would involve the adoption of a range of mitigation measures, primarily in the design and rehabilitation of key infrastructure of the Project Site.

The Applicant would implement a progressive rehabilitation program that would ensure that short-term impacts to visual amenity from exposed surfaces are reduced as far as practicable. The SAR Amenity Bund would be constructed to prevent direct views from users of the Newell Highway onto the principal operational areas of the Project Site.

The layout of the Project Site and the distance between proposed light sources and potential receptors is such that no significant impacts are predicted to occur. Notwithstanding the above, the Applicant would design and construct all Project-related lighting in accordance with relevant standards and guidelines.

6.4 Noise and Blasting

6.4.1 Introduction

The assessment of environmental risk undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in noise and blasting impacts (i.e. airblast overpressure and ground vibration). Risk sources with an assessed risk of "medium" or above after the adoption of standard mitigation measures are as follows.

- Noise emissions during site establishment, construction and operations exceeding the relevant criteria at any given time (medium to high risk).
- Noise emissions during site establishment, construction and operations resulting in sleep disturbance at residences (high risk).

In addition, the SEARs issued for the Project identified "noise, vibration and blasting" as key issues requiring assessment, including assessment of the following.

- An assessment of both construction and operational noise in accordance with the NSW Environment Protection Authority's *Noise Policy for Industry* and the NSW Government's *Voluntary Land Acquisition and Mitigation Policy*.
- Justification of the period assessed in accordance with the *Interim Construction Noise Guideline*.
- An assessment of likely road noise impacts of the Project in accordance with the *NSW Road Noise Policy*.
- An assessment of the likely blasting impacts of the Project on people, animals, buildings and infrastructure, and significant natural features, having regard to the relevant Australia and New Zealand Environment Council (ANZEC) *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZEC Guidelines).

The assessment requirements of Dam Safety NSW and Narromine Shire Council were also considered during the preparation of the Noise and Blasting Impact Assessment. A summary of the SEARs and the requirements of the above two agencies are listed within **Appendix 2** together with a record of where each requirement is addressed in the EIS.

A number of noise and blast-related questions were also raised by the local community (see Section 5).

Matters relating to dust and fume generation during blasting are addressed in Section 6.5.

A *Noise and Blasting Impact Assessment* for the Project was prepared by Muller Acoustic Consulting Pty Ltd (MAC) and is presented as Part 2 of the *Specialist Consultant Studies Compendium* and hereafter referred to as MAC (2021). The following subsections provide a summary of MAC (2021) and describe the operational safeguards and management measures that would be implemented by the Applicant. Reference is made, where appropriate, to the *Noise Management Plan* and *Blast Management Plan* for the current TGO Mine Site, with all relevant mitigation measures included in the *Noise Management Plan* and *Blast Management Plan* incorporated within this subsection.

Finally, for the avoidance of doubt, the following terminology has been used throughout this subsection.

- Residence – a building that is or may be used for residential purposes.
- Receptor – a building or structure required to be assessed for noise or blasting-related impacts. A receptor may include a residence but may also include non-residential or commercial buildings or structures, including service stations, hotels or motels.

6.4.2 Existing Environment

6.4.2.1 Existing Noise Environment

Introduction

The existing noise environment surrounding the Project Site is considered by MAC (2021) to be typical of a rural and industrial environment with environmental noise sources including birds, livestock, rural farm equipment, dogs barking and wind in trees, and transportation sources including highway traffic and aircraft. Regular monitoring of the acoustic environment in the vicinity of the TGO Mine Site has been undertaken since the development of the TGO Mine. The results of the independent noise monitoring are published on the Applicant's website in accordance with the conditions of consent for the TGO Mine and are summarised in Section 1.4.7.2. The following subsections present an overview of the specific monitoring and analysis undertaken by MAC (2021) as part of MAC (2021) for the Project.

Unattended Noise Monitoring

In order to establish the existing acoustic environment and identify noise criteria for this assessment, MAC (2021) deployed four unattended noise monitors at the locations displayed on **Figure 6.4.1** between 18 August and 26 August 2020. The monitoring equipment was located to capture existing noise levels that are representative of receptors potentially affected by Project-related noise, including the existing and proposed realignment of the Newell Highway. In accordance with the *Noise Policy for Industry*, data affected by adverse meteorological conditions (rainfall ≥0.5mm) was excluded from the analysis of noise data.

Existing Noise Monitoring Terminals

The Applicant operates two Noise Monitoring Terminals in the vicinity of the Project Site, as shown on **Figure 6.4.1**. The "Brooklands" Noise Monitoring Terminal is located approximately 300m to the west of the Tomingley village and was established in October 2017. The "Thornycroft" Noise Monitoring Terminal is located east of the TGO Mine Site and was established in July 2021 at the request of the landholder and may be removed in consultation with the landholder once sufficient data has been obtained.. The locations of the Noise Monitoring Terminals are considered by MAC (2021) to be representative of conditions outside of the influence of traffic on the local road network and the Newell Highway.

MAC (2021) compared the results of the contemporary Noise Monitoring Terminal data to that from the original *Noise Impact Assessment* for the TGO Mine (SLR, 2011) and identified that background (LA_{90}) levels are generally unchanged from pre-mining conditions. Further information on the approach undertaken to determine existing background noise levels is located in Sections 4.1 and 4.2 of MAC (2021).

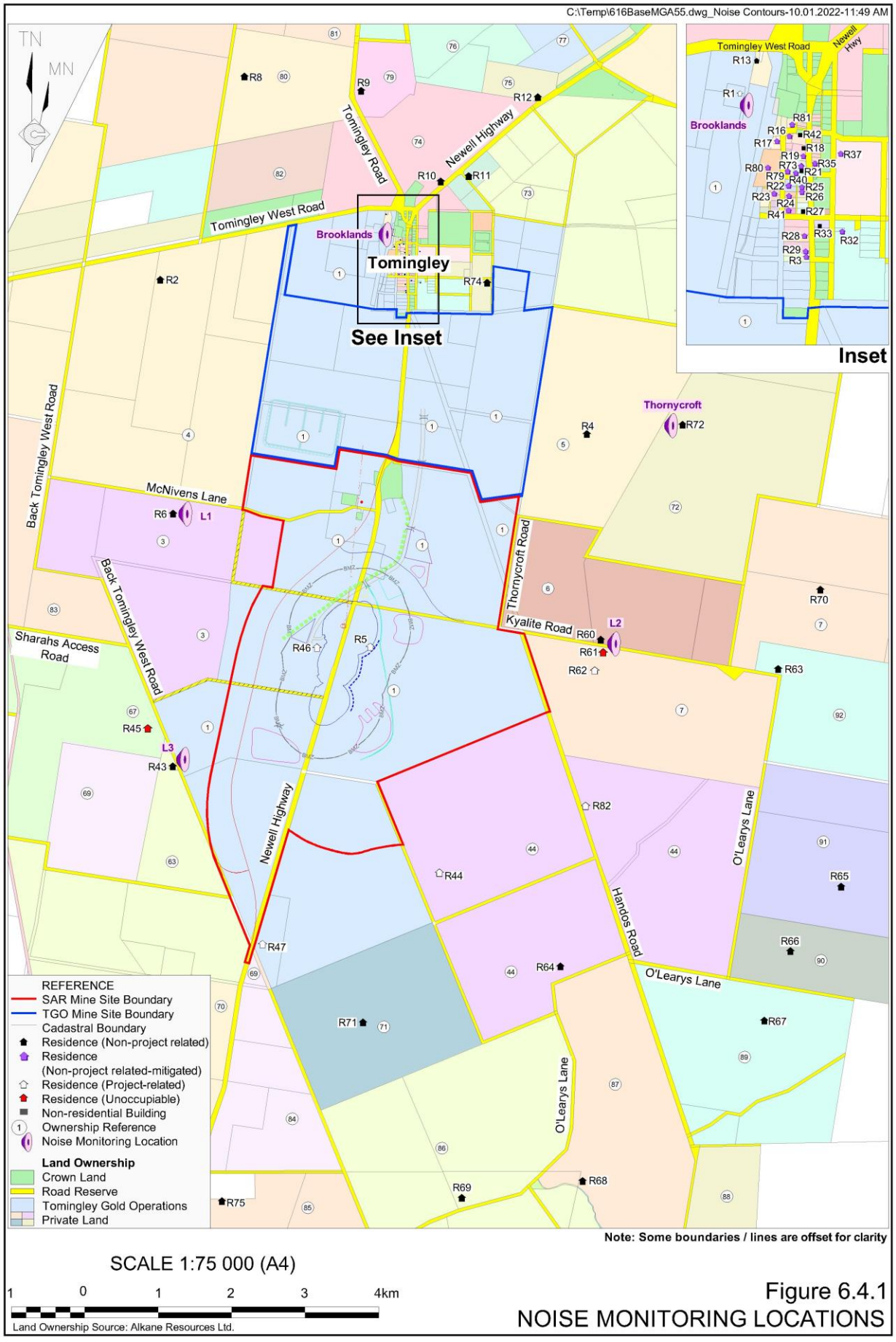


Figure 6.4.1
NOISE MONITORING LOCATIONS

Table 6.4.1 presents a summary of the unattended noise monitoring results for unattended noise loggers L1, L2 and L4, as well as the "Brooklands" and "Thornycroft" Noise Monitoring Terminals. MAC (2021) determined that the "Brooklands" Noise Monitoring Terminal was representative of noise levels withing the Tomingley village. **Table 6.4.2** presents a summary of the existing road traffic noise at unattended noise logger L4. Full results of the unattended noise monitoring are provided in Annexure B of MAC (2021).

Table 6.4.1
Unattended Background Noise Monitoring Summary

ID	Location	Measured Background Noise Level (dB L_{A90}) (RBL)			Measured dB $L_{Aeq(period)}$		
		Period[1]			Period[1]		
		Day	Evening	Night	Day	Evening	Night
L1	263 McNivens Lane	29	24	22	48	38	38
L2	331 Kyalite Road	34	28	25	49	40	39
L3	Back Tomingley West Road	30	24	21	53	41	45
L4	5686 Newell Highway	38	28	22	59	57	55
	"Brooklands"	33	32	32			
Note 1: Day - the period from 7:00am to 6:00pm Monday to Saturday or 8:00am to 6:00pm on Sundays and public holidays; Evening - the period from 6:00pm to 10:00pm; Night – the remaining periods.							
Source: MAC (2021) – modified after Tables 8 to 11 and 13							

Table 6.4.2
Unattended Road Noise Monitoring Summary

ID	Location	Measured Road Traffic Noise Level	
		Day[1] (dB $L_{Aeq(15hr)}$) RBL	Night[1] (dB $L_{Aeq(9hr)}$) RBL
L4	5686 Newell Highway	59	55
Note 1: Day – the period from 7:00am to 10:00pm; Night – 10:00pm to 7:00am			
Source: MAC (2021) – modified after Table 14			

6.4.2.2 Existing Meteorological Environment

Section 6.1.3 presents an overview of the relevant climate data and meteorological conditions of the Project Site. MAC (2021) has adopted a conservative approach when assessing the Project's noise impacts under noise enhancing meteorological conditions, namely, to adopt worst case conditions for all assessment periods. **Table 6.4.3** identifies the meteorological conditions relied upon by MAC (2021) when predicting noise levels for the Project.

Table 6.4.3
Standard and Noise Enhancing Meteorological Conditions

Assessment Condition[1]	Temperature	Wind Speed/ Direction	Relative Humidity	Stability Class
Day	20°C	3m/s all directions	50%	D
Evening	10°C	3m/s all directions	50%	D
Night	10°C	2m/s all directions	50%	F
Note 1: Day 7:00am to 6:00pm Monday to Saturday or 8:00am to 6:00pm on Sundays and public holidays; Evening 6:00pm to 10:00pm; Night - the remaining periods.				
Source: MAC (2021) – modified after Table 31				

6.4.2.3 Existing Blasting Environment

The use of blasting for both surface and underground mining is currently undertaken as part of approved operations within the TGO Mine Site. Section 1.4. presents an overview of the results of blast monitoring within the TGO Mine Site. Residents surrounding the TGO Mine Site are accustomed to blasting operations. Community consultation identified that blasts have been felt at surrounding residences, there have been no blasting-related complaints received since 2018.

The only additional sources of vibration is likely to be vibration associated with vehicles using the Newell Highway, assumed to be a very minor source.

6.4.3 Potential Impacts

6.4.3.1 Potential Noise Impacts

The following activities associated with the Project have been identified as sources of potential noise-related impacts.

- Construction activities (on site and off site), including the relocation of key infrastructure during the site establishment and construction stage (see Sections 3.3 and 3.4).
- SAR Open Cut mining operations, including the transportation of waste rock and ore to the TGO Mine Site (see Sections 3.5 and 3.6).
- Ongoing operations, including processing, within the TGO Mine Site (see Section 3.7).
- Project-related traffic on local roads (both light and heavy vehicles), predominantly within day-time periods. In addition, light vehicle traffic on an evening and night depending on the timing of Project workforce shift changes (see Section 6.2.3).
- Project Site closure/rehabilitation activities (see Section 3.14).

As identified in Section 2.2.3, the Applicant has previously signed Memoranda of Understanding with the majority of residents within Tomingley village. Each agreement identifies a range of noise mitigation measures that have been implemented to address prior TGO-related noise emissions. Mitigation measures included installing and maintaining air conditioning units, installing insulation and double-glazing windows within private residences within the village. The Applicant also continues to pay a proportion of the electricity bills for each residence to cover the costs of running the air-conditioning units. For the purposes of this document, the affected residences are referred to as “mitigated” residences.

6.4.3.2 Potential Blasting Impacts

The potential impacts from blasting relate to airblast overpressure, ground vibration, flyrock and fume emissions. Subject to their magnitude, these factors can, in turn, impact upon amenity, the structural integrity of surrounding buildings and infrastructure e.g., power transmission lines and water tanks, and pose comfort or health risks to surrounding persons and livestock through a startle effect and/or flyrock and fume.

Discussion regarding blast fume is presented in Section 6.5.7.2.

6.4.4 Assessment Criteria

6.4.4.1 Introduction

The following subsections summarise the relevant noise and blasting assessment criteria for assessing Project-related noise and blasting impacts at privately-owned residences and land in the vicinity of the Project Site. An overview is also provided of the NSW Government's *Voluntary Land Acquisition and Mitigation Policy* as it relates to those properties where the relevant noise criteria are unable to be satisfied with the adoption of all feasible and reasonable mitigation measures.

6.4.4.2 Operational Noise Criteria

Project Noise Trigger Level

The Project Noise Trigger Level provides the benchmark for assessing the potential Project-related noise impacts. The *Noise Policy for Industry* identifies the Project Noise Trigger Level as being derived using two factors.

- The intrusiveness noise level whereby the equivalent continuous noise level ($L_{Aeq,15min}$) from a specific industrial source at a residence should not exceed the rating background level[5] (RBL) by 5dB(A).
- The amenity noise level that considers cumulative noise from all industrial sources (i.e. the combined industrial noise sources) that should not be exceeded.

The Project Noise Trigger Level is derived from the lower (that is, the more stringent) value of the intrusive noise level and the amenity noise level. The noise amenity area for the residences surrounding the Project are classified as either suburban or urban in accordance with the *Noise Policy for Industry*.

Table 6.4.4 presents applicable Project Noise Trigger Level for the Project in bold text and grey highlight.

Maximum Noise Assessment

The maximum noise assessment trigger levels provide an indication for the potential for sleep disturbance at residences from maximum noise level events during night-time periods. The maximum noise level event criteria at a residence for transient Project-related night-time noise levels are derived using:

- $L_{Aeq(15minute)}$: the greater of 40dB(A) or the prevailing night-time RBL plus 5dB; and/or
- L_{AFmax} the greater of 52dB(A) or the prevailing night-time RBL plus 15dB.

The maximum noise trigger levels for the Project are indicated in bold text and grey highlight in **Table 6.4.5**.

[5] The Rating Background Level (RBL) is an overall, single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period.

Table 6.4.4
Project Noise Trigger Levels

Receptor	Noise Amenity Area	Assessment Period[1]	Amenity Noise Level	Rating Background Level (RBL) dB L_{A90}	Project Noise Trigger Levels $L_{Aeq(15minute)}$ dB(A)	
					Intrusiveness	Amenity[2,3]
Residential	Rural	Day	50	35	**40**	48
		Evening	45	30	**35**	43
		Night	40	30	**35**	38
	Suburban	Day	55	35	**40**	53
		Evening	45	32	**37**	43
		Night	40	32	**37**	38
Hotel/Motel[4]	Suburban	Day	60	35	**60**	60
		Evening	50	30	**50**	50
		Night	45	30	**45**	45
Commercial	All	When in use	65		-	**63**

Note 1: Monday – Saturday, Day 7:00am to 6:00pm; Evening 6:00pm to 10:00pm; Night 10:00pm to 7:00am. On Sundays and Public Holidays, Day 8:00am to 6:00pm; Evening 6:00pm to 10:00pm; Night 10:00pm to 8:00am.

Note 2: Project Amenity Noise Level equals the Amenity Noise Level -5dB as there is other industry in the area.

Note 3: Includes a +3dB adjustment to the amenity period level to convert to a 15-minute assessment period as per Section 2.2 of the *Noise Policy for Industry*.

Note 4: Equal to the equivalent Residential Amenity Noise Level+5dB, in accordance with the *Noise Policy for Industry*.

Source: MAC (2021) – modified after Tables 16 to 18

Table 6.4.5
Maximum Noise Trigger Levels

Location	dB $L_{Aeq(15minute)}$		dB L_{AFmax}	
	Trigger	RBL+ 5[1]	Trigger	RBL+ 15[1]
Rural - Residential	**40**	35	**52**	45
Rural - Suburban	**40**	37	**52**	45
Hotel/Motel	**40**	35	**52**	45

Note 1: Night-time RBLs are identified in **Table 6.4.4**

Source: MAC (2021) – modified after Table 19

The *Noise Policy for Industry* requires that a detailed maximum noise level event assessment should be undertaken where Project-related night-time noise levels at a residence exceed the maximum noise assessment trigger levels identified in **Table 6.4.5**.

Very Noise-Enhancing Conditions

In accordance with the *Noise Policy for Industry*, a limiting criterion of Project Noise Trigger Level +5dB would be applicable for meteorological conditions outside that adopted in MAC (2021) (see Section 6.4.2.2).

6.4.4.3 Construction Noise Assessment Criteria

Construction Noise Management Levels are defined in the NSW *Interim Construction Noise Guideline* (DECC, 2009). These levels recognise that higher levels of noise are likely to be tolerated by the community in view of the relatively short duration of works. MAC (2021) identified construction Noise Management Levels in accordance with the *Interim Construction Noise Guideline* with **Table 6.4.6** presenting the levels adopted for the Project.

Table 6.4.6
Construction Noise Management Levels

Receptor Type	Adopted Rating Background Level dB L_{A90}	Construction Noise Management Levels dB $L_{Aeq(15min)}$[1]	
		Standard Hours	Outside Standard Hours
Residential (all)	35	45	40
Commercial (when in use)	N/A	70 (external)[2]	
Note 1: Daytime – Monday to Friday - 7:00am to 6:00pm and Saturday - 8:00am to 1:00pm.			
Note 2: Assessment period defined as "when in use" in accordance with the *Interim Construction Noise Guidelines*.			
Source: MAC (2021) – modified after Table 20			

6.4.4.4 Road Traffic Noise Assessment Criteria

Criteria for the assessment of noise from project-related traffic on public roads are set out in the *Road Noise Policy* (DECCW, 2011). Under this policy the Newell Highway would be considered as a Freeway/arterial/sub-arterial road.

The relevant road traffic noise criteria for Residences in the vicinity of the Project Site are set out in **Table 6.4.7**.

Table 6.4.7
Road Traffic Noise Assessment Criteria

Road	Project Type and Land Use	Total Traffic Noise Criteria[1,2,5]	Relative Increase Criteria[1,2,3,4]
Residential Land Use			
Newell Highway	Existing residences affected by additional traffic on freeways/arterial/sub-arterial roads generated by land use developments	Day-time 60 $L_{Aeq(15hour)}$	Existing $L_{Aeq(15hour)}$ plus 12dB(A)
		Night-time 55 $L_{Aeq(9hour)}$	Existing $L_{Aeq(9hour)}$ plus 12dB(A)
Note 1: L_{Aeq} = equivalent continuous noise level.			
Note 2: Day-time 7:00am to 10:00pm, Night-time 10:00pm to 7:00am.			
Note 3: "Existing" is the projected base (i.e. non-Project-related) traffic noise levels.			
Note 4: Relative increase noise level generated by the Project for comparison with the Criteria.			
Note 5: Where the total traffic criteria are already exceeded, then limit any increase to 2dB(A) or less.			
Source: MAC (2021) – modified after Tables 21 and 22			

6.4.4.5 Voluntary Land Acquisition and Mitigation Policy

The *Noise Policy for Industry* states that the recommended noise amenity levels are based on protecting the majority of the community (90%) from being highly annoyed by industrial noise.

Therefore, provided the Project Noise Trigger Levels are achieved, the *Noise Policy for Industry* implies that most people would consider the resultant noise levels acceptable. In those cases where the Project Noise Trigger Levels are not achieved, it does not automatically follow that all people exposed to the noise would find the noise "unacceptable". In subjective terms, the *Voluntary Land Acquisition and Mitigation Policy* characterises noise impacts resulting from residual noise exceedances of the Project Noise Trigger Levels generally as follows.

- If the residual noise exceedance, namely after implementation of all reasonable and feasible noise mitigation measures, is >5dB(A) above the Project Noise Trigger Levels, then noise impacts are considered to be **significant**.
- If the residual noise exceedance is 3dB(A) to 5dB(A) above the Project Noise Trigger Levels, then noise impacts are considered to be **marginal to moderate**.
- If the residual noise exceedance is 1 to 2dB(A) above the Project Noise Trigger Levels, then noise impacts are considered to be **negligible**.

In the event the noise generated by a development exceeds the Project Noise Trigger Levels at any residence on privately-owned land by more than 5dB(A), a consent authority is able to apply voluntary acquisition rights in a development consent for the owner(s) of the subject properties. This also applies when the >5dB(A) exceedance (of the *Noise Policy for Industry* recommended noise amenity level) occurs over more than 25% of any privately-owned land where there is an existing residence or where a residence could be built under current planning controls.

The *Voluntary Land Acquisition and Mitigation Policy* also provides for the consent authority to apply mitigation rights to the owner(s) of residences at which noise levels are predicted to be moderate (i.e. 3dB(A) to 5dB(A) above the Project Noise Trigger Levels). Potential mitigation measures that could be undertaken by the Applicant on the nominated residences could include mechanical ventilation (air conditioning) to enable windows to be closed without compromising internal air quality/amenity or a range of architectural treatments such as upgraded facades, double glazing of windows facing the Mine Site, sealing doors or providing roof insulation.

The *Voluntary Land Acquisition and Mitigation Policy* records that when noise exceedances of 1 to 2dB(A) occur, the exceedances would not be discernible by the average listener and therefore would not warrant residence-based treatments or controls.

6.4.4.6 Blasting Criteria

In order to protect human comfort, the Project would be required to operate in accordance with the limits to overpressure and ground vibration set out in accordance with the ANZEC Guidelines. In summary, criteria:

- maximum overpressure due to blasting should not exceed 115dB(Lpk) for more than 5% of blasts in any period of 12 months at any occupied privately-owned residence, and should not exceed 120dB(Lpk) for any blast; and
- maximum peak particle ground velocity should not exceed 5 millimetres per second (mm/s) for more than 5% of blasts in any period of 12 months at any occupied privately-owned residence, and should not exceed 10mm/s for any blast.

Criteria to minimise vibration effects on structures, railways, roadways and electricity infrastructure are drawn from a number of sources including the German Standard *DIN 4150-3:2016 Vibrations in Buildings Part 3: Effects on Structures* (DIN 4130-3). **Table 6.4.8** presents the 'safe' limits for vibration at surrounding receptors in accordance with DIN 4150-3. Damage is defined in DIN 4150-3 to include minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls. Should such damage be observed without vibration levels exceeding the safe limits then it is likely to be attributable to other causes. DIN 4150-3 also states that when vibration levels higher than the safe limits are present, it does not necessarily follow that damage will occur (MAC, 2021).

Table 6.4.8
Structural Building Damage Safe Limit Values

Line	Type of Structure	Vibration Velocity in mm/s			
		Vibration at foundation at a given Frequency			Plane of Floor of Uppermost Storey at all Frequencies
		Less than 10Hz	10Hz to 50Hz	50Hz to 100Hz[1]	
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	
3	Sensitive Buildings: Structures that because of their particular sensitivity to vibration do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8
Note 1: At frequencies above 100Hz, the values given in this column may be used as a minimum.					
Source: MAC (2021) – modified after Table 24					

In addition, MAC (2021) identify additional criteria for the protection of a range of other infrastructure (**Table 6.4.9**).

Table 6.4.9
Infrastructure Damage Safe Limit Values

Infrastructure	Guideline Value (mm/s)
Public roads	100
Concrete bridges	100
Power transmission lines	50 to 100
Communications towers	100
Pipe – steel	100
Pipe - Clay, concrete, reinforced concrete, prestressed concrete, metal	80
Pipe – Masonry, plastic	50
Source: MAC (2021) – modified after Table 25	

6.4.5 Avoidance, Management and Mitigation Measures

6.4.5.1 Noise Impact Management and Mitigation

Introduction

The Applicant, in conjunction with MAC, has identified a range of measures to minimise the noise likely to be experienced at surrounding receptors. This has involved a detailed review of the Project Site layout and the mining sequence (see Section 3.5.4). This process has also identified the sound power levels of equipment to be used in selected locations under the assessable meteorological conditions. This was an iterative process that ultimately provided clarity for the Applicant to finalise the design of the Project and achieve the required operational and production related targets.

The noise associated within the TGO Mine Site is managed in accordance with the existing and approved *Noise Management Plan*. The following subsections provide an overview of the management and mitigation measures that would be implemented by the Applicant as part of a revised *Noise Management Plan* for the Project in consideration of the results and recommendations of MAC (2021).

Avoidance and Mitigation through Project Design

Key infrastructure within the Project Site has been designed in consideration of potential noise generation and mitigation opportunities. In particular, the Applicant would implement the following.

- Construct the SAR Amenity Bund as described in Section 3.3.2.4 during initial site establishment operations.
- Construct the outer terminal face of the SAR Waste Rock Emplacement as described in Section 3.6.5 during initial Waste Rock Emplacement construction operations.
- Construct a bund, if required, adjacent to the proposed Haul Road or operate the Haul Road at least 6m below the natural ground surface between the southern boundary the Caloma Waste Rock Emplacement and the Newell Highway as described in Section 3.3.2.4.
- Consult with the owners of Residences R6, R26, R40 and R43 in relation to the predicted operational noise levels and, if requested to do so, enter into a suitable agreement to undertake mitigation works in a manner similar to the existing mitigation at residences within Tomingley village.

Operational Management and Mitigation Measures

The Applicant would implement the following noise and blasting-related management and mitigation measures throughout the life of the Project.

- Install broadband reversing alarms on all mobile earthmoving equipment.
- Undertake land preparation operations, including vegetation clearing and soil stripping, during the daytime only.

- Ensure that noisy equipment is operated in exposed locations, such as on the outer face or on top of top of acoustic bunds or waste rock emplacements during the daytime and preferentially when the wind is blowing from the closest receptors towards the operational area.
- Install two additional real time noise monitoring terminals to the east and to the west of the SAR Mine Site, indicatively and subject to landholder consent, in the vicinity of Residence R43 and R60. Each terminal would be programmed with an identified noise trigger level that is below the Project Noise Trigger Levels. If exceeded, the terminal would notify the relevant site supervisor who would be responsible for investigating the notification and implementing corrective actions if required.
- Continue to undertake attended noise monitoring at selected locations surrounding the Project Site. In the event that that monitoring identifies that Project-related noise emissions exceed the relevant noise criteria by more than 2dB at a Residence that is not the subject of previous noise mitigation works, the Applicant would consult the landholder/resident in relation to providing additional noise mitigating controls at the residence. These controls could include installation of air-conditioning, double glazed windows or noise retarding insulation.
- Prepare and implement a revised *Noise Management Plan* that would include the following.
  - Noise monitoring procedures and real-time noise monitoring trigger levels.
  - Weather station monitoring procedures and adverse weather trigger levels (i.e. prediction or detection of Very Noise Enhancing Conditions).
  - Measures which would be implemented in the event of exceedances of either noise or adverse weather trigger levels or receipt of a complaint.
  - Noise monitoring reporting procedures.
  - Community liaison and complaints handling procedures.
  - The inclusion of noise impact awareness training in workplace inductions and training.

The noise mitigation measure commitments made by the Applicant are based on current demonstrated “achievable” noise emission standards. More efficient or cost-effective mitigation measures may be identified throughout the life of the Project and would be implemented as appropriate to achieve the same or greater level of noise mitigation.

The above noise mitigation commitments have been made to reduce noise generation and propagation from the Project as far as reasonably and feasibly practical. Throughout the life of the Project, the Applicant may negotiate individually with surrounding landowners or residents as to the acceptance of noise levels greater than the current Project-specific noise criteria.

Finally, the Applicant has indicated its commitment to maintaining open communication with surrounding landowners and residents and responding as far as reasonably possible to issues raised over Project-related noise. This communication would include but not necessarily be restricted to the following.

- Regular discussions with potentially affected residents to identify if any concerns exist.

- Prompt responses to any issue of concern.
- Noise monitoring on request at potentially affected residences.
- Refinement of on-site noise mitigation measures and operating procedures, where practicable.
- Discussions with respect to negotiated agreements with owners/occupiers of residences where such an agreement does not exist.

6.4.5.2 Blasting Impact Management and Mitigation

Introduction

An overview of the proposed blasting methodology for the SAR Open Cuts is provided in Section 3.5.2.2.

Avoidance and Mitigation through Project Design

Key infrastructure within the Project Site has been designed in consideration of potential air blast overpressure, ground vibration and fly rock generation and mitigation opportunities. In particular, the Applicant would implement the following.

- Construct all blasting-sensitive infrastructure, including public roads, powerlines and Project-related buildings outside of the identified Blast Management Zone. In particular, the proposed road alignments would eliminate the requirement for the temporary closure of the Newell Highway or Kyalite Road during blasting operations.
- Construct suitable fences with warning signs surrounding the active mining areas to prevent inadvertent or unauthorised access to the Blast Management Zone.

The proposed locations and realignments of the Newell Highway and Kyalite Road have been designed in consideration of the Blast Management Zone to reduce the risk to the public, including surrounding land and infrastructure.

Operational Management and Mitigation Measures

The existing blasting operations within the TGO Mine Site are managed in accordance with the existing and approved *Blast Management Plan*. Consistent with that document, the Applicant would implement the following management and mitigation measures throughout the life of the Project.

- Ensure that all blasts are designed and supervised by a suitably qualified and experienced blasting engineer or shotfirer to comply with the relevant blasting criteria at surrounding residences and infrastructure.
- Establish and maintain the Blast Management Zone and ensure that only authorised personnel are permitted within that zone during blasting operations.
- Store all explosives within a licenced Magazine in accordance with the relevant guidelines, regulatory requirements and licence conditions.

- Implement best blast practice methodology to minimise fly-rock and fumes.
- Monitor meteorological conditions prior to blast events and, where required, postpone blasting until more favourable meteorological conditions occur.
- Install permanent blast monitors at selected residences and monitor all blasts.
- Install temporary blast monitors at selected residences or locations where a substantiated complaint has been made or as otherwise required.

6.4.6 Assessment Methodology

6.4.6.1 Construction and Operational Noise Assessment

MAC (2021) assessed anticipated construction and operational noise levels using DGMR (iNoise, Version 2021.1) noise modelling software. The model incorporated a three-dimensional digital terrain map incorporating relevant noise sources, noise barriers and meteorological conditions. MAC (2021) identify that the modelling was undertaken in a manner that is consistent with Sheet C of the *Noise Policy for Industry*, ISO 9613:1 and ISO 9613:2.

One construction and five noise scenarios were assessed as follows. Each of the scenarios are described in Section 3.5.4.3, **Figures 3.5.8** to **3.5.12** and below.

- Scenario 1 – Construction, comprising three sub scenarios including site establishment operations within the SAR Mine Site, as well as road construction operations as follows.
  - Scenario 1A – Road construction activities for the southern section of the realigned Newell Highway.
  - Scenario 1B – Road construction activities for the northern section of the realigned Newell Highway, including Kyalite Road.
  - Scenario 1C - Road construction activities for the northern section of the realigned Newell Highway including the piling required for the Kyalite Road bridge/overpass construction.
- Scenario 2 – Operations during FY24.
- Scenario 3 – Operations during FY25.
- Scenario 4 – Operations during FY27.
- Scenario 5 – Operations during FY30.

These scenarios were selected to represent the range of potential noise impacts associated with the Project.

Equipment modelled during each scenario and their locations and sound power levels are described in Table 29 and Annexure C of MAC (2021), with equipment generally placed in typical worst-case locations for noise propagation.

MAC (2021) included the following reasonable and feasible management and mitigation measures in the noise model, in accordance with the *Noise Policy for Industry* and as identified in Section 6.4.6.

- The construction of a nominal 10m high noise amenity bund 'wall' around the outer perimeter of the SAR Waste Rock Emplacement.
- Operation of a bulldozer with a sound power level less than 112dB within the Caloma Waste Rock Emplacement during Scenarios 2 and 3.
- Operation of D10 and/or D11 bulldozers within or upon the SAR Waste Rock Emplacement only within daytime or evening periods.
- Operation of a bulldozer with a sound power level less than 112dB on the outer face of the SAR Waste Rock Emplacement during night time periods.

MAC (2021) modelled L_{AFMax} noise levels from transient events within the Project Site at the nearest residences. The predicted L_{AFMax} was then compared against the criteria outlined in Section 6.4.4.2 to assess for potential sleep disturbance.

6.4.6.2 Construction Vibration Assessment

MAC (2021) undertook a qualitative assessment of vibration impacts associated with construction operations based on the *Construction Noise and Vibration Strategy* (V4.1) (TfNSW, 2019). That strategy sets out safe working distances to achieve the human response criteria for vibration.

6.4.6.3 Road Traffic Noise

MAC (2021) assessed the potential noise impacts that may result from the proposed changes to the surrounding road network using the Brüel and Kjær Predictor Type 7810 (Version 11.10) noise modelling software. The assessment was undertaken in accordance with the *Procedure for Preparing an Operational Traffic and Construction Noise and Vibration Assessment Report* (Roads and Maritime, 2016). The model was validated based on modelled and observed road traffic noise levels in the vicinity of unattended logger L4.

6.4.6.4 Blasting

MAC (2021) modelled air-blast overpressure and ground vibration levels in accordance with *AS2187.2-2006 – Explosives—Storage and Use Part 2: Use of Explosives*. The model adopted a Maximum Instantaneous Charge of 400kg with blasting locations positioned at the outer extremities of the SAR Open Cuts to allow for a conservative estimate of potential blasting impacts.

6.4.7 Assessment of Impacts

6.4.7.1 Construction Noise and Vibration

Construction operations associated with the proposed realignment of the Newell Highway and the establishment of the SAR Mine Site are expected to operate within Noise Management Levels for all hours at all identified receptors and all scenarios (MAC 2021).

MAC (2021) states that due to the nature of the proposed construction operations and the distance to potential vibration sensitive receptors, vibration impacts from the Project would be negligible.

6.4.7.2 Operational Noise

Table 6.4.10 presents those non-Project related, non-mitigated residences where exceedances to the Project Noise Trigger Level are predicted. Project **Figures 6.4.2** to **6.4.5** present the predicted noise level contours for modelling scenarios and time periods when exceedances of Project Noise Trigger Levels are predicted to occur.

Table 6.4.10
Predicted Operational Noise Exceedances

Residence (Type)	Predicted Degree of Exceedance[1, 3] (dB $LA_{eq(15min)}$)											
	Scenario 2 - FY24[2]			Scenario 3 - FY25[2]			Scenario 4 - FY27[2]			Scenario 5 - FY30[2]		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
R06 (Rural)	-	1	-	-	-	-	-	-	-	-	-	-
R26 (Suburban)	-	2	1	-	1	1	-	-	-	-	-	-
R40 (Suburban)	-	1	-	-	1	-	-	-	-	-	-	-
R43 (Rural)	-	2	1	-	1	-	-	-	-	-	-	-

Note 1: The predicted degree of exceedance is the difference between the predicted noise level and the Project Noise Trigger Level. For example, a predicted noise level of 36dB(A) and a Project Noise Trigger Level of 35dB(A) would result in a predicted degree of exceedance of 1dB(A).

Note 2: Monday – Saturday, Day 7:00am to 6:00pm; Evening 6:00pm to 10:00pm; Night 10:00pm to 7:00am. On Sundays and Public Holidays, Day 8:00am to 6:00pm; Evening 6:00pm to 10:00pm; Night 10:00pm to 8:00am.

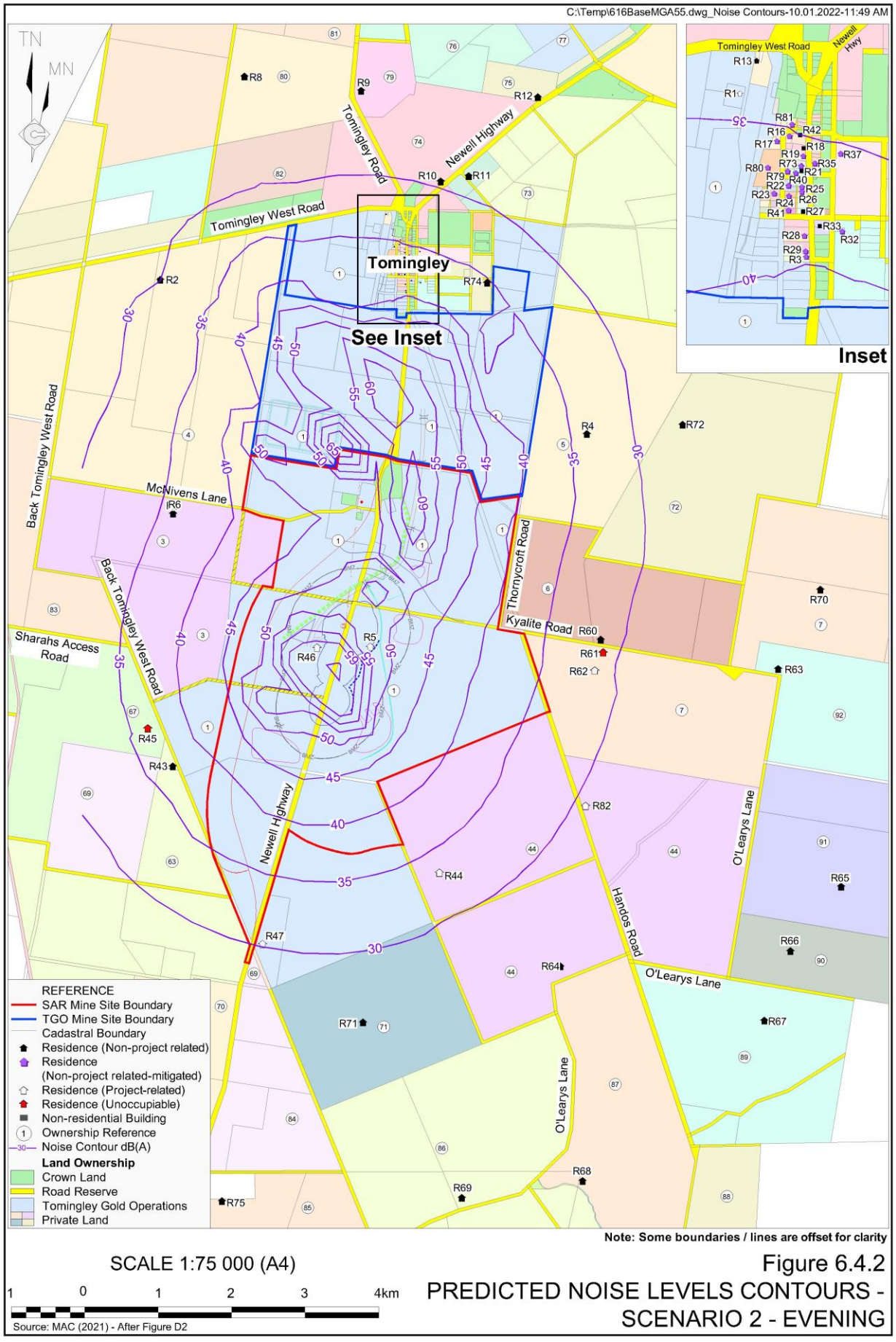
Note 3: Project Noise Trigger Levels are shown in **Table 6.4.4**

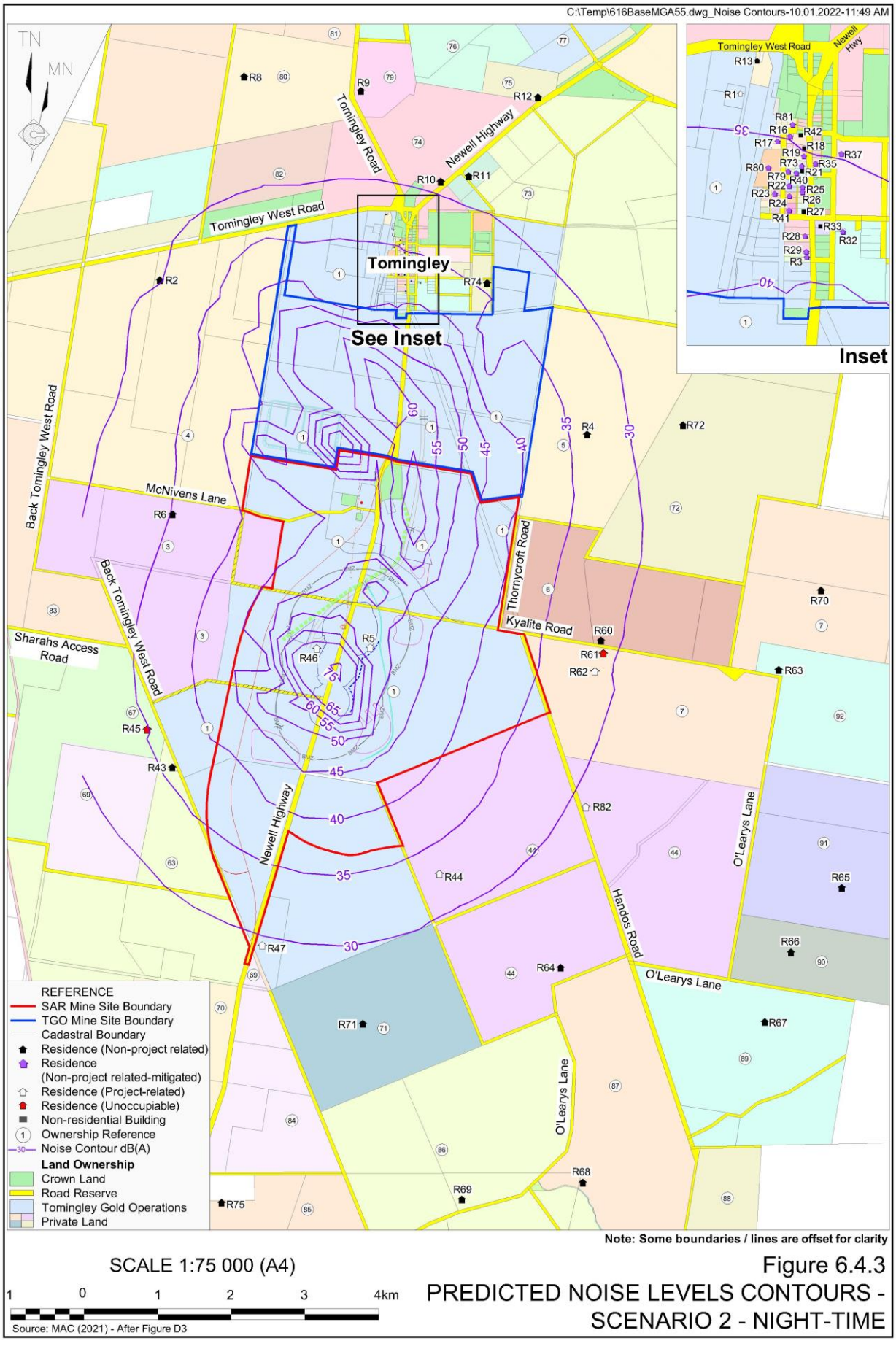
Source: MAC (2021) – modified after Tables 32 and 33.

In summary, exceedances of up to 2dB(A) above nominated Project Noise Trigger Levels are predicted to occur at three and four non-Project related Residences during Scenarios 2 and 3, respectively. In accordance with the *Noise Policy for Industry*, exceedances of up to 2dB are considered to represent negligible residual impacts and are not likely to be discernible by most people. As indicated in Section 6.4.5.1, the Applicant would consult with the owners of Residences R06, R26, R40 and R43 in relation to the predicted operational noise levels and, if requested to do so, enter into a suitable agreement to undertake mitigation works in a manner similar to the existing mitigation at residences within Tomingley village.

Finally, MAC (2021) identifies that a range of previously mitigated residences would be expected to receive noise levels between 1 and 2 dB(A) above the relevant Project Noise Trigger Levels. As the predicted exceedances are less than the 3dB(A) threshold for mitigation under the *Voluntary Land Acquisition and Mitigation Policy*, those exceedances are not considered further.

In addition, MAC (2021) estimates that the predicted maximum noise levels from L_{AFMax} events with a sound power level of 120dBA (re 10^{-12} Watts) for assessed residences would satisfy the maximum noise trigger levels of 52dB L_{AFMax} at all residences. As a result, a detailed maximum noise level assessment is not required and transient Project-related night-time noise levels would not exceed the maximum noise level event criteria at any residence.


C:\Temp\616BaseMGA55.dwg_Noise Contours-10.01.2022-11:49 AM
TN
MN
Tomingley
See Inset
Inset
Tomingley West Road
Tomingley Road
Newell Highway
Back Tomingley West Road
McNivens Lane
Sharahs Access Road
Thornycroft Road
Kyalite Road
O'Learys Lane
Handos Road
REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
Cadastral Boundary
Residence (Non-project related)
Residence (Non-project related-mitigated)
Residence (Project-related)
Residence (Unoccupiable)
Non-residential Building
Ownership Reference
Noise Contour dB(A)
Land Ownership
Crown Land
Road Reserve
Tomingley Gold Operations
Private Land
Note: Some boundaries / lines are offset for clarity
SCALE 1:75 000 (A4)
1 0 1 2 3 4km
Source: MAC (2021) - After Figure D2
Figure 6.4.2
PREDICTED NOISE LEVELS CONTOURS - SCENARIO 2 - EVENING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Newell Highway
Tomingley Road
Back Tomingley West Road
McNivens Lane
Sharahs Access Road
Thornycroft Road
Kyalite Road
O'Learys Lane
Handos Road
REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
Cadastral Boundary
Residence (Non-project related)
Residence (Non-project related-mitigated)
Residence (Project-related)
Residence (Unoccupiable)
Non-residential Building
Ownership Reference
Noise Contour dB(A)
Land Ownership
Crown Land
Road Reserve
Tomingley Gold Operations
Private Land
Note: Some boundaries / lines are offset for clarity
SCALE 1:75 000 (A4)
1 0 1 2 3 4km
Source: MAC (2021) - After Figure D3
Figure 6.4.3
PREDICTED NOISE LEVELS CONTOURS - SCENARIO 2 - NIGHT-TIME

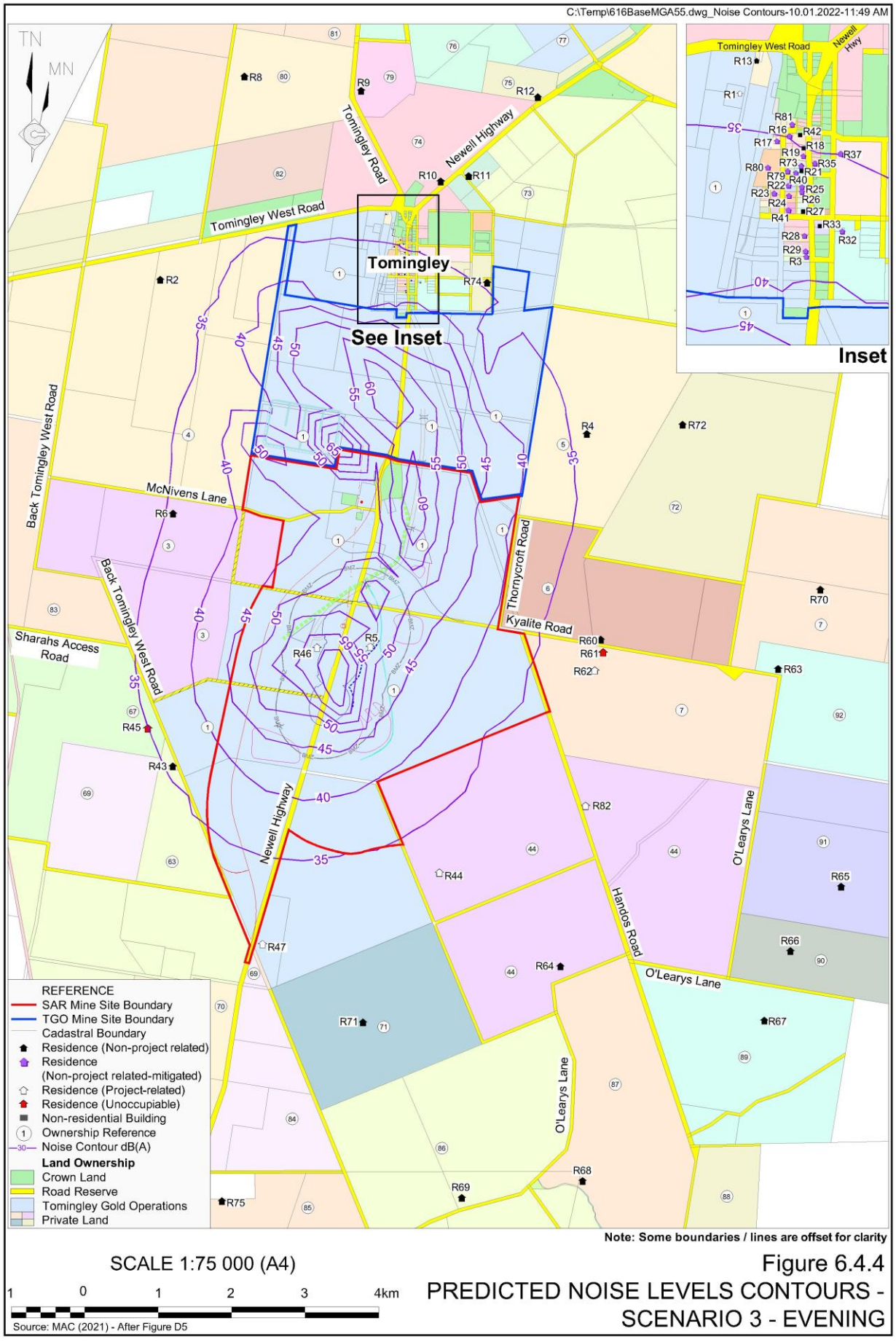
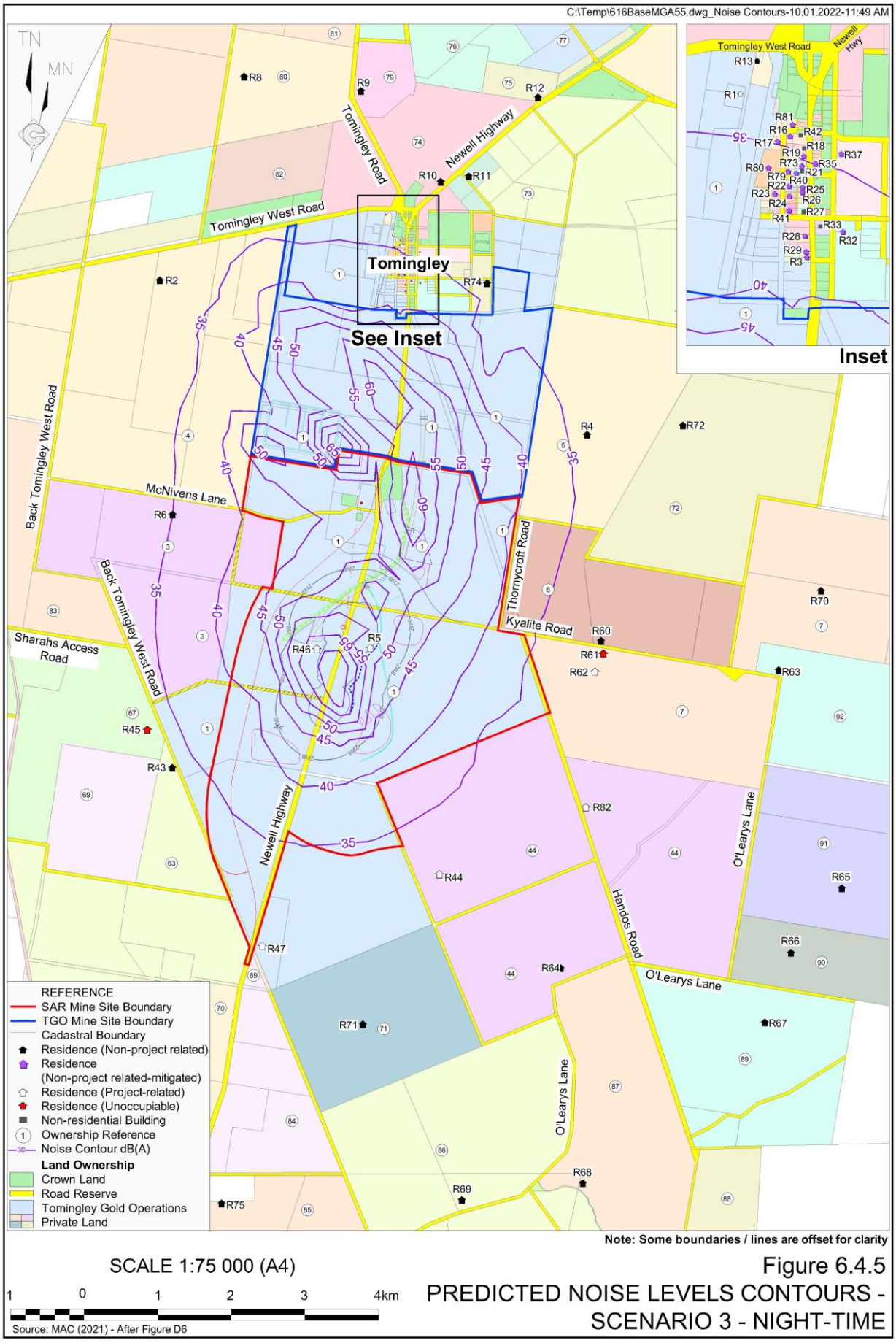


Figure 6.4.4
PREDICTED NOISE LEVELS CONTOURS - SCENARIO 3 - EVENING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Newell Highway
Tomingley Road
Back Tomingley West Road
McNivens Lane
Sharahs Access Road
Thornycroft Road
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TGO Mine Site Boundary
Cadastral Boundary
Residence (Non-project related)
Residence (Non-project related-mitigated)
Residence (Project-related)
Residence (Unoccupiable)
Non-residential Building
Ownership Reference
Noise Contour dB(A)
Land Ownership
Crown Land
Road Reserve
Tomingley Gold Operations
Private Land
Note: Some boundaries / lines are offset for clarity
SCALE 1:75 000 (A4)
1 0 1 2 3 4km
Source: MAC (2021) - After Figure D6
Figure 6.4.5
PREDICTED NOISE LEVELS CONTOURS - SCENARIO 3 - NIGHT-TIME

MAC (2021) also identifies that the Project would result in negligible low-frequency noise impacts.

Finally, a review of noise contours in **Figures 6.4.2** to **6.4.5** and Annexure D of MAC (2021) demonstrates that predicted Project noise levels do not exceed the *Voluntary Land Acquisition and Mitigation Policy* criteria at any residence location or on more than 25% of any privately owned vacant landholding.

6.4.7.3 Road Traffic Noise

MAC (2021) identifies that road traffic noise levels would be unchanged at the majority of residences, with the maximum predicted increase in the road traffic noise levels at a non-Project related residence as a result of the proposed realignment of the Newell Highway being 0.5dB(A), less than the maximum increase criteria of 2dB(A). In addition, the proposed road traffic noise levels would be substantially less than the absolute road traffic noise criteria identified in Section 6.4.4.4.

6.4.7.4 Blasting

MAC (2021) determined that the maximum blasting-related ground vibration and airblast overpressure attributable to open cut blasting at surrounding residences would be less than 115dBZ Peak and 0.8mm/s, less than the relevant human comfort assessment criteria identified in Section 6.4.4.6.

In addition, MAC (2021) identified that the maximum blasting-related open cut ground vibration at the Newell Highway and Kyalite Road Overpass would be 4.1mm/s, i.e. substantially less than the vibration levels that would result in infrastructure damage.

Finally, MAC (2021) notes that blasting-related impacts on livestock and other animals would be likely to be substantially less than that that would cause human discomfort and less than that currently experienced as a result of natural events such as thunder storms.

6.4.8 Monitoring

The Applicant would prepare an updated *Noise Management Plan* and *Blasting Management Plan* based on the existing TGO management plans. Those documents would identify the following noise and blasting-related monitoring.

- Continued operation of the existing TGO Automatic Weather Station.
- Continued operation of the existing "Brooklands" Noise Monitoring Terminal, as well as installation and operation of two similar real-time Noise Monitoring Terminals, indicatively and subject to landholder consent, in the vicinity of Residence R43 and R60.
- Continued and expanded routine attended noise monitoring at locations surrounding the Project Site, as well as in response to substantiated noise complaints or reasonable enquiries.

- Continued and expanded automated blast monitoring, including (subject to landholder consent), in the vicinity of Residence R43 and R60.
- Continued videoing for all open cut blasts, including post blast review of all imagery to monitor for flyrock and fume generation.

Monitoring results would be maintained in a suitable database and would be reported in the Annual Review to be prepared for the Project. In addition, all monitoring results would continue to be made available on request to relevant government agencies and surrounding residents.

6.4.9 Conclusion

Management of potential noise impacts during the site establishment and operation of the Project would involve the adoption of a range of mitigation measures. The Applicant would implement a regime of continuous real-time noise monitoring, predictive meteorological systems and site management procedures to ensure that noise criteria are not exceeded under noise enhancing meteorological condition at the privately-owned residences surrounding the Project Site.

Whilst noise generated within the Project Site would continue to be periodically audible surrounding the Project Site, the actual level of mine noise and associated impacts is considered generally acceptable.

Similarly, ground vibration and airblast overpressure from open cut blasts would be controlled to meet the assessment criteria identified in this document through well controlled blast design and execution. Notwithstanding compliance with the relevant criteria, blasts may at times be heard or felt surrounding the Project Site.

6.5 Air Quality and Greenhouse Gas

6.5.1 Introduction

The risk assessment undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in air quality impacts. The only risk source with an assessed risk of "medium" or above after the adoption of standard mitigation measures is "Particulate and dust emissions during site establishment, construction and operations exceeding the relevant criteria at any given time" which was assessed as having a medium risk ranking.

In addition, the SEARs issued for the Project identifies "air quality" as a key issue requiring assessment, including the following.

- The likely air quality impacts of the Project, including cumulative impacts from nearby developments, in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*, and having regard to the NSW Government's Voluntary Land Acquisition and Mitigation Policy;
- Demonstrated ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations (Clean Air) Regulation 2010*;
- The likely greenhouse gas impacts of the Project; and
- A description of the feasibility of measures that would be implemented to monitor and report on the emissions (including fugitive dust and greenhouse gases) of the Project.

The assessment requirements of Narromine Shire Council were also considered. A summary of the SEARs and the requirements of Narromine Shire Council relating to air quality and greenhouse gases are listed within **Appendix 2**, together with a record of where each requirement is addressed in the EIS.

An *Air Quality Impact Assessment* for the Project was prepared by Northstar Air Quality Pty Ltd (Northstar) in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2016), and hereafter referred to as the "Approved Methods" and is presented as Part 4 of the *Specialist Consultant Studies Compendium* and hereafter referred to as Northstar (2021).

The following subsections provide a summary of Northstar (2021) and describe the operational safeguards and management measures that would be implemented by the Applicant. Reference is made, where appropriate, to the existing and approved *Air Quality and Greenhouse Gas Management Plan* for the TGO Mine Site with all relevant mitigation measures included in that document incorporated within this subsection.

6.5.2 Existing Environment

6.5.2.1 Background Air Quality

Introduction

Northstar (2021) obtained monitoring data from the existing TGO Mine monitoring network, supplemented by regional level data from DPE-operated Air Quality Monitoring Stations where TGO data was not available to characterise the background air quality of the Project. The following present a summary of the approach used to establish background air quality levels. Further information is provided in Section 4.3 and Appendix E of Northstar (2021).

Local Air Quality Monitoring

The Applicant maintains a network of air quality monitors in the vicinity of the TGO Mine Site in accordance with the existing and approved *Air Quality and Greenhouse Gas Management Plan*. The air quality monitoring network is as follows.

- A Tapered Element Oscillating Microbalance (TEOM), which continuously measures PM_{10} (particulate matter with an aerodynamic diameter of 10µm or less) in the southern section of Tomingley village.
- A High-Volume Air Sampler that measures total suspended particulates (TSP) on a 6-day rotating cycle in the southern section of Tomingley village.
- Five dust deposition gauges that measure deposited dust levels on a monthly cycle at various locations around the perimeter of the TGO Mine and within Tomingley village.

Representative Year

The year selected for assessment in Northstar (2021) was 2017. This year was selected for the following reasons.

- The air quality monitoring data collected at the TGO Mine during 2017 provided an appropriately conservative approximation of the air quality of the area, without the impacts of the Project. 2017 was the year with the maximum material movements during the period assessed, with mining of approximately 7.7M bank cubic metres (bcm) (approximately 17Mt) of waste material and approximately 1.2Mt of ore.
- Meteorological data were shown to be representative of the longer term period assessed (2016 to 2020).
- Analyses of regional and local air quality monitoring data indicate that between 2018 and 2020, significant regional level negative influences on air quality occurred, including periods of drought and bushfire, which may not be representative of the longer term record.

Surrogate Background Data

Air quality monitoring data within the TGO Mine Site includes deposited dust, TSP and PM_{10} only. As a result, additional data was sourced from surrogate monitoring locations as follows.

$PM_{2.5}$

$PM_{2.5}$ (particulate matter with an aerodynamic diameter of 2.5µm or less) concentrations were derived from background data from the DPE air quality monitoring station located approximately 150km to the southeast at Bathurst, NSW. It should be noted that the use of data from the Bathurst area is likely to be conservatively high due to the significantly higher population of Bathurst, and the increased use of wood heating, a substantial contributor to $PM_{2.5}$ concentrations (Northstar, 2021).

NO_2

Nitrogen dioxide (NO_2) background data was derived from the DPE air quality monitoring station located at Richmond, approximately 263km to the southeast of the Project Site. Given that the Richmond air quality monitoring station is located in an urbanised area, with sources of emissions such as significant vehicular traffic and combustion emission sources associated with urbanised/industrialised areas, the adoption of the Richmond dataset to approximate NO_2 concentrations in the area surrounding the Project Site is considered to be conservative (Northstar, 2021).

Summary

Table 6.5.1 presents a summary of the background air quality levels adopted by Northstar (2021) for the assessment of the Project.

Table 6.5.1
Summary of Background Air Quality Levels

Pollutant	Averaging Period	Value	Data Source
PM_{10}	24-hour	Daily varying	TGO Mine Site 2017 Maximum measured 24-hour average PM_{10} in 2017 – 77.6µg/m^3
	Annual	19.9µg/m^3	TGO Mine Site 2017
$PM_{2.5}$	24-hour	Daily varying	Bathurst 20 17 Maximum measured 24-hour average $PM_{2.5}$ in 2017 – 17.5µg/m^3
	Annual	6.1µg/m^3	Bathurst 2017
TSP	Annual	46.8µg/m^3	TGO Mine Site 2017
Dust Deposition	Monthly	2.0g/m^2 /month	Maximum measured at the Mine dust deposition gauge network in 2017
NO_2	1-hour	Hourly varying	Richmond 2017 Maximum measured 1-hour NO2 in 2017 – 53.3µg/m^3
	Annual	9.6µg/m^3	Richmond 2017
Source: Northstar (2021) – Table 11			

6.5.2.2 Surrounding Land Sensitivity

Northstar (2021) assessed 59 receptors surrounding the Project Site, including (**Figure 6.5.1**):

- five Project-related Residences, two of which would be removed during the construction phase of the Project;
- two non-occupiable residences;
- two non-operational commercial receptors;
- two operational commercial receptors; and
- 48 non-project related residences.

In addition to the identification of discrete sensitive receptors, Northstar (2021) divided the Air Quality Assessment Area into a uniform grid to allow for the presentation of contours for predicted impacts in order to allow for the assessment of particulate concentrations across privately-owned land in in accordance with the *NSW Voluntary Land Acquisition and Mitigation Policy*.

6.5.2.3 Potential for Cumulative Impacts

The principal source of potential cumulative impacts is the existing, assessed and approved operations within the TGO Mine Site. As discussed in Section 6.5.2.1, historical (2017) monitoring data from operations within the TGO Mine Site have been included in the assumed background air quality. As discussed, that assumption is likely to overestimate the actual background particulate concentrations within and surrounding the Project Site.

The land surrounding the Project Site is managed for agricultural purposes, and therefore some highly localised particulate emissions may occur from activities such as tillage and other heavy machinery usage. These activities, while minor in comparison to those within the TGO Mine Site, would be represented within the historical background data and therefore the cumulative impacts are considered to be adequately addressed.

6.5.3 Potential Sources of Air Contaminants

6.5.3.1 Particulate Emission Sources

Principal potential sources of air contaminants identified by Northstar (2021) include but are not limited to the following.

- The construction of road infrastructure, including the proposed realignment of the Newell Highway, Kyalite Road and associated intersections.
- Land clearance activities such as soil stripping and stockpiling.
- Wind erosion from exposed surfaces.
- The construction of proposed infrastructure within the SAR Mine Site.
- The construction of Residue Storage Facility 2.

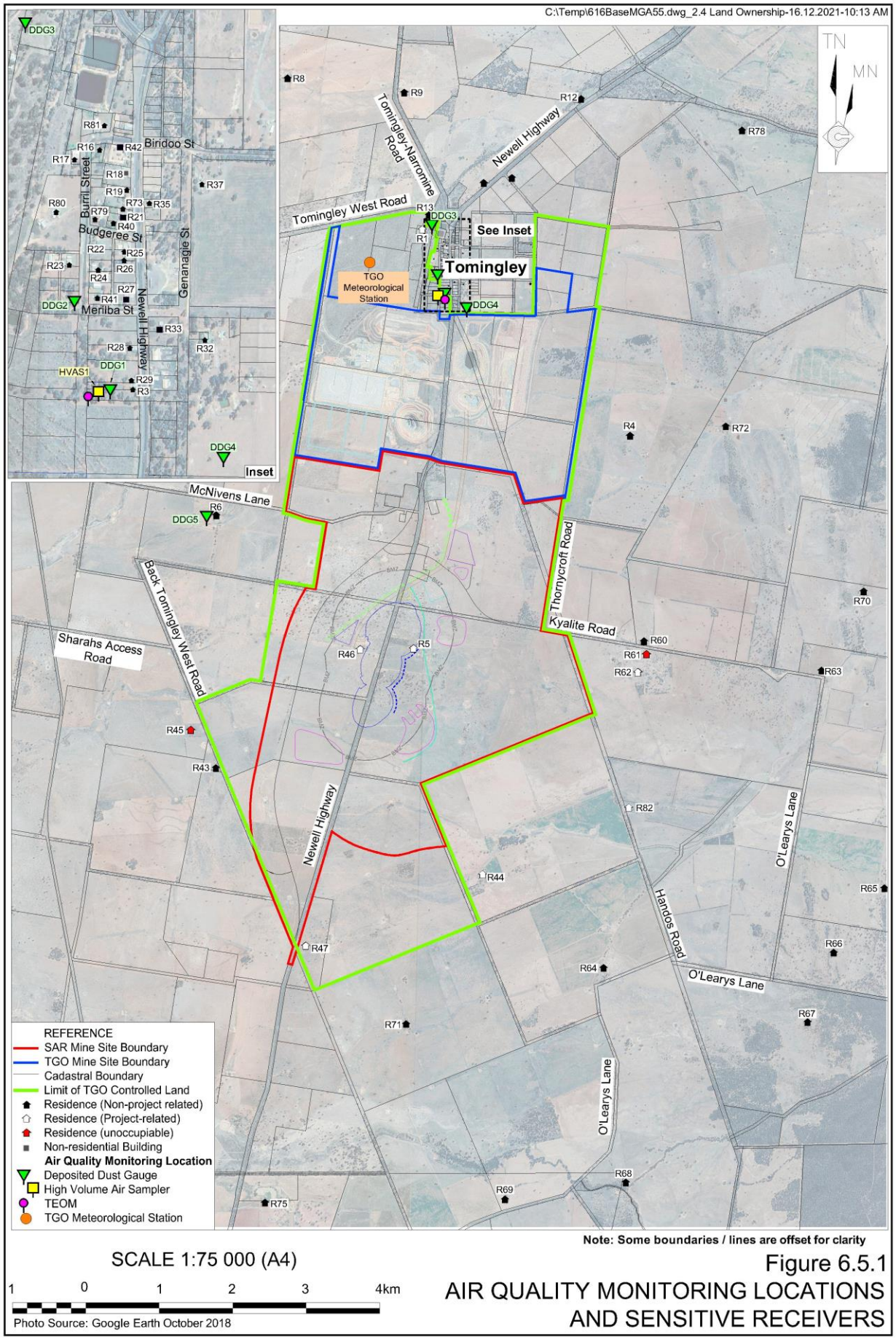

Figure 6.5.1
AIR QUALITY MONITORING LOCATIONS AND SENSITIVE RECEIVERS

- Mining-related activities, including:
  - drilling and blasting;
  - loading and hauling of waste rock;
  - maintenance of roads and trimming of Open Cut surfaces; and
  - the movement and processing of ore.
- Emissions from vehicle and equipment exhaust.
- Emissions from underground ventilation rises.

6.5.3.2 Greenhouse Gas Emission Sources

Greenhouse gases would be emitted as a result of both on-site "direct" emissions and off-site "indirect" emissions and are typically expressed as CO_2 – equivalent (CO_2-e). These emissions may be classified as follows.

- Scope 1 emissions – Direct (or point-source) emissions emitted from within the Project Site as a result of activities within the Project Site, including use of diesel in vehicles and LPG in processing operations and use of explosives.
- Scope 2 emissions – Indirect emissions associated with the generation of electricity used within the Project Site.
- Scope 3 emissions – Indirect emissions associated with Project-related activities, including emissions associated with the production and transportation of consumables, including diesel, personnel transportation to and from the Project Site and transportation of gold from the Project Site.

6.5.4 Assessment Criteria

Table 6.5.2 provides the air quality standards goals for the various classes of emissions outlined in the Approved Methods that are relevant to this assessment. These standards and goals have been adopted by Northstar (2021).

Table 6.5.2
NSW EPA Air Quality Standards and Goals

Particulate Matter Type	Averaging Period	Impact	Criterion
$PM_{2.5}$	Annual	Total	8µg/m^3
	24 hour	Total	25µg/m^3
PM_{10}	Annual	Total	25µg/m^3
	24 hour	Total	50µg/m^3
Total Suspended Particulates	Annual	Total	90µg/m^3
Deposited Dust	Annual	Incremental	2g/m^2/month
		Total	4g/m^2/month
Nitrogen Dioxide (NO_2)	Annual	Total	62µg/m^3
	1 hour	Total	246µg/m^3
Source: Northstar (2021) – modified after Table 4			

It is noted that the existing background PM_{10} 24-hour concentration data identifies that there were five exceedances of the 50µg/m^3 criteria during 2017.

In addition to the Approved Methods, the NSW Government's *Voluntary Land Acquisition and Mitigation Policy* describes the NSW Government's approach to voluntary mitigation and the acquisition of land to address dust impacts and outlines the mitigation and acquisition criteria for particulate matter. The Policy addresses noise and particulate matter only, NO_2 is not considered by the Policy.

Under the Policy, if an Applicant, after applying all reasonable and feasible avoidance and/or mitigation measures, cannot comply with the relevant impact assessment criteria, comparison with the mitigation and/or acquisition criteria is required. If these criteria are exceeded at any private residence or over more than 25% of any landholding with a building entitlement, the landowner may request mitigation measures or acquisition of their property.

6.5.5 Avoidance, Management and Mitigation Measures

6.5.5.1 Introduction

The Applicant, in conjunction with Northstar, has identified a range of measures to minimise the particulate matter emissions likely to be experienced at surrounding receptors. This has involved a detailed review of the Project Site layout and the mining sequence (see Section 3.5.4).

Particulate emissions associated within the TGO Mine Site are managed in accordance with the existing and approved *Air Quality and Greenhouse Gas Management Plan*. The following subsections provide an overview of the management and mitigation measures that would be implemented by the Applicant as part of a revised *Air Quality and Greenhouse Gas Management Plan* for the Project in consideration of the results and recommendations of Northstar (2021).

6.5.5.2 Avoidance and Mitigation through Project Design

Key infrastructure within the Project Site has been designed in consideration of potential particulate and greenhouse gas emissions and mitigation opportunities. In particular, the Applicant would implement the following.

- Sheet roads, particularly the Haul Road and Services Road, with low silt, durable materials to limit generation of silt-sized particles.
- Operate largest class of vehicle practicable to transport waste rock from the SAR Open Cut to the Caloma Waste Rock Emplacement, thereby minimising particulate and greenhouse gas emissions per tonne of material transported.
- Schedule transportation of waste rock from the SAR Open Cut to the Caloma Waste Rock Emplacement over the initial two to three years of mining operations (rather than over a shorter period) to minimise the intensity of transportation operations in the vicinity of Tomingley Village.

- Seal the initial 30m of Back Tomingley West Road and McNivens Lane from the edge of the Newell Highway and the initial 50m (as per Section 6.2) of the SAR Access Road from the edge of Kyalite Road to limit tracking of mud and sediment onto the public road network.
- Continue to assess the feasibility of installing a solar power generation facility adjacent to the TGO Mine Site to provide electricity for the Project and offset electricity sourced from non-renewable sources.

6.5.5.3 Operational Management and Mitigation Measures

The Applicant would implement, where practicable, the following air quality and greenhouse gas-related management and mitigation measures throughout the life of the Project.

- Disturb only the minimum area necessary for mining operations.
- Undertake progressive rehabilitation of areas no longer required for mining operations as soon as practicable once the area is no longer required for operational purposes.
- Avoid material movement operations on elevated sections of the Project Site during periods of high wind.
- Clearly mark all haul roads and other roads and tracks and ensure that signposted speed limits are complied with.
- Avoid blasting operations or other activities likely to generate significant dust emissions during periods of strong southerly wind, where practicable.
- Ensure adequate stemming is used during blasting operations.
- Minimise dust emissions from the existing crushing and screening operations to the extent practicable.
- Use of water sprays/sprinklers or water carts on internal, unsealed roads and in other areas to minimise dust emissions, as required.
- Minimise drop heights during loading and unloading of waste rock and ore and avoid tipping material down a tip face.
- Apply water to material stockpiles prior to loading, transportation and unloading to limit dust emissions, as required.
- Monitor meteorological conditions (including via automated alerts) to identify periods of adverse weather (little or no rainfall and wind speeds above 30km/h) and implement appropriate additional mitigation measures, including:
  - increased use of water sprays and water carts; and
  - relocation or ceasing operations likely to generate significant dust emissions.
- Undertake visual monitoring and mandatory reporting of visible dust emissions to site supervisors and implement measures to minimise or reduce observed dust emissions.
- Monitor real-time dust emissions (including via automated alerts) using the existing TEOM and proposed PM_{10} dust monitors and implement measures to minimise or reduce observed dust emissions when predefined triggers are exceeded.

- Progressively implement the following additional management measures as a Trigger Action Response Plan in the event that the above real-time monitors indicate elevated concentrations of PM_{10}.
  - Reduce speed of haul trucks and increase the frequency of watering on the Haul Road if safe to do so.
  - Cease the transportation to, and unloading of waste at the Caloma Waste Rock Emplacement.
  - Cease the transportation of ore to the ROM Pad.
  - Cease or reduce as far as practicable operations within the SAR Mine Site, including within the SAR Open Cut and/or the transportation to and unloading of waste rock at the SAR Waste Rock Emplacement.
- Continually review and implement energy efficiency measures where reasonable and practicable.
- Maintain plant and equipment to maximise efficiency and reduce emissions.
- Source locally produced goods and services to reduce transport fuel emissions.

6.5.6 Assessment Methodology

6.5.6.1 Particulates

Introduction

Northstar (2021) assessed potential particulate air quality impacts associated with the Project in accordance with the methodology provided in the Approved Methods. The following subsections present a brief overview of the applied assessment methodology. More information on the methods applied is presented in Northstar (2021).

It should be noted that there are a range of management and mitigation measures outlined in Section 6.5.5 which could not be justifiably included in the modelling assessment by Northstar (2021), either because the emission reduction efficiency afforded by their implementation is not well documented and therefore may be open to scrutiny, or they are applied on an 'as needs' basis rather than continually. Furthermore, the cumulative impacts predicted are likely to include a level of 'double-counting' associated with material movements included in the 2017 background air quality dataset that would not be occurring under the assessed construction and mining scenarios. Therefore, Northstar (2021) model predictions can be viewed as a conservative estimate of the anticipated impacts associated with the Project.

Assessment Scenarios

Northstar (2021) assessed three scenarios, namely:

- Scenario 1 – Construction operations;
- Scenario 2 – Mining and processing in FY24; and
- Scenario 3 - Mining and processing in FY25.

The three scenarios were selected to represent the highest potential air quality impacts of the Project to allow for a conservative and holistic assessment based on the amount of waste rock and ore mined, the amount of and distance of material to be transported, and the proximities of activities to sensitive receptors. These scenarios are described in full in Section 3.5.4.3.

Emissions Estimation

Potential emissions during each of the assessed construction and mining scenarios were quantified and an emissions inventory developed for the key dust generating activities within the Project Site for each scenario. This included adoption of emission factors for material handling, vehicle movements, processing operations and wind erosion and those developed by the US Environmental Protection Agency (US EPA, 1995 and updates). Emissions of oxides of nitrogen (NO_x) associated with blasting have been referenced from the *National Pollutant Inventory Emission Estimation Technique for Mining* (DSEWPC, 2010).

A full description of the emission sources, emission factors and assumptions adopted by Northstar (2021) are presented in Sections 5.1.2 and 5.1.3 and Annexure B of Northstar (2021).

Dispersion Modelling

Northstar (2021) utilised the CALPUFF dispersion modelling program to predict NO_2, dust deposition, TSP, PM_{10} and $PM_{2.5}$ concentrations at surrounding receptors. This model incorporates a meteorological model (CALMET) to inform Project only (incremental) and cumulative (Project plus background) predictions of air pollutant concentrations at each receptor for comparison against the air quality criteria nominated in Section 6.5.4. A full description of the methodology adopted for the dispersion modelling is presented in Section 5.1.1 of Northstar (2021).

Trigger Action Response Plan Modelling

Where exceedances of the relevant assessment criteria were predicted to occur, Northstar (2021) repeated the particulate dispersion modelling to allow the determination of the effectiveness of a range of cascading controls that the Applicant would adopt, if required, to manage/mitigate the most-significant emissions sources. In summary, where real-time dust monitoring identified elevated concentrations of PM_{10}, the Trigger Action Response Plan identified in Section 6.5.5.3 would be implemented. Northstar (2021) modelled the effectiveness of the proposed management measures by progressively re-running the dispersion model, incorporating the proposed measures to determine those which would be required to ensure compliance with the relevant assessment criteria.

6.5.6.2 Nitrogen Dioxide

Northstar (2021) assessed potential Nitrogen Dioxide (NO_2) concentrations based on Method 2 of the NSW EPA Approved Methods.

6.5.6.3 Greenhouse Gas

Northstar (2021) estimated greenhouse gas emissions based on information provided by the Applicant. That information included either direct estimates of diesel and other consumable usage during FY25 (the year during which the maximum material movements would occur) or actual electricity and LPG usage during FY21, adjusted on a pro rata basis to account for the additional usage expected in FY25.

6.5.7 Assessment of Impacts

6.5.7.1 Particulate Matter

Scenario 1 - Construction

Northstar (2021) determined that there would be no Project-related exceedances of the incremental or cumulative assessment criteria for deposited dust at any of the identified sensitive receptors under Scenario 1.

Similarly, Northstar (2021) determined that there would be no Project-related exceedances of the annual average cumulative assessment criteria for TSP, PM_{10} or $PM_{2.5}$ at any of the identified sensitive receptors under Scenario 1. There would also be no Project-related exceedances of the 24-hour average $PM_{2.5}$ assessment criteria any of the identified sensitive receptors under Scenario 1.

Finally,_Northstar (2021) determined that there would be no additional exceedances of the 24-hour average PM_{10} assessment criteria at any of the identified sensitive receptors under Scenario 1, noting that the assumed 2017 background PM_{10} 24-hour data includes 5 exceedances of the assessment criteria.

Scenario 2 - Mining and processing in FY24

Northstar (2021) determined that there would be no Project-related exceedances of the incremental or cumulative assessment criteria for deposited dust at any of the identified sensitive receptors under Scenario 2.

Similarly, Northstar (2021) determined that there would be no Project-related exceedances of the annual average cumulative assessment criteria for TSP, PM_{10} or $PM_{2.5}$ at any of the identified sensitive receptors under Scenario 2. There would also be no Project-related exceedances of the 24-hour average $PM_{2.5}$ assessment criteria at any of the identified sensitive receptors under Scenario 2.

Northstar (2021) did however identify that in the absence of the proposed Trigger Action Response Plan-related management measures identified in Section 6.5.5.3 that there would be an increase of 18 days on which there would be exceedances of the 24-hour average PM_{10} assessment criteria under Scenario 2. **Table 6.5.3** identifies the additional exceedances of the 24-hour average PM_{10} concentrations under Scenario 2.

Northstar (2021) conducted additional modelling of the 18 days on which additional exceedances of 24-hour average PM_{10} assessment criteria were predicted using the Trigger Action Response Plan cascading controls identified in Section 6.5.5.3. That assessment determined that the identified Trigger Action Response Plan would prevent exceedance of the relevant criteria in all cases except on three days when the background 24-hour PM_{10} concentration was more than 47.5µg/m^3, or 95% of the relevant criterion. In that case, Northstar (2021) identified that implementation of all proposed air quality management measures would represent best practice emissions control and would minimise emissions from the Project as far as practicable.

Table 6.5.3
Summary of Additional Exceedances of 24-hour Average PM_{10} Concentrations – Scenario 2

Sensitive Receptor	Number of Additional Exceedances[1]	Sensitive Receptor	Number of Additional Exceedances[1]	Sensitive Receptor	Number of Additional Exceedances[1]
R2	1	R21[2]	5	R40	5
R3	6	R22	6	R41	6
R4	4	R23	6	R42	5
R6	6	R24	6	R43	5
R8	2	R25	5	R60	1
R9	2	R26	5	R63	1
R10	3	R27[3]	6	R70	1
R11	3	R28	6	R72	1
R12	1	R29	6	R73	5
R16	5	R32	6	R79	5
R17	5	R33[3]	5	R80	5
R18[2]	5	R35	5	R81	5
R19	5	R37	4		

Note 1: Existing background of 5 exceedances.
Note 2: Commercial – Operating
Note 3: Commercial – Non-operational

Source: Northstar (2021) – modified after Figures 11 and 12.

Scenario 3 - Mining and processing in FY24

Northstar (2021) determined that there would be no Project-related exceedances of the incremental or cumulative assessment criteria for deposited dust at any of the identified sensitive receptors under Scenario 3.

Similarly, Northstar (2021) determined that there would be no Project-related exceedances of the annual average cumulative assessment criteria for TSP, PM_{10} or $PM_{2.5}$ at any of the identified sensitive receptors under Scenario 3.

Northstar (2021) did however identify that in the absence of the proposed Trigger Action Response Plan-related management measures identified in Section 6.5.5.3 that there would be an increase of 20 days on which there would be exceedances of the 24-hour average PM_{10} assessment criteria under Scenario 3. **Table 6.5.4** identifies the additional exceedances of the 24-hour average PM_{10} concentrations under Scenario 3.

Northstar (2021) conducted additional modelling of the 20 days on which additional exceedances of 24-hour average PM_{10} assessment criteria were predicted using the Trigger Action Response Plan cascading controls identified in Section 6.5.5.3. That assessment determined that the identified Trigger Action Response Plan would prevent exceedance of the relevant criteria in all cases except on three days when the background 24-hour PM_{10} concentration was more than 47.5µg/m^3, or 95% of the relevant criterion. In that case, Northstar (2021) identified that implementation of all proposed air quality management measures would represent best practice emissions control and would minimise emissions from the Project as far as practicable.

Table 6.5.4
Summary of Additional Exceedances of 24-hour Average PM_{10} Concentrations - Scenario 3

Sensitive Receptor	Number of Additional Exceedances[1]	Sensitive Receptor	Number of Additional Exceedances[1]	Sensitive Receptor	Number of Additional Exceedances[1]
R2	1	R23	7	R41	7
R3	10	R24	7	R42	6
R4	4	R25	7	R43	4
R6	4	R26	7	R60	1
R8	2	R27[3]	7	R63	1
R9	2	R28	7	R70	1
R12	1	R29	10	R72	1
R16	5	R32	8	R73	6
R17	5	R33[3]	8	R78	1
R18[2]	6	R35	7	R80	6
R21[2]	6	R37	6	R81	5
R22	6	R40	6		

Note 1: Existing background of 5 exceedances.
Note 2: Commercial – Operating
Note 3: Commercial – Non-operational

Source: Northstar (2021) – modified after Figures 13 and 14.

Summary

The results of Northstar (2021) show that on all but three of the modelled days under both Scenarios 2 and 3, a range of specific controls that would be implemented, if required, by the Applicant to ensure that additional exceedances of the 24-hour PM_{10} criterion would not eventuate. It should be noted that for the remaining three days for both Scenario 2 and 3, the background PM_{10} concentration is greater than 95% of the relevant criterion. As discussed in Section 6.5.2.1, the background air quality data includes significant emission-generating activities within the TGO Mine Site that would not occur during the Project. As a result, the assessment of cumulative impacts likely significantly overestimates background conditions, and therefore cumulative impacts surrounding the Project Site.

Finally, Northstar (2021) identify that the relevant acquisition criteria associated with the VLAMP are not exceeded at any surrounding privately-owned residence during Scenarios 1, 2 or 3. However, VLAMP mitigation criteria do not permit exceedances of air quality criteria and based on the results of air quality modelling, some exceedances of the 24-hour PM_{10} criterion may occur. Notwithstanding the above, Northstar (2021) states that the air quality modelling for the Project was undertaken using a significantly conservative approach, and therefore likely overestimate 24-hour PM_{10} levels. As a result, the VLAMP mitigation criteria are unlikely to be exceeded at surrounding residences.

6.5.7.2 Nitrogen Dioxide

Northstar (2021) determined that there would be no Project-related exceedances of the 1 hour or annual average cumulative assessment criteria for NO_2 at any of the identified surrounding residences. In addition, the Applicant would visually monitor all blasts for blast fume and, in the event that blast fume is observed, the cause of the emission would be determined and blast procedures would be amended to minimise the potential for a recurrence.

6.5.7.3 Greenhouse Gas

Table 6.5.5 presents the greenhouse gas emission sources for both direct and indirect emissions and **Table 6.5.6** presents the estimated annual greenhouse gas emissions for FY25 for each source based on emission factors sourced from the *National Greenhouse Accounts Factors: 2021* (DISER, 2021). These represent the most significant sources associated with the Project.

The calculated annual average Scope 1 emissions represent, as a maximum, approximately 0.04% of total greenhouse gas emissions for NSW and 0.01% of total greenhouse gas emissions for Australia, based on the *National Greenhouse Gas Inventory for 2019* (DISER, 2019) (**Table 6.5.7**). Northstar (2021) identify that Scope 2 and Scope 3 emissions are not compared with Australian and NSW total emissions as this results in double counting of emissions (e.g., the electricity supplier would report emissions associated with energy production as a Scope 1 emission).

Table 6.5.5
Project-related Greenhouse Gas Emission Sources

Project Component	Scope	Emission Source Description
Consumption of diesel fuel in mobile plant and equipment.	1	Emissions from combustion of fuel.
	3	Emissions associated with extraction and processing of fuel.
Consumption of LPG in processing operations.	1	Emissions from combustion of fuel.
	3	Emissions associated with extraction and processing of fuel.
Consumption of electricity.	2	Emissions associated with electricity generation.
Consumption of diesel fuel / unleaded fuel for employee transport purposes.	3	Emissions associated with the extraction and processing of fuels.
Consumption of diesel fuel in the transportation of materials to the Project Site.	3	Emissions associated with the extraction and processing of fuels.
Source: Northstar (2021) – modified after Table 17		

Table 6.5.6
Project-related Greenhouse Gas Emission Estimates

Scope		Activity Rate	Emission Factor	CO_2-e (t/yr)
1	Diesel fuel in material transport	21 224.3 kL/year	2 717.4 kg CO_2-e/kL	57 675.8
	Liquified petroleum gas	441.8 kL/year	1 303.7 kg CO_2-e/kL	576.0
			Scope 1 (subtotal)	**58 251.9**
2	Electricity consumption	93.2 GWh/year	0.78 kg CO_2-e/kWh	72 673.7
			Scope 2 (subtotal)	**72 673.7**
3	Diesel fuel in material transport[1]	21 445.9 kL/year	139 kg CO_2-e/kL	2 980.1
	Liquified petroleum gas	441.8 kL/year	91.1 kg CO_2-e/kL	40.2
	Electricity consumption	93.2 GWh/year	0.07 kg CO_2-e/kWh	6 522.0
	Employee travel	970.3 kL/year	123.1 kg CO_2-e/kL	119.5
			Scope 3 (subtotal)	**9 661.8**
			Total	**140 587.4**
Note 1: Includes the transportation of materials to the Project Site				
Source: Northstar (2021) – modified after Table 39				

Table 6.5.7
State and National Context of Project Greenhouse Gas Emissions[1]

Project-related Scope 1 Emissions	NSW Emissions[2]	Australian Emissions[2]
58 251.9	136 579 000	529 298 000
	0.04%	0.01 %
Note 1: Units - t CO_2-e per annum Note 2: NSW and Australian emissions for 2019		
Source: Northstar (2021) – Table 40		

The Applicant is committed to continue to investigate ways to minimise the emission of greenhouse gases throughout the life of the Project in order to contribute to the NSW and Australian government stated emission reduction targets. In particular, the Applicant is in the final stages of determining the feasibility of installing a solar farm of up to 4.99MW in a location close to the TGO Mine Site. The Solar Farm would require separate development consent and, if approved, would provide electricity for the Applicant's processing plant, replacing electricity that would be supplied by third-party providers. The solar farm would also have a life that would extend beyond the life of the Project and would continue to provide abatement for emissions that would otherwise occur following completion of the Project.

In addition, the Applicant would investigate and, where appropriate and practicable, implement the following.

- Maximise highly energy intensive activities during the day when renewable power is most abundant.
- Investigate options for increasing the proportion of renewable power used within the Project Site.
- Investigate the use of more fuel/emissions efficient equipment, including mobile and fixed plant.
- Maintain haul roads and mobile plant to ensure the maximum fuel efficiency.
- Educate the Project's workforce on maximizing energy efficiency and minimizing energy wastage.
- Investigate the potential to sequester carbon in soils through proven technologies on the farmland owned by the Applicant.

Finally, as described in Section A4.5.3.2 of **Appendix 4**., the Applicant would actively investigate a post-mining land use of solar power generation for sections of the Project Site. Potential also exists for pumped hydro energy storage using the proposed and existing open cuts and underground workings. In each case, further development consent would be required. However, should such final land uses be approved, there would be further abatement of future greenhouse gas emissions following the completion of mining operations.

6.5.8 Monitoring

In the event the Project is approved, the Applicant would prepare an updated *Air Quality and Greenhouse Gas Management Plan* based on the existing TGO management plan. That document would identify the following air quality and greenhouse-related monitoring.

- Continued operation of the existing TGO Automatic Weather Station.

- Continue to operate the existing air quality monitoring network, comprising:
  - one real PM_{10} in the southern section of Tomingley village.
  - one High-Volume Air Sampler that measures TSP on a 6-day rotating cycle in the southern section Tomingley village; and
  - five dust deposition gauges.
- Install further real-time PM_{10} monitoring equipment in locations to the east and west of the SAR Open Cut, indicatively in the vicinity of Residence R43 and Residence R60.
- Install further deposited dust gauges in locations to the east and west of the SAR Open Cut, indicatively in the vicinity of Residence R43 and Residence R60.
- Continue to track energy consumption and greenhouse gas emissions, establish targets for reduction and facilitate assessment and reporting against targets for reduction.

6.5.9 Conclusion

Management of potential air quality impacts during the site establishment and operation of the Project would involve the adoption of a range of mitigation measures. The Applicant would implement a regime of continuous real-time air quality monitoring, predictive meteorological systems and site management procedures to ensure that air quality criteria are not exceeded under unfavourable meteorological conditions at the privately-owned residences surrounding the Project Site.

Whilst dust and particulates generated within the Project Site would continue to be periodically detected surrounding the Project Site, the actual level of mine emissions and associated impacts is considered generally acceptable.

The total greenhouse gas emissions for the Project, not accounting for existing and proposed offsetting through biodiversity offset plantings and the reduction in long-term emissions from agricultural activity, would account for 0.04% and 0.01% of the total greenhouse gas emissions of the State of NSW and Australia, respectively.

Based on the above, the potential impact of the Project on air quality are considered to be minor. If the proposed monitoring were to identify unavoidable Project-related impacts, these would be managed by the Applicant in accordance with the VLAMP.

6.6 Surface Water

6.6.1 Introduction

The risk assessment undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in surface water impacts. Risk sources with an assessed risk of "medium" or above after the adoption of standard mitigation measures are as follows.

- Physical changes to the landscape resulting in:
  - the reduction or change of catchments causing a reduction in downstream flow (medium risk);
  - changes in overland flow resulting in increased erosion and/or flooding risk (medium risk); and
  - changes in overland flow resulting in reduced water availability for downstream users and changes in ecological processes (medium risk).
- Release of process and/or mine water to downstream watercourses resulting in disruption to aquatic ecosystem function (medium risk).
- Failure of the Residue Storage Facility resulting in damage to infrastructure and impacts on watercourses and aquatic ecosystem function (medium risk).

In addition, the SEARs issued by DPIE identified "water" as a key issue requiring assessment. The principal assessment requirements identified by DPIE relating to surface water are summarised as follows.

- An assessment of the likely impacts of the development on the quantity and quality of surface water resources, having regard to the Mining and Petroleum Gateway Panel's requirements (see Attachment 2, Conditional Gateway Certificate, presented in **Appendix 1**).
- An assessment of the hydrological characteristics of the Project Site and downstream.
- An assessment of the likely impacts of the Project on watercourses, riparian land, water-related infrastructure and systems and other water users, including impacts to water supply from dams, and riparian and licensed water users.
- A description of the measures proposed, including monitoring activities and methodologies, to ensure the Project can operate in accordance with the requirements of any relevant water sharing plan or water source embargo.
- A detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface water impacts.
- An assessment of the potential flooding impacts of the Project.
- Demonstrate how the Project would:
  - protect water quality objectives in receiving waters, where they are being achieved; and
  - contribute towards achievement of the water quality objectives, where they are not being achieved.

The assessment requirements of Biodiversity, Conservation and Science Directorate, DPIE Water and Natural Resources Access Regulator and Narromine Shire Council were also considered. A summary of the SEARs, the requirements of Biodiversity, Conservation and Science Directorate, DPIE Water and Natural Resources Access Regulator and Narromine Shire Council, and the Independent Expert Scientific Committee are listed within **Appendix 2**, together with a record of where each requirement is addressed in the EIS.

In order to assess the potential impacts of the Project on the regional and local surface water and flooding environment, a surface water assessment for the Project was undertaken by Jacobs Australia Pty Limited (Jacobs) and is presented as Part 5 of the *Specialist Consultant Studies Compendium* and hereafter referred to as Jacobs (2021a). Annexure B of Jacobs (2021a) presents a *Hydrology and Hydraulics Technical Report*. For ease of reference, that report is referred to hereafter as Jacobs (2021b).

The following subsections provide a summary of the surface water assessment and describe the operational safeguards and management measures that would be implemented by the Applicant. Reference is made, where appropriate, to the current approved *Water Management Plan* (GHD, 2017) for the existing TGO Mine Site.

6.6.2 Existing Environment

6.6.2.1 Catchment Setting

Regional Setting

The Project Site is located within the Macquarie-Bogan catchment which covers an area of approximately 74 000km^2 and encompasses the regional centres of Bathurst, Orange, Dubbo, Nyngan and Bourke (**Figure 6.6.1**).

The Macquarie and Bogan Rivers are the principal watercourses of the Macquarie-Bogan catchment. The Macquarie River rises to the south of Oberon and flows generally in a northwesterly direction. Flows in the river are regulated by Windamere and Burrendong Dams which are the major sources of both town and agricultural water for the principal population centres within the catchment. The Macquarie River also supports the Ramsar-listed Macquarie Marshes located in the western reaches of the catchment between Dubbo and Brewarrina.

The Bogan River rises to the south of Peak Hill and flows northwest through Nyngan before discharging to the Barwon River.

Local and Project Site Setting

In the vicinity of the Project Site, surface water drains generally from east to west, from the higher elevations of the Herveys Range, located approximately 10km to the east of the Project Site, to the Bogan River, located approximately 8km to the west of the Project Site (**Figure 6.6.2**).

As identified in Section 6.1.2.2, watercourses surrounding the Project Site are typically indistinct and ephemeral. The principal named watercourses that flow through the Project Site are as follows (**Figure 6.6.2**).

Figure 6.6.1
MACQUARIE - BOGAN CATCHMENT

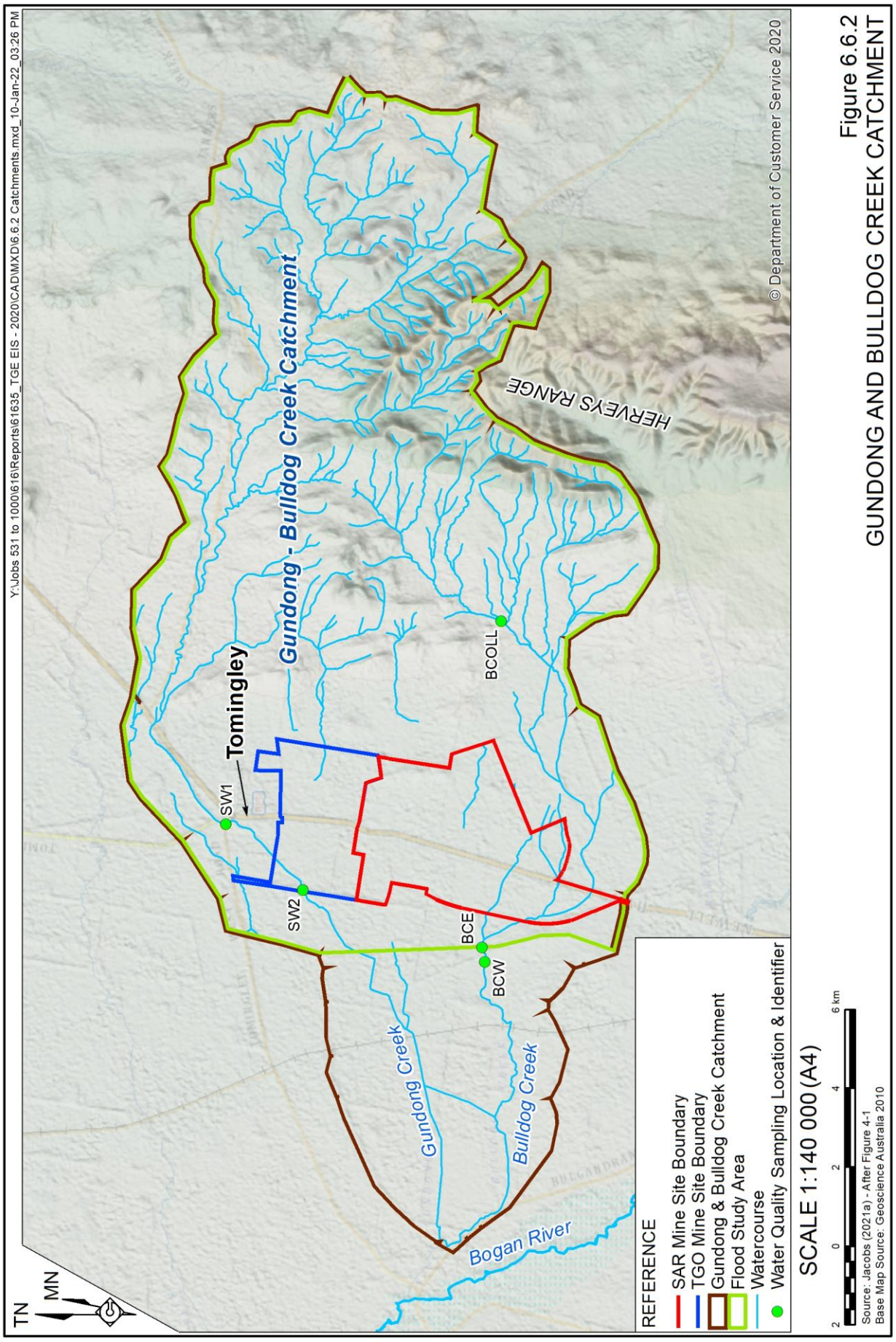

Figure 6.6.2
GUNDONG AND BULLDOG CREEK CATCHMENT

- Gundong Creek – an ephemeral watercourse that flows west and southwest, rising east of Tomingley, before passing through the northwestern section of the TGO Mine Site. The section of Gundong Creek in the vicinity of the TGO Mine Site is understood to have been diverted to its current alignment for the purposes of a market garden in the late 1800s. The original alignment of the creek was further to the west, flowing roughly parallel to Tomingley West Road.
- Bulldog Creek – an ephemeral watercourse comprising a network of indistinct drainage lines that flow to the west, rising in the Herveys Range, before flowing through the southern section of the SAR Mine Site, passing under the existing Newell Highway, turning north and crossing Back Tomingley West Road to the west of the SAR Mine Site.

Between these named watercourses are a series of unnamed watercourses, referred to for the purpose of this document as Drainage Lines A to F (see **Figure 6.6.3**).

The combined catchment area of Gundong and Bulldog Creeks is approximately 209.6km^2. Jacobs (2021a) define the catchment as flat, with ill-defined catchment boundaries and an average vectored slope of approximately 1.07%. The upper catchment is heavily forested with steeper channel reaches.

The Bulldog Creek sub-catchment area is approximately 30km^2 with an average vectored slope of 0.86%. **Plates 6.6.1** to **6.6.8** present a range of views of watercourses within the Bulldog Creek sub-catchment.

In the vicinity of the Project Site, waterways are defined as "uncontrolled streams under the *NSW Water Quality and River Flow Objectives – Macquarie-Bogan Catchment*. (DECCW, 2006). Section 4.2.2 of Jacobs (2021a) outlines the specific environmental values for uncontrolled streams within the Macquarie-Bogan catchment.

Jacobs (2021a) classified the area in the vicinity of the Project Site as 'slightly to moderately disturbed' in accordance with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018). Annexure A of Jacobs (2021a) describes the key water quality indicators and environmental values for waterways within the Gundong and Bulldog Creeks combined catchment.

6.6.2.2 Local Hydrological Setting

Table 6.6.1 and **Figure 6.6.3** presents the key hydrological features of the principal waterways and drainage lines within and in the vicinity of the Project Site.

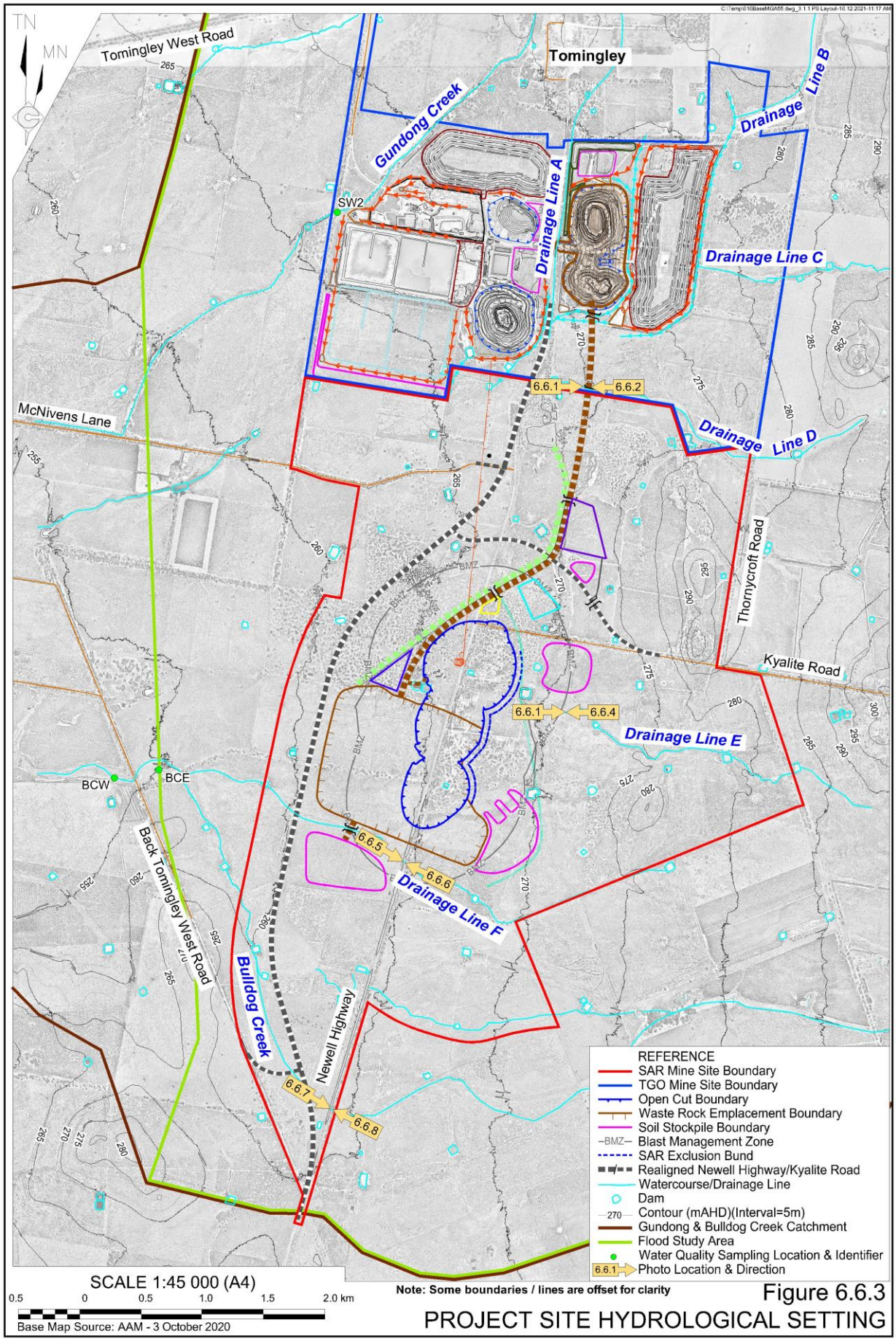

Figure 6.6.3
PROJECT SITE HYDROLOGICAL SETTING

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Plate 6.6.1: Drainage Line D - Looking East
(Source - Tomingley Gold Operations Pty Ltd)

Plate 6.6.2: Drainage Line D - Looking West
(Source - Tomingley Gold Operations Pty Ltd)

Plate 6.6.3: Drainage Line E - Looking East with existing contour bank in foreground
(Source - Tomingley Gold Operations Pty Ltd)

Plate 6.6.4: Drainage Line E - Looking West
(Source - Tomingley Gold Operations Pty Ltd)

See Figure 6.6.3 for Plates locations

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Plate 6.6.5: Drainage Line F - Looking East
(Source - Tomingley Gold Operations Pty Ltd)

Plate 6.6.6: Drainage Line F - Looking West
(Source - Tomingley Gold Operations Pty Ltd)

Plate 6.6.7: Bulldog Creek - Looking East with roadside table drain in foreground
(Source - Tomingley Gold Operations Pty Ltd)

Plate 6.6.8: Bulldog Creek - Looking West with roadside drainage in foreground and farm dam in middle ground
(Source - Tomingley Gold Operations Pty Ltd)

See Figure 6.6.3 for Plates locations

Table 6.6.1
Key Surface Water Features

Watercourse	Strahler Stream Order	Stream Type	Location Relative to Project Site	Description	Sensitive Receiving Environment (Sensitivity)
Gundong Creek	Five	Ephemeral	Traverses the northeastern corner of the TGO Mine Site. Does not traverse any proposed Project-related disturbance area.	• Limited channel definition near the Project Site but is a well-defined channel upstream. • Waterway is mapped as Key Fish Habitat (DPIE, 2021b). • No riparian vegetation near the Project Site but some present upstream, with potential instream habitat features. • Water usually not present. • Flows in a southwest direction to the Bogan River during and following rainfall only. • Minor erosion potential if the watercourse experiences high flows. • No threatened aquatic species distribution mapped in the waterway (DPIE, 2021b).	Yes - Low
Drainage Line E (**Plates 6.6.3** and **6.6.4**)	One	Drainage Depression	Traverses the central section of the SAR Mine Site and would be diverted by the SAR Open Cut Clean Water Diversion Bund	• No channel definition. Minor depression in landscape. • Occasional flow in a southwesterly direction toward Bulldog Creek. • Water may pond in depressions occasionally following rainfall.	No – Very Low
Drainage Line F (**Plates 6.6.5** and **6.6.6**)	Two	Drainage Depression	Traverses the southern section of the SAR Mine Site and would pass between the SAR Waste Rock Emplacement and southern	• No channel definition. Minor depression in landscape. • Occasional flow in a westerly direction toward Bulldog Creek. • Water may pond in depressions occasionally following rainfall. • No aquatic environment present.	No – Very Low
Bulldog Creek (**Plates 6.6.7** and **6.6.8**)	Four	Ephemeral Stream and Wetland	Traverses the southern section of the SAR Mine Site. Intersects the current and proposed alignment of the Newell Highway.	• No channel definition. • Waterway is mapped as Key Fish Habitat (DPIE, 2021a). • No aquatic features or riparian vegetation in proximity of the Project Site although potentially some aquatic habitat upstream. • Water usually not present. • Generally flows in a westerly direction to Bogan River during and following rainfall. • Minor erosion potential if experiences high flows. • No threatened aquatic species distribution mapped in the waterway (DPIE, 2021b).	Yes – Low

Source: Jacobs (2021a) – modified after Table 5-2.

6.6.2.3 Flooding

The design of the existing alignment of the Newell Highway results in a highly variable level for flood immunity and overtopping depth. However, Jacobs (2021b) state that the general flood immunity is less than 20% Annual Exceedance Probability (AEP) event[6] (i.e., there is currently more than a 20% chance in each year that the Newell Highway will be cut by flooding at a given location) with overtopping depths of between 10mm and 295mm. This corresponds with observed flooding of the highway every 3 to 4 years.

6.6.2.4 Water Usage

Water usage within and surrounding the Project Site is limited to agricultural use, with overland and flows controlled by a limited number of diversion bunds and surface water captured by a range of farm dams and storages. Within disturbed sections of the TGO Mine Site, surface water is classified as dirty, mine or process water (see Section 3.9.2.2) and is retained on site for mining-related purposes. Clean water is diverted around disturbed sections of the TGO Mine Site.

The Project Site is located within the Upper Bogan River Water Source under the *Water Sharing Plan for the Macquarie Bogan Unregulated Rivers Water Sources 2012*. A review of the NSW Water Register identified a total of 1 849 share components have been issued under this plan, distributed amongst 47 water access licences comprising:

- 6 domestic and stock licences;
- 4 stock licences;
- 2 town water supply licences;
- 14 unregulated river licences; and
- 1 unregulated river (special additional high flow) licence.

The NSW Water Register identifies that in financial year 2021, 25.8ML of the available 1 849ML of water was extracted under the issued licences.

The Applicant does not hold a surface water licence under the *Water Sharing Plan for the Macquarie Bogan Unregulated Rivers Water Sources 2012*. Rather reliance is placed upon its harvestable right under Section 53 of the *Water Management Act 2000* (see Section 6.6.7).

6.6.2.5 Water Quality

Gundong Creek

Surface water quality monitoring for Gundong Creek has been undertaken both upstream (SW1) and downstream (SW2) of the TGO Mine Site (**Figure 6.6.2**). As an ephemeral waterway, sampling is only undertaken during periods of water flow, resulting in irregular sampling opportunities and data availability.

[6] The Annual Exceedance Probability (AEP) is the probability of a rainfall event occurring in a particular 12-month period. For example, a 1% AEP rainfall event would have a 1% or 1 in 100 change of occurring in any one year. Such a rainfall event is commonly referred to as a 1 in 100-year rainfall event.

Table 6.6.2 presents the summary of the surface water quality monitoring for Gundong Creek between July 2015 and December 2017. These results are summarised as follows.

- Water quality for a range of analytes exceeds the relevant water quality objectives both upstream and downstream of the TGO Mine Site. In particular, nutrient concentrations are very high, with elevated levels of metals, including aluminium, iron, chromium, copper, zinc, selenium and lead. In fact, the levels for aluminium, selenium and iron are 73, 20 and 12 times greater than the identified water quality objectives or the protection of aquatic ecosystems, respectively. As these results are observed in samples from both upstream and downstream of the Project Site, they are unrelated to the Applicant's operations.

Table 6.6.2
Median Water Quality – Gundong Creek

Water Quality Indicator (units)	Sampling Point		Water Quality Objective (aquatic ecosystems)[1]
	Upstream - SW1 (number of samples)	Downstream - SW2 (number of samples)	
Electrical Conductivity (µS/cm)	168 (58)	175 (57)	<456
pH	7.42 (58)	**8.3 (57)**	7-8
Turbidity (NTU)	**165 (6)**	**138 (6)**	<20
Total Suspended Solids (mg/L)	16.5 (58)	14 (57)	No guideline
Ammonia (mg/L)	0.01 (58)	0.0075 (58)	0.013
Oxidised Nitrogen (mg/L)	**0.35 (58)**	**0.295 (58)**	0.015
Total Nitrogen (mg/L)	**1.3 (58)**	**1.25 (58)**	0.6
Total Phosphorus (mg/L)	**0.085 (56)**	**0.075 (56)**	0.035
Aluminium (total) (mg/L)	**3.99 (57)**	**4.03 (57)**	0.055
Iron (total) (mg/L)	**3.7 (57)**	**3.59 (57)**	0.3
Mercury (total) (mg/L)	<0.0001 (56)	<0.0001 (56)	0.00006
Molybdenum (total) (mg/L)	0.001 (26)	0.001 (26)	0.034
Nickel (total) (mg/L)	0.003 (57)	0.003 (57)	0.011
Arsenic (total) (mg/L)	0.002 (57)	0.002 (57)	0.013
Boron (total) (mg/L)	0.025 (28)	0.025 (29)	0.94
Cadmium (total) (mg/L)	0.00005 (57)	0.00005 (57)	0.0002
Chromium (total) (mg/L)	**0.004 (57)**	**0.004 (57)**	0.001
Copper (total) (mg/L)	**0.004 (57)**	**0.004 (57)**	0.0014
Zinc (total) (mg/L)	**0.01 (57)**	**0.01 (57)**	0.008
Selenium (total) (mg/L)	**0.005 (57)**	**0.01 (57)**	0.0005
Lead (total) (mg/L)	**0.005 (57)**	**0.004 (57)**	0.0034

Note 1: See Table 5-3 of Jacobs (2021a) for source of water quality objective
Note: **Bold** text indicates values in exceedance of water quality objectives.

Source: Jacobs (2021a) – modified after Table 5-3

- There is variable water quality in Gundong Creek with many indicators not meeting the nominated targets for protection of aquatic ecosystems.
- There is typically limited variation between the upstream and downstream water quality results, with only one additional exceedance of the water quality objectives downstream compared to the upstream, namely for pH, with an increase in the median value from 7.42 to 8.3.

Bulldog Creek

Surface water quality monitoring of Bulldog Creek occurred in June, November and December 2021. Monitoring was undertaken at three locations, namely BCE, BCW and BCOLL (**Figure 6.6.2**). Site BCOLL is located on Bulldog Creek at O'Learys Lane upstream of the Project Site. Locations BCE and BCW are located downstream of the Project Site east and west of the Back Tomingley West Road ford across Bulldog Creek. **Table 6.6.3** presents the results of surface water quality results for Bulldog Creek.

Table 6.6.3
Existing Water Quality and Compliance of Gundong Creek

Water Quality Indicator (units)	Sampling Point			Water Quality Objective (aquatic ecosystems)[1]
	Upstream – BCOLL (June, November and December 2021)	**Downstream – BCE** (June 2021)	**Downstream – BCW** June and December 2021)	
Electrical Conductivity (µS/cm)	101-152	107	107-179	<456
pH	7.17-7.36	7.09	6.92-7.12	7- 8
Total Suspended Solids (mg/L)	2.5-18	**22**	**2.5-22**	<20
Ammonia (mg/L)	0.005-0.04	<0.01	0.005-0.02	N/A
Oxidised Nitrogen (mg/L)	**0.04-1.37**	0.01	**0.01-0.04**	0.013
Total Nitrogen (mg/L)	**1.5-3.0**	**1.8**	**1.7-2.0**	0.015
Total Phosphorus (mg/L)	**0.08-0.14**	**0.22**	**0.11-0.18**	0.6
Aluminium (total) (mg/L)	**0.54-4.54**	**9.7**	**0.15-5.63**	0.035
Iron (total) (mg/L)	**0.60-4.48**	**6.7**	**0.62-5.52**	0.055
Mercury (total) (mg/L)	<0.0001	<0.0001	<0.0001	0.3
Molybdenum (total) (mg/L)	**0.0005-0.026**	<0.001	<0.001	0.00006
Nickel (total) (mg/L)	0.004-0.005	0.007	0.003-0.005	0.034
Arsenic (total) (mg/L)	0.001-0.002	0.003	0.002	0.011
Boron (total) (mg/L)	**0.0025-0.13**	<0.05	0.025-0.08	0.013
Cadmium (total) (mg/L)	<0.0001	<0.0001	<0.0001	0.94
Chromium (total) (mg/L)	**0.001-0.005**	**0.009**	**0.001-0.006**	0.0002
Copper (total) (mg/L)	**0.0005-0.003**	**0.007**	**0.005-0.006**	0.001
Zinc (total) (mg/L)	**0.0025-0.007**	**0.027**	**0.0025-0.013**	0.0014
Selenium (total) (mg/L)	<0.01	<0.01	<0.01	0.008
Lead (total) (mg/L)	**0.0005- 0.007**	**0.003**	**0.0005-0.002**	0.0005

Note 1: See Table 5-3 of Jacobs (2021a) for source of water quality objective

Note: **Bold** text indicates values in exceedance of water quality objectives.

Source: Jacobs (2021a) – modified after Table 5-4

Table 6.6.3 shows that the existing water quality of Bulldog Creek is often above recommended levels for water quality objectives. The upstream and downstream environment is generally of similar quality, and all sites are within recommended levels for pH, electrical conductivity, selenium and the trace metals mercury, nickel, arsenic and cadmium. Molybdenum and boron were above guidelines at the upstream monitoring site. Concentrations of TN, TP, aluminium and iron were significantly higher than recommended guideline values at all sites. Selenium was below detection limit at all sites on all occasions

6.6.3 Potential Surface Water Impacts

Jacobs (2021a) identified a number of Project-related aspects that could potentially impact the downstream surface water environment, including the following.

- Flow reduction through:
  - interception of runoff by the Project water management system; and/or
  - changes in runoff characteristics in areas disturbed by the mining-related activities.
- Water availability through:
  - loss of access for existing water users as the result of streamflow reduction; and/or
  - Project Site water requirements placing additional demand on local surface water resources.
- Water quality changes through:
  - uncontrolled discharge of dirty water to the downstream surface water environment; and/or
  - the discharge of mine or process water containing dissolved metals, salts or chemicals to the downstream surface water environment either via uncontrolled discharge from surface water management infrastructure or seepage to shallow groundwater systems connected to surface water systems.
- Flooding within:
  - existing watercourses such that adjacent land may experience an increase (or decrease) in the frequency, magnitude, velocity and water levels as a result; and/or
  - areas that that may impact on the operation of the Newell Highway, including through overtopping of the highway.

Sections 6.1, 6.2 and 6.3 of Jacobs (2021a) describe the potential sources of surface water impacts across the construction, operational and decommissioning (including final landform) stages of the Project.

6.6.4 Avoidance, Management and Mitigation Measures

6.6.4.1 Introduction

The Applicant, in conjunction with Jacobs and GHD, has identified a range of measures to minimise the potential for adverse surface water impacts.

Surface water within the TGO Mine Site is managed in accordance with the existing and approved *Surface Water Management Plan*, presented as Appendix C of the site's *Water Management Plan* (GHD, 2017). The *Water Management Plan* would continue to be implemented within the TGO Mine Site and, if approval for the Project is granted, the Plan will be reviewed and revised to include specific management and monitoring that would be required to manage the surface water environment within the SAR Mine Site.

A separate *Construction Soil and Water Management Plan* would be prepared to address surface water management during SAR Mine Site construction and site establishment operations.

Finally, as indicated in Section 3.4.3, one or more detailed *Construction Environmental Management Plans* would be prepared for construction of the proposed realigned Newell Highway and Kyalite Road. That Plan would include a separate *Soil and Water Management Subplan*, incorporating an *Erosion and Sediment Control Plan.* It is anticipated that each of these Plans would be required to be prepared in consultation with the relevant government agencies and approved by DPE.

6.6.4.2 Avoidance and Mitigation through Project Design

Key infrastructure within the Project Site has been designed in consideration of potential surface impacts and mitigation. In particular, the Applicant would implement the following (**Figure 3.9.2**).

- Construct the proposed SAR Open Cut and SAR Administration Area Clean Water Diversions to divert clean water around the proposed SAR Mine Site disturbance areas. The bunds would have a minimum freeboard of 0.5m above the anticipated 0.1% AEP flood level.
- Construct dirty water diversion structures, sediment basins and the SAR Water Storage Dam in a manner that would contain all dirty water within the SAR Mine Site.
- Establish pump and pipe infrastructure between the proposed sediment basins and the SAR Water Storage Dam to allow the required storage volume of the sediment basins to be restored within 5 days of a rainfall event.
- Establish pump and pipe infrastructure between the SAR Water Storage Dam and the TGO Mine Site to allow two-way transfer of water.
- Construct culverts under all public roads and the proposed Haul Road and Services Road.

6.6.4.3 Operational Management and Mitigation Measures

The Applicant would implement the following surface water-related management and mitigation measures throughout the life of the Project.

- Implement all measures identified in the various *Water Management Plans* for the Project. In particular, install all erosion and sediment control structures prior to undertaking substantial surface disturbing activities.
- Ensure that dirty, mine or process water is separated and retained within the Project Site for use for mining-related purposes.
- Ensure that all clean water from upslope of the Project Site is conveyed around disturbed sections of the Project Site at non-erosive velocities and is discharged to the downstream environment.
- Inspect and maintain all surface water management infrastructure to ensure it continues to operate as designed and maintain surface water storages to ensure adequate capacity is maintained to capture and store surface water within the Project Site.
- Rehabilitate all disturbed areas as soon as practicable once no longer required for mining-related purposes.
- Store hydrocarbons, reagents and chemicals in accordance with the relevant Australian Standard or manufactured instructions.
- Undertake refuelling and maintenance activities in designated sections of the Project Site with spill capture and management infrastructure and protocols.
- Securely store and regularly remove all waste oil and contaminated waste from the Project Site.
- Ensure that the proposed pastefill plant is bunded to prevent discharge of low pH water.
- Ensure that water use within the Project Site is managed in accordance with the water balance presented in Section 3.9.4 or subsequent versions included within the *Water Management Plan.*
- Monitor surface water flows and quality at a range of locations upslope, within and downslope of the Project Site, including within Gundong and Bulldog Creeks, as well as in unnamed watercourses.

6.6.5 Assessment Methodology

6.6.5.1 Water Quality

The water quality assessment area includes the Gundong and Bulldog Creek Catchment (**Figure 6.6.2**). Jacobs (2021a) assessed potential water quality impacts associated with the following activities against the requirements of the *NSW Water Quality Objectives*.

- Construction of the realigned Newell Highway and Kyalite Road, as well as construction and establishment of the SAR Mine Site.

- Operation of the existing TGO and proposed SAR mining operations.
- Decommissioning and establishment of the final landform.

6.6.5.2 Flooding and Hydrology

Jacobs (2021b) modelled the hydrologic impacts of the proposed infrastructure and landform elements of the SAR Mine Site using the hydrologic software XP-RAFTS 2018.1 and the hydraulic software TUFLOW (2020) for the following rainfall events.

- 20% AEP
- 10% AEP
- 5% AEP
- 5% AEP with anticipated climate change
- 2% AEP
- 1% AEP
- 0.1% AEP

The model was parametrised as follows. Additional detail in relation to model setup is presented in Jacobs (2021b).

- Catchment representation - **Figure 6.6.2** presents the catchment area assessed by Jacobs (2021b). The assessed catchment largely corresponds with the combined catchment of Gundong and Bulldog Creeks upstream of Back Tomingley West Road. The catchment was divided into 30 sub-catchments based on available 5m contour data.
- Design rainfall – Design rainfall depths and intensities were adopted based on the Bureau of Meteorology Intensity–Frequency–Duration data for each sub-catchment. Table 2-1 of Jacobs (2021b) presents the adopted rainfall depths for the modelled rainfall events.
- Temporal patterns – the critical temporal patterns for the hydraulic model were determined based on *Australian Rainfall and Runoff 2019* to determine the critical duration event.
- Catchment losses – were determined using the Flood Frequency Analysis-Reconciled (Probability Neutral) losses specific to NSW developed by the NSW Office of Environment and Heritage.

The RAFTS model was validated using the Regional Flood Frequency Estimation tool, with model inputs adjusted until within reasonable bounds, until the modelled design flows were within the confidence limits of the tool.

Potential climate change impacts on the modelled results were assessed using the 5% AEP event. The *Australian Rainfall and Runoff* (2019) Representative Concentration Pathways guidelines for an intermediate climate change scenario was selected, representing a 13.1% increase in rainfall intensity by the year 2090. Table 2-5 of Jacobs (2021b) presents the rainfall intensity growth factors adopted by Jacobs (2021b).

The hydraulic model used to estimate flood levels and flow velocities was a 1D/2D hydrodynamic TUFLOW model. The model utilised the flows generated by the XP-RAFTS hydrologic model. The TUFLOW model setup is presented in Section 3.1 of Jacobs (2021b) and summarised below.

- Model extent and terrain - The model extent covers 10.7km length of the Newell Highway and extends approximately 3.5km upstream and 3.7km downstream of the road with a total area of 58km^2. The model terrain was based on a 1m resolution LiDAR data captured in 2020.
- Boundary Conditions – a direct rainfall approach (rain-on-grid) was applied for the SAR Catchment. Additional inflows representing the catchments upstream of the rain-on-grid model area were incorporated based on the flows generated by the XP-RAFTS hydrologic model. The downstream boundary was modelled as a free flow boundary.
- Culverts – existing culverts, including location and size, were based on an inspection and as constructed drawings of the existing Newell Highway. Proposed culvert locations and sizes were determined in consultation with Constructive Solutions in an iterative manner.

6.6.6 Assessment of Impacts

6.6.6.1 Water Quality

Jacobs (2021a) undertook an assessment of water quality impacts of the principal watercourses described in Section 6.6.2.2 during construction, operation, and decommissioning and rehabilitation of the Project. Sections 6.1 to 6.3 of Jacobs (2021a) present the results of that assessment. However, in summary, taking into consideration the proposed management and mitigation measures, including the proposed retention of dirty, mine and process water within disturbed sections of the Project Site and implementation of erosion and sediment control measures, Jacobs (2021a) determined the following.

- The principal watercourses in the vicinity of the Project Site are minimally sensitive to hydrological and water quality impacts based on identified characteristics of the waterways.
- Proposed management and mitigation measures would result in no significant impacts to surface water quality from the construction, operation, and decommissioning and rehabilitation of the Project.
- The Project is not expected to impact on achieving the following NSW Water Quality Objectives.
  - Protection of aquatic ecosystems.
  - Visual amenity (of surrounding watercourses).
  - Use for primary or secondary contact recreation.
  - Use for irrigation, stock or domestic water supply.

6.6.6.2 Flooding

Sections 3.2 and 3.4 of Jacobs (2021b) presents the results of the flood modelling undertaken for the Project.

Existing Flooding

Figure 6.6.4 presents the modelled existing flow paths within and surrounding the SAR Mine Site. In summary, there are three main flow paths through the Project Site as follows.

- A northern flow path associated with Gundong Creek.
- A central flow path associated with Drainage Line D.
- A southern flow path associated with minor tributaries that merge with Bulldog Creek downstream of the existing Newell Highway. Significantly, the named Bulldog Creek upstream of the existing Newell Highway is not the principal watercourse in that area.

Figure 6.6.5 presents the modelled existing flood depths for the 5% AEP rainfall event. In summary:

- a peak flow of 63m^3/s and 12m^3/s would arrive at the Newell Highway through the Drainage Line D and southern flow path (Bulldog Creek) respectively; and
- flood depths of up to 1.4m occur immediately upstream of the Newell Highway in the vicinity of Drainage Line D and up to 1.2m upstream of the Newell Highway in the vicinity of Drainage Line F and Bulldog Creek.

Modelling indicates that the existing Newell Highway is overtopped under a 20% AEP rainfall event, with up to 295mm of water over the Highway in the vicinity of Drainage Line D and between Drainage Line E and Bulldog Creek.

Anticipated Flood Levels

Figure 6.6.6 presents the modelled flood depths for the 5% AEP rainfall event with the proposed SAR Mine Site infrastructure and realigned Newell Highway and Kyalite Road. The 5% AEP results are summarised as follows.

- Flood depths of approximately 1.0m would occur immediately upstream of the proposed SAR Open Cut Clean Water Diversion Bund. Under a 0.1% AEP rainfall event, flood depths of approximately 1.5m would occur immediately upstream of the Bund. The Applicant has committed to establishing the Bund with a minimum 0.5m freeboard above the 0.1% AEP rainfall event.
- Flood depths of up to 2.0m would occur immediately upstream of the proposed Haul Road and Services Road in the vicinity of Drainage Line D, with the Haul Road and Services Road acting as a control structure for water in this area.
- Flood depths of up to 1.5m are expected immediately upstream of the realigned Newell Highway in the vicinity of Drainage Line D.

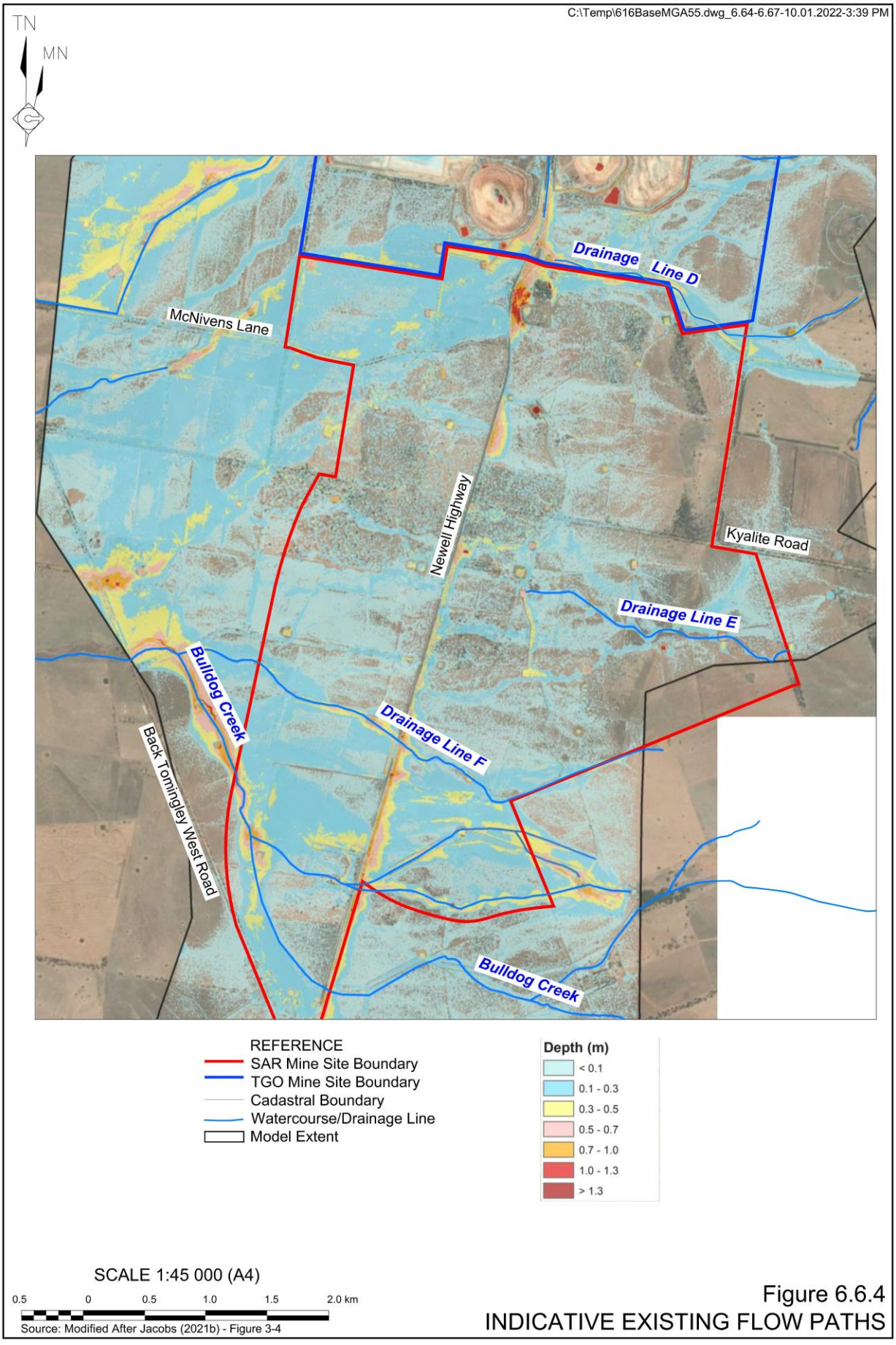


Figure 6.6.4
INDICATIVE EXISTING FLOW PATHS

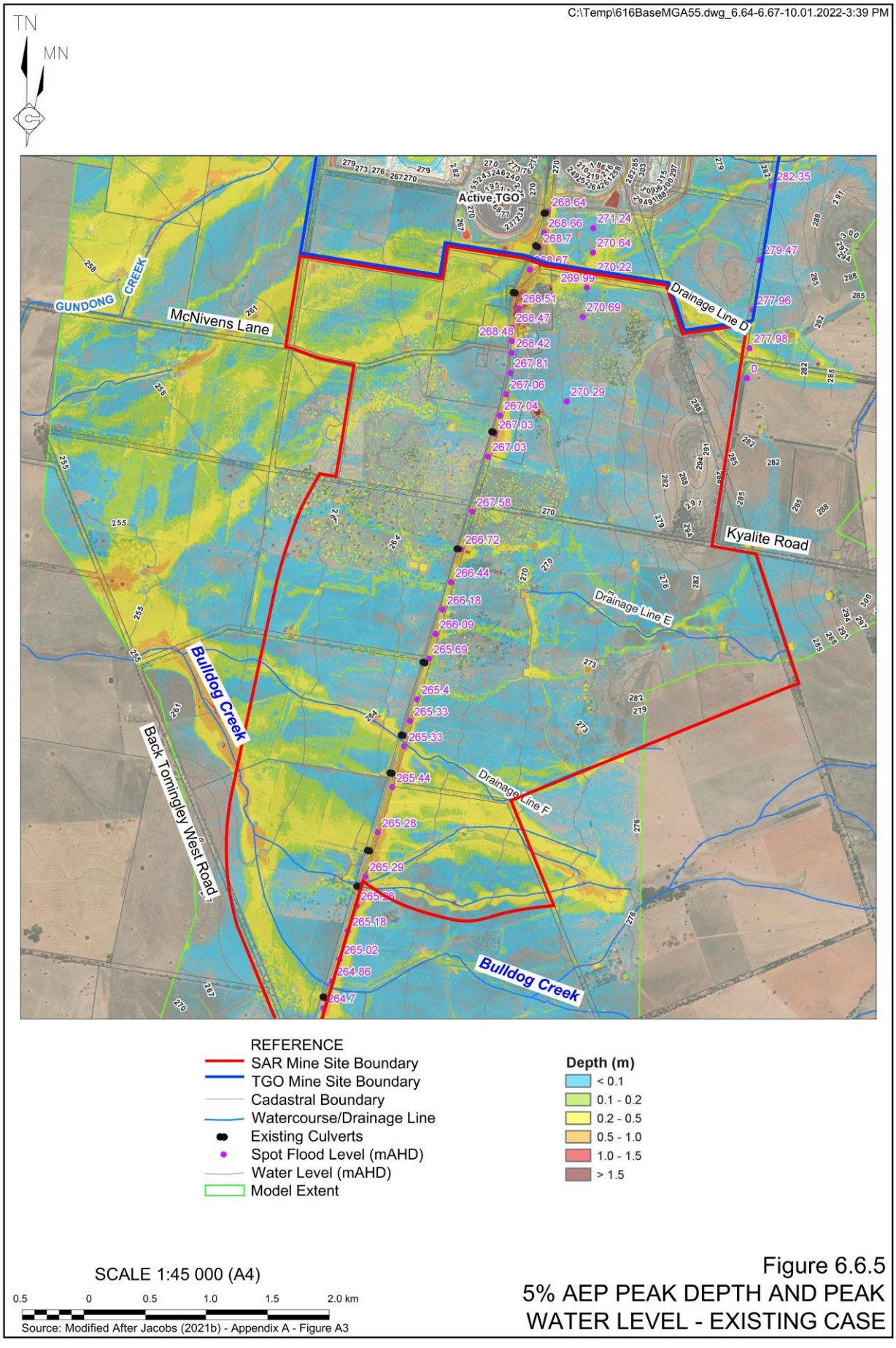


Figure 6.6.5
5% AEP PEAK DEPTH AND PEAK WATER LEVEL - EXISTING CASE

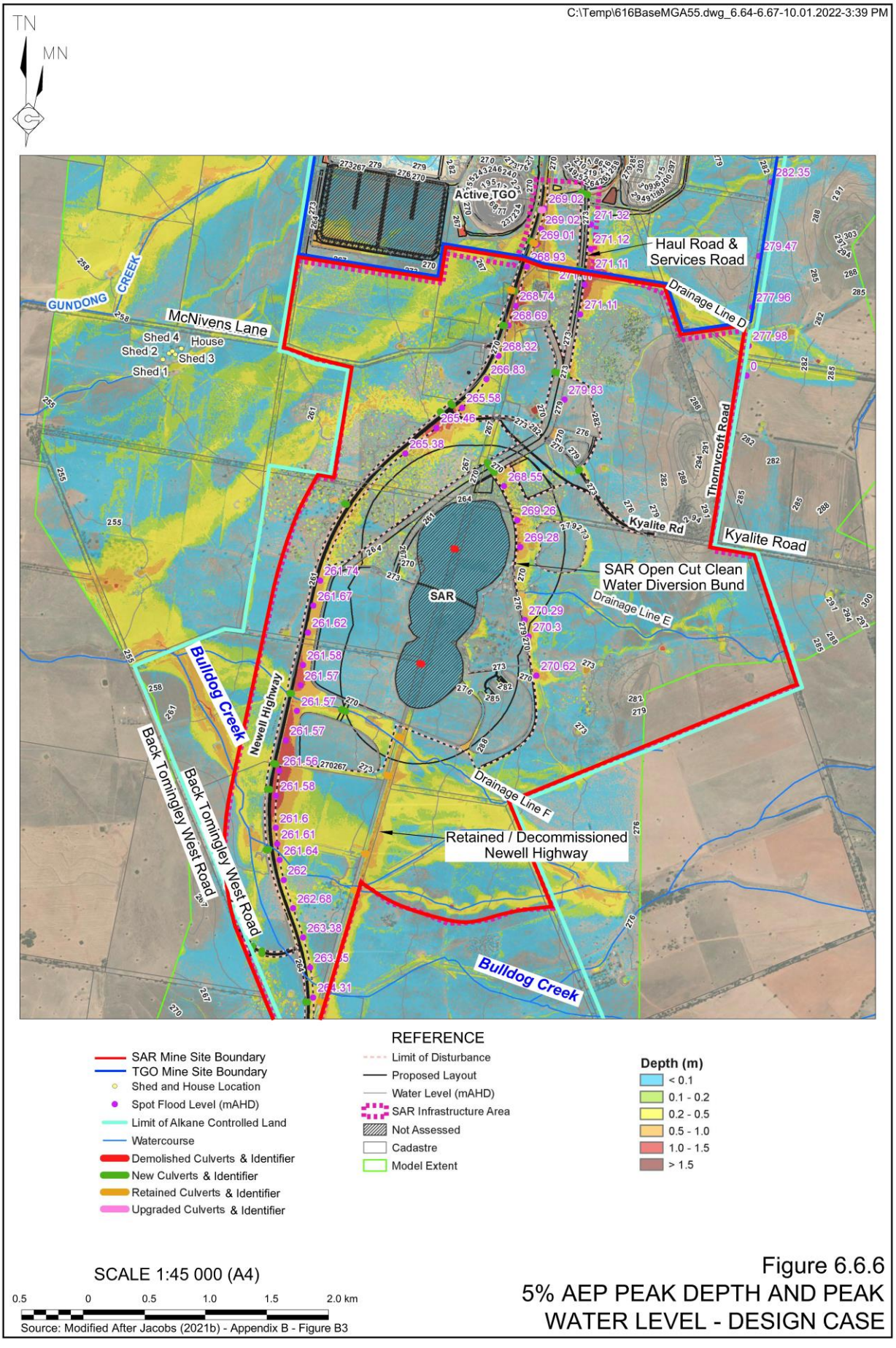


Figure 6.6.6
5% AEP PEAK DEPTH AND PEAK WATER LEVEL - DESIGN CASE

- Flood depths of up to 1.0m are expected immediately upstream of the retained Newell Highway in the vicinity of Drainage Line F and Bulldog Creek, with the retained Highway acting as a control structure for water in this area.
- Flood depths of up to 1.5m are expected immediately upstream of the retained Newell Highway in the vicinity of Drainage Line F and Bulldog Creek.

Flood Immunity of Public Roads

Jacobs (2021b) identifies that the proposed realigned Newell Highway would achieve a 1% AEP flood immunity with a minimum freeboard of 200mm across the proposed new alignment, with some areas anticipated to reach a 0.1% AEP flood immunity. Compared to the maximum 20% AEP flood immunity of the current Newell Highway within Project Site, this represents a significant increase in flood immunity.

In addition, preliminary design of the culverts under the realigned Newell Highway would minimise scour risk with velocities below 3m/s during a 5% AEP event. Jacobs (2021b) also identify that 25% blockage of culverts on the realigned Newell Highway would not impact on achieving a 5% AEP flood immunity on that road.

The proposed realigned Back Tomingley West Road is expected to be overtopped by approximately 100mm under a 5% AEP rainfall event. Given the fact that Back Tomingley West Road is a Local road with low volumes of traffic, this is not considered to be a significant impact.

The flood immunity of the proposed realigned Kyalite Road would not be impacted the Project.

Flood Level Difference

Figure 6.6.7 presents the change in peak flood levels for the 5% AEP event. The results are summarised as follows.

- Peak flood levels upslope of the proposed Haul Road and Services Road and the realigned Newell Highway would be approximately 800mm higher than currently. This is primarily as a result of the construction the proposed roads resulting in ponding of water where no water previously ponded.
- Peak overland flow levels immediately south of the Wyoming 1 Open Cut are expected to be approximately 100mm lower than currently, primarily because the Newell Highway would not be overtopped during a 5% AEP rainfall event and peak flows would therefore be lower and later than is currently the case.
- Peak overland flow levels south and west of the approved Residue Storage Facility 2 are expected to be approximately 100mm lower than before the facility was constructed. This is partly as a result of the construction of the approved Residue Storage Facility 2 directing water further south and partly as a result of the Highway no longer overtopping. The Applicant has discussed this matter with the owners of both properties potentially impacted and has agreed to construct diversion banks to re-establish existing flows.

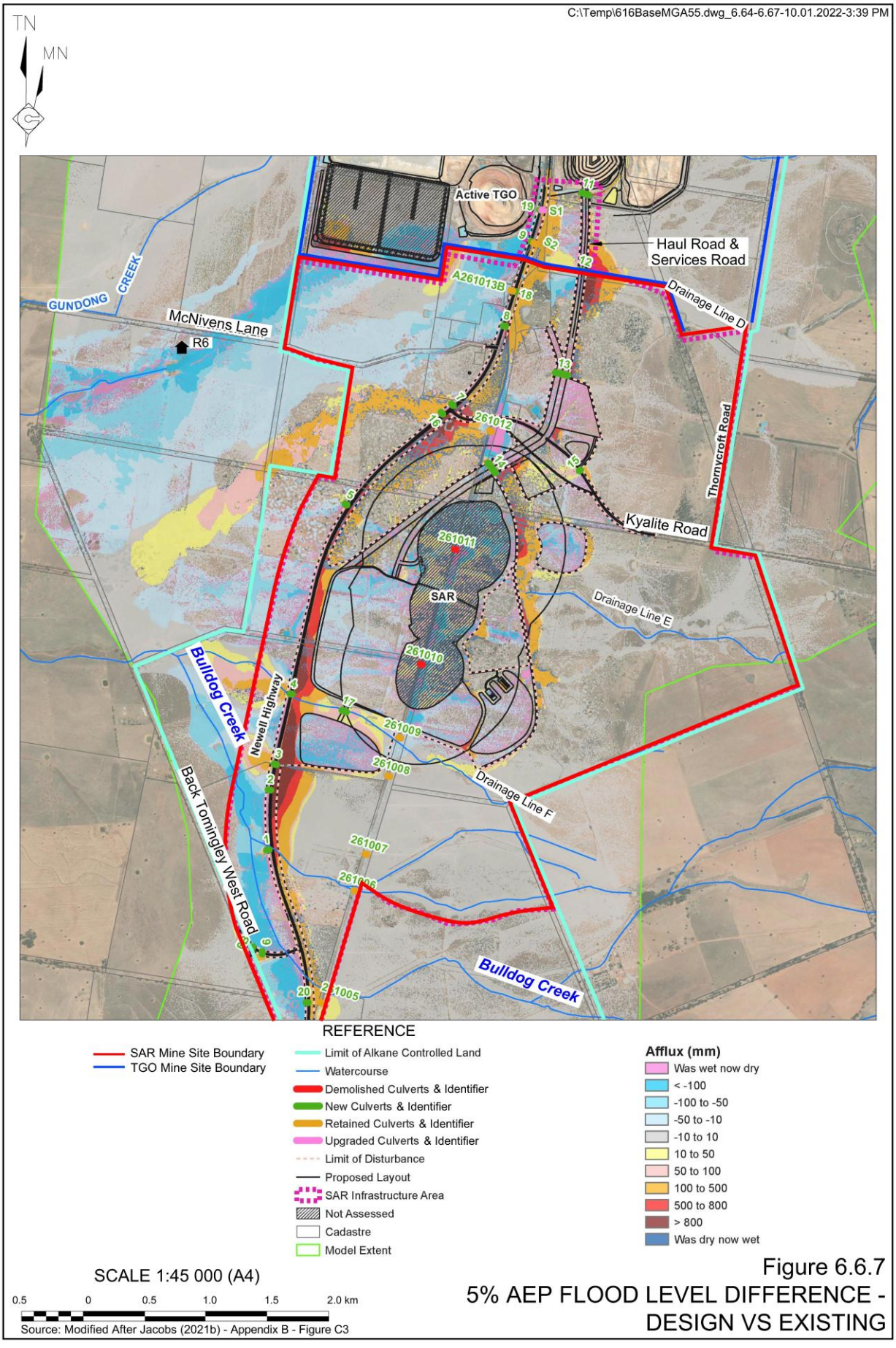


Figure 6.6.7
5% AEP FLOOD LEVEL DIFFERENCE - DESIGN VS EXISTING

- Peak overland flood levels downslope of the proposed intersection of the Newell Highway and Kyalite Road are expected to be approximately 100mm higher than currently. This is primarily the result of additional water being diverted to the north around the SAR Open Cut and passed through culverts to the south of the intersection. The Applicant has discussed these additional flows with the single landholder potentially affected and has agreed to relocate gate access to paddocks to facilitate access during periods of overland flow.
- Peak overland flood levels to the southwest of the SAR Open Cut are expected to be approximately 100mm higher than currently. This is primarily the result of additional water being diverted to the south around the SAR Open Cut. In addition, improvements in the flood immunity of the Newell Highway would result in water accumulating on the eastern side of the Highway and flowing northwards to proposed Culverts 2, 3 and 4 rather than overtopping the Highway as currently happens at existing Culverts 261005, 261006 and 261007. The anticipated additional flood height would be restricted to the Applicant's own land.
- Peak overland flood levels within the named Bulldog Creek downstream of the realigned Highway would be approximately 100mm lower than currently. This is primarily because the Newell Highway would not be overtopped during a 5% AEP rainfall event and peak flows would be lower than is currently the case, as well as diversion of water to the north as described previously.
- Overland flood levels at the point where Bulldog Creek meets Drainage Line F would be largely unchanged as a result of the Project because surface water flows merge at this point, resulting in a negligible change to water levels once each of the flood paths have merged.

Flood Impacts on Residence R6

Figure 6.6.7 presents the change in peak flood levels for the 1% AEP event in the vicinity of Residence R6, including surrounding infrastructure. Jacobs (2021b) estimate that in each case, the Project would result in improved flood immunity or reduced flood depth at the principal residence and surrounding farm sheds. The Applicant has committed to work with the owners of Residence R6 to ensure continued flow of surface water, but would also ensure that the existing flood levels at Residence R6 are not increased as a result of the proposed works.

Flood Volume and Timing

Figure 6.6.8 presents the modelled hydrograph results downstream of the proposed realigned Newell Highway under a 5% AEP event. In summary, Jacobs (2021b) predict a reduction in peak flow rate of $16m^3/s$ or 9% and a 2-hour delay in the peak flow as a result of the Highway no longer overtopping. Flood volume is predicted to be reduced by 2.9%, primarily due to the reduction in total catchment area (e.g. from the SAR Open Cuts). Jacobs (2021b) state that the predicted downstream impacts are relatively minor and unlikely to cause any material impacts.

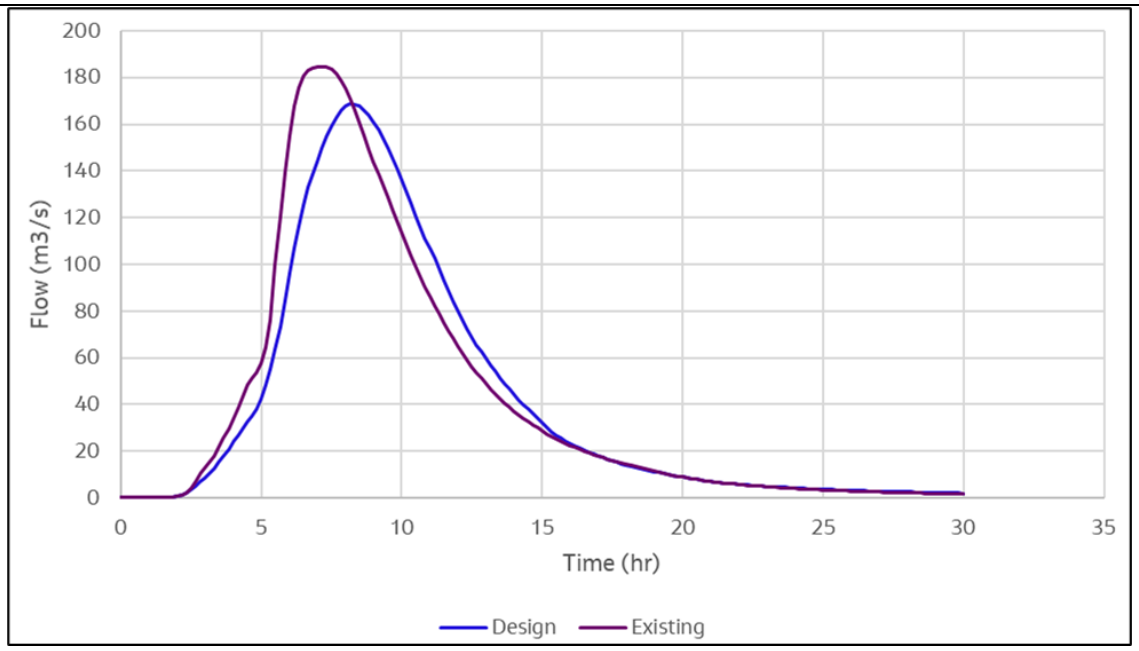


Figure 6.6.8
5% AEP Existing vs Design Hydrographs AEP Event

Source: Jacobs (2021b) - Figure 3.13

Post-mining Removal of Haul Road and Services Road

The Applicant proposes to reduce the width of the Haul Road and Services Road to that required for the proposed final land use, with proposed culverts and under road drainage retained (see Section 3.14). Notwithstanding this, Jacobs (2021b) undertook modelling of the anticipated final landform with the proposed Haul Road and Services Road removed. That assessment determined that there would be an increase in flood levels of up to 230mm upslope of the realigned Newell Highway should the Road be removed completely. However, culvert flow velocity would remain less than 3m/s. Notwithstanding the above, the proposed realignment of the Newell Highway would still achieve a 5% AEP flood immunity. Predicted flood levels downstream of Alkane controlled land would increase by up to 70mm should the Road be removed, with all increased flood levels restricted to agricultural land.

6.6.7 Licencing

The Applicant acknowledges its obligation to obtain a licence, or relevant exemption, to capture and retain surface water within the Project Site under Part 5 of the *Water Sharing Plan for the Macquarie Bogan Unregulated Rivers Water Sources 2012*.

Clause 3 of Schedule 1 of the *Water Management (General) Regulation 2018* identifies the following as excluded works for which a water access licence is not required.

> *"Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority … to prevent the contamination of a water source, that are located on a minor stream."*

As a result, licences are not required for the following water storages.

- Open cut sumps.
- Settling and Process Water Pond.
- Wyoming 1 Central Dam - North and South.
- SAR Water Storage Dam.
- Wyoming 3 Open Cut.

In addition, a licence is not required for the Raw Water Dam as that dam receives water from the "Woodlands" and "Dappo" bore only. However, a licence or exemption would be required for the existing and proposed sediment basins, because the water captured is and would be used for mining-related purposes.

Finally, in consultation with the Environment Protection Authority, Sediment Basins within the TGO Mine Site have been designed with a capacity that exceeds the requirement of *Managing Urban Stormwater* to limit the potential for discharge of sediment-laden water. As a result, the Applicant contends that the structures are classified as pollution control structures and are therefore exempt structures under Clause 3 of Schedule 1 of the *Water Management (General) Regulation 2018.* Sediment basins within the TGO Mine Site would be similarly sized and would also be exempt structures.

6.6.8 Monitoring

The Applicant would prepare an updated *Surface Water Management Plan* based on the existing TGO management plan that would identify the following surface water-related monitoring.

- Continued operation of the existing TGO Automatic Weather Station.
- Continued monitoring of surface water quality at the following locations within the TGO Mine Site under the following circumstances.
  - Gundong Creek (SW1 and SW2) ..... during discharge and when flowing
  - Existing sediment basins..... during discharge and following rainfall
  - Wyoming Central Dam – North ..... quarterly
  - Raw Water Dam ..... quarterly
  - Open cut sumps..... monthly (Weak Acid Dissociable Cyanide only)
  - Process Water Dam..... monthly (Weak Acid Dissociable Cyanide only)
  - Wyoming Central Dam – South .... monthly (Weak Acid Dissociable Cyanide only)
- Monitoring of surface water quality at the following locations within the SAR Mine Site under the following circumstances.
  - Bulldog Creek (BCE and BCOLL) during discharge and when flowing
  - Existing sediment basins..... during discharge and following rainfall
  - SAR Site Storage Dam ..... quarterly

6.6.9 Conclusion

Management of potential surface water impacts during the site establishment and operation of the Project would involve the adoption of a range of mitigation measures. The Applicant would establish erosion and sediment control measures during the initial site establishment phase of the Project and would ensure that all dirty, mine or process water would be retained within the Project Site for mining-related purposes. As a result, off-site impacts to surface water quality are not anticipated.

In addition, while the Project would result in minor changes to surface water flow patterns in the vicinity of the Project Site, with a substantial improvement in flood immunity for the realigned Newell Highway and minor changes to the existing flood levels downslope of the realigned Newell Highway. The proposed changed flood regime would primarily affect overland flows, with existing watercourses typically indistinct and poorly defined. As a result, the Project would not significantly impact on surrounding watercourses. In addition, these changes would primarily occur on the Applicant's own land, with consultation with two potentially affected landholders in progress.

The Project would result in reduction in flow volumes at Back Tomingley West Road (the limit of the hydrologic model) of approximately 2.9% as a result of water retained within disturbed sections of the Project Site. This reduction is considered to be insignificant.

Finally, the Project would not impact on water-related infrastructure or systems, other water users.

6.7 Groundwater

6.7.1 Introduction

The risk assessment undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in adverse impacts to groundwater. Risk sources with an assessed risk of "medium" or above after the adoption of standard mitigation measures is limited to discharge of contaminated groundwater into natural drainage (medium risk).

The SEARs for the Project require the EIS to include an assessment of the following potential impacts of the Project on groundwater.

- An assessment of the likely impacts of the Project on the quantity and quality of groundwater resources, having regard to the *NSW Aquifer Interference Policy*.
- An assessment of the hydrological characteristics of the Project Site, including the downstream environment.
- An assessment of the likely impacts of the Project on aquifers, watercourses, riparian land, water-related infrastructure and systems and other water users, including impacts to water supply from dams, and riparian and licensed water users.
- A description of the measures proposed, including monitoring activities and methodologies, to ensure the development can operate in accordance with the requirements of any relevant Water Sharing Plans or water source embargo.
- A detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts.

The assessment requirements of the Biodiversity, Conservation and Science Directorate, DPIE Water, Natural Resources Access Regulator, and Narromine Shire Council, and the Independent Scientific Committee were also considered during the preparation of the groundwater assessment. In addition, a conditional Gateway Certificate was issued on 15 November 2021. The requirements of that Certificate were also considered during the preparation of the groundwater assessment. A summary of the SEARs and the requirements of the consulted government agencies and conditional Gateway Certificate are listed in **Appendix 2,** together with a record of where each requirement is addressed in the EIS.

A *Groundwater Assessment* for the Project was undertaken by Jacobs Australia Pty Limited (Jacobs) and is presented as Part 6 of the *Specialist Consultant Studies Compendium* and hereafter referred to as Jacobs (2021c). It is noted that a draft of Jacobs (2021c) was provided with the application for the conditional Gateway Certificate and the final version of the groundwater assessment has addressed relevant recommendations of the Certificate.

The following subsections provide a summary of the groundwater assessment and describe the operational safeguards and management measures that would be implemented by the Applicant. Reference is made, where appropriate, to the current approved *Water Management Plan* (GHD, 2017) for the existing TGO Mine Site.

6.7.2 Regulatory and Policy Setting

Water Sharing Plans

The Project Site is located within the area governed by the Lachlan Fold Belt Murray Darling Basin (MDB) Groundwater Source of the *Water Sharing Plan for the NSW MDB Fractured Rock Groundwater Sources 2020* (the MDB Water Sharing Plan). The Groundwater Source is subdivided into management zones and the Project Site is located within the 'Lachlan Fold Belt MDB (Other) Management Zone'. The alluvial material that overlays the fractured rock within the Project Site is not covered by any alluvial Water Sharing Plan and is therefore covered by the MDB Water Sharing Plan.

As at March 2021, the *NSW Water Register* (Water NSW, 2021) indicates the Lachlan Fold Belt MDB Groundwater Source has 1 098 Water Access Licences (WALs) and a total share component of 75 819 units, with each unit generally permitting extraction of 1ML of water per year. The MDB Water Sharing Plan indicates the Lachlan Fold Belt MDB Groundwater Source has a long-term average annual extraction limit of 253 788 ML. Thus, about 70% of the groundwater in this water source is currently unassigned. Trading in this water source is common, and in the 2020/2021 water/financial year there were 52 records of transfer trading (Water NSW, 2021).

As outlined in Section 3.9.3, the Applicant currently operates a water supply bore on the "Woodlands" property[7] located approximately 7km to the east of Narromine (see **Figure 3.9.3**). Water Access Licence (WAL) 20270, issued under the Lower Macquarie Zone 6 Groundwater Source of the *Water Sharing Plan for the Macquarie-Castlereagh Groundwater Sources 2020*, permits extraction of up to 1 000MLpa from that bore. Extracted water is pumped via an approved water supply pipeline to the TGO Mine Site. That pipeline and water supply is also used to supplement the water supply for Tomingley village.

The Applicant proposes to replace an existing dilapidated bore[8] on the "Dappo" property (Lot 235, DP 755131). The replacement bore would:

- extract water from the same groundwater source and the same depth as the existing bore;
- be within 20m of the existing bore; and
- have an internal diameter the same as the existing bore.

In accordance with Clause 44 of the *Water Sharing Plan for the Macquarie-Castlereagh Groundwater Sources Order 2020*, the proposed bore would be classified as a "replacement bore" and no additional hydrogeological impact assessment is required.

The existing "Dappo" bore has an existing water allocation of 716MLpa under WAL11692. The Applicant proposes to subdivide WAL11692 and acquire a part of that licence to permit extraction of up to 400MLpa from the replacement bore. As the existing bore and associated WAL are already licenced and approved, the Applicant contends that a change of purpose from "irrigation" to "mining" is the only approval required and that no further groundwater assessment is required.

[7] Water Supply Works Authority 80WA705442.
[8] Water Supply Works Authority 80CA703364.

NSW Aquifer Interference Policy

The *NSW Aquifer Interference Policy* outlines 'Minimal Impact Considerations' for the assessment of aquifer interference activities, such as those proposed for the Project.

Different 'Minimal Impact Considerations' from the *NSW Aquifer Interference Policy* are applicable to different groundwater source types. In the context of the Policy, the Project Site is located within the 'porous and fractured rock water sources' sub-category of the 'less productive groundwater sources' category. This characterisation is made on the basis that groundwater systems in the vicinity of Project Site do not simultaneously have existing bores that can yield greater than 5L/s and a total dissolved solids concentration of <1 500mg/L.

Small perched discrete alluvial groundwater systems associated with watercourses exist in the vicinity of the Project Site. These groundwater systems are not recognised as being part of a distinct alluvial water source in the MDB Water Sharing Plan. Therefore, potential impacts to these alluvial groundwater systems have been assessed against the criterium applicable for the 'less productive' 'porous and fractured rock water sources' category.

In accordance with the *NSW Aquifer Interference Policy*, the Minimal Impact Considerations outlined in **Table 6.7.1** apply.

Table 6.7.1
Minimal Impact Considerations

Water Source	Water Table	Water Pressure	Water Quality
Porous and fractured rock groundwater sources	1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: a) high priority GDE; or b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan. A maximum of a 2m decline cumulatively at any water supply work. 2. If more than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: a) high priority GDE; or b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan then appropriate studies would be required to demonstrate to the Minister's satisfaction that the variation would not prevent the long-term viability of the dependent ecosystem or significant site. If more than 2m decline cumulatively at any water supply work, then make good provisions should apply.	1. A cumulative pressure head decline of not more than a 2m decline, at any water supply work. 2. If the predicted pressure head decline is greater than requirement 1 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline would not prevent the long-term viability of the affected water supply works unless make good provisions apply.	3. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity. 4. If condition 1 is not met then appropriate studies would be required to demonstrate to the Minister's satisfaction that the change in groundwater quality would not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.
Source: DPI (2012)			

6.7.3 Existing Groundwater Environment

6.7.3.1 Hydrostratigraphic Setting

Section 1.4.2 presents and overview of the geological setting of the Project Site. In summary, The TGO and SAR deposits are hosted by the Mingelo Volcanics, a north-south orientated unit of Ordovician-aged volcaniclastic breccias, andesitic lavas, volcaniclastic sandstones and siltstones intruded by sub-volcanic feldspar porphyries. Immediately to the west of the Mingelo Volcanics is the slightly younger siltstones and sandstones of the Cotton Formation. The basement geology is almost entirely covered by alluvial sequences of clays, sand and gravel up to approximately 70m thick.

Figures 3.7 to **3.9** present cross sections and a long section through the Roswell and San Antonio deposits. The groundwater environment within and surrounding the MLA Area is dominated by three broad groundwater systems as follows.

- Perched aquifer: A shallow and localised perched water table system associated with the larger drainages, particularly Gundong Creek. These systems are not located close to the MLA Area and as such will have no significant interaction from a groundwater perspective.
- Cainozoic alluvial groundwater system: The Cainozoic alluvial system comprises a relatively thick layer of generally low permeability fluvial sediments. In the vicinity of the MLA Area this unit has been shown to be unsaturated and does not locally represent an aquifer.
- Fractured rock groundwater system: Locally, in the vicinity of the MLA Area, the regional water table is expressed within the basement lithologies. The primary permeability of these basement lithologies is likely to be very low, however there is potential for enhanced permeability associated with structural deformation and discontinuities, zones of mineralisation, and chemical weathering within the transition zone from completely oxidised saprolite to moderately weathered formation.

Jacobs (2021c) estimated the groundwater recharge rate in the vicinity of the Project Site using the chloride mass balance methodology at 0.3mm/year or 0.05% of mean annual rainfall.

6.7.3.2 Regional Groundwater Setting

Regional Bore Network

The Australian Groundwater Explorer (BoM, 2021) identifies 34 registered bores within 10km of the SAR Open Cut (**Figure 6.7.1**). Annexure A of Jacobs (2021c) presents the available data on the 34 registered bores which are summarised as follows.

- Thirteen are for general water supply, including for domestic, agricultural and industrial uses.
- Twenty are for monitoring purposes.
- One is for exploration purposes.

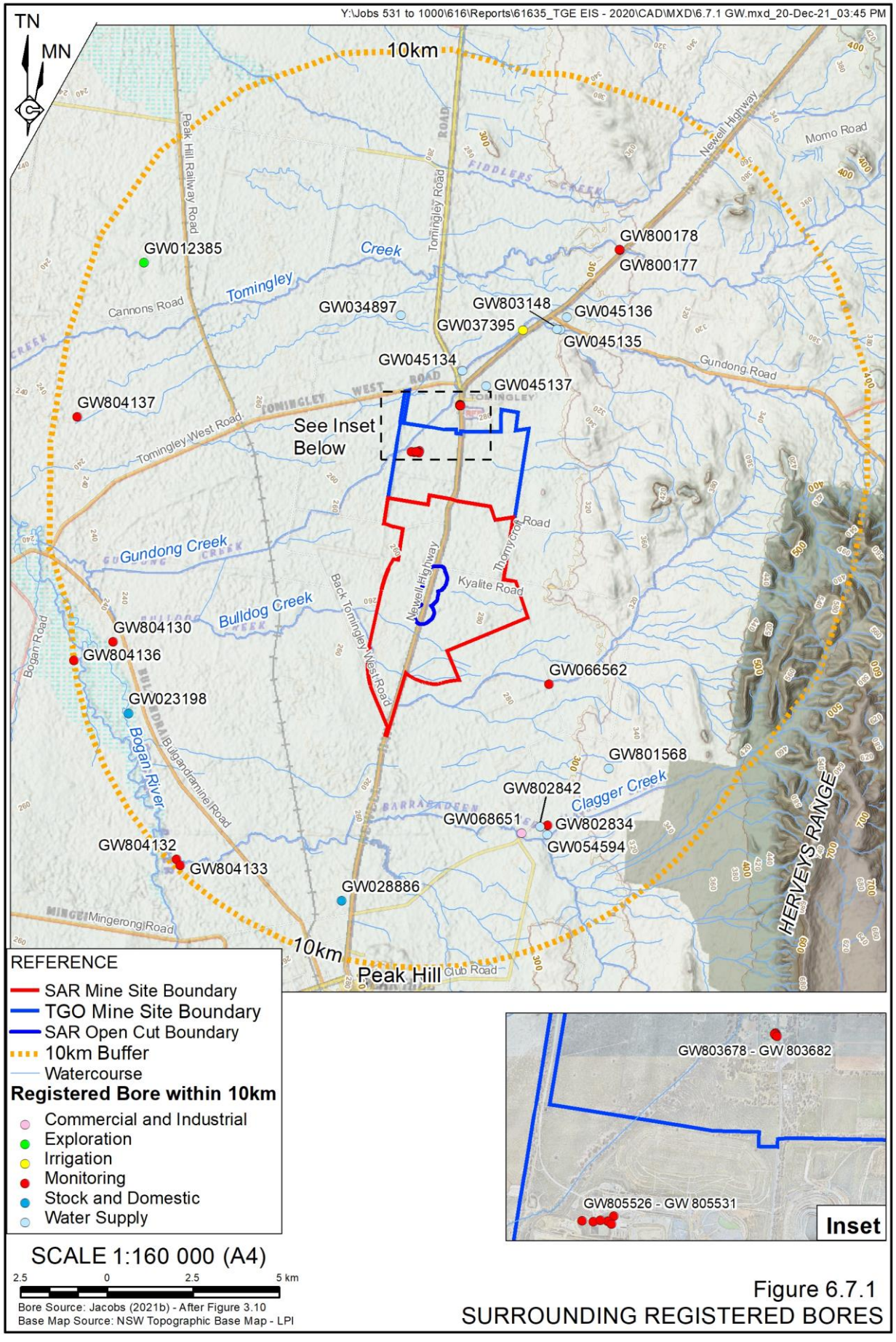


Figure 6.7.1
SURROUNDING REGISTERED BORES

Regional Groundwater Level

Figure 6.7.2 presents the regional groundwater gradient within the fractured rock aquifer surrounding the Project Site based on recorded groundwater levels in registered bores surrounding the Project Site, with the groundwater levels largely mimicking surface topography. The groundwater gradient is steepest in the vicinity of the Herveys Ranges, becoming less steep in the vicinity of the Bogan River. Groundwater flow is generally down-gradient and orthogonal to the contour lines. In the vicinity of the Project Site, indicated flow is to the west then northwest.

Groundwater levels in the vicinity of the Project Site are around 60m below ground level (mbgl) and, regionally, groundwater levels are significantly lower than the elevation of surrounding major watercourses. Jacobs (2021c) states that this suggests that, with limited exceptions, groundwater discharge to watercourses is not regionally significant.

Groundwater Dependent Ecosystems

Jacobs (2021c) assessed the potential occurrence of groundwater dependent ecosystems (GDEs) through a review of the BoM GDE Atlas, and high priority GDE mapping in the *Water Sharing Plan for the NSW MDB Fractured Rock Groundwater Sources*. **Figure 6.7.3** presents the potential terrestrial and aquatic GDE areas mapped in the vicinity of the Project Site. In summary, the mapped GDEs may be described as follows.

- Small areas of high potential terrestrial GDEs are associated with Tomingley Creek and Gundong Creek.
- There are several isolated tracts of low potential terrestrial GDE in the vicinity of the Project Site.
- Areas of moderate and high potential aquatic GDEs are interpreted within small sections of Gundong, Bulldog and Tomingley Creeks. All mapped aquatic GDEs are located greater than 4km from both the existing and proposed mining operations.
- The MDB Water Sharing Plan identifies an area of high priority GDEs associated with the Bogan River located approximately 8.5km to the southwest of the Project Site

6.7.3.3 Local Groundwater Setting

Project-related Monitoring Bore Network

Figure 6.7.4 presents the location of the Project-related monitoring bores within and surrounding the Project Site. In summary, the applicant has constructed:

- ten shallow piezometers in the vicinity of Residue Storage Facility 1;
- eight shallow piezometers in the vicinity of the Wyoming Central Dam;
- ten shallow piezometers in the vicinity of the Processing Plant and associate water storages dams;
- six deep-fractured rock monitoring bores (WYMB-series bores);
- one shallow-alluvial monitoring bore (GDCMB01); and
- four deep monitoring bores surrounding the SAR Open Cut (RWWB-series bores).

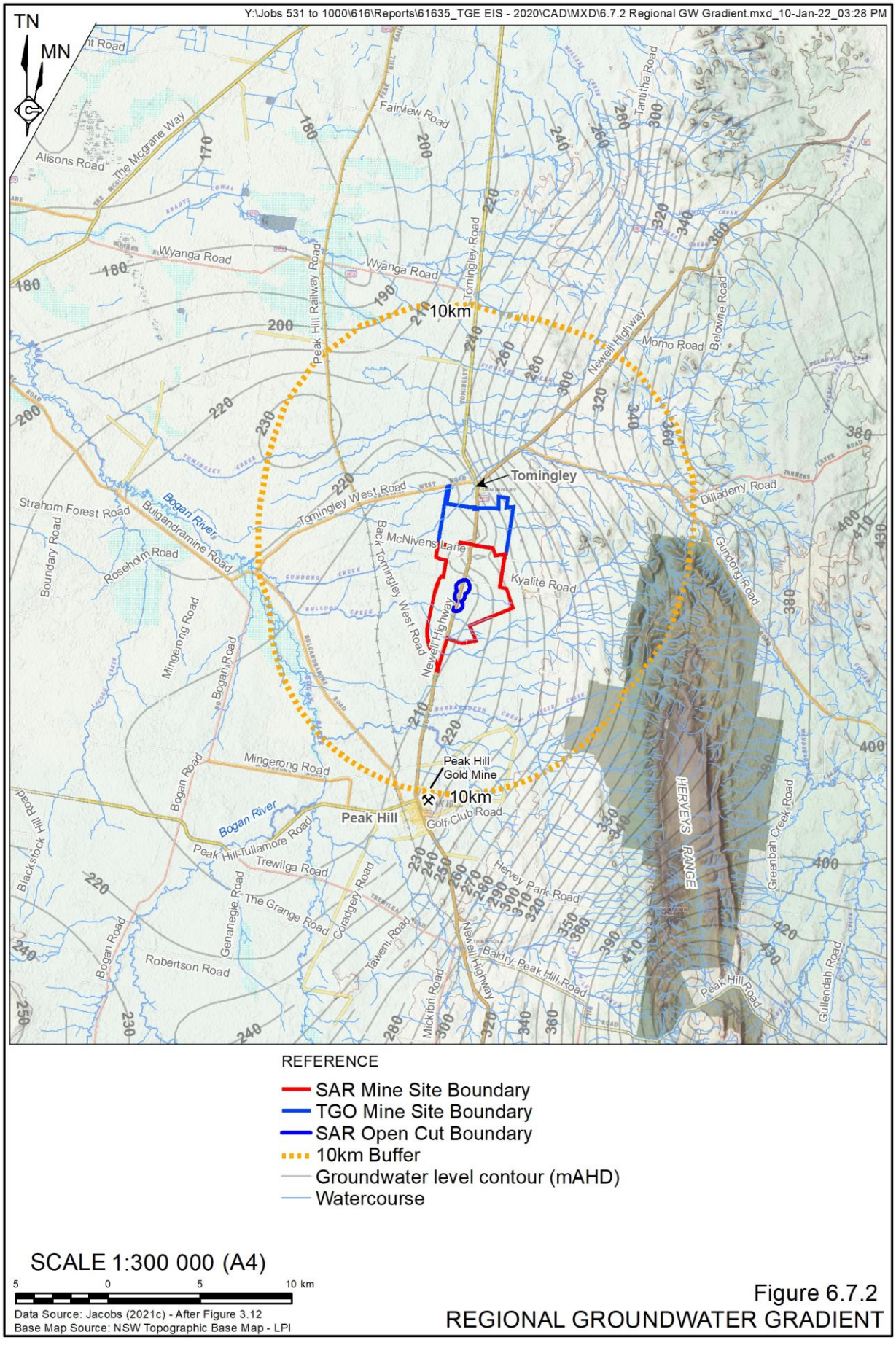
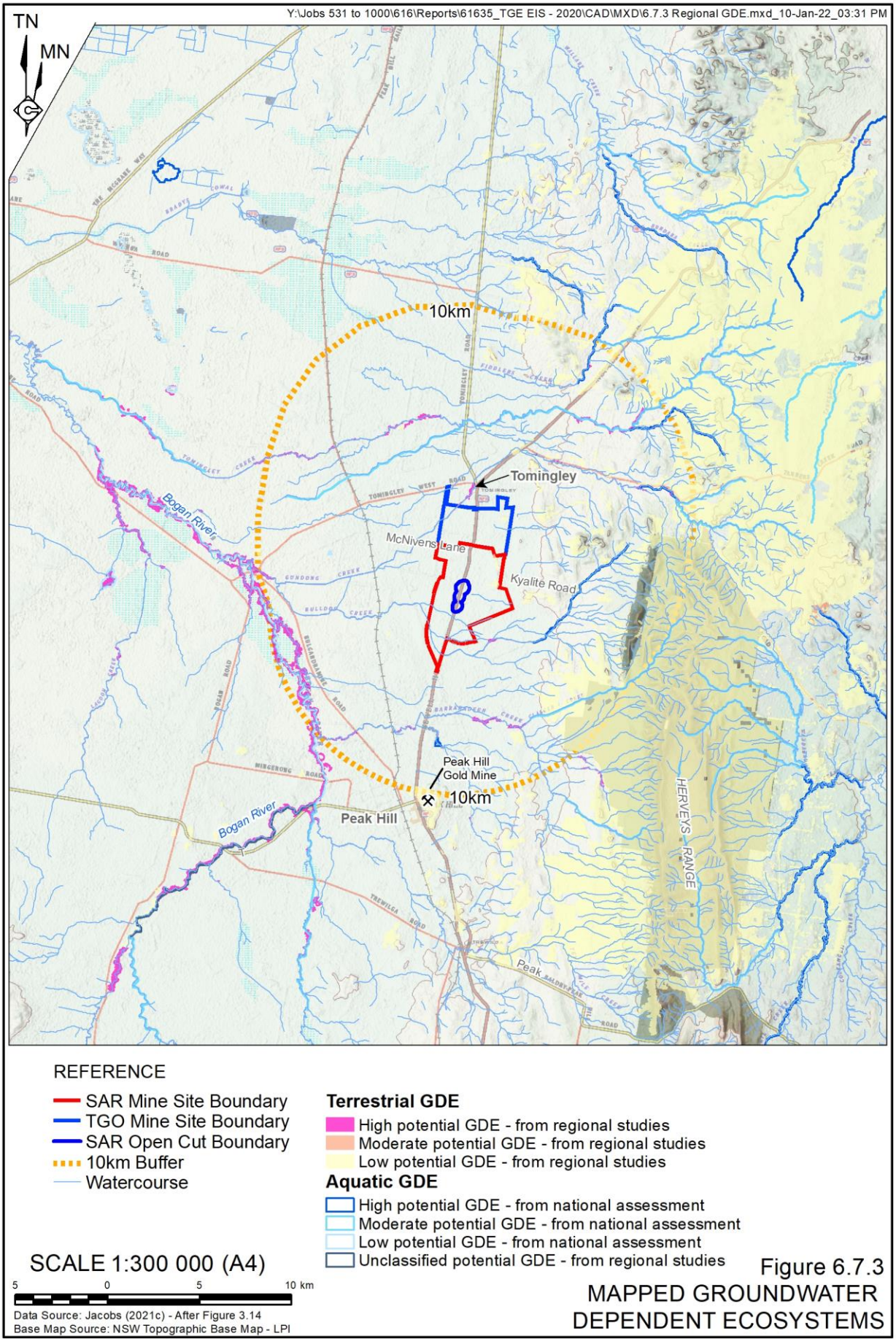


Figure 6.7.2
REGIONAL GROUNDWATER GRADIENT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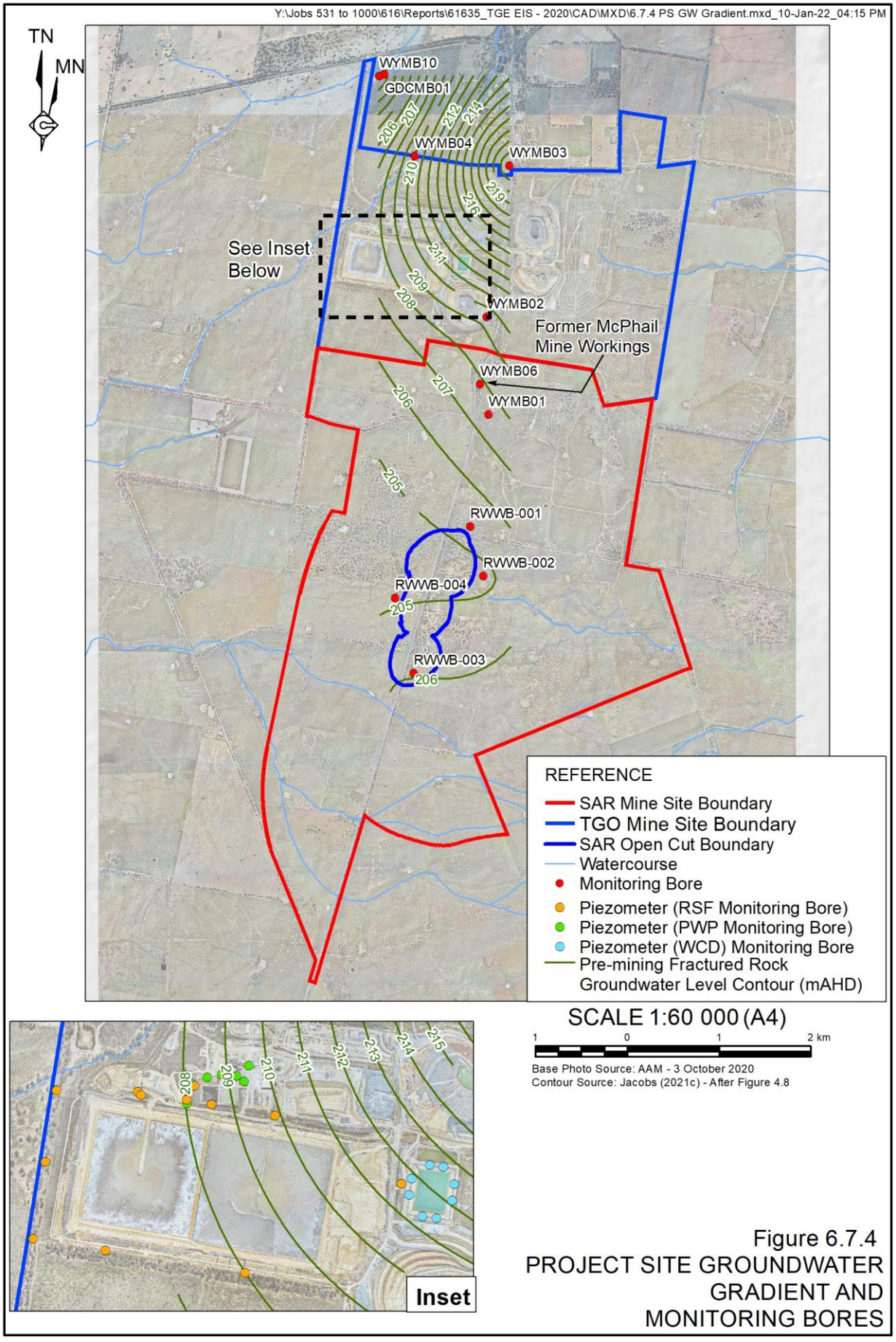
Kyalite Road
Bogan River
Peak Hill Gold Mine
10km
Peak Hill
Bogan River
HERVEYS RANGE
REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
SAR Open Cut Boundary
10km Buffer
Watercourse
Terrestrial GDE
High potential GDE - from regional studies
Moderate potential GDE - from regional studies
Low potential GDE - from regional studies
Aquatic GDE
High potential GDE - from national assessment
Moderate potential GDE - from national assessment
Low potential GDE - from national assessment
Unclassified potential GDE - from regional studies
SCALE 1:300 000 (A4)
5 0 5 10 km
Data Source: Jacobs (2021c) - After Figure 3.14
Base Map Source: NSW Topographic Base Map - LPI
Figure 6.7.3
MAPPED GROUNDWATER DEPENDENT ECOSYSTEMS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WYMB06
WYMB01
RWWB-001
RWWB-002
RWWB-004
RWWB-003
206
207
212
214
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219
216
211
209
208
205
See Inset Below
Former McPhail Mine Workings
REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
SAR Open Cut Boundary
Watercourse
Monitoring Bore
Piezometer (RSF Monitoring Bore)
Piezometer (PWP Monitoring Bore)
Piezometer (WCD) Monitoring Bore
Pre-mining Fractured Rock Groundwater Level Contour (mAHD)
SCALE 1:60 000 (A4)
1 0 1 2 km
Base Photo Source: AAM - 3 October 2020
Contour Source: Jacobs (2021c) - After Figure 4.8
Inset
Figure 6.7.4
PROJECT SITE GROUNDWATER GRADIENT AND MONITORING BORES

Project Site Groundwater Level

TGO Mine Site

Quarterly groundwater monitoring is undertaken within the WYMB-series bores and GDCMP01 in accordance with the existing and approved *Water Management Plan* for the TGO Mine Site. Section 4.2.1 of Jacobs (2021c) provides a description of the groundwater levels in the vicinity of the TGO Mine Site. In summary:

- water levels within the shallow alluvial aquifer is relatively stable, with long-term trends reflective of long-term climatic influences;
- the hard rock monitoring bores WYMB03, WYMB04 and WYMB10 (located over 700m from existing mining operations) display relatively stable to slightly increasing water level trends, likely reflective of long-term climatic influences;
- water levels within WYMB02, located adjacent to the Wyoming 1 Open Cut, show a distinct declining trend and response to mining since mid-2016. Prior to 2016 water levels were very stable.
- Hard rock monitoring bores WYMB01 and WYMB06 display different responses to the other hard rock monitoring bores, with both monitoring bores responding to a significantly wet period in mid- to late-2016. These bores are in close proximity to the historic McPhails Gold Mine (**Figure 6.7.4**). Surface water is known to flow into these workings following moderate rainfall and Jacobs (2021c) interpret this response to be a result of surface water inflows.

SAR Mine Site

The four monitoring bores were established in November 2020 adjacent to the SAR Open Cut (**Figure 6.7.4**). Section 4.2.2 of Jacobs (2021c) provides a description of the groundwater levels in the vicinity of the SAR Open Cut. These are summarised as follows.

- Groundwater level trends within RWWB001 and RWWB003 over the period of observation are relatively stable. In mid-March 2021, RWWB001 showed erratic fluctuations that are attributed to interference from nearby resource drilling operations.
- Groundwater level trends within RWWB002 demonstrate a very slow recovery following drilling and bore construction. RWWB002 was drilled dry with no indication of groundwater. The prolonged recovery, over a period of approximately 130 days is indicative of the very tight and low permeability of the formation at that location.
- RWWB004 is screened to a depth of 52mbgl and has remained dry since construction.

Jacobs (2021c) state that RWWB001, RWWB002 and RWWB003 are monitoring the regional fractured rock groundwater level, while RWWB004 demonstrates a lack of saturation overlying bedrock in the vicinity of the bore.

Project Site Groundwater Gradient

Figure 6.7.4 presents the groundwater gradient within the fractured rock aquifer within the Project Site. Predominant pre-mining groundwater flow direction is generally to the west. Water level monitoring within WYMB02 results suggests that groundwater level has been reduced as a result of mining operations and that in the vicinity of that bore, groundwater flows are towards the Wyoming 1 mine workings.

Hydraulic Connectivity

The localised discrete alluvial aquifers and the fractured rock aquifer are considered by Jacobs (2021c) to be hydraulically disconnected. The difference in groundwater levels at adjacent monitoring bores GDCMB01 and WYMB010 (**Figure 6.7.4**) is of the order of 70m and demonstrates the hydraulic separation of the shallow alluvial aquifer (GDCMB01) and the underlying fracture rock aquifer (WYMB010).

The Applicant, in light of recommendations provided in the conditional Gateway Certificate, proposes to construct two additional paired bores in the vicinity of Gundong Creek and Bulldog Creek to further demonstrate separation of these alluvial aquifer systems.

Project Site Groundwater Quality

Table 6.7.2 presents a summary of the key groundwater quality parameters from the Project-related monitoring bores. In summary:

- the average pH for all monitoring bores is neutral to slightly alkaline, ranging from 6.7 to 7.5;
- the average electrical conductivity for all monitoring bores is typically saline, ranging from 11 393µS/cm to 28 567µS/cm;
- at the SAR Mine Site, electrical conductivity and total dissolved solids increase with depth; and
- the hard rock monitoring bores WYMB01 and WYMB06 are likely influenced by observed freshwater ingress into the historic McPhail Gold Mine workings **(Figure 6.7.4**), as shown by the significantly lower salinity values.

Project Site Hydraulic Properties

Hydraulic conductivity values used by Jacobs (2021c) were derived from a combination of the following:

- rising head data from groundwater monitoring bores;
- rising head data from airlifted resource drillholes;
- packer testing within diamond drillholes;
- airlift yield and recover testing undertaken by Jacobs from Project-related boreholes; and
- historic conductivity testing from previous groundwater assessments for TGO, including both airlift and slug type testing.

A full description of the hydraulic conductivity testing methodology and analyses is provided in Section 4.4 of Jacobs (2021c). The results are summarised as follows.

Table 6.7.2
Summary of Project Site Groundwater Quality Physical Parameters

Monitoring Bore	pH[1]			Electrical Conductivity (µS/cm)[1]			Total Dissolved Solids (mg/L)[1]		
	Mean	Min	Max	Mean[2]	Min	Max	Mean[2]	Min	Max
RWWB001	6.67	6.58	6.77	28 567	25 600	32 700	19 375	18 700	19 800
RWWB002	6.74	6.63	6.87	20 040	18 400	22 320	15 400	14 300	16 400
RWWB003	6.92	6.86	6.97	19 307	17 800	22 320	12 200	11 700	12 500
RWWB004	No water intersected								
WYMB01	7.50	7.08	8.00	11 393	1 241	12 350	7 627	6 400	8 400
WYMB02	7.41	6.80	8.33	20 626	1 877	25 610	14 627	12 800	16 400
WYMB03	7.38	6.70	8.12	19 062	1 817	22 100	13 845	11 500	14 900
WYMB04	7.32	6.89	8.05	24 512	2 124	29 180	18 250	15 800	20 400
WYMB06	7.45	6.83	8.21	12 172	1 174	15 480	8 627	6 830	10 000
WYMB10	7.28	6.72	7.86	25 217	1 967	51 700	16 831	2 190	20 000
GDCMB01	7.19	6.80	8.01	552	345	1 137	629	280	1 000

Note 1: SAR Mine Site data range: 2020 – 2021; TGO Mine Site data range: 2013 – 2018.

Note 2: For reference, the average electrical conductivity and total dissolved solids values for sea water are 50 000µS/cm and 35 000mg/L respectively.

Source: Jacobs (2021c) – modified after Table 4.2

Hydraulic Conductivity

Hydraulic Conductivity is the rate at which water moves through a groundwater system under a hydraulic gradient. Table 4.7 of Jacobs (2021c) presents the statistical summary of all hydraulic conductivity testing undertaken as part of the groundwater assessment for the Project. In summary:

- hydraulic conductivity for the fractured rock aquifer groundwater monitoring bores ranged from $2.9x10^{-6}$m/d (RWWB002) to 0.11m/d (WYMB006); and
- the geometric mean is approximately $2.1x10^{3}$m/d, which is classified as a 'very low' conductivity rating and indicates a 'very tight' rock mass with respect to discontinuities.

It is noted that bore WYMB006, where the maximum value occurred, is located in close proximity to historical underground workings of the Myalls United Gold Mine. When considering WYMB006 as an outlier, the geometric means is approximately $1.1x10^{3}$m/d. Notwithstanding the above, based on the nature of the testing undertaken and the type of aquifers involved, the maximum hydraulic conductivity test value of 0.11m/d is considered by Jacobs (2021c) to be relatively low.

Storage

Specific yield is the ratio of the volume of water released from a groundwater system via gravity drainage with the volume of the saturated groundwater system.

Groundwater system storage within the vicinity Project Site is inferred to be low for the basement lithologies (volcanics and meta-sediments). Specific yield, where unconfined, is inferred to be in the range of 1% to 10%. Specific yield is expected to be at the lower end of the range based on the very tight nature of the rock mass and lack of any significant primary porosity.

Additionally, specific storage is the amount of water that a portion of an aquifer releases from storage, per unit mass or volume of aquifer, per unit change in hydraulic head, while remaining fully saturated. Based on available testing results, the geometric mean value for specific storage is estimated at $1.3x10^{-7}$. Younger (1993) suggests that typical values of specific storage range from the order of $1x10^{-6}$ for moderately fractured rock to $7x10^{-7}$ for unfractured rock.

6.7.4 Conceptual Hydrogeology

Section 5 of Jacobs (2021c) provides a detailed description of the conceptual hydrological model of the groundwater systems of the Project Site and surrounding areas and is summarised as follows.

- Three broad groundwater systems are present in the vicinity of the Project Site (see Section 6.7.3.1):
  - a perched aquifer associated with the larger surface drainage systems such as Gundong Creek;
  - a Cainozoic alluvial groundwater system comprising a relatively thick layer of fluvial sediments with generally low permeability and little to no saturation in the vicinity of the Project Site; and
  - the fractured rock groundwater system with overall low permeability.
- Based on the observed depth to groundwater in the vicinity of the Project Site, the fracture rock groundwater system is the primary system of interest in regard to potential impacts from the Project.
- There is poor hydraulic connection between the various groundwater systems.
- Regional groundwater flow is from areas of higher elevation in the east to the low lying areas in the west; however, localised preferential flow along the dominant direction of structural orientation of the underlying geology may be present.
- Hydraulic conductivity of the fractured rock groundwater system will typically be very low and of the order of $1x10^{3}$m/d to $1x10^{-5}$m/d.
- Rainfall recharge is the dominant recharge process but given the large thickness of unsaturated Cainozoic alluvial deposits, is likely to be low to very low.
- Based on observations from the current extraction areas, groundwater inflows for the Project are anticipated to be low.
- Within the Project Site, the dominant mechanism for groundwater discharge is likely to be inflows to mine workings and evaporation from Open Cut walls and sumps.

6.7.5 Avoidance, Management and Mitigation Measures

The Applicant, in conjunction with Jacobs, has identified a range of measures to minimise the potential for adverse groundwater impacts.

Groundwater within the TGO Mine Site is managed in accordance with the existing and approved *Groundwater Management Plan,* presented as Appendix D of the site's *Water Management Plan* (GHD, 2017). The *Water Management Plan* would continue to be implemented within the TGO Mine Site and, if approval for the Project is granted, the Plan will be reviewed and revised to include specific management and monitoring that would be required to manage the groundwater environment within the SAR Mine Site.

6.7.5.1 Avoidance and Mitigation through Project Design

Key infrastructure within the Project Site has been designed in consideration of potential surface impacts and mitigation. In particular, the Applicant would implement the following.

- Backfill the Caloma 1 and 2 Open Cuts and SAR Open Cut South and Central Pits to limit the area of final voids available for evaporation of groundwater, thereby minimising long-term groundwater losses.
- Construct the Residue Storage Facilities and all water storages that would store process or mine water in a manner that would minimise the potential for seepage of contaminated water into the groundwater system.

6.7.5.2 Operational Management and Mitigation Measures

The Applicant would implement the following groundwater-related management and mitigation measures throughout the life of the Project.

- Construct paired monitoring bores in the vicinity of Gundong and Bulldog Creeks to demonstrate separation of the shallow alluvial aquifer and the deeper fractured rock aquifer.
- Prepare and implement a revised *Groundwater Management Plan* that addresses the following matters.
  - A monitoring program, including suitable parameters, to record, amongst other matters, the volume of groundwater inflow and outflow (dewatering) during underground and surface mining operations.
  - A groundwater monitoring program that includes monitoring bores within and surrounding the Project Site, including monitoring of both groundwater levels and quality (see Section 6.7.8).
  - A program to verify the groundwater modelling predictions incorporated in Jacobs (2021c), including whether groundwater inflow and drawdown in is line with predictions and if there is risk of increased hydraulic connectivity due to mining operations.
  - Trigger Action Response Plans.
  - A program to review and verify the groundwater model periodically.

- Ensure that water access licenses for a minimum annual extraction rate of 427ML from the Lachlan Fold Belt Murray Darling Basin (MDB) Groundwater Source of the *Water Sharing Plan for the NSW MDB Fractured Rock Groundwater Sources 2020* are obtained prior to the commencement of the SAR Open Cut.
- Undertake remodelling of the anticipated groundwater inflows to the TGO and SAR workings prior to 31 December 2025, taking into consideration groundwater monitoring results collected in the intervening period.
- Ensure that additional water access licences are obtained in light of the results of the proposed groundwater remodelling prior to 31 December 2025.
- Ensure that where groundwater that is to be stored at surface or used for mining-related purposes, it is stored and used in a manner that ensures that it is not permitted to flow to natural land surface or surface drainages.
- Ensure that all chemicals and hydrocarbons are stored in accordance with the manufacturer's specifications or the relevant Australian Standard to prevent contamination of groundwater.

6.7.6 Assessment of Impacts

6.7.6.1 Assessment Methodology

Project Groundwater Flow Model

Groundwater flow models can be used to predict future groundwater take due to mining operations to inform water licensing and entitlement requirements. A Class 2 numerical groundwater flow model was developed for the Project using the United States Geological Survey modelling code, MODFLOW. Table 6.1 of Jacobs (2021c) presents the quantitative indicator requirements for the determination of the model class.

Model parameters may be described as follows.

- Model extent – approximately 37km east to west and 67km north to south.
- Model grid – three cell sizes were used as follows.
  - 15.625m x 15.625m cells in the vicinity of the existing TGO Mine Site.
  - 62.5m x 62.5m cells in the vicinity of the SAR Mine Site.
  - 500m x 500m cells in the remaining areas of the model extent.
- Model layers – six model layers were established based on topography and the proposed mining levels
- Hydraulic conductivity zones - Seven hydraulic conductivity zones were established based on Narromine 1:250 000 Metallogenic Series Sheet (Bowman et.al, 1980).
- Model boundary conditions – cells that permit water inflow and outflow were established as a General-Head Boundary orthogonal to the dominant groundwater flow at the north-western extent of the model. The northern, southern and eastern

extremities are generally parallel to the dominant regional flow direction. The Herveys Range was used as a no flow boundary to represent the conceptualised groundwater flow divide in this location.

- Model timing – the time period for the model consisted of simulated monthly stress periods over a period of approximately 17.5 years between November 2014 and February 2031. Post mining recovery was simulated for a period of 200 years.
- Model recharge – a recharge rate of 1% of mean annual rainfall was adopted across two recharge zones based on the transitional zone between outcropping bedrock in the east and alluvium in the west (**Table 6.7.3**).
- Model evapotranspiration – evaporation and transpiration from the areas where the water table is within 2m of the surface was assumed to 3.93mm/day (**Table 6.7.3**).
- Modelled hydraulic properties – **Table 6.7.3** presents the calibrated hydraulic conductivity values used in the numerical model.
- Modelled mining operations – Additional drain boundaries were incorporated into the model to represent the various stages of both the approved and proposed open cut and underground operations within the Project Site.
- Modelled backfilling operations – Where relevant, open cut drain boundaries were made inactive from scheduled backfilling commencement dates. Underground drain boundaries were made inactive at the end of scheduled underground mining operations to simulate potential groundwater recovery.

Table 6.7.3
Modelled Hydraulic Properties

Parameter	Final Adopted Base Case Model Value
Horizontal hydraulic conductivity (m/d)[1]	Zone 1 – fractured rock west of Zone 2, 0.05 Zone 2 – siltstone and shale, 0.01 Zone 3 – fractured rock in area of mine, 0.01 Zone 4 – siltstone and sandstone, 0.001 Zone 5 – granite, 0.001 Zone 6 – Dulladerry Rhyolite, 0.001 Zone 7 – Hervey Group (shale, siltstone and sandstone), 0.001
Recharge rate as 1% of mean annual rainfall (mm/year)	Zone 1: 0.036 Zone 2: 0.177
Evaporation rate (mm/d)	3.93
Storage	Specific storage = 1.3×10^{-7} Specific yield = 0.075
DRN conductance for open cuts (m^2/d)	390 625 for 62.5 x 62.5m cells and 24 414 for 15.625 x 15.625m cells
DRN conductance for Wyoming 1 (m^2/d)	0.00065 for 15.625m x 15.625m cells and 0.0104 for 62.5m x 62.5m cells
Note 1: Applied vertical hydraulic conductivity = 1/10 x horizontal hydraulic conductivity.	
Source: Jacobs (2021c) – modified after Table 6.9	

6.7.6.2 Model Calibration

Section 6.8 of Jacobs (2021c) presents a detailed description of the calibration of the groundwater model based on recorded groundwater levels within the Project Site and regional monitoring bore network (see Section 6.7.3). In summary, Jacobs (2021c) states that while the model generally overpredicts head, the numerical model is generally in accordance with observed Project Site monitoring data and is representative of the modelled mining induced drawdown.

6.7.6.3 Assessment Results

Section 6.10 of Jacobs (2021c) presents the results of the groundwater modelling. The following presents a necessarily brief overview of the results of that modelling.

Groundwater Inflow

Figure 6.7.5 presents the anticipated groundwater inflows to Project-related mine workings throughout the life of the Project. The modelled inflow rate for the Project during the mining period is typically within the range of 0.5ML/day to 2.5ML/day, with a maximum rate of 3.04ML/day predicted to occur during January 2027.

The modelled inflow rate for the post-mining period was approximately 118ML per year, once the water within the final voids have reached equilibrium. Jacobs (2021c) states that modelling indicates that inflow rates are likely to taper off over relatively short time periods. In addition, groundwater take would likely be less than that predicted by the numerical model. Section 6.7.7 presents the licencing implications of the predicted groundwater inflow rates.

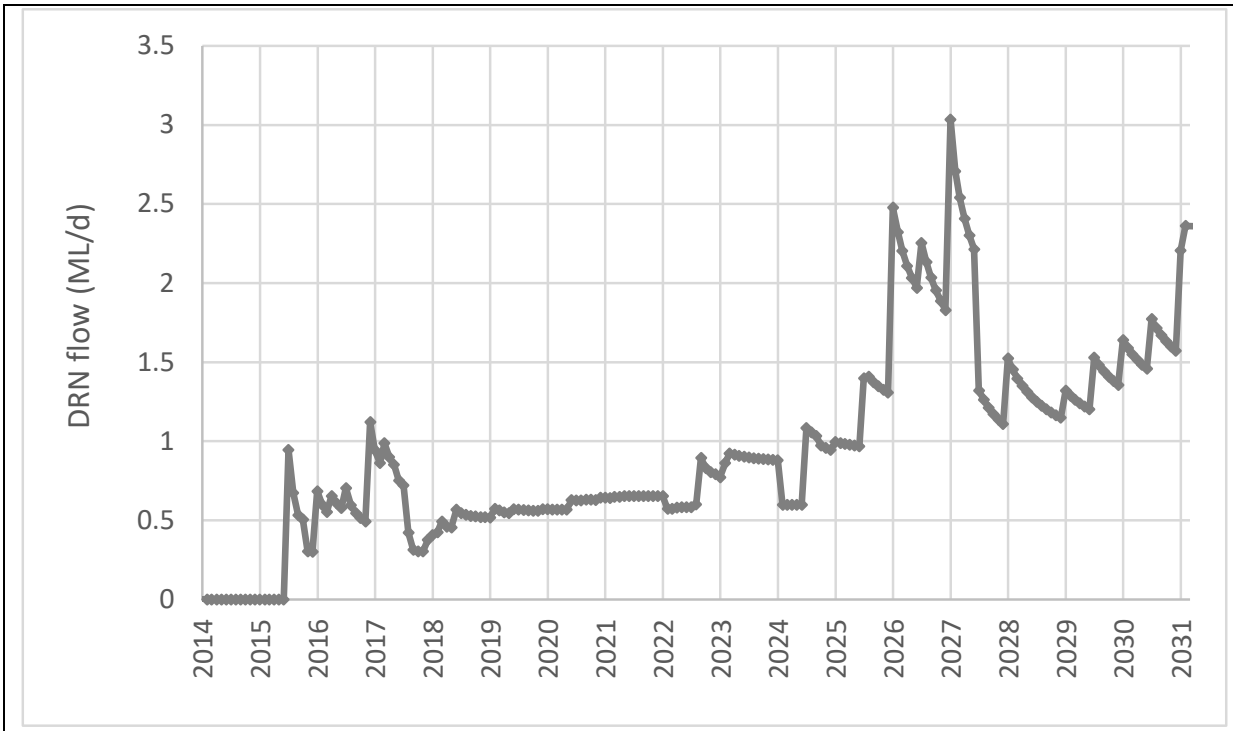


Figure 6.7.5
Predicted Groundwater Inflows

Source: Jacobs (2021c) – Figure 7.1

Groundwater Drawdown

Figures 6.7.6 presents the predicted groundwater drawdown at the end of the proposed mining operations. The modelled 2m drawdown contour is not predicted to encroach on any non-Project related registered groundwater bores.

Figure 6.7.7 presents the predicted groundwater drawdown 200 years after the end of mining operations. The modelled 2m drawdown contour is predicted to encroach on a cluster of 5 monitoring bores associated with the monitoring of a BP Service Station located within Tomingley village, approximately 800m north of the TGO Mine Site.

Jacobs (2021c) states shallow, alluvial bores located to the north of Tomingley village would not be impacted by the Project because they are hydraulically disconnected from the underlying fractured rock groundwater system.

Surrounding Groundwater Dependent Ecosystems

Jacobs (2021c) states that despite modelled drawdown contours propagating beneath areas mapped as potential GDE, GDEs are assessed as unlikely to be impacted by mining. These mapped potential GDEs, if actually associated with groundwater, are likely to be associated with shallow perched alluvial groundwater systems that are disconnected from the fractured rock aquifer. As such, they are assessed as unlikely to be subjected to drawdown associated with mining.

Baseflow reduction

Jacobs (2021c) state that the Project is unlikely to cause material reductions in baseflow to watercourses because Project-induced groundwater level drawdown is not anticipated to affect groundwater levels in perched alluvial groundwater systems.

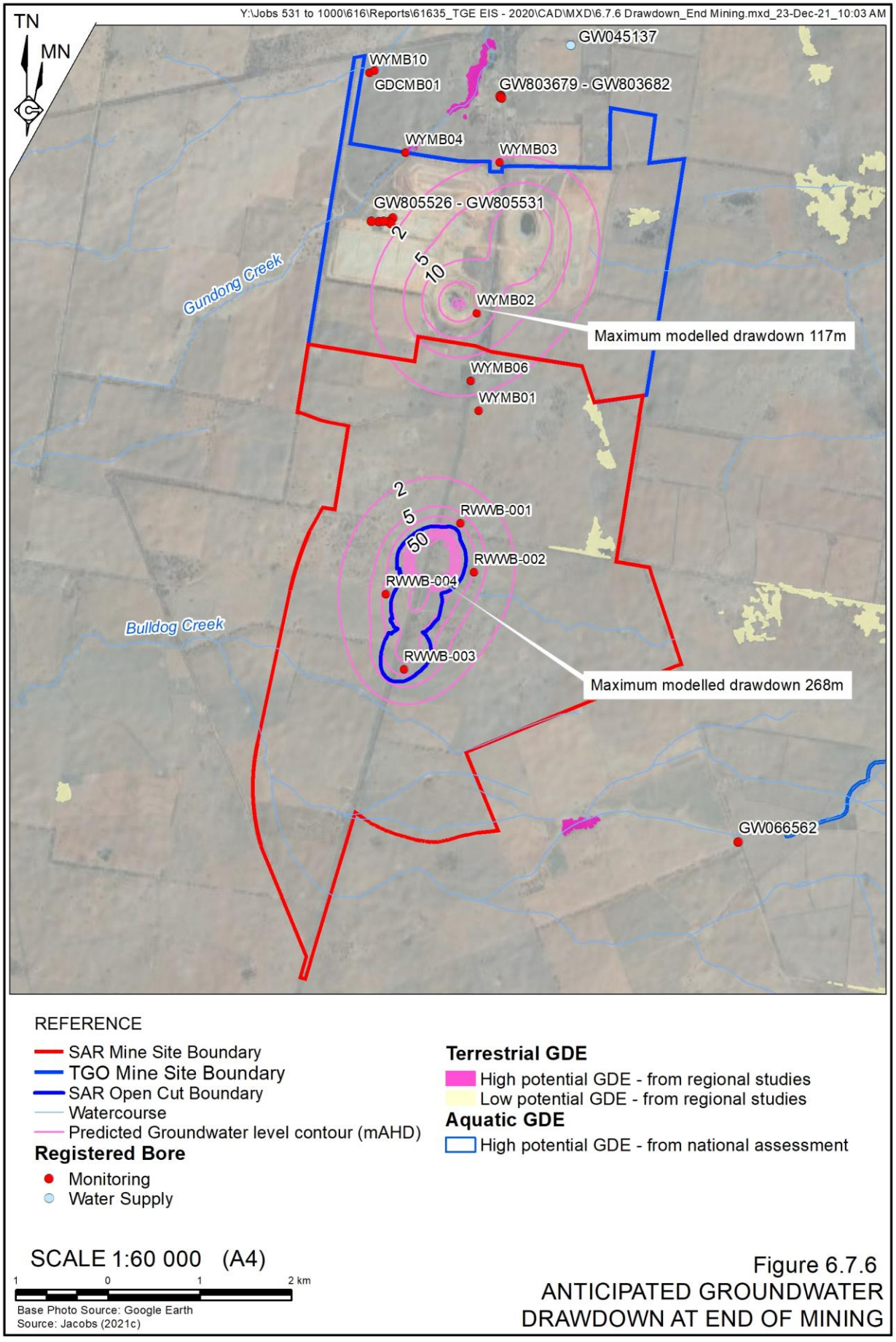
Groundwater Quality

Section 7.5 of Jacobs (2021c) presents an assessment of potential risks and impacts associated with groundwater quality and is summarised as follows.

- The Project is unlikely to lower the groundwater beneficial use category beyond a distance of 40m from the Project Site, in accordance with the Minimal Impact Considerations of the *NSW Aquifer Interference Policy*.
- Potential contamination risks from Project-related activities are considered to be low.

In addition, the Applicant proposes to use pastefill generated using residue from the Processing Plant within the proposed SAR Underground Mine (see Section 3.5.3). The use of pastefill is not anticipated to have any adverse groundwater quality impacts for the following reasons.

- The TGO and SAR residue is non-acid forming.
- Combining residue with a binding agent such as cement effectively creates concrete which would encapsulate the residue in a low permeability matrix.
- The paste would be placed underground into an environment devoid of oxygen or other substances that the residue could react with.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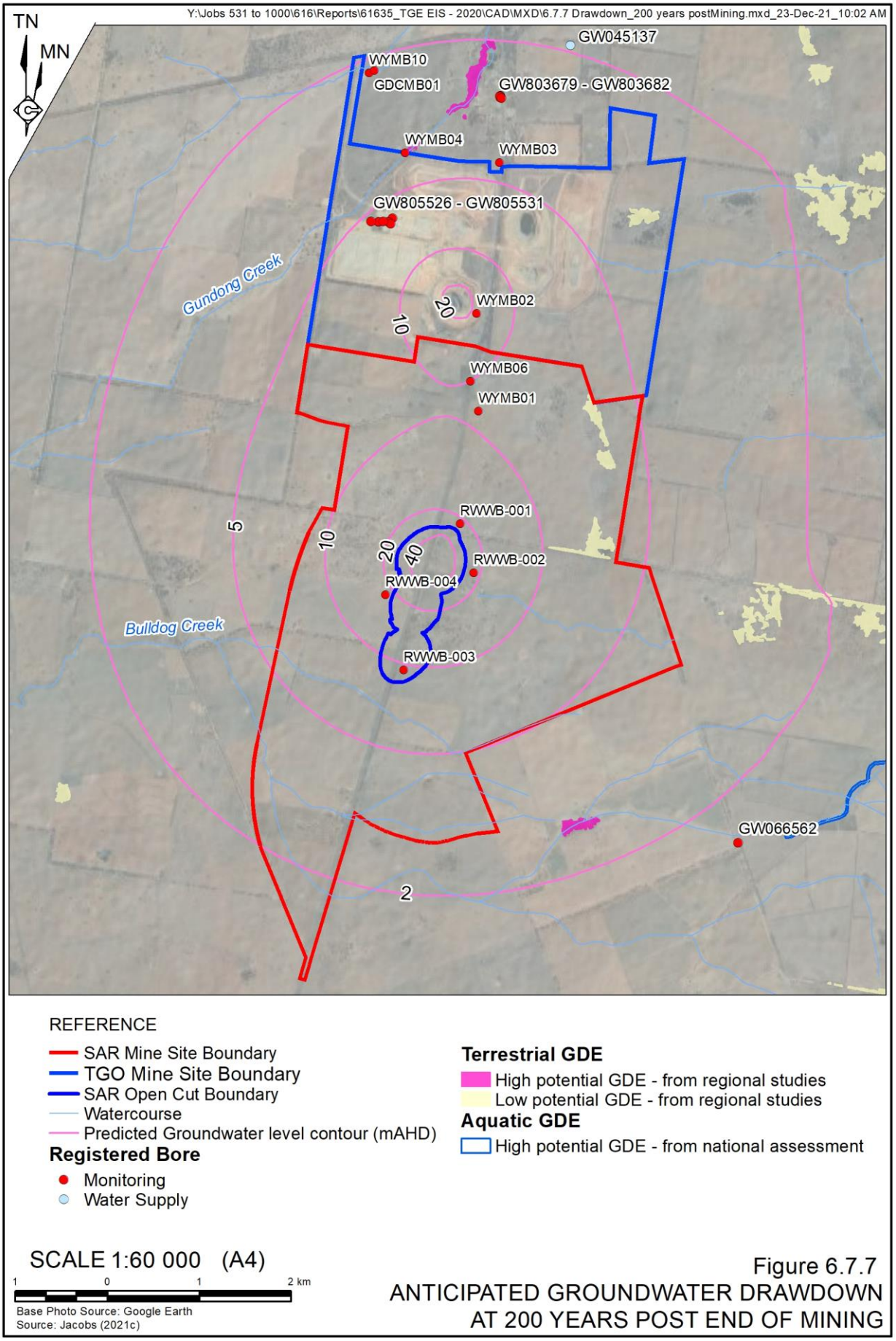
TN
MN
GW045137
WYMB10
GDCMB01
GW803679 - GW803682
WYMB04
WYMB03
GW805526 - GW805531
2
5
10
Gundong Creek
WYMB02
Maximum modelled drawdown 117m
WYMB06
WYMB01
2
5
50
RWWB-001
RWWB-002
RWWB-004
Bulldog Creek
RWWB-003
Maximum modelled drawdown 268m
GW066562
REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
SAR Open Cut Boundary
Watercourse
Predicted Groundwater level contour (mAHD)
Registered Bore
Monitoring
Water Supply
Terrestrial GDE
High potential GDE - from regional studies
Low potential GDE - from regional studies
Aquatic GDE
High potential GDE - from national assessment
SCALE 1:60 000 (A4)
1 0 1 2 km
Base Photo Source: Google Earth
Source: Jacobs (2021c)
Figure 6.7.6
ANTICIPATED GROUNDWATER
DRAWDOWN AT END OF MINING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TN
MN
GW045137
WYMB10
GDCMB01
GW803679 - GW803682
WYMB04
WYMB03
GW805526 - GW805531
Gundong Creek
WYMB02
20
10
WYMB06
WYMB01
RWWB-001
5
10
20
40
RWWB-002
RWWB-004
Bulldog Creek
RWWB-003
GW066562
2
REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
SAR Open Cut Boundary
Watercourse
Predicted Groundwater level contour (mAHD)
Registered Bore
Monitoring
Water Supply
Terrestrial GDE
High potential GDE - from regional studies
Low potential GDE - from regional studies
Aquatic GDE
High potential GDE - from national assessment
SCALE 1:60 000 (A4)
1 0 1 2 km
Base Photo Source: Google Earth
Source: Jacobs (2021c)
Figure 6.7.7
ANTICIPATED GROUNDWATER DRAWDOWN
AT 200 YEARS POST END OF MINING

- The paste would be placed into an fractured rock aquifer with very low permeability within an area that is likely to be a groundwater sink.

Final Void Water Level and Quality

Wyoming 1 and Roswell Open Cuts are proposed to remain as open voids at the end of mining operations. Jacobs (2021c) states that based on the observed and modelled rates of groundwater inflow and evaporation within the Project Site, the open voids are likely to behave as groundwater sinks.

Equilibrium water levels with the Wyoming 1 and Roswell Open Cuts are predicted to be approximately 200m AHD and 180m AHD respectively. This is approximately 20m and 25m below the pre-mining regional water table levels, respectively and well below the natural ground surface. Jacobs (2021c) states that the majority (> 90%) of the groundwater level recovery would occur approximately 37 years for water within Wyoming 1 Open Cut and 80 years for Roswell Open Cut.

The final void water chemistry is predicted to gradually decline as evaporation increases the concentration of salts within the final voids. However, the low hydraulic conductivity of the rock mass and the fact that the water level would remain lower than the surrounding regional water table, the reduced water quality is unlikely to migrate a significant distance to the voids. As previously identified, the potential reduction in groundwater quality is unlikely to reduce the beneficial use category beyond a distance of 40m of the final voids, nor would any non-Project related registered bores likely be impacted.

Cumulative Impacts

Jacobs (2021c) state that cumulative impacts associated with the McPhail and Peak Hill Gold Mine are unlikely to occur for the following reasons.

- McPhail Gold Mine - the historic mine workings are very small in extent and are separated from the existing and proposed mining operations. Potential historic mining induced drawdown is anticipated to have recovered relatively quickly because the workings are subjected to flow from surface flooding.
- Peak Hill Gold Mine – Jacobs (2021c) state that the water level in the Peak Hill Gold Mine Open Cut is interpreted to have come to an equilibrium level that is slightly below the regional water table level. As a result, and given that the Peak Hill Gold Mine is located approximately 10km south of the Project Site, cumulative impacts are considered highly unlikely.

6.7.6.4 Uncertainty Analysis

Jacobs (2021c) undertook uncertainty analysis for the predictive model to determine the sensitivity of the model to paternal uncertainty in relation to key parameters. Sections 6.8.3 and 6.10.4 and Annexure D of Jacobs (2021c) present an overview of that analysis. In summary, the model predictions are most sensitive to the adopted average value of hydraulic conductivity and recharge with changes significantly increasing or reducing the predicted inflow to the mines. Notwithstanding the above, Jacobs (2021c) states that none of the modelled uncertainty scenarios would significantly alter the primary base case findings of the assessment.

6.7.7 Licencing

The Applicant currently holds Water Access Licences for a combined 290ML/year from the Lachlan Fold Belt MDB Groundwater Source under WAL28643 (220ML/year) and WAL29266 (70ML/year).

Figure 6.7.8 presents the annualised groundwater inflows throughout the life of the Project. In summary, annual groundwater inflows are predicted to increase from approximately 230ML in 2021 to approximately 427ML in 2025, before increasing to approximately 767ML in 2026. Notwithstanding this, actual inflows to the existing TGO workings have historically been at levels that are too low to be measurable. As a result, the Applicant contends, based on 6 years of experience operating the TGO Mine, that the groundwater model is likely to be overstating existing groundwater inflows.

As a result, and to account for the short-term predicted groundwater take and allow for the incorporation of long-term monitoring data into the groundwater model, the Applicant would implement the following.

- Obtain sufficient water access licence entitlement for the predicted annual groundwater take for 2025 of 427ML, comprising the currently help entitlement of 290ML, as well as an additional entitlement of 137ML.
- Review and revise the groundwater model based on additional long-term monitoring data before 31 December 2024 (see Section 6.7.5.2) and, if required, obtain additional licence allocation before 31 December 2025 in advance of the predicted maximum rate of groundwater inflow in 2026.

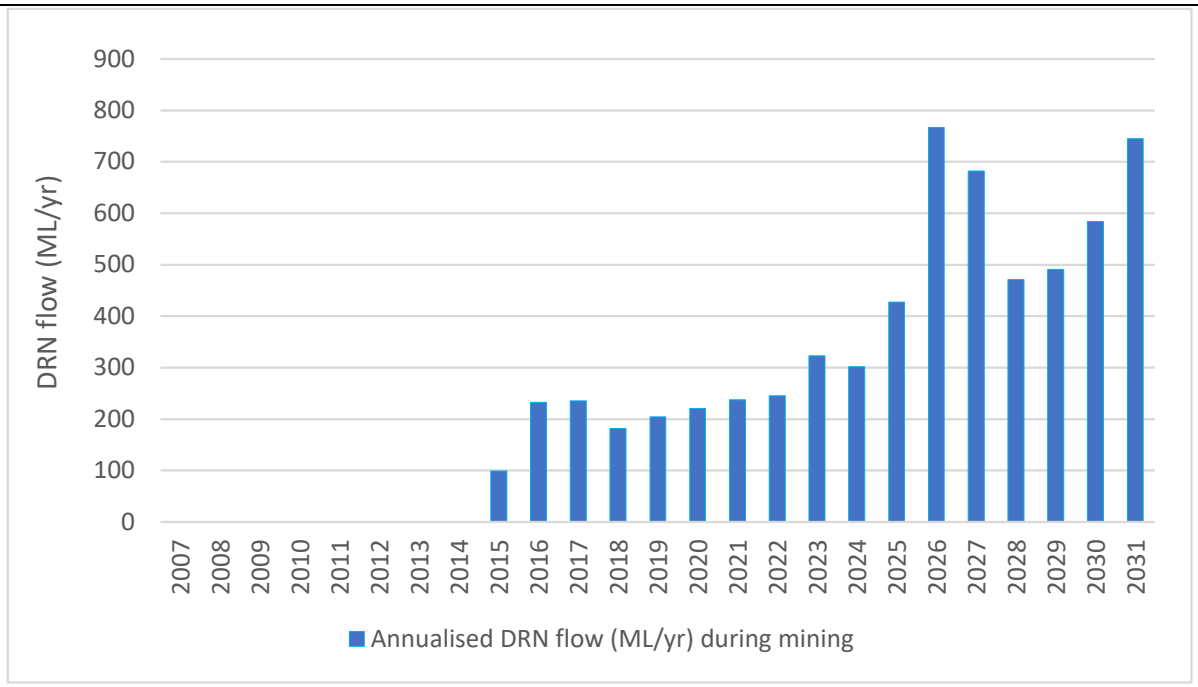


Figure 6.7.8
Predicted Annualised Groundwater Inflows

Source: Jacobs (2021c) – Figure 7.1

The Applicant was advised by a water broker on 1 November 2021 that the Lachlan Fold Belt Murray Darling Basin (MDB) Groundwater Source is a commonly traded market with adequate depth to allow certainty in relation to the availability of additional allocations if required.

6.7.8 Monitoring

As outlined in Section 6.7.5, groundwater monitoring for the TGO Mine Site is currently undertaken in accordance with the approved *Water Management Plan* which, if approval for the Project is granted, would be revised and adapted to encompass the entire Project Site. The revised Plan would incorporate the following.

- Construct paired monitoring bores in the vicinity of Gundong and Bulldog Creeks to demonstrate separation of the shallow alluvial aquifer and the deeper fractured rock aquifer.
- Monitor groundwater inflows to the existing and proposed working, including all direct and indirect inputs and losses.
- Undertake the following monitoring within bores RWWB001, RWWB002, RWWB003 and RWWB04 (unless it remains dry)
  - Groundwater level monitoring via data logger at a daily frequency, including installation of a dedicated barometric logger to enable barometric compensation of the data.
  - Groundwater quality monitoring, with the existing analysis suite for the TGO fractured rock monitoring bores.
- Update the groundwater trigger levels as follows.
  - For GDCMB01, the trigger level would be increased from 269.64m AHD ('Stage 1 Trigger') and 268.64m AHD ('Stage 2 Trigger') to 271.04m AHD, to better correspond with observed minimum groundwater levels.
  - The TGO fractured rock monitoring bore groundwater level triggers would be removed. No specific trigger levels are considered necessary for these bores.
  - The groundwater quality trigger GDCMB01 would be removed. There is limited potential for mining to cause changes to groundwater quality at this bore.
- Undertake a comparison of the following on an annual basis.
  - Observed groundwater level drawdown at Project-related fractured rock monitoring bores with the drawdown predicted at the end of mining.
  - Observed groundwater inflow rates (with consideration of evaporation), the modelled groundwater take and the licenced groundwater allocation.

  If the observed drawdowns or groundwater take rates deviate significantly from the model predictions, then an investigation would take place. If the measured groundwater take exceeds the modelled prediction or is greater than 75% of the licenced allocation, then the Applicant would undertake a review and revision of the groundwater model or would obtain additional allocation.

6.7.9 Conclusion

The Applicant contends that the Project would not have a significant impact on groundwater resources in the vicinity of the Project Site for the following reasons.

- Jacobs (2021c) predicts that groundwater drawdown would not impact on bores other than monitoring bores surrounding the Project Site.
- The fractured rock aquifer to be impacted by the Project is hydraulicly disconnected from the shallow alluvial aquifer.
- The quality of groundwater within the fractured rock aquifer is poor, with limited beneficial use, other than for mining operations.
- The Applicant would undertake detailed monitoring of groundwater levels and quality and groundwater take throughout the life of the Project. If observations deviate from that predicted by Jacobs (2021c), the Applicant would undertake an investigation and would implement remedial actions, including remodelling and/or obtaining additional licence allocation.
- The Applicant would review and revise the groundwater model before 31 December 2024 and, if required, obtain additional licence allocation before 31 December 2025 in advance of the predicted maximum rate of groundwater inflow in 2026.

6.8 Land and Soil Capability

6.8.1 Introduction

The risk assessment undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in soils and land capability impacts. The only risk source with an assessed risk of "medium" after the adoption of standard mitigation measures relates to is the potential for a reduction in the overall Land and Soil Capability Class of land within the SAR Mine Site.

In addition, the SEARs issued for the Project identifies "soils and land capability" as a key issue requiring assessment, including the following.

- An assessment of the likely impacts of the Project on the soils and land capability of the Project Site and surrounds, including the identification of any biophysical strategic agricultural land (BSAL) and having regard to the Mining and Petroleum Gateway Panel's requirements.
- An assessment of the likely Agricultural Impacts of the Project,
- An assessment of the compatibility of the Project with other land uses in the vicinity of the Project Site.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from the Biodiversity, Conservation and Science Directorate which require the assessment to identify any potential Acid Sulfate Soils within the vicinity of the Project Site.

Finally, the Gateway Certificate included a recommendation to "identify and address all areas of BSAL, including those less than 20ha in area."

Soil for rehabilitation of the TGO Mine Site has either already been stripped and is in existing soil stockpiles or, in the case of Residue Storage Facility 2, would be stripped and stockpiled in accordance with the existing development consent. As result, the soil and land capability assessment focusses on the soil resources of the Mine Site only. Notwithstanding this, Section 6.8.3.3 presents a soil balance for the Project Site as a whole

Sustainable Soils Management Pty Ltd (SSM) prepared the following assessments for the SAR Mine Site.

- *Land and Soil Capability Assessment*, referred to hereafter as SSM (2021a) and presented as Part 7a of the *Specialist Consultant Studies Compendium.*
- *Biophysical Strategic Agricultural Land Assessment*, referred to hereafter as SSM (2021b) and presented as Part 7b of the *Specialist Consultant Studies Compendium*.

SSM (2021a) and SSM (2021b) were undertaken concurrently. SSM (2021a) assessed the soils and land capability of the SAR Mine Site, whereas SSM (2021b) assessed BSAL within the proposed MLA Area, plus a 100m buffer, referred to hereafter as the BSAL Assessment Area (**Figure 6.8.1**).

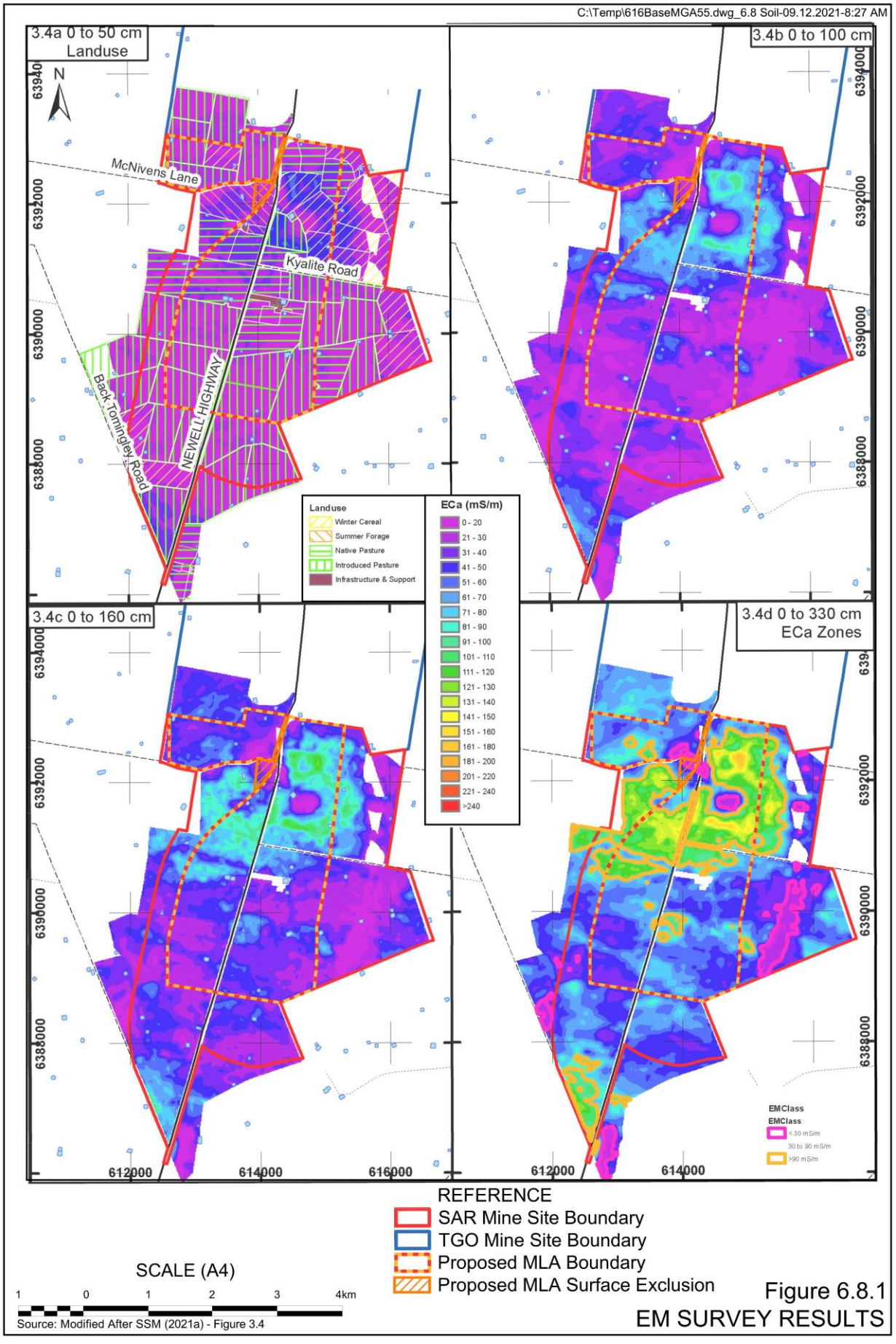


Figure 6.8.1
EM SURVEY RESULTS

The following subsections provide a summary of the above reports. Section 3.3.3.5 and 3.14.8.3 present additional information in relation to soil stripping, stockpiling, placement and rehabilitation operations. Section 6.9 presents additional information in relation to the anticipated agricultural management and mitigation measures and associated impacts.

6.8.2 Assessment Methodology and Existing Environment

6.8.2.1 Introduction

SSM (2021a and 2021b) assessed the land and soil capability of the SAR Mine Site based on a combination of the following.

- Desktop assessment.
- Electromagnetic induction (EM) survey.
- Field surveys.

The following subsections present an overview of the assessment methodology and results of the above assessments.

6.8.2.2 Desktop Assessment

Sections 3.1 and 3.3 of SSM (2021a) provide a detailed description of the desktop soils assessment undertaken for the Project. In summary, SSM (2021a) identified five soil landscapes within the SAR Mine Site as follows.

- Strahorn Soil Landscape with dominant soil type of Chromosols with minor Vertosols on plains.
- Valley Heights Soil Landscape with dominant soil type of Chromosols on rises.
- Tomingley Soil Landscape with dominant soil type of Chromosol and Sodosol on level to undulating outwash plain.
- Stony Hill Gilgai Soil Landscape with dominant soil type of Vertosols and Chromosols with gilgai surface shape on level to gently undulating plains.
- Mugincoble Soil Landscape with dominant soil type shallow soil on low hills.

In addition, SSM (2021a) identify the following regolith features within the SAR Mine Site.

- The majority of the SAR Mine Site is mapped as alluvial depositional plains.
- More than nine erosional depressions occur within the SAR Mine Site.
- Parent material of the near surface alluvium is dominated by Obley Granite in the north and Dulladerry Volcanics in the south. Both would be expected to weather to produce a sandy soil.
- Six patches of gilgai[9] are mapped within the SAR Mine Site.

[9] Gilgais are small depressions in the soil surface, typically associated with expanding clay soils. Gilgais are typically associated with substantial micro-relief comprising closely spaced mounds and depressions..

6.8.2.3 EM Survey

SSM (2021a) undertook an EM survey across the SAR Mine Site. EM surveys enable the measurement of soil conductivity at varying depths below the soil surface. In summary, more electrically conductive soils are typically more saline. As a result, EM surveys allow detailed mapping of soil properties and correlation between widely spaces soil sample locations. The SAR Mine Site was surveyed with a DualEM21HS to record results at the following depth ranges at 5m intervals on transects 50m apart.

- Surface to 0.3m
- Surface to 0.5m
- Surface to 0.8m
- Surface to 1.0m
- Surface to 1.6m
- Surface to 3.2m

Figure 6.8.1 present the results of the EM Survey. In particular, areas of high electrical conductivity, particularly at depth, correlate well with areas of mapped gilgai, likely associated with highly saline subsoils. Conversely, areas of low conductivity correlate with low rises, likely with shallow soils.

6.8.2.4 Field Survey and Laboratory Analysis

A total of 56 soil test pits and 11 surface observations were undertaken within the SAR Mine Site. Two densities of sampling locations were used by SSM (2021a) as follows.

- BSAL Assessment Area (880ha) – comprising the proposed MLA Area plus a 100m buffer. This area was sampled using 39 soil pits and 5 observation sites where only surface properties were recorded, for an average sample density of 20ha/sample.
- Remainder (936ha) – comprising areas that would be subject to disturbance associated with the realigned public roads, but not mining-related disturbance. This area was sampled with 17 soil pits and 6 observation sites, giving an average density of 41ha per soil sample site.

SSM (2021a) state the density of soil sampling used was in accordance with relevant recommendations (Schoknecht *et al*., 2008).

Soil test pits were dug to at least 1.5m or refusal and a range of physical properties were recorded. Representative samples were also selected and tested by a NATA accredited facility for overall fertility and chemistry, including chemical indicators of soil structure. A full description of testing parameters is provided in Section 2.6 of SSM (2021a).

Within the BSAL Assessment Area, soils were assessed in accordance with the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (OEH and OASFS, 2013).

6.8.2.5 Soil Mapping Units and Land and Soil Capability

Based on the results of the above, SSM (2021a) identified the following six Soil Mapping Units, and associated land and soil capabilities, within the SAR Mine Site (**Figure 6.8.2**).

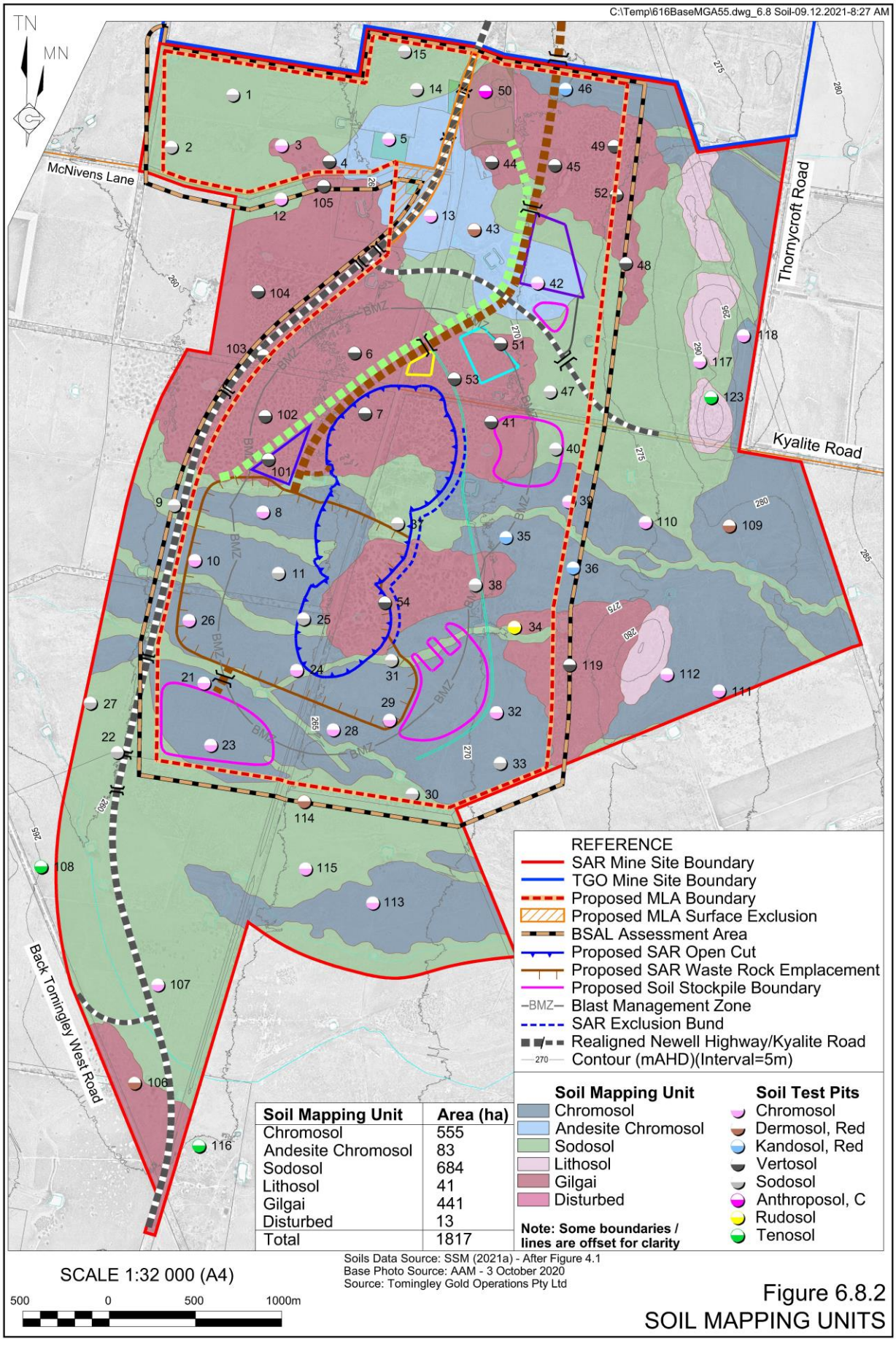


Figure 6.8.2
SOIL MAPPING UNITS

Chromosol and Andesite Chromosol Soil Mapping Unit

The Chromosol Soil Mapping Unit is characterised by a duplex profile comprising silty or sandy clay loam over clay, with parent material identified in the field as Dulladerry Volcanics. The topsoil is moderately thick, well drained and slightly acidic with desirably low exchangeable aluminium, low salinity, low cation exchange capacity and adequate levels of macronutrients and micronutrients except zinc.

The Andesite Chromosol Soil Mapping Unit is characterised by a duplex profile comprising silty or sandy clay loam over clay, with parent material identified in the field as andesite. The topsoil is slightly acidic, with desirably low exchangeable aluminium, low salinity, exchangeable sodium percentage and cation exchange capacity and adequate levels of macronutrients and micronutrients except zinc.

SSM (2021a and 2021b) classified the Chromosol Soil Mapping Unit as Land and Soil Capability Class 4 – moderate capability land and as BSAL.

Sodosol Soil Mapping Unit

The Sodosol Soil Mapping Unit is characterised by a duplex profile, with poorer surface drainage than the Chromosol or Andesite Chromosol Soil Mapping Units. The Soil Mapping Unit is generally sandy, has slightly acidic topsoil with marginally high exchangeable aluminium, low salinity, and moderately low capacity to store nutrients. Cation ratios are adequate in the surface 30cm but the soil becomes more sodic and magnesic with depth, which is associated with slow internal drainage.

SSM (2021a and 2021b) classified the Sodosol Soil Mapping Unit as Land and Soil Capability (LSC) Class 6 – low capability land and non-BSAL.

Gilgai Soil Mapping Unit

The Gilgai Soil Mapping Unit has a clay-rich soil, with well-developed gilgais. Soils of the Gilgai Soil Mapping Unit are typically clay-rich, with mildly acidic and non-saline topsoil over strongly alkaline and saline subsoil. SSM (2021a) notes that the Gilgai Soil Mapping Unit has soil that is potentially productive, but this is constrained by poor drainage and elevated salinity, which limit agricultural productivity.

SSM (2021a and 2021b) classified the Gilgai Soil Mapping Unit as LSC Class 6 – low capability land and non-BSAL.

Lithosol Soil Mapping Unit

The Lithosol Soil Mapping Unit is located on the upper slopes around rises formed by rock outcrops. The soil is similar to other Soil Mapping Units in the vicinity, however, is more-shallow and therefore is likely less productive due to a reduced water holding capacity.

SSM (2021a and 2021b) classified the Lithosol Soil Mapping Unit as LSC Class 6 – low capability land and non-BSAL.

Disturbed Soil Mapping Unit

The Disturbed Soil Mapping Unit is located on the previously rehabilitated tailings storage facility associated with reprocessing of historic tailings at the McPhail Mine in the 1990's, prior to the Applicant's association with the Project. The soil is strongly alkaline and saline and is deficient in macronutrients.

SSM (2021a) classified the Disturbed Soil Mapping Unit as LSC Class 6 – low capability land and non-BSAL.

6.8.2.6 Acid Sulphate Soils

SSM (2021a) identified that the nearest Acid Sulfate Soils are located over 250km from the SAR Mine Site and that no acid sulphate soils were observed.

6.8.3 Soil Stripping and Placement Recommendations

6.8.3.1 Soil Stripping Recommendations

Table 6.8.1 presents the soil stripping depths recommended SSM (2021a), indicative area and volume of the specific Soil Mapping Units that would be available to be stripped.

Table 6.8.1
Recommended Soil Stripping Depths and Volumes

Soil Mapping Unit	Area to Be Disturbed (ha)	Recommended Stripping Depth (cm)		Volume to be Stripped (m^3)	
		Topsoil	Subsoil	Topsoil	Subsoil
Chromosol	189	30	50	567 000	945 000
Andesite Chromosol	28		70	84 000	196 00
Sodosol	111		50[1]	333 000	555 000
Gilgai	133	30[2]	Nil	199 500	Nil
Disturbed	1	Nil	Nil	Nil	Nil
Total	**462**			**1 183 500**	**1 696 000**

Note 1: Sodosol subsoil would require the addition of gypsum at a rate of 2t/ha for each 10cm subsoil stripped during stripping operations.

Note 2: Topsoil would only be stripped from the mounds of the Gilgai Soil Mapping Unit, conservatively assumed to be 50% of the available area.

Source: SSM (2021a) – modified after Table 8.2

6.8.3.2 Soil Placement Recommendations and Soil Balance

As described in Section 3.3.3.5, Landloch (2021b) identified that only topsoil from the Chromosol and Sodosol Soil Mapping Units should be used to rehabilitate steeper sections of the SAR Waste Rock Emplacement and that a minimum thickness of 300mm of soil should be used. Other sections of the SAR Mine Site may be rehabilitated using any of the Soil Mapping Units identified for stripping in Section 6.8.3.1, with soil to be spread to a minimum depth of 200mm.

Table 6.8.2 presents the recommended thicknesses of soil to be spread during rehabilitation operations, as well as the volume of soil that would be required for rehabilitation of the final landform within the SAR Mine Site. In addition, the Applicant proposes to enhance a section of land categorised as Category 1 (exempt) land under the NSW Local Land Services Land Management Framework (see Section 6.9.3.2).[10] **Table 6.8.2** also presents the volume of soil expected to be required for enhancement of this area.

Table 6.8.2
SAR Mine Site Soil Placement Depths and Volume

Final Landform Element	Area to be rehabilitated	Recommended Minimum Placement Depth	Volume to be Placed
SAR Waste Rock Emplacement	140ha[1]	30cm	420 000m^3
All other mining-related disturbance	209ha	20cm	418 000m^3
		Sub - total	**838 000m^3**
Land and Soil Enhancement Area	50ha	50cm[2]	250 000m^3
		Total	**1 088 000m^3**
Note 1: Footprint of the SAR Waste Rock Emplacement = 136ha. Surface area of the constructed SAR Waste Rock Emplacement = 140ha			
Note 2: Assumed average depth of gilgais within the Land and Soil Enhancement Area			
Source: SSM (2021a) – modified after Table 8.4			

In summary, approximately 838 000m^3 of soil would be required for rehabilitation operations, with a further approximately 250 000m^3 required for enhancement operations. The Applicant would prioritise use of the combined Chromosol and Sodosol topsoils for rehabilitation and land enhancement operations.

6.8.3.3 Soil Balance

TGO Mine Site

The Applicant has stripped and stockpiled soil resources from prior areas of disturbance within the TGO Mine Site. A substantial proportion of the stockpiled soil has been used to complete rehabilitation of Waste Rock Emplacements 2 and 3. In addition, soils within the footprint of Residue Storage Facility 2 would be stripped and stockpiled immediately to the south of the facility as described in the approved TGO Mining Operations Plan. **Table 6.8.3** presents the soil balance for the TGO Mine Site. In summary, adequate soils will be available to rehabilitate all disturbed areas within the TGO Mine Site.

SAR Mine Site

Tables 6.8.2 and **6.8.3** present the volumes of soil available to be stripped and the volume required for rehabilitation and land enhancement operations. In summary, approximately 2 879 500m^3 of soil would be available to be stripped and approximately 1 088 000m^3 of soil would be required. As a result, the total volume of soil required would be approximately 38% of the total volume of soil that is available.

[10] Category 1 (exempt) land under the Land Management Framework is land where native vegetation can be cleared without approval from Local Land Services. The Applicant has consulted with Local Land Services who have confirmed that the proposed Land and Soil Enhancement Area is Category 1 (exempt) land.

Table 6.8.3
TGO Mine Site Soil Balance

Component	Calculation/Assumption	Approximate Volume
Soil Available for Rehabilitation		
Existing TGO soil Stockpiles	Aerial survey - 3 October 2020	472 300m^3
Soil to be stripped from Residue Storage Facility 2 footprint	72ha x 0.4m stripping depth[1]	288 00m^3
	Total	**760 300m^3**
Soil Required for Rehabilitation		
Existing disturbed areas requiring soil[2]	206.5ha[2] x 0.2m^3 soil placement depth	413 000m^3
Residue Storage Facility 2	72ha x 0.2m soil placement depth	144 000m^3
Caloma Waste Rock Emplacement	42ha x 0.2m soil placement depth	84 000m^3
	Total	**641 000m^3**
	Surplus	**119 300m^3**

Note 1: Source – Approved TGO Mining Operations Plan – Section 2.3.2.2
Note 2: Source – Approved TGO Mining Operations Plan – after Table 23

6.8.4 Potential Impacts

SSM (2021a) considered the potential impacts to the soil resources and land capability in the absence of management and mitigation measures would be as follows.

- Soil compaction associated with heavy vehicle and machinery use during soil stripping, stockpiling and re-spreading operations.
- Loss of soil resource when areas of soil are removed for construction of the SAR Open Cut, buried under the SAR Waste Rock Emplacement or disturbed during construction of infrastructure.
- Soil sheet erosion when the stable topsoil is disturbed and when surface drainage is modified by reshaping the land.
- Soil gully erosion in drains constructed to divert surface water around the disturbed areas of the SAR Mine Site.
- Soil contamination from material such as hydrocarbons.

6.8.5 Avoidance, Management and Mitigation Measures

The Applicant would implement the following soil and land capability-related management and mitigation measures throughout the life of the Project.

Soil Stripping

- Delineate the areas to be stripped using suitable markers.
- Strip soil materials in accordance with the stripping depths provided in **Table 6.8.1** and ensure soils of different classes are not mixed.

- Locate machinery circuits to minimise compaction of both undisturbed and stockpiled soil.
- Apply water where required to soils prior to and during stripping to maintain a 'slightly moist' condition. Material should not be stripped in either an excessively dry or wet condition.
- Minimise the handling and rehandling of salvaged soil as far as practicable.

Soil Stockpiling

- Directly place stripped soil onto areas undergoing rehabilitation where practicable.
- Stockpile soils of different classes separately.
- Construct soil stockpiles with a maximum side slope of 1:3 (V:H).
- Construct soil stockpiles with a maximum height of 4m.
- Construct combined topsoil and subsoil stockpiles with a maximum height of 3m.
- Retain a 'rough' surface profile for soil stockpiles to promote water infiltration rather than runoff.
- Seed soil stockpiles with appropriate groundcover species, where practicable.
- Maintain all erosion and sediment control infrastructure in the vicinity of soil stockpiles throughout the life of the Project.
- Monitor the condition of soil stockpiles throughout the life of the Project, including the presence of avoidable soil erosion or degradation.
- Minimise rehandling of soil as far as practicable, unless it is required to address loss of soil stockpile integrity.

Soil Respreading

- Place subsoil and topsoil in the locations and to the depths identified in **Table 6.8.2**.
- Test stockpiled soils prior to use to determine soil properties and identify required ameliorants including fertilizer treatments.
- Monitor for adverse meteorological conditions prior to and during soil handing operations and do not commence or continue works until favourable conditions are present.
- Reshape and rip, where practicable, all land surfaces prior to the placement of soil.
- Apply any required ameliorants during soil spreading operations.
- Plan and manage vehicle movements to reduce the compaction of soils as far as practicable.
- Ensure soils and surfaces have adequate moisture content during respreading operations to minimise loss of soil and other dust related impacts,

- Lightly scarify upper surface of topsoils to encourage rainfall infiltration.
- Stabilise final landform with appropriate pasture or other species as soon as practicable after respreading operations.

6.8.6 Assessment of Impacts

6.8.6.1 Soil Striping, Stockpiling and Respreading

The major source of soil disturbance associated with the Project would be the stripping, stockpiling and respreading of soil. Successful rehabilitation of the SAR Mine Site would therefore depend on the following.

- Stripping and stockpiling sufficient suitable topsoil and subsoil resources to provide for required rehabilitation operations.
- Preserving the quality of stockpiled soil resources by maintaining biological activity and adequate aeration in stockpiled soil.
- Respreading soils as recommended by SSM (2021a), including placement of Chromosol and Sodosol only on steeper sections of the SAR Waste Rock Emplacement.

Assuming that the management and mitigation measures identified in Section 6.8.5 are implemented, SSM (2021a) state that adequate soil resources would be available to rehabilitate the SAR Mine Site.

6.8.6.2 Land and Soil Capability

SSM (2021a) estimated the pre, during and post-mining land and soil capability based on the *Land Soil Capability Assessment guidelines* (OEH, 2012). **Figures 6.8.3**, **6.8.4** and **Table 6.8.4** present the existing and anticipated areas of each land and soil capability class within the SAR Mine Site before, during and following mining operations. In addition, the Applicant proposes to undertake a range of agricultural enhancement activities described in Section 6.9 within sections of its land that would not be disturbed by the Project. **Table 6.8.4** also presents the anticipated changes in land and soil classification assuming successful implementation of those activities. In summary, assuming that the proposed agricultural enhancement activities are successful, the project would result in:

- a decrease of approximately 62ha of Class 4 land;
- a decrease of approximately 1ha of Class 6 land; and
- an increase of approximately 49ha of Class 8 land.

In addition, the proposed backfilling of the Caloma 1 and Caloma 2 Open Cuts and the creation of the Caloma Waste Rock Emplacement would result in the conversion of approximately 42ha of land that is currently LSC Class 8 to LSC Class 6 land.

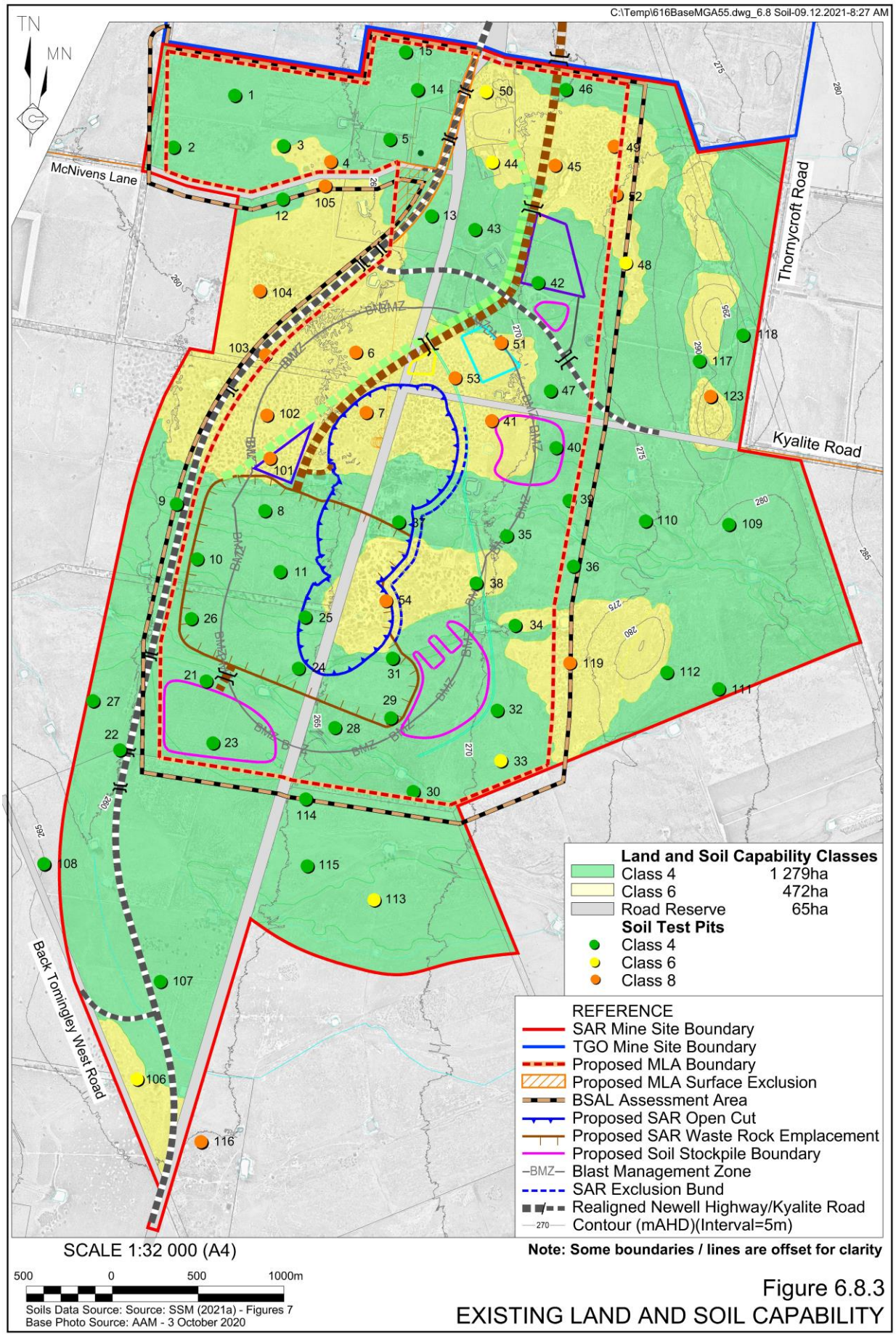


Figure 6.8.3
EXISTING LAND AND SOIL CAPABILITY

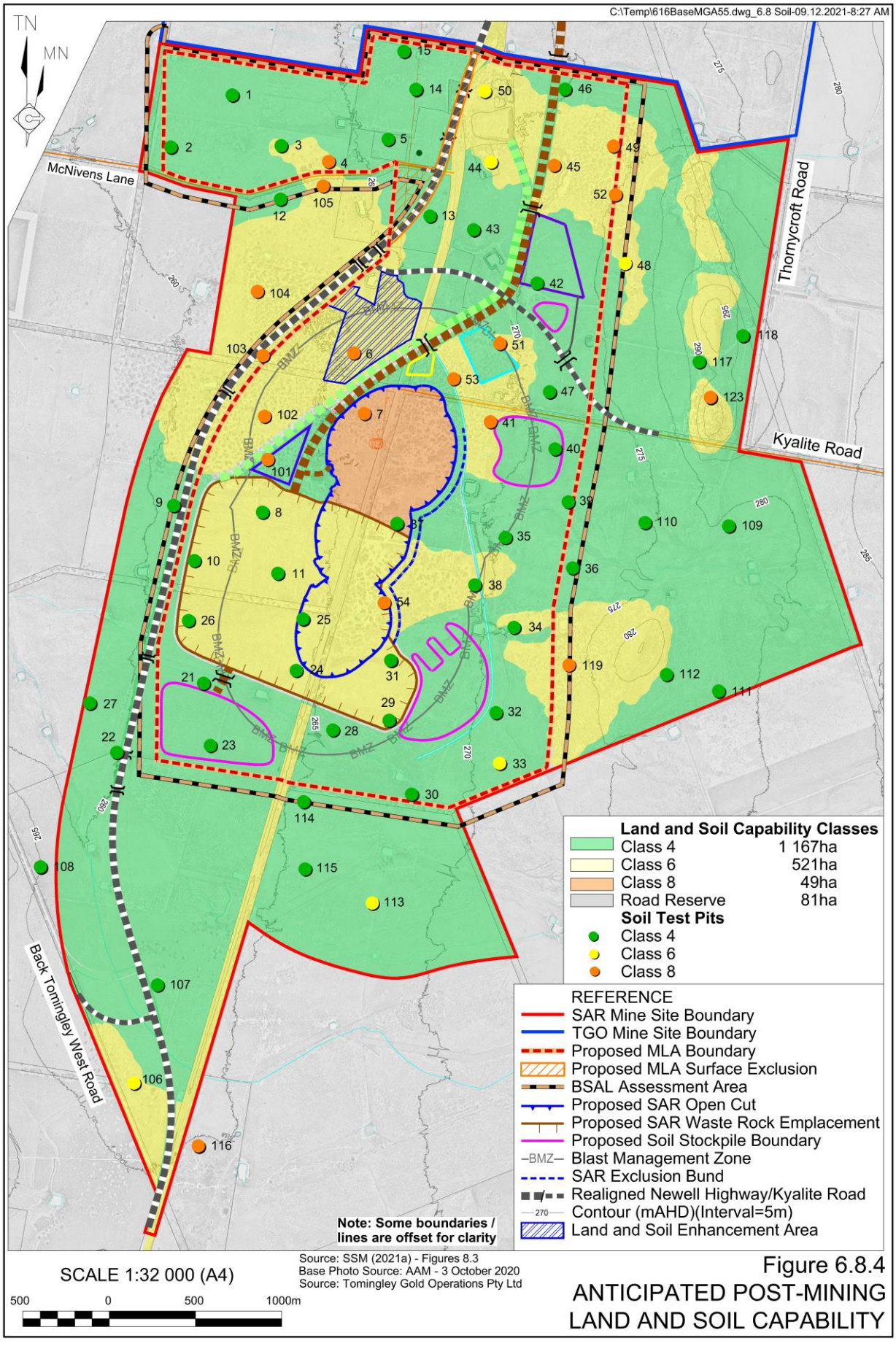

C:\Temp\616BaseMGA55.dwg_6.8 Soil-09.12.2021-8:27 AM
TN
MN
McNivens Lane
Thornycroft Road
Kyalite Road
Back Tomingley West Road
Land and Soil Capability Classes
Class 4 1 167ha
Class 6 521ha
Class 8 49ha
Road Reserve 81ha
Soil Test Pits
Class 4
Class 6
Class 8
REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
Proposed MLA Boundary
Proposed MLA Surface Exclusion
BSAL Assessment Area
Proposed SAR Open Cut
Proposed SAR Waste Rock Emplacement
Proposed Soil Stockpile Boundary
BMZ Blast Management Zone
SAR Exclusion Bund
Realigned Newell Highway/Kyalite Road
Contour (mAHD)(Interval=5m)
Land and Soil Enhancement Area
Note: Some boundaries / lines are offset for clarity
SCALE 1:32 000 (A4)
500 0 500 1000m
Source: SSM (2021a) - Figures 8.3
Base Photo Source: AAM - 3 October 2020
Source: Tomingley Gold Operations Pty Ltd
Figure 6.8.4
ANTICIPATED POST-MINING LAND AND SOIL CAPABILITY

Table 6.8.4
Land and Soil Capability Areas[1] - Pre, During and Post-mining

LSC Class	Pre-mining Area (ha)[4]	During Mining[4]		Post-mining (without enhancement)[4]		Post-mining (with enhancement)[5]	
		Area (ha)	Change from pre-mining (ha)	Area (ha)	Change from pre-mining (ha)	Area (ha)	Change from pre-mining (ha)
Class 4	1 279	962	-317	1 167	-112	1 217	-62
Class 6	472	379	-93	521	+49	471	-1
Class 8	-	-	-	49	+49	49	+49
Road Reserve	65	81	+16	81	+16	81	+16
Active Mining Area[2]		394	+394	-	-	-	-
Total[3]	**1 817**	**1 817**		**1 817**		**1 817**	

Note 1: Within the SAR Mine Site.
Note 2: Active mining area = all land within the proposed limit of disturbance.
Note 3: Apparent arithmetic inconsistences are associated with rounding.
Note 4: Source: SSM (2021a) – Figures 7.2, 8.2 and 8.3
Note 5: Source: Toongi Pastoral Company Pty Ltd

6.8.7 Monitoring

The Applicant would undertake the following soil-related monitoring throughout the life of the Project.

- Test soil and apply ameliorants as required prior to stripping and placing stripped soils into stockpiles.
- Maintain a soil register detailing the location and volume of each soil stockpile, including, the anticipated final use for the identified soil.
- Test soil and apply ameliorants as required prior to extracting from soil stockpiles and using for rehabilitation.
- Monitor and record soil movements to enable clear demonstration of the classification of soils used to rehabilitate each section of the SAR Mine Site.

6.8.8 Conclusion

Management of potential land and soil capability impacts throughout the life of the Project would involve the adoption of a range of mitigation measures. The Applicant would selectively strip, stockpile and respread soils in accordance with the measures identified in Section 6.8.5. The volume of soil available to be stripped would substantially exceed the volume of soil required for rehabilitation. As a result, adverse impacts on rehabilitation as a result of inadequate soil resources is not anticipated.

In addition, the Project would result in a reduction in the area of Land and Soil Capability Class 4 land within the Project Site. This would, however, be offset by a commensurate increase in the agricultural productivity of the Applicant's other landholdings. As a result, impacts to the Land and Soil Capability would not be significant.

6.9 Agriculture

6.9.1 Introduction

The risk assessment undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in agricultural impacts. The risk source with an assessed risk of "medium" or above after the adoption of standard mitigation measures is "Reduction of Land and Soil Capability Class within the SAR Mine Site" (high risk).

In addition, the SEARs issued for the Project identifies "soils and land capability" as a key issue requiring assessment. The principal assessment requirements identified by DPIE relating to agriculture are summarised as follows.

- An assessment of the likely Agricultural Impacts of the Project, including identification of any strategic agricultural land, documented in an Agricultural Impact Statement.
- An assessment of the compatibility of the Project with other land uses in the vicinity of the Project Site, paying particular attention to the agricultural land use in the region.

Finally, the Gateway Certificate included recommendations for matters to be considered in regard to agricultural impacts, including:

- how soils would be managed to improve soil drainage and increase soil fertility; and
- strategies to be used to improve productivity of Land and Soil Capability Class 6 to Land and Soil Capability Class 4, and to rehabilitate disturbed land to Land and Soil Capability Class 4 to offset mining impacts.

Agriculture is the dominant land use in the local area in the vicinity of the Project Site, with mining for gold contributing significantly to the economic, social and agricultural viability of the area intermittently since the late 1800s until the present. The potential impact of the Project on the long-term viability of agricultural production in the local area was raised by the community on a number of occasions (see Section 5.2.2). In summary, the following agricultural-related matters were commonly identified by the community as matters of concern. Other matters raised by the community are identified in Section 5.2 and **Appendix 16**.

- The permanent loss of agricultural land and associated agricultural production.
- Off-site weed and pest impacts due to on-site operations.
- Downstream changes to surface water drainage and quantity.
- Blasting related impacts to livestock.

An *Agricultural Impact Statement* was prepared by the Applicant, hereafter referred to as TGO (2021), and is presented as Part 8 of the *Specialist Consultant Studies Compendium.* It is noted that land within the TGO Mine Site is primarily used for mining purposes. As a result, this assessment focuses on the SAR Mine Site and surrounding Applicant-owned land.

The following subsections provide a summary of TGO (2021) and also address, where relevant, the potential for off-site impacts to surrounding agricultural industry not specifically addressed in other sections of the EIS.

6.9.2 Existing Environment

6.9.2.1 History of Agricultural Enterprises

The Tomingley district has been a mixed farming district since the 1880s. The area was one of the early broadacre wheat growing districts in NSW and Peak Hill boasted the first public silo in Australia on 14 August 1918. Development of the heavily vegetated landscape focused on timber and cropping, with some landowners also working in the nearby gold mines to support early land establishment. Agricultural products were often taken to Narromine via horse-drawn wagon where supplies could be bought and brought back to Tomingley. In addition to dryland cropping and grazing, the Tomingley area was also home to the Rosewood Trotting Stud, a successful operation which at one point was one of the oldest operating trotting stud in Australia. Further information on the history of the area in the vicinity of the Project Site, including the Rosewood Trotting Stud, is located in Section 6.12.2.

Contemporary agricultural operations within the SAR Mine Site have typically been dominated by merino and more recently crossbred sheep, with wheat, oats and barley being the more commonly grown crops. Farming operations within the SAR Mine Site over the past decade have been run by small family operations comprising husband/wife, father/son or single person operations.

The Applicant has acquired all freehold land within the SAR Mine Site, consisting of nine separate properties (**Figure 6.9.1**). Three of the purchases involved with land swaps to facilitate maintenance of family farming enterprises, two have enabled the former owners to retire, with premiums paid for the land and four have delivered significant premiums to continuing farming operations. At the time that the properties were purchased by the Applicant, eight or nine people were employed on the land purchased. As with many small farms in the Peak Hill – Tomingley district, on-farm incomes are typically supplemented with paid off-farm employment. The Applicant is advised that in many cases, off-farm employment generated more than 50% of the annual income for each family operation.

Further details are provided in Section 2.2.2 of TGO (2021a) for the principal properties that are controlled by the Applicant within and in the vicinity of the Project Site.

6.9.2.2 Local Agricultural Productivity

The Applicant purchased all land within the SAR Mine Site between 2020 and 2021. **Table 6.9.1** presents a summary of the agricultural activities for each of the purchased properties prior to purchase. No suitable data is available to quantify actual agricultural returns for the prior operations. Notwithstanding this, based on publicly available gross margin budgets for similar operations in surrounding areas published by the NSW Government indicates that the current gross margin of all properties purchased and controlled by the Applicant is approximately $784,000pa.

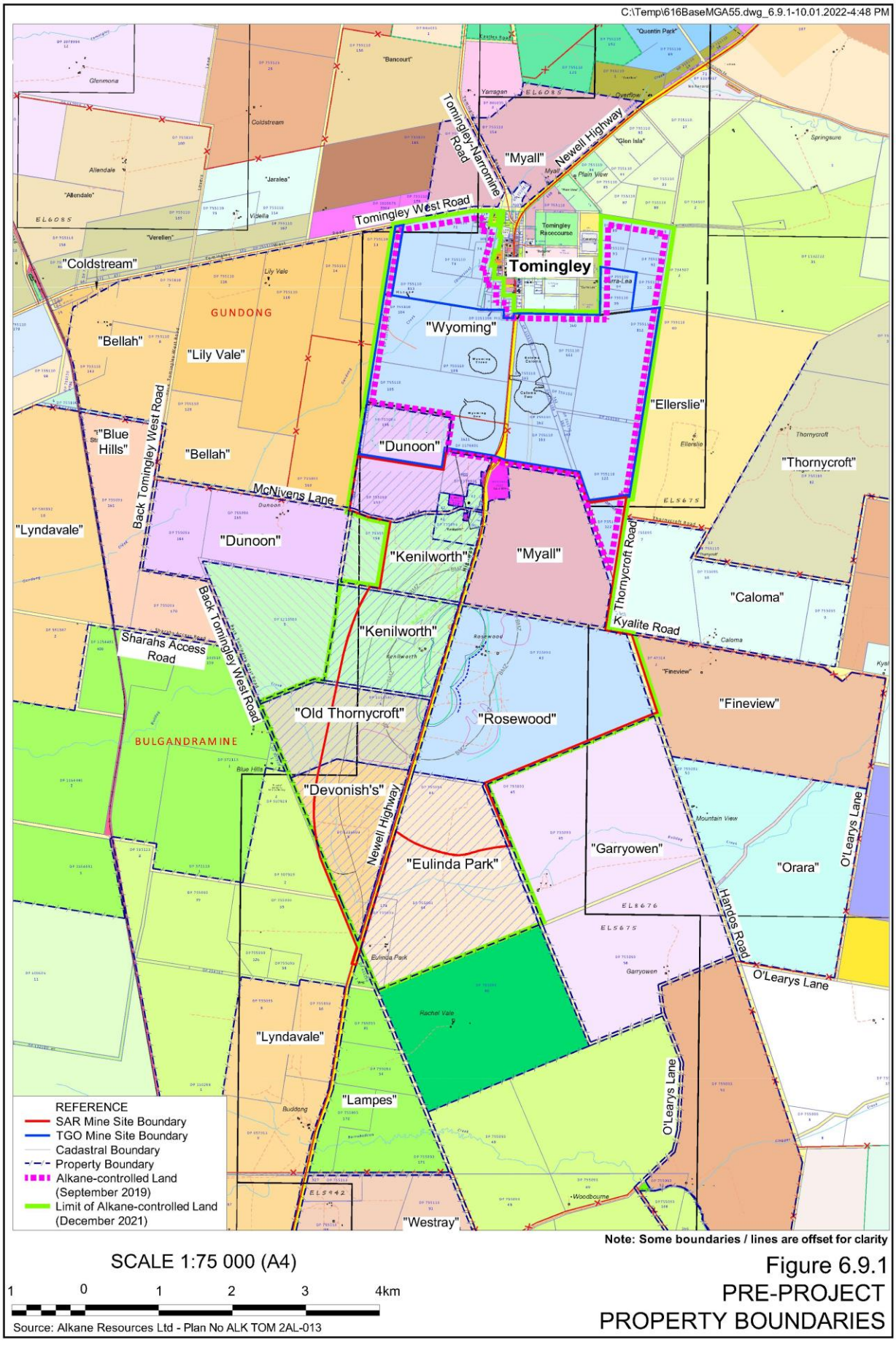

C:\Temp\616BaseMGA55.dwg_6.9.1-10.01.2022-4:48 PM
Tomingley
"Myall"
Newell Highway
Tomingley-Narromine Road
Tomingley West Road
"Coldstream"
GUNDONG
"Bellah"
"Lily Vale"
"Wyoming"
"Ellerslie"
"Blue Hills"
"Dunoon"
"Thornycroft"
Back Tomingley West Road
McNivens Lane
"Lyndavale"
"Kenilworth"
Thornycroft Road
"Caloma"
Kyalite Road
Sharahs Access Road
"Old Thornycroft"
"Rosewood"
"Fineview"
BULGANDRAMINE
"Devonish's"
"Eulinda Park"
"Garryowen"
"Orara"
O'Learys Lane
Handos Road
"Lampes"
"Westray"
REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
Cadastral Boundary
Property Boundary
Alkane-controlled Land (September 2019)
Limit of Alkane-controlled Land (December 2021)
Note: Some boundaries / lines are offset for clarity
SCALE 1:75 000 (A4)
1 0 1 2 3 4km
Source: Alkane Resources Ltd - Plan No ALK TOM 2AL-013
Figure 6.9.1
PRE-PROJECT
PROPERTY BOUNDARIES

Table 6.9.1
SAR Mine Site – Prior Agricultural Enterprises

Property	Enterprises	Area Purchased (ha)
"Myall"	Sheep, crops	312
"Rosewood"	Horses, sheep, crops	517
"Eulinda Park"	Sheep (1X ewes)	431
"Devonish's"	Sheep, crops	202
"Old Thornycroft"	Sheep, crops	207
"Kenilworth"	Sheep, crops	352
"Dunoon"	Sheep, crops	200
	Total	**2 221**
Source: TGO (2021a) – modified after Table 5		

For the approximately 1 817ha of land within the SAR Mine Site, TGO (2021) states that the current carrying capacity of the land is approximately 3.1 dry sheep equivalent (DSE) per ha, or approximately 5 633 DSE in total.

6.9.3 Proposed Land Use and Management

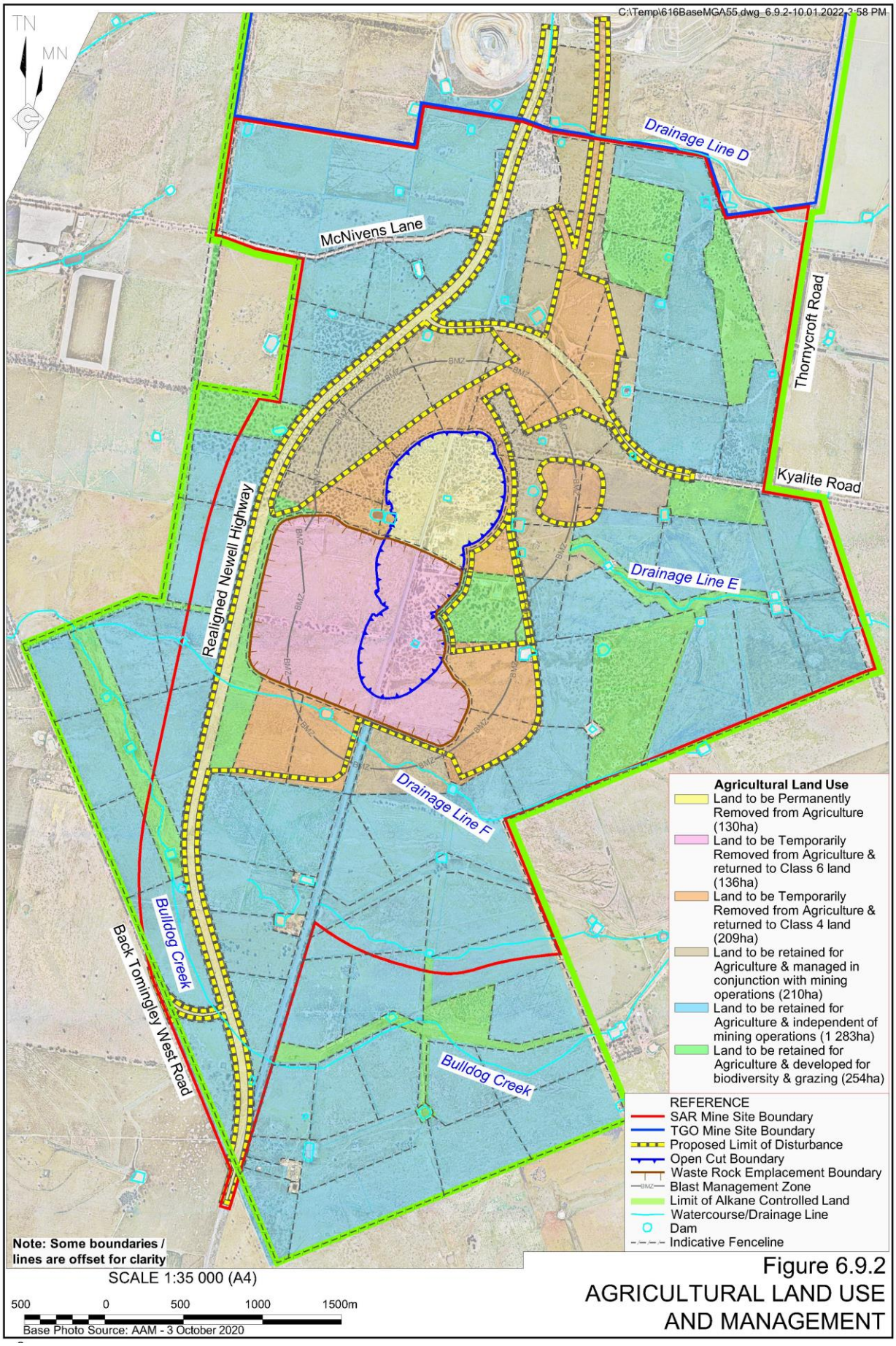
6.9.3.1 Proposed Land Use

Figure 6.9.2 presents the land that would continue to be used for agriculture during and following the life of the Project. That land may be divided into three categories as follows.

- Land to be retained for agriculture and managed independently of mining operations. This land would be outside the Project's Blast Management Zone and ongoing agricultural operations would not be constrained by proposed mining operations.
- Land to be retained for agriculture and managed in conjunction with mining operations. This land would be outside the Project's disturbance footprint but within close proximity of active mining operations. As a result, ongoing agricultural operations would be constrained by proposed mining operations, including exclusion during blasting and for other reasons and would likely be limited to hay making or similar during surface mining operations.
- Land to be retained for agriculture and developed for mixed biodiversity and grazing.

Figure 6.9.2 also presents the land that would be either temporarily or permanently removed from agriculture. In summary, this would include the following.

- Land to be permanently removed from grazing, comprising the final void and realigned Newell Highway and Kyalite Road and associated intersections.
- Land to be temporarily removed from agriculture, comprising:
  - The SAR Waste Rock Emplacement which would be returned to grassland with targeted grazing.
  - All other areas of disturbance which would be returned to pasture/cropping use.


C:\Temp\616BaseMGA55.dwg_6.9.2-10.01.2022 3:58 PM
TN
MN
Drainage Line D
McNivens Lane
Thornycroft Road
Kyalite Road
Realigned Newell Highway
Drainage Line E
Drainage Line F
Bulldog Creek
Back Tomingley West Road
Bulldog Creek
BMZ
Agricultural Land Use
Land to be Permanently Removed from Agriculture (130ha)
Land to be Temporarily Removed from Agriculture & returned to Class 6 land (136ha)
Land to be Temporarily Removed from Agriculture & returned to Class 4 land (209ha)
Land to be retained for Agriculture & managed in conjunction with mining operations (210ha)
Land to be retained for Agriculture & independent of mining operations (1 283ha)
Land to be retained for Agriculture & developed for biodiversity & grazing (254ha)
REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
Proposed Limit of Disturbance
Open Cut Boundary
Waste Rock Emplacement Boundary
Blast Management Zone
Limit of Alkane Controlled Land
Watercourse/Drainage Line
Dam
Indicative Fenceline
Note: Some boundaries / lines are offset for clarity
SCALE 1:35 000 (A4)
500 0 500 1000 1500m
Base Photo Source: AAM - 3 October 2020
Figure 6.9.2
AGRICULTURAL LAND USE AND MANAGEMENT

6.9.3.2 Proposed Land Management

Introduction

The management of agricultural production on the majority of land controlled by the Applicant is currently undertaken by Toongi Pastoral Company Pty Limited (Toongi Pastoral). Toongi Pastoral, a former subsidiary of Alkane, and has been responsible for agricultural activities over Alkane's former landholdings associated with the Dubbo Project at Toongi. The following subsections present an overview of the proposed land management and soil improvement operations that the Applicant would implement to manage and mitigate the permanent loss of agricultural land within and in the vicinity of the Project Site.

Land to Continue to be Used for Agriculture

Figure 6.9.2 presents the land that would continue to be used for agriculture during and following the life of the Project. The Applicant would continue to graze and crop that land with the intention of increasing the carrying capacity of the land from an average of 3.1DSE/ha to 6.0DSE/ha at a rate of approximately 5% increase per year. In order to achieve this, the Applicant would implement the following.

- Progressively undertake fencing and water supply works identified in **Figure 6.9.2**.
- Apply soil ameliorants based on soil testing and advice from a suitably qualified and experienced agronomist to manage any inhibitors to pasture production. This may include the application of fertiliser, lime and / or gypsum.
- Establish deep rooted perennial pastures, including more desirable/palatable species than those currently present.
- Intensively manage the number of livestock on particular sections of the land, providing higher stocking density than historical grazing systems.
- Use destocking and restocking to match carrying grazing capacity to available plant biomass.
- Provide periods of rest and recovery to encourage more available biomass for livestock production systems.
- Establish areas be managed for biodiversity and grazing in areas of existing native vegetation and sensitive areas surrounding key watercourses to provide ecological services and shelter. This would be achieved through fencing selected areas to exclude stock and through natural or assisted revegetation with native species.

In addition, and as indicated in Section 6.8.3.2 and shown on **Figure 6.8.3**, the Applicant has identified an area of approximately 50ha of Category 1 (exempt) land under the NSW Local Land Services Land Management Framework.[11] That area is currently gilgai affected and consequently is classified as Land and Soil Capability Class 6. The Applicant proposes to enhance that land to achieve a Land and Soil Capability of Class 4 using the following methodology.

- Level, shape and till the proposed Land and Soil Enhancement Area to ensure a free draining surface.

[11] Category 1 (exempt) land under the Land Management Framework is land where native vegetation can be cleared without approval from Local Land Services. The Applicant has consulted with Local Land Services who have confirmed that the proposed Land and Soil Enhancement Area is Category 1 (exempt) land

- Where required, place stripped soil in areas that would otherwise not be free draining. For the purposes of the soil balance, an average of up to 50cm of soil across the 50ha area to be enhanced has been assumed. This is likely to be a substantial overestimate and may not be required at all.
- Engage a suitably qualified and experienced agronomist or soil scientist to determine additional amelioration and agricultural practices required to ensure that the shaped landform achieves Land and Soil Capability (LSC) Class 4 status.

Land to be Temporarily Removed from Agriculture

Land that would be temporarily removed from agriculture and returned to Land and Soil Capability Class 6 land would be limited to the SAR Waste Rock Emplacement. That land would be used for low intensity grazing, principally to manage fuel loads with maintaining a minimum 60% vegetation coverage in accordance with the recommendations of Landloch (2021b). Section 3.14.8 presents the measures that would be implemented to achieve that objective.

Land that would be temporarily removed from agriculture and returned to Land and Soil Capability Class 4 land would include all disturbed areas with the exception of the final void and SAR Waste Rock Emplacement and any areas or retained hardstand or roads. That would use used for grazing and cropping operations. Section 3.14.8 of the EIS presents the measures that would be implemented to achieve that objective.

6.9.4 Potential Impacts

6.9.4.1 Land to be Removed from Agriculture

Figure 6.9.2 and **Table 6.9.2** presents the land to be temporarily and permanently removed from agriculture.

Table 6.9.2
Land to be Removed from and Retained for Agriculture

Infrastructure Area	Area (ha)	Temporary/Permanent Removal from Agricultural Production	Justification
Final void	49	Permanent removal from agriculture	Final void unsuitable for agricultural activities
Realigned Newell Highway and local Roads	81		Realigned roads will be retained in the final landform
SAR Waste Rock Emplacement	136	Temporary removal from agriculture. Returned to native vegetation with targeted grazing	Waste Rock Emplacement slopes (1:6 (V:H)) and rehabilitated landform suitable for native vegetation. Grazing to be used to manage fuel loads and control weeds.
All other mining-related disturbance	209	Temporary removal from agriculture. Returned to pasture/cropping use.	Infrastructure to be removed, including hardstand materials, soil spread and land returned to agricultural production (LSC Class 4)
Remaining Areas	1 747	Continued agricultural use	No interruption to agricultural production (see Section 6.9.3.1)
Total	**2 222**		
Source: TGO (2021a) – modified after Table 6			

The Applicant does not anticipate establishing a Biodiversity Offset Area within the SAR Mine Site, with the required biodiversity offset credits likely to be obtained from off-site sources in accordance with the requirements of the *Biodiversity Conservation Act 2016*. However, should a Stewardship Site be able to be established without adversely impacting on agricultural productivity, such an arrangement may be established.

6.9.4.2 Potential Impacts to Surrounding Land Uses

The agriculture industry inherently depends on a number of environmental factors that have the potential to be impacted by the Project which have been addressed in other sections of this EIS, namely:

- soil quality and characteristics (Section 6.8);
- surface water quality and availability (Section 6.6);
- groundwater quality (Section 6.7);
- economic viability of local and regional agriculture and support services (Section 6.14); and
- social impacts, including the ability for surrounding farming operators to expand or increase their landholdings (Section 5.2.2).

Other matters raised by surrounding landholders in the vicinity of the SAR Mine Site included the following.

- Removal of grazing pressures that would otherwise result in a reduction in weed abundance and surface disturbance activities which create favourable environments for early colonisation by weed species.
- Management of feral and overabundant native pest species.

Therefore, the potential impacts to background pest and weed species abundance and pressure have been assessed in consideration of impacts to both agriculture and biodiversity.

6.9.5 Avoidance, Management and Mitigation Measures

6.9.5.1 Introduction

The Applicant, in conjunction with SSM, Toongi Pastoral and Landloch, has identified a range of measures to minimise agricultural impacts likely to be experienced by surrounding landholders. This has involved detailed discussion with those landholders and agreement on preferred measures to manage potential impacts. In addition, the Applicant recognises and acknowledges the significant value in its long history of consultation with the local community, having operated within the local area for over 30 years. The ongoing development of land management practices by the Applicant has largely been influenced by the knowledge of local residents and farming operations that has been developed over generations.

6.9.5.2 Avoidance and Mitigation through Project Design

Key infrastructure within the Project Site has been designed in consideration of potential permanent or avoidable impacts to agricultural production and mitigation opportunities. The extent of surface disturbance, including permanent and temporary impacts, would represent the greatest potential for the avoidance of potential impacts. In particular, the design of the SAR Open Cut has been refined over multiple iterations as the Applicant's understanding of the both the underlying geological resource and potential for environmental impacts has increased over the planning and assessment stages of the Project.

In addition, the SAR Open Cut Clean Water Diversion was substantially redesigned following consultation with the owner of Property 44 ("Garryowen" – **Figure 6.9.1**) to ensure that no additional surface water would flow onto that property.

6.9.5.3 Operational Management and Mitigation Measures

Agricultural Resource and Production

The Applicant would implement the soil management and amelioration practices as outlined in Section 6.9.3.2 in order to increase the Land and Soil Capability Class of the land within and in the vicinity of the SAR Mine Site.

It should be noted that specific land management practices would depend on site-specific conditions that would be implemented, reviewed and refined by the Applicant over the course of the development of the land. Factors that would influence the specific management practices for a given area include, but are not limited to variations in:

- soil type and depth;
- soil water holding capacity and drainage;
- soil chemistry and fertility; and
- land slope and aspect.

Weed, Pest and Disease Management

TGO Mine Site

Management of weed species with the TGO Mine Site and Biodiversity Offsetting Area is managed in accordance with the approved *Mining Operations Plan* and *Biodiversity Management Plan* which incorporates the *TGO Site Specific Procedure for Weed Management*. The applicant would review these documents in consideration of any Project-related changes to operations within the TGO Mine Site as well as the potential for indirect impacts to ongoing management practices.

SAR Mine Site – Agricultural Lands

During the life of the Project, for land under agricultural production, weed management would consist of a combination of mechanical, grazing and chemical controls to manage populations of weed species with the aim of maintaining levels commensurate to surrounding agricultural lands. The specific management of agricultural weeds, pests and disease would be undertaken with

consideration of the agricultural production and management targets and the potential for off-site impacts to surrounding land users. Where relevant, the Applicant would consult and cooperate with neighbouring landholders to manage weeds, pests and disease.

SAR Mine Site - Operational Lands

The proposed management of weed and pest species during rehabilitation is described in Section 6.10.5.2. During site development and operational phases, where land cannot be managed for agriculture due to mining-related operations, the Applicant would implement the following management and mitigation practices.

- Undertake regular weed and pest monitoring and inspections of the SAR Mine Site in accordance with a revised *Biodiversity Management Plan*.
- Record the results of weed and pest monitoring and review in consideration of the results of monitoring undertaken for the TGO Mine Site and other land under the control of the Applicant (i.e. biodiversity monitoring results).
- Conduct targeted mechanical and/or chemical weed and pest control where results indicate a significant Project-related increase in weed or pest activity.
- Conduct targeted mechanical and/or chemical weed and pest controls where results indicate the potential for Project-related off-site impacts to surrounding land uses.
- Monitor for the effectiveness of any control measures undertaken within a practicable period, depending on the type of control used and the specific target.
- Regularly review the results of weed and pest monitoring, including post-control monitoring and revise any relevant management plans were required.
- Maintain all records and results for use in the development and implementation of a *Rehabilitation Management Plan* (see Section 3.14)

6.9.6 Assessment of Impacts

6.9.6.1 Impacts on Agricultural Resources

Figure 6.9.2 presents Alkane-controlled land that would be temporarily or permanently removed from agriculture. In summary:

- approximately 130ha comprising the proposed final void and relocated Newell Highway and local roads would be permanently removed from agriculture;
- approximately 136ha would be temporarily removed from agriculture and returned to native vegetation with targeted grazing;
- approximately 209ha would be temporarily removed from agriculture and returned to pasture/cropping use; and
- approximately 1 764ha would continue to be used for agricultural purposes.

6.9.6.2 Impacts on Agricultural Productivity

Land Controlled by the Applicant

TGO (2021) states that the proposed land and soil management practices would result in an overall increase in agricultural productivity for land controlled by the Applicant, including accounting for the permanent loss of approximately 130ha of agricultural land. Rehabilitation of the SAR Mine Site is expected to occur by 2035 (see Section 3.14), at which time the predicted DSE/ha would reach approximately 6.0. **Table 6.9.3** presents a summary of the existing and anticipated carrying capacity of land within the SAR Mine Site.

Table 6.9.3
SAR Mine Site Agricultural Productivity

Stage	Available Area (ha)		Estimated Average Carrying Capacity (DSE/ha)[1]	Total Carrying Capacity (DSE)	Agricultural Gross Margin Returns[2]
	SAR Mine Site	Remaining TGO-controlled land			
Pre-mining	1 817	405	2021 – 3.1 2022 – 3.3	6 888 7 170	$784,000pa $816,000pa
During Mining	1 342	405	2023 – 3.4 2024 – 3.6 2025 – 3.8 2026 – 4.0 2027 – 4.2 2028 – 4.4 2029 – 4.6 2030 – 4.8 2031 – 5.0 2032 – 5.3	5 842 6 072 6 313 6 565 6 831 7 110 7 402 7 710 8 032 8 371	$665,000pa $691,000pa $719,000pa $747,000pa $778,000pa $809,000pa $843,000pa $878,000pa $914,000pa $953,000pa
Post Mining (during to rehabilitation)	1 342	405	2033 – 5.6 2034 – 5.8	8 727 9 101	$993,000pa $1,036,000pa
Post Mining (post rehabilitated)	1 551	405	2035 – 6.0	10 562	$1,202,000pa
Note 1: SAR Mine Site only. Remaining TGO-controlled land conservatively assumed to have a carrying capacity of 3.1 DSE/ha throughout the life of the Project. In reality, it is likely that this land would also be improved. Note 2: Source: Toongi Pastoral Company Pty Ltd					
Source: TGO (2021a) – Table 8					

In addition, the proposed backfilling of the Caloma 1 and Caloma 2 Open Cuts and the creation of the Caloma Waste Rock Emplacement would result in the conversion of approximately 42ha of land that is currently LSC Class 8 to LSC Class 6 land.

6.9.6.3 Impacts to Surrounding Land Uses

The design of the Project has been undertaken in consideration of the potential of off-site impacts to surrounding land uses. Through the implementation of specific management and mitigation practices for each of the matters identified in Section 6.9.5, it is considered unlikely that the Project would result in unacceptable impacts to surrounding land users. Notwithstanding the above, the Applicant would continue to maintain open communications with surrounding landholders so that in the event that a perceived or substantiated off-site impact has been identified, the Applicant can respond and manage impacts in a responsible and effective manner.

6.9.7 Monitoring

Agriculture-specific monitoring that would be undertaken would include the following.

- Surface water and groundwater monitoring, including water quality, water levels and water usage, would be monitored at key locations monthly, following major rainfall events and prior to any discharge.
- Monitoring of LSC improvements would be routinely completed during and following proposed works to increase LSC Class 6 to Class 4 land to demonstrate that the completed works have achieved the proposed increase in land capability.
- Weed and pest monitoring would be routinely completed during the life of the Project, with monitoring frequency and effort to be determined based on site-specific conditions.
- Monitoring of agricultural productivity of Applicant-owned land would be routinely undertaken, with agricultural inputs and yields recorded seasonally to demonstrate the anticipate improvements in agricultural productivity.

The results of all monitoring programs, including agricultural monitoring, will be presented in the Annual Return for the Project.

Detailed Trigger Action Response Plans would be prepared for the Project and incorporated within the required management plans.

6.9.8 Conclusion

Management of potential agricultural impacts throughout the life of the Project would involve the adoption of a range of mitigation measures. In addition, the Applicant would implement a range of management and mitigation measures to ensure that the Project would not result in any significant negative impacts on the long-term agricultural potential of the land within and in the vicinity of the Project Site.

In addition, the Project would result in a reduction in the area of Land and Soil Capability Class 4 land within the Project Site. This would, however, be offset by a commensurate increase in the agricultural productivity of the Applicant's other landholdings. As a result, impacts to agricultural resources and productivity would not be significant.

6.10 Biodiversity

6.10.1 Introduction

The risk assessment undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in adverse impacts to biodiversity. Through the adoption of standard mitigation and management measures, all residual risks were assessed as being "low".

The SEARs issued for the Project identified "biodiversity" as a key issue requiring assessment, including assessment of the following.

- The biodiversity values and the likely biodiversity impacts of the development throughout its life, and impacts on biodiversity values in the region, in accordance with Section 7.9 of the *Biodiversity Conservation Act 2016*, the *Biodiversity Assessment Method* (BAM) (DPIE, 2020a) and documented in a *Biodiversity Development Assessment Report* (BDAR).
- The BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the BAM.

The assessment requirements of the Biodiversity, Conservation and Science Directorate, Mining, Exploration and Geoscience and Narromine Shire Council were also considered during the preparation of the biodiversity assessment. A summary of the SEARs and the requirements of the above three agencies are listed within **Appendix 2** together with a record of where each requirement is addressed in the EIS.

A Biodiversity Development Assessment Report (BDAR) for the Project was prepared by AREA Environment & Heritage Consultants Pty Ltd (AREA) and is presented as Part 9 of the *Specialist Consultant Studies Compendium* and hereafter referred to as AREA (2021). The following subsections provide a summary of the BDAR and describe the operational safeguards and management measures that would be implemented by the Applicant. The Biodiversity Study Area for the Project is as shown on **Figure 6.10.1**. Reference is made, where appropriate, to the current TGO *Biodiversity Management Plan* for the current TGO Mine Site and *Property Vegetation Plan* for the existing Biodiversity Offset Area. All relevant mitigation measures presented in the TGO *Biodiversity Management Plan* are incorporated within this subsection.

6.10.2 Desktop Assessments

6.10.2.1 Introduction

AREA (2021) undertook an extensive desktop assessment for the Biodiversity Study Area to identify known significant biodiversity values within the vicinity of the Project Site. This data was then used in part to design site or area specific field survey methodologies in accordance with the BAM. The following subsections present an overview of the desktop assessments.

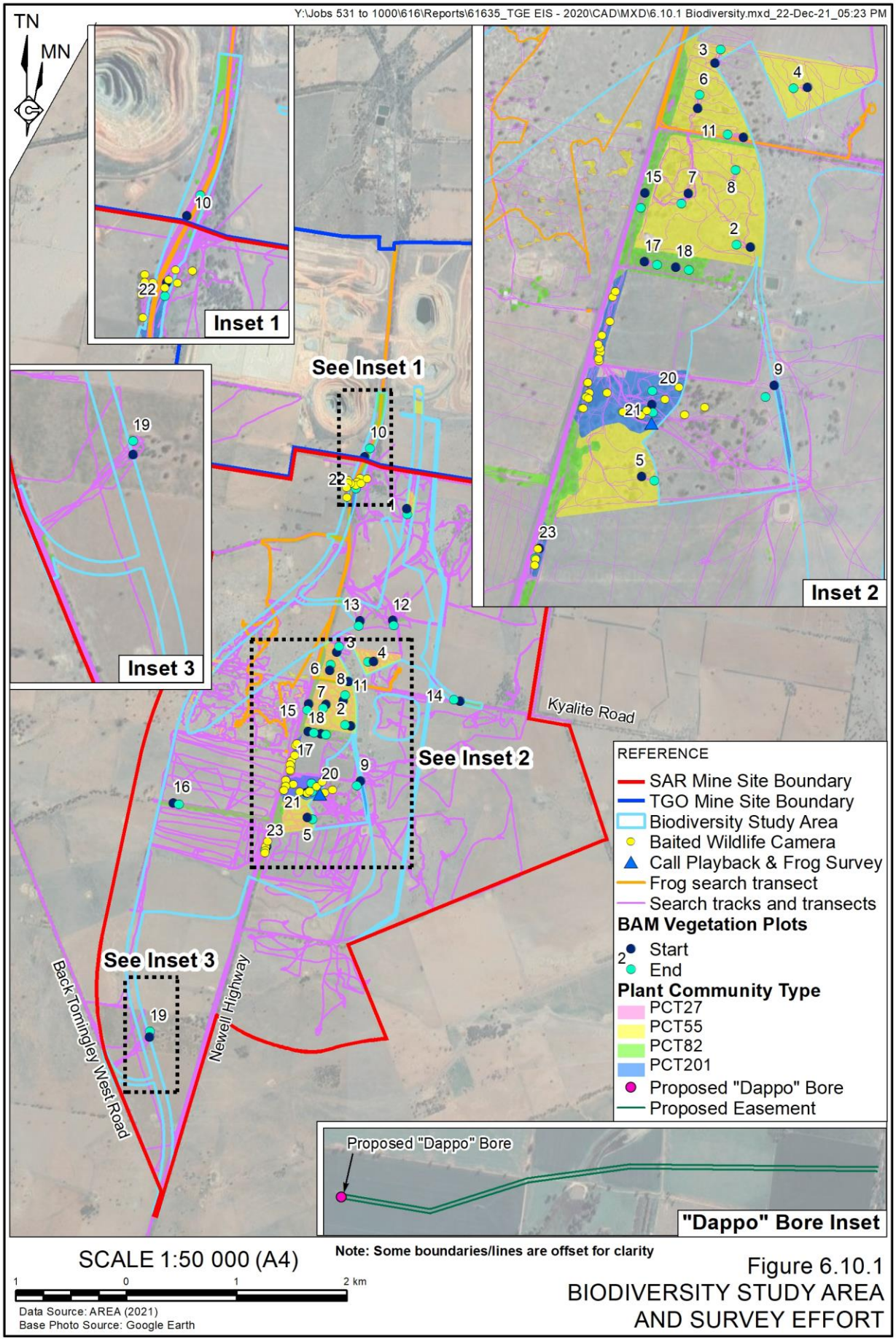


Figure 6.10.1
BIODIVERSITY STUDY AREA AND SURVEY EFFORT

6.10.2.2 Landscape Assessment

A landscape assessment was undertaken by AREA (2021) in accordance with Section 3 of the BAM. This assessment considered landscape value and the potential impacts associated with the Project through the consideration of factors including:

- local topography and native vegetation cover;
- Interim Biogeographic Regionalisation for Australia (IBRA) bioregions and subregions;
- rivers, streams and wetlands;
- habitat connectivity;
- areas of geological significance;
- areas of outstanding biodiversity value; and
- areas identified as Terrestrial Biodiversity Land under the *Narromine Local Environmental Plan 2011*.

6.10.2.3 Threatened Species Assessment

Methodology

Predicted occurrence of threatened species was determined via the BAM Calculator Tool for the IBRA Darling Riverine Plain Bioregion and Bogan-Macquarie Subregion. The list of candidate threatened species was then reviewed in consideration of the following databases.

- NSW BioNet Atlas Database.
- Environment Protection and Biodiversity Conservation Act 1999 (EBPC Act) Protected Matters Search Tool.
- DPE Threatened Species Profile Database.

AREA (2021) also reviewed the most recent vegetation datasets for the locality including the State Vegetation Type Map: Central West Lachlan State Vegetation Map (v1_PCT_E_4468). The vegetation mapping was considered when reviewing and validating the vegetation communities of the Biodiversity Study Area.

Results

Flora

A total of eight threatened flora species were either predicted to occur within 1.5km of the Biodiversity Study Area by the EPBC Act Protected Matters Search Tool or were identified as being recorded within 10km of the Biodiversity Study Area based on the results of the NSW BioNet Atlas Database (**Table 6.10.1**).

Table 6.10.1
Threatened Flora Species – Desktop Assessment Results

Common Name	Scientific Name	Protected Matters Search Tool (1.5km)	Bionet Atlas Database (10km)	EPBC Act Status	BC Act Status
-	*Androcalva procumbens*	Yes	-	Vulnerable	Vulnerable
-	*Austrostipa wakoolica*	Yes	-	Endangered	Endangered
Winged Pepper-cress	*Lepidium monoplocoides*	Yes	-	Endangered	Endangered
Tarengo Leek Orchid	*Prasophyllum petilum*	Yes	-	Endangered	Endangered
A leek-orchid	*Prasophyllum sp. Wybong*	Yes	-	Critically Endangered	Not Listed
Slender Darling-pea	*Swainsona murrayana*	Yes	-	Vulnerable	Vulnerable
-	*Tylophora linearis*	Yes	Yes	Endangered	Vulnerable
Bluegrass	*Dichanthium setosum*	-	Yes	Vulnerable	Vulnerable
Source: AREA (2021) – modified after Tables 5-2 and 5-4					

6.10.2.4 Presence of Category 1 Land

AREA (2021) consulted with Local Land Services (Department of Regional NSW) and the Biodiversity, Conservation & Science Directorate to confirm the presence of Category 1 (exempt land) and Category 2 (regulated land) in accordance with Sections 60H and 60I (respectively) of the *Local Land Service Act 2013* (LLS Act) and as plotted on the *Native Vegetation Regulatory Map* of the Act. Where Category 1 (exempt land) exists, native vegetation clearing is allowable in accordance with the *Land Management (Native Vegetation) Code 2018,* and with approval from Local Land Services if required. For the purposes of the biodiversity assessment for the Project, land consistent with Category 1 (exempt land) as described in Section 60H of the LLS Act, does not require further assessment.

In addition to the above, AREA (2021) used data collected during field work to confirm the presence or absence of Category 1 (exempt) land within the Biodiversity Study Area. Further information is presented in Section 3 of AREA (2021).

6.10.2.5 Potential Ecosystem Credit Species

Ecosystem credit species are those that can be reliably predicted from the habitat surrogates and their presence is through an assessment of suitable habitat. These species are predicted by the BAM Calculator to occur based on their known presence or predicted presence in the IBRA subregion, the known association with Plant Community Types (PCTs) and the size and condition of the vegetation patches on the site. Ecosystem credit species may be excluded from this list where they require particular habitat or geographic features (as prescribed by the BAM Calculator) which are not present.

Table 6.10.2 presents the ecosystem credit species identified by the BAM Calculator. Two species (grey highlight) were excluded based on habitat or geographic constraints and two additional species (underlined text) were added as they were identified as being potentially present by the EPBC Act Protected Matters tool.

Table 6.10.2
Ecosystem Credit Species

Scientific Name	Common Name	Habitat constraints	Geographic constraints	BC status	EPBC status
Falco subniger	Black Falcon	-	-	Vulnerable	Not listed
Hamirostra melanosternon	Black-breasted Buzzard (foraging)	-	-	Vulnerable	Not listed
Grus rubicunda	Brolga	-	-	Vulnerable	Not listed
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	-	East of the Newell Highway	Vulnerable	Not listed
Nyctophilus corbeni	Corben's Long-eared Bat	-	-	Vulnerable	Vulnerable
Stagonopleura guttata	Diamond Firetail	-	-	Vulnerable	Not listed
Artamus cyanopterus cyanopterus	Dusky Woodswallow	-	-	Vulnerable	Not listed
Petroica phoenicea	Flame Robin	-	-	Vulnerable	Not listed
Calyptorhynchus lathami	Glossy Black-Cockatoo (foraging)	Presence of *Allocasuarina* and *Casuarina* species	-	Vulnerable	Not listed
Falco hypoleucos	Grey Falcon	-	-	Endangered	Vulnerable
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	-	-	Vulnerable	Not listed
Pteropus poliocephalus	Grey-headed Flying-fox	-	-	Vulnerable	Vulnerable
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	-	-	Vulnerable	Not listed
Phascolarctos cinereus	Koala (Foraging)	-	-	Vulnerable	Vulnerable
Lophochroa leadbeateri	Major Mitchell's Cockatoo (Foraging)	-	-	Vulnerable	Not listed
Grantiella picta	Painted Honeyeater	-	-	Vulnerable	Vulnerable
Calyptorhynchus banksii samueli[1]	Red-tailed Black Cockatoo (inland subspecies)	-	North of Nyngan	Vulnerable	Not listed
Chthonicola sagittata	Speckled Warbler	-	-	Vulnerable	Not listed
Dasyurus maculatus	Spotted-tailed Quoll	-	-	Vulnerable	Endangered
Polytelis swainsonii	Superb Parrot (foraging)	-	-	Vulnerable	Vulnerable
Haliaeetus leucogaster[1]	White-bellied Sea Eagle	Within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines	-	Vulnerable	Not listed
Hirundapus caudacutus	White-throated Needletail	-	-	Not listed	Vulnerable

Note 1: Excluded from further assessment.

Source: AREA (2021) – modified after Table 5-7

6.10.2.6 Potential Species Credit Species

Species credit species (candidate species) are those that cannot be reliably predicted from the habitat surrogates and their presence is to be assessed through habitat assessment and targeted surveys. When key habitat features or constraints for a given candidate species are identified within the Biodiversity Study Area, further consideration of the candidate species is required. When a candidate species is known to occur or assumed to occur, they require offsetting.

Table 6.10.3 presents the Species Credit species (candidate species) identified using the BAM Calculator. Two additional species (underlined text) was added as it were identified as being potentially present by the EPBC Act Protected Matters tool.

Where habitat or geographic constraints are not present, potential Species Credit species can be excluded from further survey. Species shaded grey in **Table 6.10.3** have been excluded by AREA (2021) excluded. The remaining species were identified as requiring specific targeted assessments during field surveys.

Table 6.10.3
Species Credit Species

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Species	Common Name	Habitat constraints	Geographic limitations	BC status	EPBC status
Ardeotis australis	Australian Bustard	-	-	Endangered	Not listed
Calyptorhynchus banksii samueli[1]	Red-tailed Black-Cockatoo (inland subspecies) (breeding)	Hollow bearing trees - Living or dead tree with hollows greater than 15cm diameter and greater than 5m above ground	North of Nyngan	Vulnerable	Not listed
Calyptorhynchus lathami	Glossy Black-Cockatoo (breeding)	Hollow bearing trees; Living or dead tree with hollows greater than 15cm diameter and greater than 5m above ground	-	Vulnerable	Not listed
Chalinolobus dwyeri[1]	Large-eared Pied Bat	Cliffs, within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels	-	Vulnerable	Vulnerable
Crinia sloanei	Sloane's Froglet	-	-	Vulnerable	Endangered
Dichanthium setosum	Bluegrass	-	-	Vulnerable	Vulnerable
Diuris tricolor	Pine Donkey Orchid	-	-	Vulnerable	Not listed
Haliaeetus leucogaster[1]	White-bellied Sea-Eagle (Breeding)	Living or dead mature trees within suitable vegetation within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines Waterbodies;	-	Vulnerable	Not listed

Table 6.10.3 (Cont'd)
Species Credit Species

Species	Common Name	Habitat constraints	Geographic limitations	BC status	EPBC status
Hamirostra melanosternon[1]	Black-breasted Buzzard (breeding)	Land within 40 m of riparian woodland on inland watercourses/waterholes containing dead or dying eucalypts	-	Vulnerable	Not listed
Lophochroa leadbeateri	Major Mitchell's Cockatoo (Breeding)	Hollow bearing trees. Living or dead tree with hollows greater than 10cm diameter	-	Vulnerable	Not listed
Phascogale tapoatafa	Brush-tailed Phascogale	-	-	Vulnerable	Not listed
Phascolarctos cinereus[1]	Koala (breeding)	Areas identified via survey as important habitat	-	Vulnerable	Vulnerable
Polytelis swainsonii	*Polytelis swainsonii Superb Parrot (breeding)*	Hollow bearing trees; Living or dead *E. blakelyi, E. melliodora, E. albens, E. camaldulensis, E. microcarpa, E. polyanthemos, E. mannifera, E. intertexta* with hollows greater than 5cm diameter greater than 4m above ground or trees with a diameter at breast height of greater than 30cm	-	Vulnerable	Vulnerable
Pteropus poliocephalus[1]	Grey-headed Flying-fox (breeding)	Breeding camps	-	Vulnerable	Vulnerable
Swainsona murrayana	Slender Darling Pea	-	-	Vulnerable	Vulnerable
Swainsona plagiotropis	Red Darling Pea	-	-	Vulnerable	Vulnerable
Swainsona recta	Small Purple-pea	-	-	Endangered	Endangered
Turnix maculosus	Red-backed Button-quail	-	-	Vulnerable	Not listed
Note 1: Grey Highlight = Excluded from further assessment.					
Source: AREA (2021) – modified after Table 5-9					

6.10.3 Field Surveys

6.10.3.1 Introduction

AREA (2021) undertook multiple rounds of field surveys within the Biodiversity Survey Area between September 2019 and December 2021, with the total survey effort for the Project totalling approximately 35 days. Field surveys were undertaken in accordance with the following guidelines.

- *Biodiversity Assessment Methodology* (DPIE, 2020a).
- *Surveying threatened plants and their habitats NSW survey guide for the Biodiversity Assessment Method* (DPIE 2020b).

- *NSW Survey Guide for Threatened Frogs 'A guide for the survey of threatened frogs and their habitats for the Biodiversity Assessment Method'* (DPIE 2020c).
- *'Species credit' threatened bats and their habitats NSW survey guide for the Biodiversity Assessment Method* (OEH, 2018).
- *Guide to Surveying Threatened Plants* (OEH, 2015).
- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft* (DEC, 2004).
- Various Australian Government survey requirements (for species birds, bats, reptiles, frogs, fish and mammals) listed under the EPBC Act.

6.10.3.2 Flora Assessments

Plant Community Types and threatened plant species within the Biodiversity Study Area were identified and mapped using a combination of BAM plots, transects, walking meanders and opportunistic observation (**Figure 6.10.1**). PCTs that were identified within the Biodiversity Survey Area were assessed for association with Threatened Ecological Communities (TECs) under the BC Act and EPBC Act.

Where significant native vegetation occurred within areas mapped as Category 1 (exempt land) (**Figure 6.10.2**), AREA (2021) undertook an assessment of the vegetation using the BAM 'Streamlined assessment module - Scattered trees assessment' where the vegetation met the definition of scattered trees. Where significant native vegetation cover (i.e., grasses, forbs and shrubs) was identified within areas of Category 1 (exempt land), AREA (2021) applied the standard BAM assessment methodology to confirm the overall poor condition of the native vegetation within these areas and the associated designation as Category 1 (exempt land).

6.10.3.3 Fauna Assessments

Fauna surveys methodologies within and in the vicinity of the Biodiversity Study Area consisted of the following (**Figure 6.10.1**).

- Transects and walking meanders
- Diurnal observation of tree hollows
- Baited wildlife cameras
- Diurnal observations of bird species
- Call-playback
- Opportunistic observation

Targeted threatened fauna surveys were undertaken for those species identified as having a moderate to high likelihood of occurrence and identified as Species Credit species. The presence or absence of key habitat constraints and geographic limitations relevant to each threatened species were confirmed during targeted surveys, including:

- hollow-bearing trees;
- cliffs and other rocky habitat;

- mature trees (live or dead) within 1km of significant waterbodies and other riparian vegetation;
- mapped habitat features; and
- evidence of breeding camps.

6.10.4 Survey Results

6.10.4.1 Plant Community Types

Figure 6.10.2 displays vegetation mapped by AREA (2021) within the Biodiversity Study Area and **Table 6.10.4** summarises the extent and condition of vegetation within the Project Area.

Table 6.10.4
PCTs, Vegetation Zones and Condition within the Biodiversity Study Area

Plant Community Type	Vegetation Zone	Condition Class	Area within Biodiversity Study Area (ha)
PCT 55 – Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	1	Poor	25.60
	2	Moderate	14.87
	3	Good	3.31
		Subtotal	43.78
PCT 82 – Western Grey Box - Poplar Box - White Cypress Pine tall woodland on red loams mainly of the eastern Cobar Peneplain Bioregion	4	Moderate	4.03
	5	Good	14.83
	6	"Kurrajong"[1]	1.91
		Subtotal	20.77
PCT 201 – Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	7	Moderate – Trees	0.03
	8	Moderate – Cleared	2.38
	9	Good	8.39
		Subtotal	10.80
PCT 27 – Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	10	Moderate	0.68
		Subtotal	0.68
		Total	**76.03**

Note 1: Includes an area of PCT 82 of which the upper stratum was dominated by a planted fodder crop of Kurrajong (Brachychiton populnea) (see Section 4.3 of AREA (2021).

Source: AREA (2021) – modified after Table 4-17

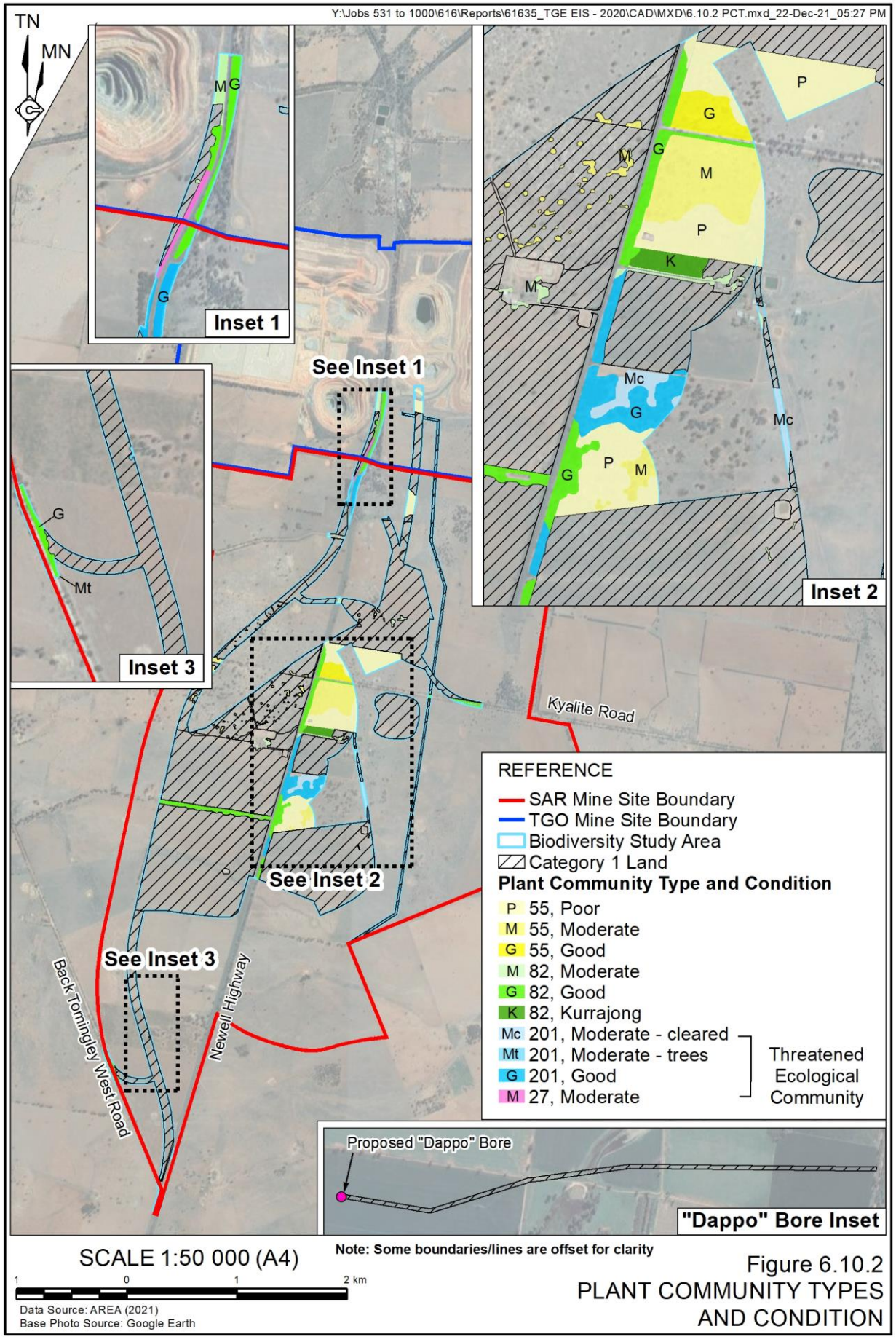


Figure 6.10.2
PLANT COMMUNITY TYPES AND CONDITION

6.10.4.2 Threatened Ecological Communities

Two TEC listed under the BC Act and/or the EPBC Act were identified by AREA (2021) as being associated with PCTs within the Biodiversity Study Area. The TEC include the following (**Figure 6.10.2**).

- *Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions* TEC (Fuzzy Box Woodland TEC).

  The Fuzzy Box Woodland TEC is associated with PCT 201 - Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion and is listed as Endangered under the BC Act.

- Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes Bioregions TEC (Myall Woodland TEC)

  The Myall Woodland TEC is associated with PCT 27 - Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion and is listed as Endangered under both the BC Act and EPBC Act.

6.10.4.3 Targeted Assessments

Twelve species were identified as requiring targeted assessment, however no individuals of any of the twelve species were identified within the Biodiversity Study Area. Table 5-11 of AREA (2021) provides a detailed overview of the targeted survey programs for these species.

6.10.4.4 Threatened Species

Three species of threatened fauna were detected by AREA (2021) during field surveys. One species, the Glossy Black-cockatoo (*Calyptorhynchus lathami*), was represented by a single lone male specimen. The presence of this species was considered by AREA (2021) as an anomaly and likely related to the significant period of bushfires that occurred in the early months of 2020. This observation therefore was excluded from the assessment. The remaining two species, the Grey-crowned Babbler (eastern subspecies) (*Climacteris picumnus victoriae*) and the Superb Parrot (*Polytelis swainsonii*), were included as ecosystem credit species.

6.10.5 Avoidance, Management and Mitigation

6.10.5.1 Avoidance of Potential Impacts through Project Design

The original disturbance footprint and overall layout of the Project Site was determined by the location of the SAR deposits and their proximity to existing mine-related infrastructure. In addition, the proposed realignment of the Newell Highway and Kyalite Road, and the associated intersections, has largely been constrained by the requirement to achieve optimal road design and safety standards.

Notwithstanding this, the Project design has been developed and amended multiple times, taking into account the results of biodiversity surveys and the outcomes from consultation with local residents and other Government agencies. In particular, the design of the SAR Waste Rock Emplacement has been significantly influenced by the presence of PCT 201 and the associated Fuzzy Box Woodland TEC. The layout and design and layout of critical elements within the SAR Mine Site including the SAR Waste Rock Emplacement, SAR Magazine and soil stockpiles have been chosen where practicable to avoid impacts to threatened ecological communities and overall biodiversity values within the Project Site. The presence of significant biodiversity values has, within constraints imposed by road design guidelines, also influenced the proposed realignment of the Newell Highway and other significant surface infrastructure.

Table 6.10.5 presents the progressive reduction of potential impacts to native vegetation since October 2020. In total, the avoidance areas within the Project design have resulted in a total reduction in the potential impact to PCT 201 of approximately 13.75ha, and an overall reduction of potential impacts to native flora of 62.53ha.

Table 6.10.5
Avoidance of Impacts Through Project Design

Design	Total Native Vegetation (ha)	Total Impact to PCT201
October 2020	138.56	24.55
October 2021	112.47	11.36
Proposed	76.03	10.80
Source: AREA (2021) – modified after Table 6-4		

Finally, the Applicant notes that AREA (2021) assessed all areas of disturbance based on the maximum "limit of disturbance" provided by the Applicant. In reality, the Project would result in smaller areas of disturbance than assessed and the Applicant would avoid disturbing native vegetation and TEC, to the extent practicable, irrespective of the fact that consent has been sought for that disturbance.

6.10.5.2 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures during the construction and operational phases of the Project to further mitigate and manage biodiversity impacts.

- Prepare and implement a *Biodiversity Management Plan* in accordance with the protocols for the existing TGO *Biodiversity Management Plan*. The Plan would describe the biodiversity mitigation and management measures, monitoring of rehabilitation outcomes and the implementation of the proposed biodiversity offsets.
- Ensure all workers are inducted in relation to Project environmental procedures, including environmental risk and emergency management.
- Survey and mark out the limits of approved native vegetation clearing and areas of native biodiversity to be retained and ensure that surface disturbing activities are limited to approved areas.

- Construct temporary fencing around significant areas of native biodiversity during construction operations.
- Avoid clearing native vegetation and hollow-bearing trees during the breeding season of hollow-dwelling fauna (i.e. Spring).
- Undertake pre-clearing inspections of hollow-bearing trees to confirm the absence of roosting/breeding threatened species and manage any vertebrate fauna identified during inspections to minimise the risk of mortality or injury.
- Undertake vegetation clearance in accordance with best practice principles, including staged vegetation clearance where practicable.
- Respond to native fauna detected during vegetation clearing operations in accordance with the Fauna Handling and Rescue Procedure outlined in the TGO *Biodiversity Management Plan*.
- Ensure machinery entering the Project Site has been adequately cleaned and inspected for foreign plant material including seeds prior to operating on site.
- Control weed species within the Project Site in accordance with the BC Act.
- Install warning signs at known wildlife crossing locations and adhere to speed limits to reduce the risk of vehicle strike to native fauna.

6.10.5.3 Offsetting of Residual Impacts

Biodiversity Offsetting Requirements

Using the BAM Calculator, AREA (2021) has determined the biodiversity offsetting requirements for the Project. **Tables 6.10.6** presents the ecosystem credits that would be required to offset the residual biodiversity impacts of the Project. In summary, 1 724 Ecosystem Credits would be required to be retired to mitigate the residual biodiversity impacts of the Project. The Applicant proposes to retire these biodiversity offset credits through a combination of mechanisms under the BC Act.

Table 6.10.6
Ecosystem Credits

PCT ID	PCT Name	BAM – Standard		BAM – Scattered Trees		Total
		Hollow Bearing Trees	Other	Hollow Bearing Trees	Other	
55	Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	145	395	7	5	552
82	Western Grey Box - Poplar Box - White Cypress Pine tall woodland on red loams mainly of the eastern Cobar Peneplain Bioregion	608	95	8	22	733
201	Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	398	27	0	1	426
27	Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	0	13	0	0	13
	Total	1 151	530	15	28	**1 724**
Source: AREA (2021) – modified after Table 7-1						

6.10.6 Assessment of Impacts

6.10.6.1 Introduction

This subsection presents an assessment of the anticipated Project-related impacts on listed flora and fauna species and communities. Both direct and indirect impacts are considered together with relevant legislative considerations.

6.10.6.2 Direct Impacts

The project would result in the removal of 76.03ha of native vegetation comprising the following.

- PCT27 (associated with Myall Woodland TEC)..... 0.68ha
- PCT55..... 43.78ha
- PCT82..... 20.77ha
- PCT201 (associated with Fuzzy Box Woodland TEC)..... 10.80ha

Notwithstanding this, the Applicant would, to the extent practicable, avoid disturbing native vegetation and TEC within the approved limit of disturbance, irrespective of the fact that consent has been sought for that disturbance.

The proposed disturbance would occur during the initial years of the Project and, whilst rehabilitation would occur, those impacts would remain, to a lessening extent, over the medium to long-term. In particular, development of habitat features such as hollows can take 100 years or greater to form. Additionally, a proportion of the impact would be irreversible, with approximately 130ha of land, albeit land currently used for agriculture, permanently removed.

As identified in Section 6.10.5.3, the Applicant would retire the biodiversity offset credits required for the Project in accordance with the requirements of the BC Act.

6.10.6.3 Serious and Irreversible Impacts

Introduction

AREA (2021) identify impact from the Project on the Fuzzy Box Woodland TEC as potentially a Serious and Irreversible Impact.

Principles for determining whether a Serious and Irreversible Impact would occur are provided by Clause 6.7(2) of the *Biodiversity Conservation Regulation 2017* and can be summarised as follows.

> *An impact is to be regarded as serious and irreversible if it is likely to contribute significantly to the risk of an ecological community becoming extinct where it may:*
>
> – *accelerate the rate of decline for the community;*
>
> – *result in a decline in an already significantly reduced population size and/or geographic distribution; and/or*
>
> – *the community is unlikely to respond to measures to improve its habitat or integrity.*

AREA (2021) conducted a desktop assessment to identify the total mapped area of all PCTs associated with the Fuzzy Box Woodland TEC. In addition, field surveys were used to ground truth and further identify and map the location and area of Fuzzy Box Woodland TEC within 10km of the Biodiversity Assessment Area. The Serious and Irreversible Impact assessment by AREA (2021) was conducted using a rapid assessment approach and was limited to observations from publicly accessible roads. Further information regarding the approach to this assessment can be found in Section 6.1.1 of AREA (2021).

Regional Fuzzy Box Woodland TEC

Table 6.10.7 identifies that there is approximately 94ha of PCTs associated with the Fuzzy Box Woodland TEC are mapped on State Vegetation Mapping within 10km of the Biodiversity Assessment Area. However, AREA (2021) identified a further 150ha of these PCTs, indicating that a minimum of 244ha of Fuzzy Box Woodland TEC occurs within 10km of the Biodiversity Assessment Area. AREA (2021) state that this is likely to be a conservative assessment as substantial additional Fuzzy Box Woodland TEC is likely to occur on private land that could not be assessed.

Table 6.10.7
Fuzzy Box Woodland TEC within 10km of the Biodiversity Assessment Area

Total Area Located on State Vegetation Mapping	Total Area Identified by AREA (2021)	Total Additional Area	Total Known Area
94ha	154ha	150ha	244ha
Source: AREA (2021) – modified after Section 6.1.1			

Local Fuzzy Box Woodland TEC

Fuzzy Box Woodland TEC within the Biodiversity Assessment Area occurs across four patches assessed as three vegetation zones (**Table 6.10.8**). For Zone 9, AREA (2021) state that this Zone displays more-mature vegetation and higher biodiversity and habitat values than Zones 7 and 8. Weed abundance was also higher in Zones 7 and 8 compared to Zone 9.

Table 6.10.8
PCT 201 BAM Scores

Zone	PCT ID	Condition	Area (ha)	Composition Condition Score	Structure Condition Score	Function Condition Score	Vegetation Integrity Score
7	201	Moderate (trees)	0.03	46.6	42.0	8.9	25.9
8		Moderate (cleared)	2.38	60.5	54.2	3.7	22.9
9		Good	8.39	87.9	99.4	97.1	94.7
Source: AREA (2021) – modified after Table 4-17							

Potential Impacts

The Project would result in the clearing of up to 10.8ha of Fuzzy Box Woodland TEC as PCT 201, or approximately 4.43% of the total known area of PCT 201 within 10km of the Biodiversity Study Area. Section 6.1.1 of AREA (2021) provides a detailed assessment of the potential Serious and Irreversible Impact of the loss of PCT 201 within the Biodiversity Study Area and is summarised as follows.

- Disruption of Ecological Processes
  - Existing agricultural activities and infrastructure such as the Newell Highway prevent unassisted regeneration of PCT 201 within and in the vicinity of the Biodiversity Assessment Area.
  - Previous revegetation works as part of the TGO Mine operations have shown that this community does respond to conservation efforts.
  - The removal of PCT 201 within the Biodiversity Assessment Area would not likely result in increased erosion which may affect surrounding biodiversity and ecosystems.
  - The removal of PCT 201 within the Biodiversity Assessment Area would not impact other patches of Fuzzy Box Woodland TEC in the vicinity of the Biodiversity Assessment Area.
- Invasion and Establishment of Exotic Species
  - PCT 201 is heavily affected from the impacts of weed species and domestic stock.
  - PCT 201 within the Biodiversity Assessment Area is already significantly impacted by weed species and abundance.
  - The Project would result in the implementation of weed management practices and a reduction of grazing levels by domestic stock within land controlled by the Applicant both within and in the vicinity of the Biodiversity Assessment Area.

Actions to Avoid and Mitigate Impacts to PCT201

The Applicant has implemented the following to avoid and mitigate impacts to PCT201.

- The Project layout has been refined to reduce the area of PCT201 to be disturbed from 24.55ha to 10.80ha.
- The Applicant has established a Biodiversity Offset Area for the TGO Mine, including:
  - 26ha of replanted Fuzzy Box Woodland TEC; and
  - 15ha of remnant Fuzzy Box Woodland TEC.
- The Applicant has also replanted approximately 800 Fuzzy Box seedlings within its land, including along fence lines, adjacent to the proposed realigned Newell Highway and adjacent to Watercourse E.

Conclusion

In light of the above, the Applicant contends that the Project would not result in Serious and Irreversible Impact on the Fuzzy Box Woodland TEC.

6.10.6.4 Indirect Impacts

Pests and Weeds

The Project Site and surrounding area represents a heavily modified environment with a high density and richness of exotic plant and animal species, primarily derived from agricultural or other human activities. These exotic species have the potential to negatively impact on areas of increased cover and/or density of native plant species. The increased level of disturbance that would result due to the Project would likely favour introduced weed species that have adapted to high-disturbance environments.

However, with the implementation of the *Biodiversity Management Plan*, including procedures for monitoring and, if required, management of weeds and pests, the potential for an increase in pest plant and animal species richness and density would be adequately managed.

Connectivity and Habitat Fragmentation

The Project would result in some loss of connectivity and habitat fragmentation. However, the Project Site largely consists of managed exotic pastural vegetation. Native vegetation within and in the vicinity of the Project Site forms part of a highly fragmented landscape at the local scale. While some level of connectivity would be lost and levels of habitat fragmentation would increase, the landscape would still retain features suitable for landscape connectivity. Similar to the direct impact of vegetation clearing, this fragmentation would be largely reversible over time with the rehabilitation of the disturbance areas. Therefore, in considering the rehabilitation and the remnant vegetation that would be retained (e.g. the vegetation corridors of the existing Newell Highway), the Project has the potential to result in long-term protection of habitat connectivity. However, it is noted that some areas, such as the retained void, would remain irreversibly altered.

Injury and Mortality

Fauna injury or mortality can occur during the clearing phase of construction, during the removal of habitat, and from collision with vehicles during the operation of the Project. This would be mitigated to the extent possible through a Pre-clearance Survey Protocol, however, some injuries and mortalities may occur. These impacts would be of a short-term duration, principally occurring during clearing activities, and to a lesser extent during active operations. Following completion of operations and rehabilitation, this risk would be removed.

In addition, the proposed realignment of the Newell Highway would result in a reduced risk of vehicle strike along the sections of the existing Newell Highway with mature native vegetation that would be retained beyond the life of the Project.

Inadvertent Impacts to Adjacent Vegetation and/or Habitat

Impacts from machinery, materials and persons entering areas of retained vegetation and habitat could be adequately managed through the *Biodiversity Management Plan* which would include restrictions for accessing retained and adjacent vegetation. The potential for these inadvertent impacts would be limited to the life of the Project.

Groundwater Drawdown and Groundwater Dependent Ecosystems

AREA (2021) state that there is no evidence of substantial reliance on groundwater resources in the area surrounding the Project Site and significant Groundwater Dependent Ecosystems are unlikely to be present. Notwithstanding this, in the event that terrestrial vegetation with a significant reliance on subsurface groundwater did occur, it would be likely to rely solely on shallow, alluvial aquifers. As identified in Section 6.7, Jacobs (2021c) have determined that the shallow, alluvial aquifers within and surrounding the Project Site are hydraulically not connected with the deeper fractured rock aquifer that would be impacted by the Project. Therefore, the predicted drawdown in the underlying fractured rock aquifer is unlikely to impact upon groundwater dependent ecosystems.

Noise and Vibration

Section 6.4.7 outline the noise and vibration levels that would result from the Project. In the context of the Project, avoidance behaviour may result during blasting. However, there are many examples of fauna foraging and breeding on active mine projects, suggesting that fauna become acclimatised to mine-related noise and blasting. It should also be noted that the Project would not result in any activities that are not already present within the local environment.

Lighting

Light pollution is likely to have both positive and negative effects. As demonstrated in a number of external assessments, some species of nocturnal birds and bats will frequently hunt around lighting towers given that the light attracts insects including moths and other flying invertebrates. Other nocturnal species may avoid well-lit areas given that these may increase vulnerability to predation. However, it is important to note that lighting within the Project Site would be directed towards operational areas only, not surrounding vegetated areas and that the Project would not result in any activities that are not already present within the local environment.

6.10.6.5 Koala Habitat Assessment

Core Koala habitat is defined by Clause 4(1) of the State Environmental Planning Policy (Koala Habitat Protection) 2021 as:

> *"(a) an area of land which has been assessed by a suitably qualified and experienced person as being highly suitable koala habitat and where koalas are recorded as being present at the time of assessment of the land as highly suitable koala habitat, or*
>
> *(b) an area of land which has been assessed by a suitably qualified and experienced person as being highly suitable koala habitat and where koalas have been recorded as being present in the previous 18 years."*

AREA (2021) states that the following tree species identified during field assessments are listed as being associated with Koala in accordance with the *State Environmental Planning Policy (Koala Habitat Protection) 2021*.

- White Cypress Pine (*Callitris glaucophylla*)
- Fuzzy Box (*Eucalyptus conica*)

- Western Grey Box (*Eucalyptus macrocarpa*)
- Bimble Box (*Eucalyptus populnea*)

Notwithstanding the above, AREA (2021) states that the Biodiversity Study Area is unlikely to contain core Koala habitat as defined by the *State Environmental Planning Policy (Koala Habitat Protection) 2021* based on the following.

- No Koala, or any sign of Koala, were recorded during field assessments.
- One record of Koala within 10km of the SAR Mine Site component of the Biodiversity Study Area was identified during desktop assessments, however this record is from 1986 and therefore more than 18 years old.
- Two records of Koala within 10km of the "Dappo" bore component of the Biodiversity Study Area were also identified, however only one was within the previous 18 years. In addition, no trees are proposed to be removed as part of the development of the "Dappo" bore and pipeline.

6.10.6.6 Matters of National Environmental Significance

The EPBC Act addresses 'Matters of National Environmental Significance'. Potentially relevant Matters of National Environmental Significance to the Project include:

- listed threatened species and ecological communities;
- listed migratory species protected under international agreements; and
- National heritage places.

Under the EPBC Act, if a project has the potential to have a significant impact on Matters of National Environmental Significance, it is required to be referred to the Commonwealth Government's Department of Agriculture, Water and the Environment for assessment as to whether it represents a 'controlled action' and therefore requires approval from the Commonwealth Minister for the Environment.

AREA (2021) states that significant impacts to Commonwealth related matters is unlikely. Where impact may occur, these impacts are covered by NSW legislation including the Biodiversity Offsetting Scheme. Therefore, AREA (2021) determined that the Project would not require referral.

6.10.7 Conclusion

The Project would result in the removal of a total of 76.03ha of native vegetation of variable condition. This includes 11.48ha of TEC identified by the BC Act and EPBC Act. The Project would require the retirement of 1 724 Ecosystem Credits and no Species Credits.

In assessing the potential for significant impacts, AREA (2021) concludes that the potential disturbance of 10.8ha of PCT 201 which meets the criteria for a TEC has the potential to be considered as an SAII in the absence of any mitigation measures. However, AREA (2021) determined that substantially more PCT201 exists within the area surrounding the Project Site than is shown on regional mapping and the Applicant has preserved and replanted significant areas of Fuzzy Box within its land.

6.11 Aboriginal Heritage

6.11.1 Introduction

The risk assessment undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in adverse Aboriginal heritage impacts. These risk sources and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Damage or destruction of known Aboriginal heritage sites resulting in loss of Aboriginal cultural heritage values and reduction of archaeological record (medium risk).

In addition, the SEARs issued for the Project identified "heritage" as a key issue requiring assessment, including assessment of the following.

- An assessment of the likely Aboriginal heritage (cultural and archaeological) impacts of the development, including adequate consultation with Aboriginal stakeholders having regard to the *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010a), and documented in an *Aboriginal Cultural Heritage Assessment Report* (ACHAR) including the significance of cultural heritage values for Aboriginal people who have a cultural association with the land.
- The results of a surface survey (and test excavations, if required) undertaken by a qualified archaeologist to better assess the integrity, extent, distribution, nature and overall significance of the archaeological record.
- Demonstrate attempts to avoid impact upon cultural heritage values and identify any conservation outcomes, including mitigation measures and procedures for accidental finds at any stage of the Project.

The assessment requirements of Heritage NSW and Narromine Shire Council were also considered during the preparation of the Aboriginal cultural heritage assessment. A summary of the SEARs and the requirements of Heritage NSW and Narromine Shire Council are listed within **Appendix 2** together with a record of where each requirement is addressed in this EIS.

An *Aboriginal Cultural Heritage Assessment Report* (SAR ACHAR) for the Project was undertaken by OzArk Environment & Heritage Pty Ltd (OzArk) and the report is presented as Part 10a of the *Specialist Consultant Studies Compendium* and is hereafter referred to as OzArk (2021a).

An *Addendum Aboriginal Cultural Heritage Assessment Report* (Addendum ACHAR) for the "Dappo" bore pipeline was undertaken by OzArk and the report is presented as Part 10b of the *Specialist Consultant Studies Compendium* and is hereafter referred to as OzArk (2021b).

The SAR ACHAR and Addendum ACHAR were prepared by OzArk in accordance with the *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (OEH, 2011), and the *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010a).

The SAR Heritage Study Area for OzArk (2021a) is shown on **Figure 6.11.1**. Previous ACHARs have been prepared to accompany the original application for Project Approval for the TGO Mine (OzArk, 2011) and the MOD5 application for Residue Storage Facility 2 (OzArk, 2020). There would be no additional areas of ground disturbing activities within the TGO Mine Site. As a result, the SAR Heritage Study Area for this application is limited to the SAR Mine Site, together with a small section of the TGO Mine Site in the vicinity of Residue Storage Facility 2.

The "Dappo" Heritage Survey Area, comprising the easement for the "Dappo" bore pipeline, was also assessed by OzArk (2021b), and is also shown on **Figure 6.11.1**.

The following subsections provide a summary of OzArk (2021a and 2021b) and describe the operational safeguards and management measures that would be implemented by the Applicant.

6.11.2 Consultation

Consultation with the Aboriginal community was undertaken in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010a). Consultation undertaken under each of the four stages of the DECCW (2010a) is detailed in Section 3 of OzArk (2021a and 2021b). The following provides a summary of that consultation.

Stage 1 – Notification of Project Proposal of Registration of Interest

A preliminary list of potential Aboriginal stakeholders for the Project was identified through consultation with the following agencies.

- BCD (now Heritage NSW)
- Peak Hill Local Aboriginal Land Council (PHLALC)
- Office of The Registrar, *Aboriginal Land Rights Act 1983*
- National Native Title Tribunal
- NTSCORP Limited (Native Title Service Provider for Aboriginal Traditional Owners in New South Wales and the Australian Capital Territory)
- Narromine Shire Council
- Central West Local Land Services

A public notification inviting Aboriginal groups or people with an interest in the Heritage Study Area to register their interest in the Project was placed in the *Daily Liberal* newspaper on 26 March 2020.

Following the completion of the SAR ACHAR for the Project, the Applicant identified that the Addendum ACHAR was required.

Given the consultation was still 'live', the existing list of Registered Aboriginal Parties (RAPs) for the Tomingley Gold Extension Project were utilised for the Addendum Project. However, as the "Dappo" Heritage Study Area is located within the boundary of the Narromine Local Government Area, the Narromine Local Aboriginal Land Council (NLALC) were added to the list of RAPs. Consultation with Heritage NSW was also undertaken on 8 October 2021 to ensure no additional groups or individuals had registered since 24 March 2020, the date of the original consultation. No additional groups or individuals were identified.

The following groups or individuals registered an interest in the Project and therefore represent the RAPs.

- Peak Hill Local Aboriginal Land Council
- Corroboree Aboriginal Corporation
- Tubba-Gah Aboriginal Corporation
- Paul Brydon
- Gunjeewong Cultural Heritage Corporation Heritage Preservation
- Bogan River Peak Hill Wiradjuri Aboriginal Corporation
- Jay and Warren Daley
- Narromine Local Aboriginal Land Council ("Dappo" Heritage Study Area only)

Stages 2 and 3 – Project Details and Aboriginal Cultural Significance

SAR ACHAR

A copy of the proposed field survey methodology which also contained detailed Project information was circulated to the RAPs on 28 April 2020.

A Project update letter and revised sampling strategy was distributed to all RAPs on 30 June 2020 following an increase in the size of the SAR Heritage Study Area.

On 20 October 2020, RAPs were sent a letter advising that due to mine scheduling constraints, the area required for the construction Residue Storage Facility 2 would be assessed as part of Amendment 5 of MP 09_0155, rather than as part of assessment for the Project.

On 10 February 2021, a letter was sent to RAPs advising the inclusion of the proposed realignment of Kyalite Road, and the requirement for further fieldwork.

RAPs were given 28 days to review the information and provide any feedback. No feedback was received from any RAPs at any time during Stages 2 and 3 of the consultation.

"Dappo" ACHAR

A Project update letter and proposed field survey was circulated to the RAPs on 18 October 2021.

Feedback was received from two stakeholders; one in agreement with the proposed methodology and the other noting the presence of several springs in the vicinity of the "Dappo" Heritage Study Area associated with a nearby waterway.

Stage 4 – Draft ACHAR

SAR ACHAR

A copy of the draft SAR ACHAR was sent to all RAPs for review on 25 August 2021 with a closing date of 23 September 2021. No comments were received on the draft SAR ACHAR.

"Dappo" Heritage Study Area

A copy of the draft Dappo ACHAR was distributed to all RAPs for review on 16 December 2021 with a closing date of 18 January 2022. No comments were received on the draft report.

6.11.3 Aboriginal Cultural Heritage Context

6.11.3.1 Ethnohistory

At the time of colonial settlement, the SAR and "Dappo" Heritage Study Areas were within the territory of people belonging to the Wiradjuri tribal and linguistic group. Situated in the Murray Darling Basin, the Wiradjuri tribal area covers three primary physiographic divisions. At a regional scale the SAR and "Dappo" Heritage Study Areas fall within the central division. The central division is known as the heart of Wiradjuri territory and encompasses the transitional western slopes into the Central Tablelands. At the local scale, the SAR Heritage Study Area is considered to be that of the Bogan River Wiradjuri people, whose range included Tomingley and was bounded on its' eastern side by the Hervey Ranges (OzArk, 2021a).

SAR Heritage Study Area

Early accounts (1817) of observations and interactions between colonial explorers and Aboriginal peoples in the nearby Lachlan Valley and surrounding areas (including what is now Peak Hill, Tomingley and the Bogan River) detailed the often-frequent occurrence of temporary campsites and resources use, such as marked trees and extensive signs of the harvesting of freshwater mussels. These early explorers noted that signs of Aboriginal activity were almost exclusively in the vicinity of water. Later encounters (1835) identified how the diet of the local Aboriginal peoples to the southwest of Peak Hill differed from those of the lower Darling, with significant reliance placed on possum, kangaroo and emu, with a notable input of freshwater mussels (OzArk, 2021a).

Aboriginal cultural heritage research in the areas surrounding the SAR Heritage Study Area from the mid 1990's identified a diverse and varying level of Aboriginal occupation. In particular, the prevalence of culturally modified trees and open camp sites across the landscape alluded to an environment that allowed hunter-gatherer lifestyle and technology, as well as varying forms of resource extraction. Observations of the differing types of culturally modified trees concluded both scarring from general hunter-gather resource use and carving from more culturally complex traditions were prevalent across the landscape, however levels of occurrence were higher in proximity to water. Open campsites were primarily located in close proximity to reliable water sources such as rivers, creeks, billabongs and lakes, and Gilgai formations, playa lakes, ephemeral drainages, and usually at elevated terrace locations, or along non-flood prone, elevated ground nearby these formations. The local geology of the area provided extensive volcanic and quartz resources, evidenced both by the prevalence of artefacts of these types in the surrounding area and the known location of quarry sites and an axe-griding site, the latter of which is so far the only known site of its kind in the Goobang National Park (OzArk, 2021a).

"Dappo" Heritage Study Area

The ethnohistory of the "Dappo" Heritage Study Area originates from around the same time as that of the SAR Heritage Study Area. Records from 1817 – 1818 show familiarity with European technology, but not peoples; observations of steel hatchets in the possession of Aboriginal peoples suggest trading between regional groups, however, these records also describe behaviour which also suggest unfamiliarity with Europeans. In addition, early observations describe behaviours such as hunting parties and cultural body modification practices.

Aboriginal cultural heritage research in the areas surrounding the "Dappo" Heritage Study Area from the early 1980's shows a similar pattern of land use and occupation to that of the SAR Heritage Study Area, with the key environmental factors determining the prevalence of sites being proximity to water, geological formations and food availability.

6.11.3.2 Aboriginal Heritage Database Search

In addition to the search of the Aboriginal Heritage Information Management System (AHIMS) (Section 6.11.3.3) OzArk (2021a) conducted a search of the following relevant databases.

- Commonwealth Heritage Listings.
- National Native Title Claims Search.
- *Narromine Local Environmental Plan 2011.*

In summary, no Aboriginal places, sites or Native Title claims were identified as being present within the SAR Heritage Study Area or "Dappo" Heritage Study Area.

6.11.3.3 AHIMS Site Analysis

A full summary of the results of previous archaeological investigations in the SAR Heritage Study Area can be found in Section 5.4.1 of OzArk (2021a).

SAR Heritage Study Area

A search of the AHIMS database undertaken by OzArk (2021a) for a 30km by 30km area centred on the SAR Heritage Study Area (SAR AHIMS search area) identified a total of 98 Aboriginal heritage sites. One of the identified AHIMS-registered sites (35-6-0142 (NHT-ST4)) was identified as being located within the SAR Heritage Study Area (**Figure 6.11.2**). The full results of the AHIMS database search are presented in Annexure 3 of OzArk (2021a).

It is noted that one other site (31-6-0036) was identified as being located within SAR Heritage Study Area. However, OzArk (2021a) state that this location is incorrect, and in fact the site is actually located in the Menindee Lakes area and as such was not considered further.

Table 6.11.1 provides a summary of the number, types and occurrence frequency of the identified elements within the SAR AHIMS search area.

Table 6.11.1
AHIMS Search Results – SAR

Site Type	Number	Frequency (%)
Culturally modified trees (scarred or carved)	73	75.3
Stone artefact scatter	12	12.4
Isolated finds	8	8.2
Culturally modified trees; burial	2	2.1
Stone artefact scatter with PAD	1	1.0
Stone quarry with artefacts	1	1.0
Total	**97**	**100**
Source: OzArk (2021a) – Table 5-5		

"Dappo" Heritage Study Area

A full summary of the results of previous archaeological investigations in the "Dappo" Heritage Study Area can be found in Section 5.4.1 of OzArk (2021b).

A search of the AHIMS database undertaken by OzArk (2021b) for a 10km by 10km area centred on the "Dappo" Heritage Study Area ("Dappo" AHIMS search area) identified a total of 117 Aboriginal heritage sites. It is noted that one site (35-3-0213) is an artefact reburial site and as such was omitted from further analyses. No Aboriginal heritage sites were located within the "Dappo" Heritage Study Area. The closest recorded site is a scarred tree (35-3-0173) located approximately 230m to the north. The full results of the AHIMS database search are presented in Annexure 2 of OzArk (2021b).

Table 6.11.2 provides a summary of the number, types and occurrence frequency of the identified elements within the SAR AHIMS search area.

Table 6.11.2
AHIMS Search Results – "Dappo"

Site Type	Number	Frequency (%)
Culturally modified tree (carved or scarred)	95	81.9
Stone artefact scatter	10	8.6
Isolated find and PAD	3	2.6
PAD	3	2.6
Culturally modified tree (carved) and burial	1	0.9
Isolated finds	1	0.9
Artefact scatter and PAD	1	0.9
Grinding grooves	1	0.9
Ceremony and dreaming	1	0.9
Total	**116**	**100**
Source: Ozark (2021b) – modified after Table 5-2		

6.11.3.4 Landscape Resources

SAR Heritage Study Area

A full description of the landscape context for the SAR Heritage Study Area is provided in Section 4 of OzArk (2021a). In summary, however, the landscape of the SAR Heritage Study Area and surrounds would have not restricted historic Aboriginal occupation. However, the lack of critical or unique resources within the immediate landscape would have likely restricted the area in regard to long-term occupation. In particular, available water sources would have been restricted to the ephemeral flows of Bulldog Creek and/or areas of gilgai, which can provide a seasonal water source. In comparison, the Bogan River, which is located approximately 7km to the west of the Project Site, would likely have been a much more significant resource area to the local population. The SAR Heritage Study Area also lacks any significant rocky outcrops that would provide a place of shelter or resource harvesting or processing, such as those known in the nearby Goobang National Park (OzArk, 2021a).

The historic flora and fauna resources of the SAR Heritage Study Area would have been typical of the wider region. Tree species would have included *Eucalyptus microcarpa* (Grey Box) and *E. populnea subsp. bimbil* (Bimble Box) throughout with *E. melliodora* (Yellow Box) and *E. conica* (Fuzzy Box) occurring in the 'damper areas', and *E. camaldulensis* (River Red Gum) occurring on creek banks. Elevated red soiled gravel ridges supported *E. dwyeri* (Dwyer's Red Gum), whilst drier soils may support an occasional *Brachychiton populneus* (Kurrajong), *Allocasuarina cristata* (Belah) or *Allocasuarina luehmannii* (Bulloak) but are mostly dominated by *Callitris glaucophylla* (White Cypress Pine) (OzArk, 2021a). The landscape would have supported a variety of fauna resources, such as birds, possums, macropods and Koala, as well as freshwater organisms such as fish and mollusc. Much of the evidence for historical resource use by local Aboriginal groups comes the reports of early European explorers, who documented the hunting of Kangaroo and the presence of frequent, extensive midden of freshwater mussel shells (OzArk, 2021a).

"Dappo" Heritage Study Area

Ozark (2021b) states that the landscape and climate of the area in the vicinity of the "Dappo" Heritage Study Area would not have restricted historic Aboriginal occupation. However, relative to surrounding landscapes it does not contain key features such as a permanent or semi-permanent water supply or stone outcroppings which are most likely to attract longer-term Aboriginal occupation.

The historic flora and fauna would have been similar to that of the SAR Heritage Study Area and would have likely supported hunter gatherer landscape use. Much of the evidence for historical resource use by local Aboriginal groups comes the reports of early European explorers, who documented hunting parties with dead possums and snakes (OzArk, 2021b).

6.11.4 Assessment Methodology

6.11.4.1 Predictive Model

Landscape Types

OzArk (2021a) utilised a predictive model developed as part of the *Central West Local Land Services Travelling Stock Reserves Study* (OzArk, 2016) to broadly predict the type and character of Aboriginal cultural heritage sites that are likely to exist within the SAR Heritage Study Area

and "Dappo" Heritage Study Area. **Figure 6.11.1** shows the principal landscape types of the SAR and "Dappo" Heritage Study Areas. In summary, the dominant landscape type for the SAR and "Dappo" Heritage Study Areas is "Alluvial Plains Landscapes", with smaller areas of "Slopes Landscapes" located near to or within the eastern and southern borders of the SAR Heritage Study Area.

Potential Site Types

SAR Heritage Study Area

OzArk (2021a) applied the *Aboriginal Sites Decision Support Tool* to create a landscape scale model to predict the occurrence of key Aboriginal site types within the SAR Heritage Study Area. The *Aboriginal Sites Decision Support Tool* is used primarily for regional landscape modelling, as the resolution of the model is restricted by that of the input data to a scale of 1:100 000 or above. Five models were created to predict the probability of occurrence for scarred trees, artefact sites, quarry sites and burial sites. A conceptual model of landscape disturbance was also created based on modelling accumulated impacts. The results of these models are presented in Section 5.6.1 of OzArk (2021a) and are summarised as follows.

- Modified (scarred) trees are the most likely site to occur within the SAR Heritage Study Area.
- Stone artefacts have a low to moderate potential to occur, with occurrence potential increasing in proximity towards Bulldog Creek.
- Stone quarries have a generally low potential to occur within the SAR Heritage Study Area.
- Burial sites have a low to moderate potential to occur, with occurrence potential increasing in proximity to Bulldog Creek.

The *Aboriginal Sites Decision Support Tool* accumulated impacts model indicates very low to moderate levels of disturbance throughout the SAR Heritage Study Area, indicating that sites have an increased likelihood of being in their original context.

"Dappo" Heritage Study Area

OzArk (2021b) state that the "Dappo" Heritage Study Area is located wholly within an Alluvial Plains Landscape and does not contain any key landforms identified by the OzArk (2016) model. Based on the above, artefact scatters and isolated finds are considered the most likely to occur.

Predictive Model

The predictive model was based on the following factors.

- Local and regional site distribution in relation to landform features identified within the SAR and "Dappo" Heritage Study Areas.
- Consideration of site types, raw material types and site densities likely to be present within the SAR and "Dappo" Heritage Study Areas.
- Findings of the ethnohistorical research and the potential for material traces to be present within the SAR and "Dappo" Heritage Study Areas.

- Potential Aboriginal use of natural resources present (or once present) within the SAR and "Dappo" Heritage Study Areas.
- Consideration of the temporal and spatial relationships of sites within the SAR and "Dappo" Heritage Study Areas and surrounding regions.
- Post-depositional influences on Aboriginal material culture.

SAR Heritage Study Area

Based on the above, OzArk (2021a) predicted that artefact sites (including both artefact scatters and isolated finds) are the most likely site types to be encountered within the SAR Heritage Study Area, particularly so in the areas classified as 'Slopes.' However, artifact sites are expected to also occur, albeit in lower density in the areas classified as 'Plains'.

The likelihood of the occurrence of scarred trees is also significantly lower in the Slopes/Plains landscape zones. However, based on the results of previous studies in the vicinity of the SAR Heritage Study Area and the prevalence of individual remnant Eucalypt specimens across the surrounding landscape, culturally modified trees are expected to be located within the current SAR Heritage Study Area; in particular, those in vicinity of Bulldog Creek (OzArk, 2021a).

All other Aboriginal site types have a reduced predicted level of occurrence as follows (OzArk, 2021a).

- Quarry sites are predicted to possibly occur if and where suitable outcroppings of rock exist on any areas of exposed rock such as isolated hills across the SAR Heritage Study Area.
- Hearths/ovens are considered unlikely to occur within the SAR Heritage Study Area due to historical soil disturbance activities.
- Burial and other ceremonial sites are not predicted to occur due to a lack of favourable geological landforms.

"Dappo" Heritage Study Area

OzArk (2021b) states that the "Dappo" Heritage Study Area is located within a heavily modified landscape with a long history of land clearance and soil disturbance. In consideration of the limited spatial extent of the "Dappo" Historic Study Area and the high levels of historic disturbance, the following presents an overview of the results of the predictive model

- Isolated finds are the most likely to occur within the "Dappo" Heritage Study Area.
- Artefact scatters, if present, would most likely be of low density.
- Scarred trees are highly unlikely due to previous land use history.
- Burial sites are unlikely to occur due to a lack of key landscape features.
- Ceremonial sites are highly unlikely due to overall rarity and a high likelihood of historic disturbance.

6.11.4.2 Archaeological Survey

The field survey component of the Aboriginal Cultural Heritage Assessment was undertaken by OzArk in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW, 2010b).

SAR Heritage Study Area

The field survey within the SAR Heritage Study Area was undertaken between 6 July 2020 and 2 September 2020 by the following qualified persons.

- Fieldwork Director: ..... Stephanie Rusden (OzArk Senior Archaeologist)
- Archaeologist: .....Ben Churcher (OzArk Principal Archaeologist)
- Archaeologist: .....Dr Alyce Cameron (OzArk Senior Archaeologist)

In addition to the above, representatives of the following RAPs attended the field surveys.

- Tubba-Gah Aboriginal Corporation
- Bogan River Peak Hill Wiradjuri Aboriginal Corporation
- Peak Hill Local Aboriginal Land Council
- Jay and Warren Daley

The survey methodology included a meandering pedestrian transect (**Figure 6.11.1**). The pedestrian transect path was selected in order to sample all landforms within the SAR Heritage Study Area whilst concentrating on landforms with the greatest archaeological potential.

"Dappo" Heritage Study Area

The field survey within the "Dappo" Heritage Study Area was undertaken on 8 November 2021 and 10 December 2021 by Dr Jodie Benton (OzArk Director). In addition, a representative from the Narromine LALC was present during the 8 November survey.

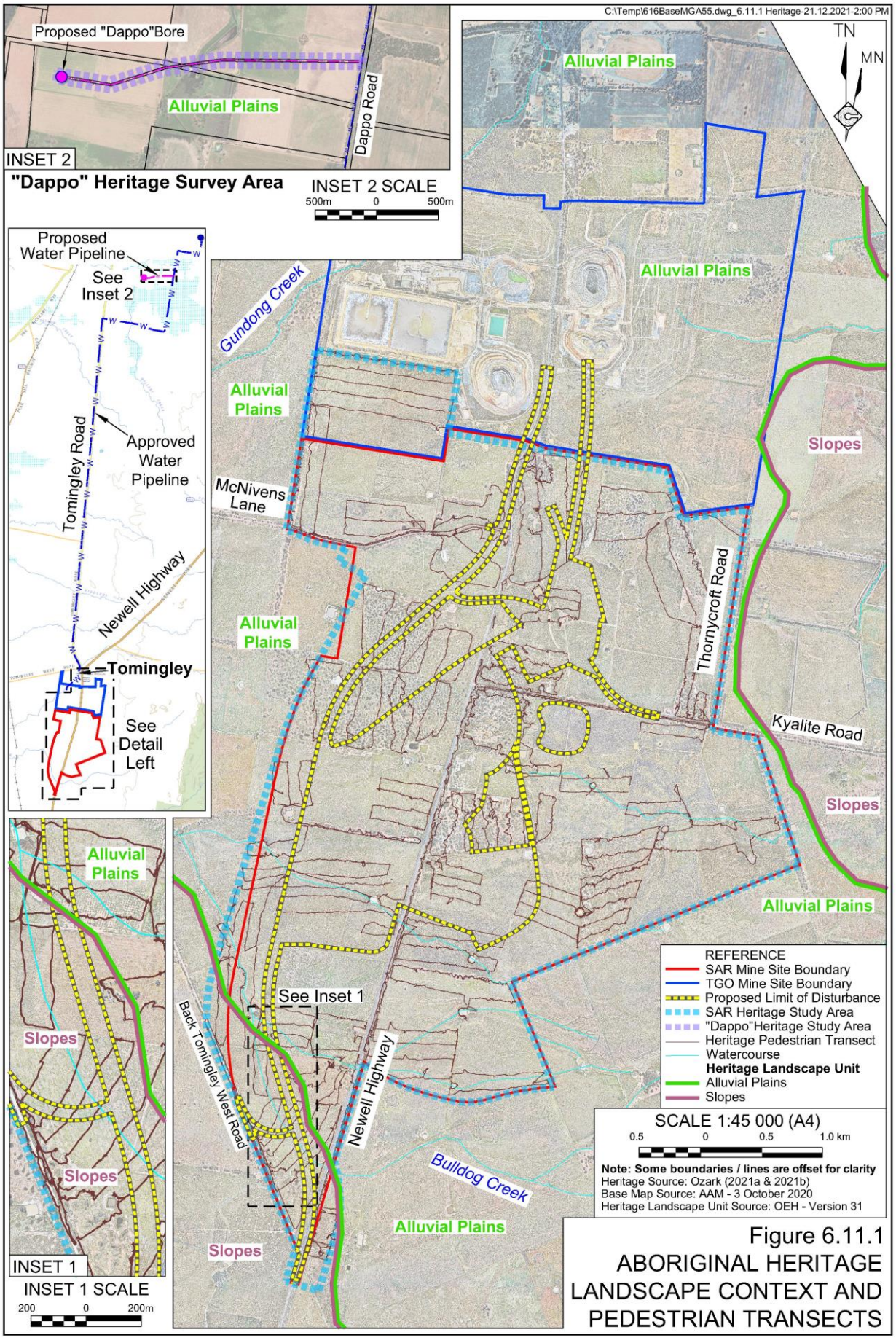
6.11.5 Field Survey Results

6.11.5.1 Coverage and Constraints

SAR Heritage Study Area

Table 6.11.3 presents a summary of the survey coverage and results for each of the two identified landform survey units within the SAR Heritage Study Area. In summary, 39 Aboriginal sites encompassing 64 artefacts or features were identified.

OzArk (2021a) note that the level of access across the SAR Heritage Study Area was high, and that the relatively flat terrain and vegetation did not pose any additional constraints. High levels of ground surface exposure in certain sections of the SAR Heritage Study Area were facilitated by exposed gilgai, ploughing activity, erosion scalds, farm and animal tracks and areas around fences and gates. Increased erosion levels in the undulating Slopes landscape unit was the primary reason for the high visibility and exposure levels within that landscape unit.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TN
MN
Proposed "Dappo"Bore
Alluvial Plains
Dappo Road
INSET 2
"Dappo" Heritage Survey Area
INSET 2 SCALE
500m 0 500m
Proposed Water Pipeline
See Inset 2
Approved Water Pipeline
Tomingley Road
Newell Highway
Tomingley
See Detail Left
Gundong Creek
Alluvial Plains
McNivens Lane
Slopes
Thorncroft Road
Kyalite Road
Back Tomingley West Road
See Inset 1
Bulldog Creek
INSET 1
INSET 1 SCALE
200 0 200m
REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
Proposed Limit of Disturbance
SAR Heritage Study Area
"Dappo"Heritage Study Area
Heritage Pedestrian Transect
Watercourse
Heritage Landscape Unit
Alluvial Plains
Slopes
SCALE 1:45 000 (A4)
0.5 0 0.5 1.0 km
Note: Some boundaries / lines are offset for clarity
Heritage Source: Ozark (2021a & 2021b)
Base Map Source: AAM - 3 October 2020
Heritage Landscape Unit Source: OEH - Version 31
Figure 6.11.1
ABORIGINAL HERITAGE LANDSCAPE CONTEXT AND PEDESTRIAN TRANSECTS

Table 6.11.3
Field Survey Landform Coverage and Results – SAR Heritage Study Area

Landscape Unit	Survey Unit Area (ha)	Visibility (%)	Exposure (%)	Effective Coverage		No. Aboriginal Sites	No. Artefacts or Features
				(%)	(ha)		
Alluvial Plains	188	70	40	28	52.7	37	61
Slopes	65.3	80	60	48	31.3	2	3
Source: OzArk (2021a) – modified after Tables 6-1 and 6-2							

"Dappo" Heritage Study Area

Table 6.11.4 presents a summary of the survey coverage and results the one landform survey unit within the "Dappo" Heritage Study Area. In summary, no Aboriginal sites were identified.

Table 6.11.4
Field Survey Landform Coverage and Results – "Dappo" Heritage Study Area

Landscape Unit	Survey Unit Area (m^2)	Visibility (%)	Exposure (%)	Effective Coverage		No. Aboriginal Sites	No. Artefacts or Features
				(%)	(m^2)		
Alluvial Plains	48781	5	60	3	1463	0	0
Source: OzArk (2021b) – modified after Tables 6-1 and 6-2							

OzArk (2021b) states that the primary limiting factor to the survey was very low levels of surface exposure due to extremely dense ground cover and high standing water level resulting in restricted access to some areas, as well as the prevalence of crop in the paddocks. Notwithstanding the above, OzArk (2021b) considered that landform type, and to a lesser degree the high levels of disturbance, was the key factor in the lack of Aboriginal sites.

6.11.5.2 Aboriginal Sites Recorded

No Aboriginal sites were identified within the "Dappo" Heritage Study Area.

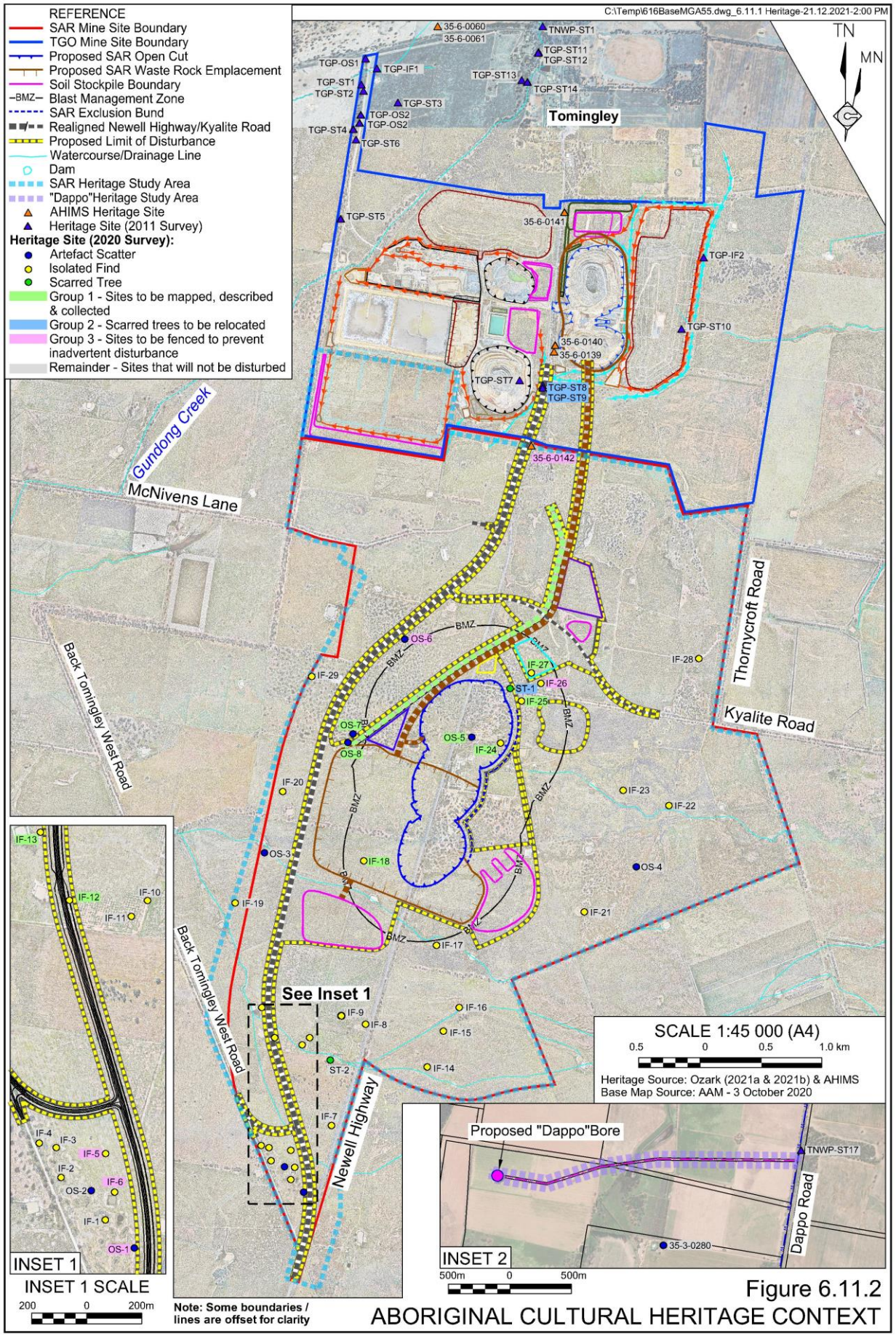
Table 6.11.5 and **Figure 6.11.2** present a summary of the results of the field survey undertaken by OzArk (2021a) for the SAR Heritage Study Area. In summary, OzArk (2021a) identified 39 Aboriginal cultural heritage sites within the SAR Heritage Study Area, including:

- two scarred trees;
- eight artefact scatters; and
- twenty-nine isolated finds.

None of the isolated finds or artefact scatters identified were considered to be associated with subsurface deposits. Sites Tomingley OS-6, OS-7 and OS-8 were located in areas with consistent gilgai landforms which suggests primary (undisturbed) site locations, however all other isolated finds and artefact scatters were considered to be located in a secondary (disturbed) context.

Table 6.11.5
Aboriginal Sites Recorded

Site name	Site description
Isolated Finds	
Tomingley IF-1	Complete volcanic flake.
Tomingley IF-2	Complete chert flake.
Tomingley IF-3	Complete quartz flake.
Tomingley IF-4	Piece of green knapped glass in disturbed context.
Tomingley IF-5	Volcanic side-scraper.
Tomingley IF-6	Grinding dish.
Tomingley IF-7	Ground-edge hatchet.
Tomingley IF-8	Complete chert flake.
Tomingley IF-9	Side scraper manufactured from a fine-grained siliceous material.
Tomingley IF-10	Complete quartz flake.
Tomingley IF-11	Complete quartzite flake.
Tomingley IF-12	Broken quartzite flake.
Tomingley IF-13	Complete quartz flake.
Tomingley IF-14	Complete quartz flake.
Tomingley IF-15	Complete quartzite flake.
Tomingley IF-16	Broken quartzite flake.
Tomingley IF-17	Broken quartzite flake.
Tomingley IF-18	Complete quartzite flake.
Tomingley IF-19	Silcrete core.
Tomingley IF-20	Complete chert flake.
Tomingley IF-21	Broken chert flake.
Tomingley IF-22	Complete quartzite flake.
Tomingley IF-23	Complete volcanic flake.
Tomingley IF-24	Complete volcanic flake.
Tomingley IF-25	Broken chert flake.
Tomingley IF-26	Complete quartz flake.
Tomingley IF-27	Broken volcanic flake.
Isolated Finds	
Tomingley IF-28	Complete volcanic flake.
Tomingley IF-29	Side scraper manufactured from a volcanic material.
Artefact Scatter	
Tomingley OS-1	Low density scatter consisting of five artefacts.
Tomingley OS-2	Low density scatter consisting of 17 artefacts.
Tomingley OS-3	Low density scatter consisting of four artefacts (including a ground-edge hatchet).
Tomingley OS-4	Low density scatter consisting of two artefacts.
Tomingley OS-5	Low density scatter consisting of two artefacts.
Tomingley OS-6	Low density scatter consisting of two artefacts in a paddock with consistent Gilgai.
Tomingley OS-7	Low density scatter consisting of two artefacts in a paddock with consistent Gilgai.
Tomingley OS-8	Low density scatter consisting of two artefacts in a paddock with consistent Gilgai.
Scarred Tree	
Tomingley ST-1	Box tree with an elongated scar.
Tomingley ST-2	Box tree with an elongated scar.


REFERENCE
SAR Mine Site Boundary
TGO Mine Site Boundary
Proposed SAR Open Cut
Proposed SAR Waste Rock Emplacement
Soil Stockpile Boundary
BMZ Blast Management Zone
SAR Exclusion Bund
Realigned Newell Highway/Kyalite Road
Proposed Limit of Disturbance
Watercourse/Drainage Line
Dam
SAR Heritage Study Area
"Dappo"Heritage Study Area
AHIMS Heritage Site
Heritage Site (2011 Survey)
Heritage Site (2020 Survey):
Artefact Scatter
Isolated Find
Scarred Tree
Group 1 - Sites to be mapped, described & collected
Group 2 - Scarred trees to be relocated
Group 3 - Sites to be fenced to prevent inadvertent disturbance
Remainder - Sites that will not be disturbed
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TN
MN
Tomingley
Gundong Creek
McNivens Lane
Back Tomingley West Road
Thornycroft Road
Kyalite Road
Newell Highway
Dappo Road
See Inset 1
INSET 1
INSET 1 SCALE
200 0 200m
INSET 2
500m 0 500m
Proposed "Dappo"Bore
SCALE 1:45 000 (A4)
0.5 0 0.5 1.0 km
Heritage Source: Ozark (2021a & 2021b) & AHIMS
Base Map Source: AAM - 3 October 2020
Note: Some boundaries / lines are offset for clarity
Figure 6.11.2
ABORIGINAL CULTURAL HERITAGE CONTEXT

6.11.5.3 Previous Aboriginal Sites Located

The location of three previously recorded Aboriginal sites within the SAR Heritage Study Area was confirmed during the field survey (**Table 6.11.6** and **Figure 6.11.2**). These sites were reassessed and checked against the AHIMS records, with OzArk (2021a) noting that scarred tree 35-6-0142 was located approximately 75m northeast of the coordinates provided by AHIMS. An updated site card has been submitted to AHIMS with the correct coordinates provided.

Table 6.11.6
Previously Recorded Aboriginal Sites

AHIMS ID	Site name	GDA Zone 55 Easting	GDA Zone 55 Northing	Feature(s)
35-6-0142[1]	NHT-ST4	614463	6392981	Scarred tree
35-6-0184	TGP-ST8	614553	6393485	Scarred tree
35-6-0185	TGP-ST9	614551	6393461	Scarred tree
Note 1: Updated location shown.				
Source: OzArk (2021a) – Table 6-17				

6.11.5.4 Discussion

SAR Heritage Study Area

The results of the field survey are generally in accordance with the predictive model used by OzArk (2021a), as well as previous archaeological surveys in the area. In summary, stone artefact and scarred tree type sites were the most likely artefact sites predicted to occur within the Heritage Study Area based on landform analysis and the increased levels of historic disturbances within the surrounding landscape. Certain landform types such as Slope landscape and areas in proximity to watercourses were predicted to have higher occurrences of artefacts; however, these areas of higher potential were only a small percentage of the overall SAR Heritage Study Area, and as such, the predicted occurrence of artefact sites in these areas did not match that predicted by the predictive model. In addition, the high levels of historic disturbance within the SAR Heritage Study Area likely increased dispersion or disturbance of the observed sites. This is evident in that all except two of the sites identified during field surveys were in a primary context.

OzArk (2021a) state that the relative abundance of the type of artefact sites (in particular the high number of isolated finds and low-density artefact scatters) confirm that the limited resources of the SAR Heritage Study Area would likely have supported only sporadic visits in the past. Further, the SAR Heritage Study Area holds little potential for the existence of any undetected Aboriginal sites due to the nature of the landforms present, the distance from permanent or semi-permanent water sources, and the high levels of past disturbance.

"Dappo" Heritage Study Area

OzArk (2021b) states that the results of the field surveys are generally in accordance with the predictive model used. While the relatively small level of exposure may have affected the results, as mentioned in Section 6.11.5.3, the lack of key landscape features likely meant that the immediate area would not have been favourable for long term occupation. In addition, the relatively small size of the "Dappo" Heritage Study Area and the lack of mature vegetation also likely contributed to the lack of Aboriginal sites.

6.11.6 Significance Assessment

SAR Heritage Study Area

Appropriate management of Aboriginal cultural heritage sites and items is typically determined based on their significance as well as the likely impacts of the proposed development. Heritage assessment criteria in NSW generally correspond with the significance values outlined in the *Australia International Council on Monuments and Sites Burra Charter* (Australia ICOMOS, 2013). Significance values considered for the purposes of the assessment of cultural and archaeological significance include:

- historical significance (i.e. importance to a historically significant person, place, event or activity in an Aboriginal community);
- aesthetic significance (i.e. importance to location);
- social or cultural significance (i.e. importance to the Aboriginal community); and
- scientific significance (i.e. importance to archaeologists).

A variety of factors including site integrity, structure, contents and rarity within the broader region are used to assess significance. It is acknowledged that Aboriginal people are the primary determiners of the social or cultural significance of the Aboriginal cultural heritage of an area.

A draft copy of OzArk (2021a) was sent to all RAPs for review on 25 August 2021 . No feedback was received relating to the social or cultural value of the newly recorded sites or the SAR Heritage Study Area. As such, for the purposes of assessing the potential impact to Aboriginal cultural heritage, the recorded sites have been accorded high social and cultural values (OzArk, 2021a).

OzArk (2021a) assessed the SAR Heritage Study Area as having overall low historic, aesthetic and historic value, primarily due to the nature of Aboriginal sites identified during field surveys, as well as the significantly high levels of historical disturbance found across the SAR Heritage Study Area.

Two Aboriginal cultural heritage sites identified during the most recent field surveys were identified as having higher scientific, aesthetic of historic significance values, as follows (**Table 6.11.5**).

- Tomingley IF-4 consists of a piece of knapped glass which potentially shows that traditional Aboriginal use of the Heritage Study Area continued into the modern period. As such, the site has been assessed as having low to moderate historic and scientific values.
- Tomingley IF-7 is easy for the layperson to interpret and is a good example of archetypal ground-edge hatchet. However, the site is located in a disturbed context (cleared and ploughed paddock) and therefore is assessed as having low to moderate scientific and aesthetic values.

In addition to the above, three scarred trees within the Heritage Study Area that were identified during previous archaeological assessments were confirmed by OzArk (2021a) as having low-moderate to moderate levels of significance (**Table 6.11.7**).

Table 6.11.7
Artefact Significance Assessment

Site name	Site Description	Social or Cultural Value	Scientific Value	Aesthetic Value	Historic Value
Tomingley IF-4	Piece of green knapped glass in disturbed context	High	Low to Moderate	Low	Low to Moderate
Tomingley IF-7	Ground-edge hatchet	High	Low to Moderate	Low to Moderate	None
NHT-ST4	Scarred tree	High	Low to Moderate	Low to Moderate	None
TGP-ST8	Scarred tree	High	Moderate	Low	None
TGP-ST9	Scarred tree	High	Moderate	Low	None
Source: OzArk (2021a) – modified after Table 7-2					

"Dappo" Heritage Study Area

As no Aboriginal objects or cultural values were identified in the "Dappo" Heritage Study Area, no assessment of significance was included in Ozark (2021b).

6.11.7 Avoidance, Management and Mitigation Measures

6.11.7.1 Avoidance of Potential Impacts through Project Design

The Applicant, following receipt of the results of the initial Aboriginal heritage survey identified that a number of sites located in the southern section of the SAR Heritage Survey Area would potentially be disturbed by the proposed alignment of the Newell Highway as it was then designed. As a result, the proposed Highway alignment was adjusted to avoid those Aboriginal sites.

Other sites were unable to be avoided for the following reasons.

- They are located within the footprint of the proposed SAR Open Cut, the location of which was determined by the geological resource.
- They are located within the footprint of the SAR Waste Rock Emplacement, the location of which was determined by balancing the need to protect native vegetation, agricultural land and maintain surface water flow paths.

As a result, the Applicant contends that it has made all reasonable efforts to avoid, to the extent practicable, impacting on Aboriginal sites.

6.11.7.2 Operational Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures in order to avoid or mitigate any adverse impacts upon Aboriginal cultural heritage values.

- Ensure that areas outside the proposed Limit of Disturbance are not subject to Project-related disturbance.

- Ensure that all identified Aboriginal objects and sites are recorded in the Mine's spatial database.
- Prepare and implement an *Aboriginal Cultural Heritage Management Plan* in consultation with RAPs and Heritage NSW, including identification, in consultation with the RAPs, an area within the SAR Mine Site be set aside as a reburial location for Aboriginal objects salvaged from areas of proposed disturbance.
- Implement the following management strategies identified for each site as listed in **Table 6.11.8**.
  - Group 1 – Sites to be mapped, described and collected
    - Flag all visible surface artefacts at a site in the field.
    - Photograph the site after flagging and before recording.
    - Record key artefact information for all artefacts.
    - Photograph a selection of indicative and / or unusual artefacts from each site.
    - Collect the artefacts once all recording is complete according to site with artefacts from each site being kept separate.
    - Incorporate data recorded in a report.
    - Submit an Aboriginal Site Impact Recording Form (ASIRF) detailing the salvage process and results of the sites.
  - Group 2 –Scarred trees to be relocated
    - Photograph the scarred section of the tree prior to removal.
    - Follow the advice of a suitably qualified arborist during the removal of the scarred section of each tree.
    - Place the scarred portion of the trees in a place of safe-keeping, and with the agreement of the RAPs, potentially place the salvaged portions on display to allow continued interpretation.
  - Group 3 – Sites to be fenced to prevent inadvertent disturbance.
    - Erect a high-visibility fence around each site or group of sites, including a 5m buffer.
    - Maintain fencing for the duration of site construction operations at a minimum.
    - Ensure fenced areas are managed as no-go areas.
- Implement the following unanticipated finds protocol in the event that a previously unknown Aboriginal site is identified within the proposed areas of disturbance.
  - Cease all work in the vicinity of the site immediately.
  - Temporarily fence the site to prevent further disturbance.

  - Contact Heritage NSW, the RAPs and/or a qualified archaeologist to provide further advice or to assess the site.
  - Should the site be determined to be an Aboriginal object, ensure that the site location is registered with AHIMS and that a site card is submitted.
  - Avoid disturbing the site, if practicable. If not practicable ensure that all appropriate approvals are obtained prior to disturbance.
- Implement the following unanticipated finds protocol in the event that a previously unknown Aboriginal site is identified outside of the proposed disturbance areas.
  - Contact Heritage NSW, the RAPS and/or a qualified archaeologist to provide further advice or to assess the site.
  - Should the site be determined to be an Aboriginal object, ensure that the site location is registered with AHIMS and that a site card is submitted and that the site is marked on site plans to prevent future inadvertent disturbance.
- Implement the following protocol in the event that suspected human skeletal material is discovered within areas to be disturbed.
  - Cease all work in the vicinity of the site immediately.
  - Temporarily fence the site with a minimum buffer of 10m, ensuring that no further disturbance occurs to the skeletal remains or associated artefacts. If skeletal remains have been removed from the ground, these should be stored in a dry location on site.
  - Contact the NSW Police and Heritage NSW to assist with identification of the burial.
  - Ensure that the Aboriginal community (i.e. RAPs) are notified of the discovery.
  - Ensure that the Aboriginal remains are recorded under the direct supervision of a specialist anthropologist or other suitably qualified person.
  - Ensure that the location of the burial is registered as an Aboriginal site on the AHIMS database.
  - Ensure that work within the cordoned off area is not recommenced until authorisation is received in writing from Heritage NSW.

6.11.8 Assessment of Impacts

SAR Heritage Study Area

Table 6.11.8 and **Figure 6.11.2** presents the identified Aboriginal cultural heritage sites that would be disturbed by the Project. In summary, 12 Aboriginal sites would be directly impacted by the Project (Groups 1 and 2), and six additional sites have the potential for further impacts from Project-related activities and would require specific management during site construction operations (Group 3).

Table 6.11.8
Anticipated Impacts and Management Groups

Site Name	AHIMS ID	Site Type	Degree of Harm	Management strategy
Tomingley IF-12	35-6-0269	Isolated find	Total	Group 1 – Surface Collection
Tomingley IF-13	35-6-0270	Isolated find	Total	
Tomingley IF-18	35-6-0275	Isolated find	Total	
Tomingley IF-24	35-6-0281	Isolated find	Total	
Tomingley IF-25	35-6-0282	Isolated find	Total	
Tomingley IF-27	35-6-0284	Isolated find	Total	
Tomingley OS-5	35-6-0291	Artefact scatter	Total	
Tomingley OS-7	35-6-0293	Artefact scatter	Total	
Tomingley OS-8	35-6-0294	Artefact scatter	Total	
Tomingley ST-1	35-6-0296	Scarred tree	Total	Group 2 – Scarred Tree Relocation
TGP-ST8	35-6-0184	Scarred tree	Total	
TGP-ST9	35-6-0185	Scarred tree	Total	
Tomingley IF-05	35-6-0262	Isolated find	None	Group 3 – Sites Requiring Fencing
Tomingley IF-06	35-6-0263	Isolated find	None	
Tomingley IF-26	35-6-0283	Isolated find	None	
Tomingley OS-1	35-6-0287	Artefact scatter	None	
Tomingley OS-6	35-5-0292	Artefact scatter	None	
NHT-ST4	35-6-0142	Scarred tree	None	

"Dappo" Heritage Study Area

As no Aboriginal sites or specific cultural values were recorded during the assessment for the "Dappo" Heritage Study Area, there would be no known impacts to Aboriginal cultural heritage.

6.11.9 Conclusion

The Project would result in the direct disturbance of 12 Aboriginal sites within the SAR Heritage Study Area. No Aboriginal sites were identified within the "Dappo" Heritage Study Area.

Salvage of sites and objects to be disturbed and preparation of an *Aboriginal Cultural Heritage Management Plan* in consultation with the RAPs and Heritage NSW would ensure that cultural heritage sites and values within the Project Site would be protected in accordance with the expectations of the local Aboriginal and wider community as well as the requirements of the NSW Government.

6.12 Historic Heritage

6.12.1 Introduction

The risk assessment undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in adverse historic heritage impacts. There were no risk sources with an assessed risk of "medium" or above.

In addition, the SEARs issued for the Project identified "heritage" as a key issue requiring assessment, including assessment of the following.

- The likely historic heritage impacts of the development, including the results of a surface survey (and test excavations, if required) undertaken by a qualified archaeologist.
- Demonstrated attempts to avoid impact upon cultural heritage values and identify any conservation outcomes, including mitigation measures and procedures for accidental finds at any stage of the Project.
- An assessment of the impact on historic heritage in accordance with the *NSW Heritage Manual*, including heritage conservation areas and State and local heritage items within and near the site, and detailed mitigation measures to offset potential impacts on Heritage values.

The assessment requirements of Heritage NSW and Narromine Shire Council were also considered. A summary of the SEARs and the requirements of Heritage NSW and Narromine Shire Council are listed within **Appendix 2**, together with a record of where each requirement is addressed in the EIS.

A *Historic Heritage Assessment Report* for the Project was undertaken by OzArk Environment & Heritage Pty Ltd (OzArk) and is presented as Part 11a of the *Specialist Consultant Studies Compendium* and are hereafter referred to as OzArk (2021c).

An *Addendum Historic Heritage Assessment Report* for the "Dappo" bore pipeline by OzArk and the report is presented as Part 11b of the *Specialist Consultant Studies Compendium* and is hereafter referred to as OzArk (2021d).

The OzArk (2021c and 2021d) were prepared in accordance with the *NSW Heritage Manual* (Heritage Office, 1996) and *Heritage Council's Historical Archaeology Code of Practice (Heritage Council 2006)*. The Historic Heritage Assessment was undertaken concurrently with the Aboriginal Heritage Survey and encompasses the same Study Areas as those assessments (**Figures 6.11.1** and **6.12.1**).

The following subsections provide a summary of OzArk (2021c and 2021d) and describe the operational safeguards and management measures that would be implemented by the Applicant.

6.12.2 Existing Environment

6.12.2.1 Early Settlement

SAR Heritage Study Area

The first period of European settlement in the area surrounding the Project Site began soon after the Oxley expedition in 1817. Settlement of these areas was, at the time, outside of the boundary of regulated land selection within the colony of New South Wales. This period of unregulated land selection along the Bogan River was marked by violent conflicts between the local Aboriginal population and the squatters that continued for decades.

The name 'Tomingley' first appears in the Government Gazette of 1848 naming a run of 22 400 acres claimed by J. Gilmore and covering the entirety of modern Tomingley. The origins of the word are linked both to an early settler of the area, Tom Ingley, and from a Wiradjuri word for 'death adder' (*Acanthophis sp.*).

A historically significant waterhole named Ten Mile Holes was once located to the northeast of the present-day Tomingley village. This was the first place after leaving the Bogan River where water could predictably be found on the journey east. Ten Mile Holes therefore provided a camping place for travellers and later for teams who were carting ore from the Cobar mines to Orange before the arrival of the railway.

"Dappo" Heritage Study Area

The area in the vicinity of the "Dappo" Heritage Study Area was settled generally around the same time as the SAR Heritage Study Area. Accessibility to the area was facilitated by Cobb & Co. coaches travelling through or near what is now the town of Trangie. The arrival of the railway in Trangie and Narromine in the 1880's saw further expansion. The possibility of irrigation schemes was raised as early as 1893 by William O'Neill, one of the first people to grow wheat for grain in Narromine. Severe droughts at the turn on the 20th Century reinforced the need for irrigation to support the local area. The Burrendong Dam, completed in 1969, provided a stable and consistent water source via which irrigation in the Narromine region became more prevalent. Further irrigation schemes were developed in the years following that greatly expanded the agricultural capabilities of the surrounding region.

6.12.2.2 Historical Mining Context

Gold was first discovered in the area which would become the Tomingley village in 1879, ten years prior to the discovery of gold in the nearby town of Peak Hill. The Tomingley Gold Mining Company was established in 1883 and installed a 15 head crusher and a series of dams for processing immediately to the west of the current Tomingley village.

The original mining leases in the area in the area immediately south of the TGO Mine Site were pegged in 1883 by Donald McPhail (**Figure 6.12.1**). By 1895 five leases south of Tomingley had been sold to an English syndicate that established the Myall United Gold Mine in that area. That Mine was part of the locality known as McPhail and the Mine became known as the McPhail Mine. The main shaft at the McPhail Mine was 350 feet in depth and by 1899 the Mine had considerable infrastructure, including 40 stampers, a large water storage tank and cyanide treatment vats.

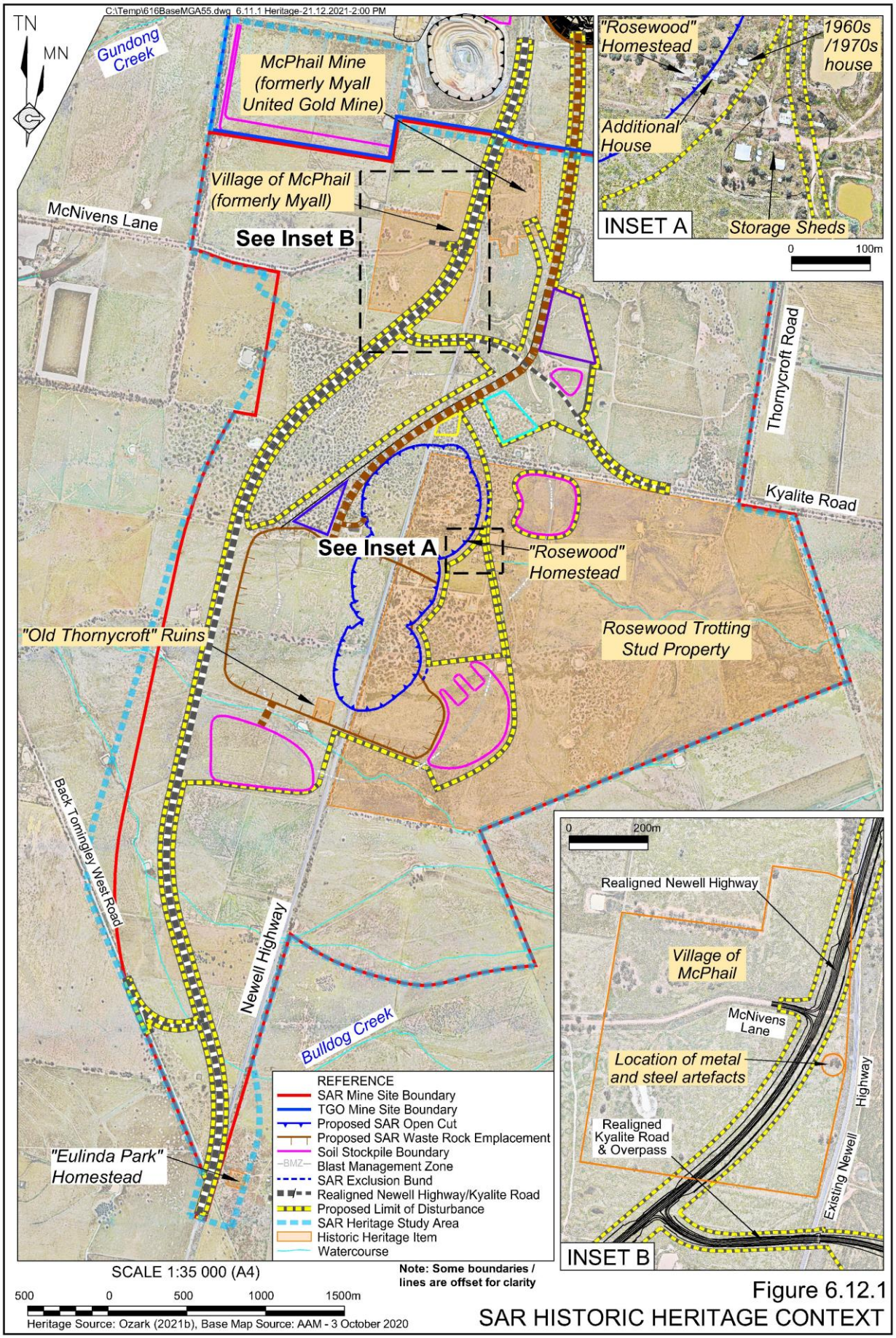

Figure 6.12.1
SAR HISTORIC HERITAGE CONTEXT

The McPhail Mine operations prospered until 1905, before production slowed and finally ceased in 1913. The McPhail Mine produced approximately 50 000oz of gold over this period. The tailings from the McPhail Mine have been re-processed twice since closure; first in 1924 and then again in the late 1990's by Tailings Treatment Pty Ltd, during which time the McPhail Tailings Dam and a large metal water tank were constructed (OzArk, 2021c). The re-processing operations in the 1920's and 1990's likely resulted in significant disturbance and/or changes to the heritage potential of the McPhail Mine.

6.12.2.3 Village of McPhail

The McPhail Mine supported the village of McPhail (previously known as Myall) which was located to the west of the McPhail Mine and approximately 2km south of Tomingley (**Figure 6.12.1**). In 1884, one year after mining commenced in the area there were approximately 40 miners and their families residing in the villages of McPhail and Tomingley. By 1889 the combined population of the two villages rose to approximately 250 (OzArk, 2021c). **Figures 6.12.2** and **6.13.3** display the historical layout of the villages of Tomingley and McPhail, respectively and **Plate 6.12.1** presents a view of the McPhail village from about 1900.

Water for the McPhail Mine and village was sourced primarily from the spring at Ten Mile Holes and Gundong Creek. In order to secure a more permanent water source, Gundong Creek was diverted by a local market gardener, Wah Sing, for the production of vegetables to help support the local community.

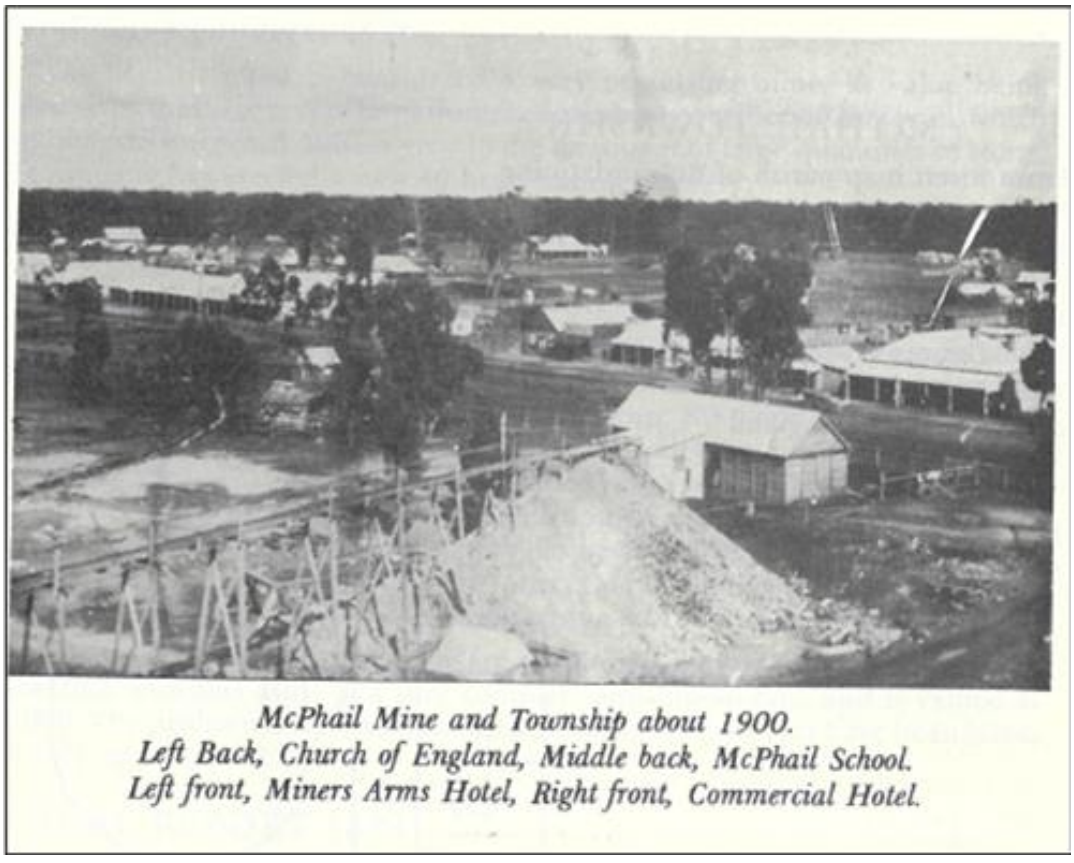

Plate 6.12.1
View of the McPhail Village looking Southwest from approximately 1900
Source: OzArk (2021c) – Figure 3-4

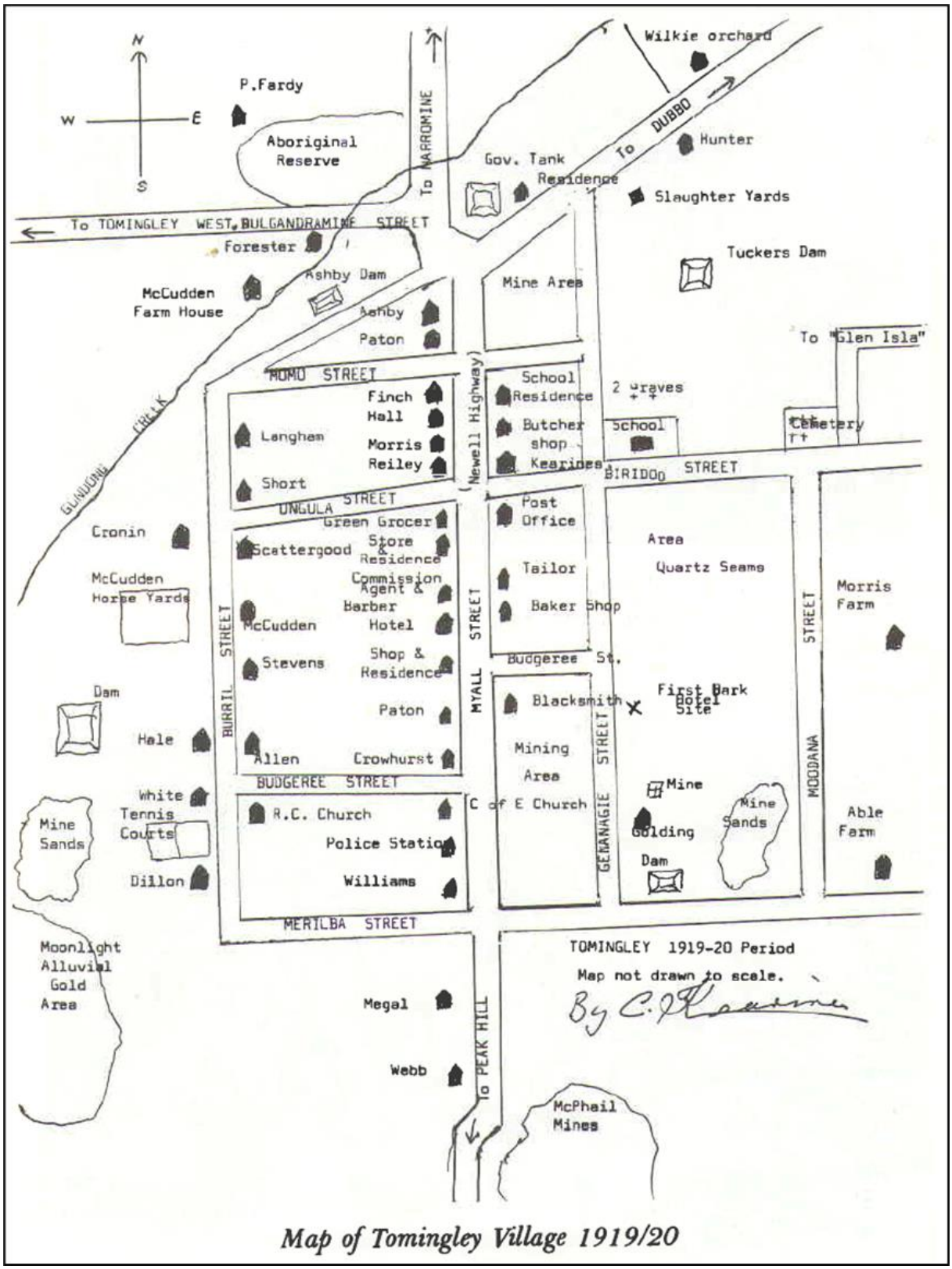

Figure 6.12.2
Sketch Map of Tomingley Township in 1919/20

Source: OzArk (2021c) – Figure 3-10

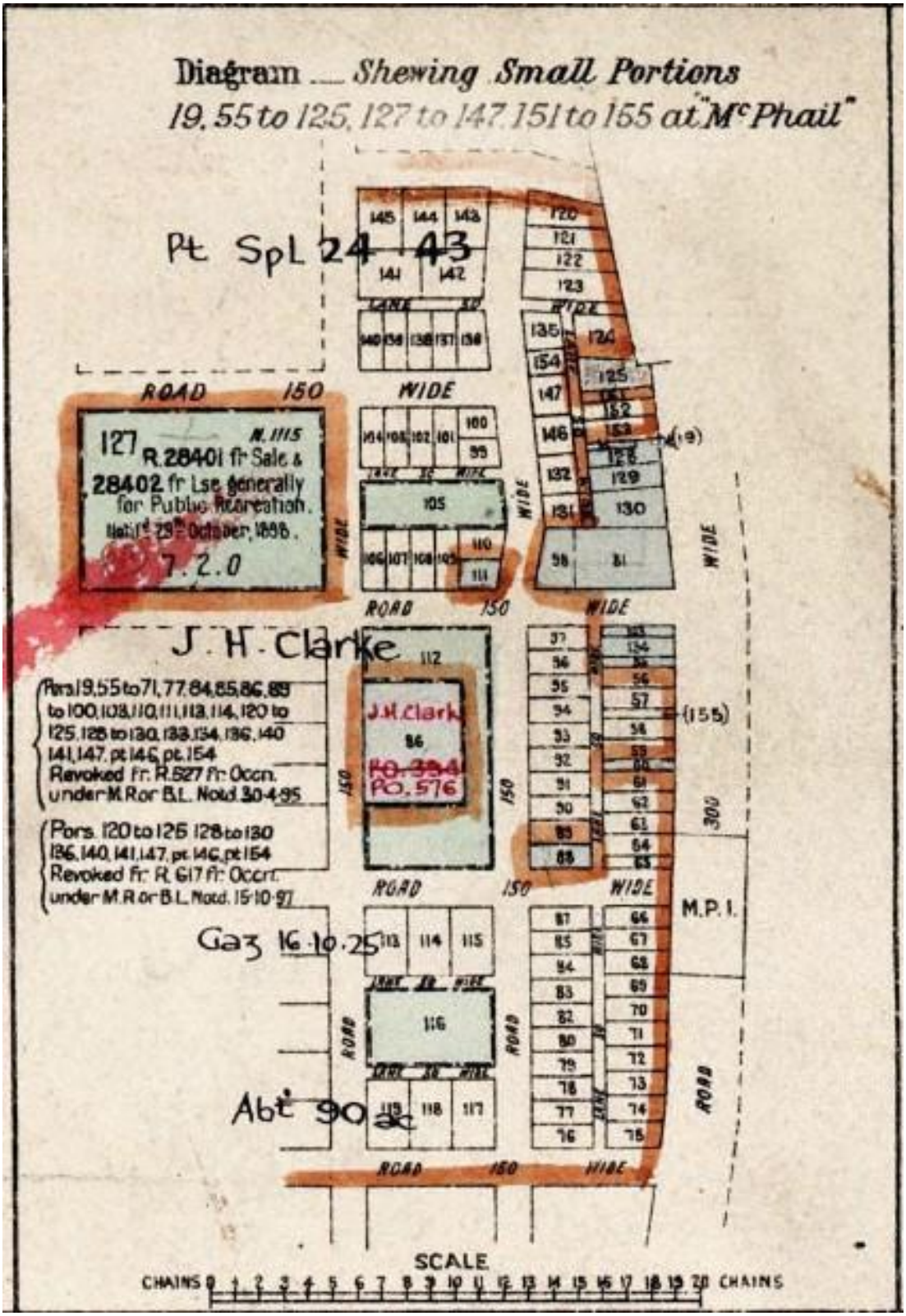

Figure 6.12.3
Diagram of the Village of McPhail from 1921

Source: OzArk (2021c) – Figure 3-7

6.12.2.4 Tomingley Area in the 20th Century

Agricultural production continued alongside and in support of the gold mining activity within the area at the turn of the 20th century. Tomingley became the rural centre as the population and businesses of McPhail dispersed once the returns from the goldfield diminished (OzArk, 2021c).

The "Rosewood" Property, located approximately 5km south of the Tomingley village, was established by William Daniel Hando in 1897 and encompassed 1 279 acres (518.6ha) (**Figure 6.12.1**). William Hando worked at the nearby McPhail Mine during the day while developing the property during the evenings. The first crop of wheat was harvested in 1902 before William Hando began to breed Clydesdale horses, exhibiting at local shows. He later became one of the pioneers of trotting in NSW and eventually went on to establish the "Rosewood" Trotting Stud on the "Rosewood" Property. At its peak, the "Rosewood" Trotting Stud was one of the biggest breeders of pacing stock in Australia, breeding and racing many championship horses.

A homestead style villa was built around 1915, with further development including sleeping quarters, woolsheds, storage sheds and other agricultural and related infrastructure constructed over the intervening period. OzArk (2021c) state that the villa is an example of a classic Edwardian-style homestead in a good, relatively unmodified condition (**Plate 6.12.2**).

Plate 6.12.2 "Rosewood" Homestead

Source: OzArk (2021c) – Cover Photograph

6.12.3 Heritage Registers

OzArk (2021c) searched the following heritage registers to identify any previously recorded historic heritage items within the SAR and "Dappo" Heritage Study Areas.

- National and Commonwealth Heritage Listings
- State Heritage Register
- Section 170 Heritage and Conservation Register
- *Narromine Local Environmental Plan 2011*

In summary, no recorded historic heritage sites were identified within the SAR or the "Dappo" Heritage Study Areas.

6.12.4 Field Survey Methodology and Results

The field survey for the historic heritage assessment was undertaken by OzArk concurrently with the Aboriginal heritage survey. Section 6.11.4 presents the assessment methodology for the combined survey.

Table 6.12.1 presents the results of the historic heritage field survey. **Figure 6.12.1** presents the location of the historic heritage sites identified within the SAR Heritage Study Area. A full description of the items identified is provided in Section 4.4 of OzArk (2021c).

Table 6.12.1
SAR Historic Heritage Sites

Site name	Site description
McPhail Mine	• Remnant features concrete and quartz structure, mounding from past mining. • Isolated concentrations of discarded materials i.e. brick, glass, ceramics, metal. • Some archaeological potential in area of possible brick and stone foundations.
Village of McPhail	• Isolated concentrations of discarded materials i.e. brick, glass, ceramics, metal. • No built structures or foundations present at surface. • Commercial structures likely located within the footprint of the existing Newell Highway. Potential exists for foundations or evidence of prior structures to occur within the footprint of the realigned Highway.
"Rosewood" Trotting Stud	• Homestead style cottage built in 1915; sleeping quarters; woolshed; storage sheds. • No archaeological potential at the location of a former mud-hut.
"Eulinda Park" Homestead	• Bungalow-style homestead with west and northern veranda.
"Old Thornycroft" ruins	• Two collapsed wooden frames and corrugated iron adjacent to exotic tree and nearby stock ramp.
Source: OzArk (2021c) – after Section 4.4	

There were no items of historic Heritage significant within the "Dappo" Heritage Study Area as the area is predominantly a ploughed paddock regularly cropped for wheat and other crops.

6.12.5 Significance Assessment

Evaluations and statements of significance were completed for those heritage items identified within the SAR Heritage Study Area which are considered by OzArk (2021c) to hold some archaeological potential. The assessments were made with the assumption that the sites contain intact or partially intact archaeological deposits.

The evaluation and subsequent statements of significance in accordance with the *Australia ICOMOS Burra Charter* (Burra Charter, 2013) of all five heritage items identified within the Study Area are summarised in **Table 6.12.2**.

In summary, the rural character of the SAR Heritage Study Area has contributed to the low potential of the archaeological resource as occupation was at a low density and has been subjected to disturbances such as ploughing. Except for the village of McPhail, the McPhail Mine, and the "Rosewood" Trotting Stud, the identified historic heritage items have been assessed as having no heritage significance.

Any archaeological remains associated with the village of McPhail and the McPhail Mine would likely have little or only local significance.

Any additional, unidentified historic heritage items that may be present within the SAR Heritage Study Area are likely to be insignificant rural structures, such as ruined sheds, fences, and stockyards, as well as utilitarian farming objects. If present, these are likely to be typical of those found throughout the Central West and rural NSW and have no heritage significance.

6.12.6 Avoidance, Management and Mitigation Measures

6.12.6.1 Introduction

It is anticipated that the specific historic heritage management practices undertaken for the Project would be managed in accordance with an approved *Historic Heritage Management Plan* that would be developed in consultation with DPE and Heritage NSW. The development of that document would only commence once any approval for the Project has been granted.

Notwithstanding the above, it is anticipated that all historic heritage management and mitigation measures would be in accordance with the recommendations detailed in OzArk (2021c) and summarised in the following subsections.

Table 6.12.2
Assessment of Heritage Items

Historic Heritage Criterion	McPhail Mine	Village of McPhail	"Rosewood" Trotting Stud	"Eulinda Park" Homestead	"Old Thornycroft" Ruins
An item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area).	Local	Local	Local	Nil	Nil
An item has a strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local area).	Nil	Nil	Local	Nil	Nil
An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).	Nil	N/A	Local	Nil	Nil
An item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons.	Nil	Nil	Nil	Nil	Nil
An item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area).	Local	Local	Nil	Nil	Nil
An item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area).	Nil	N/A	Nil	Nil	Nil
An item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places; or cultural or natural environments (or a class of the local area's cultural or natural places; or cultural or natural environments).	Nil	N/A	Nil	Nil	Nil
Source: OzArk (2021c) – modified after Tables 5-1 to 5-5					

6.12.6.2 Avoidance of Potential Impacts through Project Design and Review

The Applicant, following receipt of the results of the initial historic heritage survey identified that a number of sites would potentially be disturbed by the Project. The Applicant determined that the proposed realigned Newell Highway would remain within the existing road reserve in the vicinity of the McPhail Mine, thereby ensuring no disturbance of that site.

Other sites were unable to be avoided for the following reasons.

- McPhail Village – the Applicant prepared at least 18 designs for the realigned New Highway, with each rejected for a range of reasons, including by Transport for NSW to ensure that the road would meet the required design standard (see Section 6.2). As a result, the village of McPhail could not be avoided.
- "Rosewood" Trotting Stud and Homestead – the size of the SAR Open Cut in the vicinity of the "Rosewood" Homestead was determined based on optimisation of the known resource in accordance with the Applicant's obligations to maximise recovery of the resource under the *Mining Act 1992*. The optimisation resulted in an Open Cut that would require the removal of the "Rosewood" homestead. The Applicant would, prior to the removal of the "Rosewood" Homestead, rerun the optimisation of the open cut and underground mining operations prior to mining of the Roswell resource commencing and, if practicable and consistent with its obligations under the *Mining Act 1992*, would reduce the size of the SAR Open Cut North Pit to retain the "Rosewood" Homestead.

As a result, the Applicant contends that it has made all reasonable and feasible efforts to avoid, to the extent practicable, impacting on historic heritage sites.

6.12.6.3 Operational Management and Mitigation Measures

The Applicant would implement the following historic heritage-related management and mitigation measures.

- Ensure that areas outside the proposed Limit of Disturbance are not subject to Project-related disturbance.
- Ensure that all identified historic heritage sites are recorded in the Mine's spatial database.
- Prepare and implement a *Historic Heritage Management Plan* in consultation with The Heritage Council of NSW prior to commencement of construction and site establishment operations.
- Undertake a test excavation program under the supervision of a qualified Archaeologist within selected sections of the footprint of the realigned Newell Highway in the vicinity of the former McPhail village prior to construction of the Highway. The test excavation program would indicatively include the following.
  - Strip the top 20cm of soil (the 'plough zone') using a machine.

  - Inspect the exposed area and hand excavate any identified archaeological remains including concentrations/deposits of artefacts, structural remains, or deeper cut features, and ensure appropriate archival recording of the remains.
  - If no archaeological remains are identified, undertake further monitored machine stripping until pre-occupation sub-soils are exposed.
- Undertake photographic archival recording of the "Rosewood" Homestead prior to disturbance. A representative set of photographs of each of the outbuildings would be collected at the time of the archival recording to provide context.
- Implement the following Unanticipated Finds Protocol in the event that a historic artefact is identified during the life of the Project.
  - Immediately cease all ground surface disturbing activities in the immediate vicinity of the find(s).
  - Notify NSW Police if the finds are suspected to be human skeletal remains.
  - Seek the opinion of a qualified Archaeologist in relation to the significance of the find.
  - In the event that the find is determined to not have heritage significance, work may recommence.
  - In the event that the find has heritage significance, facilitate the recording and assessment of the find by a suitably qualified Archaeologist, including the development of appropriate management strategies. Re-commence ground surface disturbance only following compliance with any legal requirements and gaining written approval from Heritage NSW.

6.12.7 Assessment of Impacts

6.12.7.1 Potential Historic Heritage-related Impacts

No locally listed heritage items are located within or near to the SAR or "Dappo" Heritage Study Areas. However, based on the field survey and proposed limit of disturbance, it is anticipated that the following sites would not be impacted.

- McPhail Mine – No project related disturbance is proposed withing Crown Land occupied by the McPhail Mine.
- "Eulinda Park" Homestead – this site would be outside the proposed limit of disturbance.

Notwithstanding the above, the following historic heritage sites would potentially be impacted by the Project.

Village of McPhail (partial impact)

The proposed realignment of the Newell Highway is located partially within the area of the village of McPhail, in particular, in the presumed vicinity of the location of potential commercial and residential areas of the village. OzArk (2021c) note that the proposed alignment of the Newell

Highway is expected to be to the west of the principal buildings within the commercial area of the village in particular, with the current alignment of the Newell Highway assumed to have been constructed on the likely location of the actual buildings.

The proposed area to be impacted would be relatively small when compared to the overall size of the village. In addition, the former village site is no longer interpretable as it consists only of a fragmented surface expression of ephemeral items. However, the potential archaeological resource at the village may provide a tangible link to the historical development and ownership of the village of McPhail. The proposed test excavation and archival recording program would ensure that any buried historic heritage items are identified and recorded prior to disturbance.

"Rosewood" Trotting Stud (direct impact)

The principal heritage component of the "Rosewood" Trotting Stud is the Edwardian style homestead, which is located within or in very close proximity of the proposed SAR Open Cut and, pending further open cut optimisation, would require removal. Several outbuildings with no significant historic values are also located within the proposed Limit of Disturbance and would be required to be removed.

The Applicant would rerun the optimisation of the open cut and underground mining operations prior to mining of the Roswell resource commencing and, if at all practicable, would reduce the size of the SAR Open Cut North Pit to retain the "Rosewood" Homestead. The Homestead would not be removed until that optimisation had been completed.

In the event that the Homestead cannot be retained, OzArk (2021c) state that the demolition would remove a representative and increasingly rare style of architecture, an Edwardian style homestead, and would result in the loss of the aesthetic value of the item. Further, demolition of the homestead would also harm the item's historic and associative value. However, based on the fact that the "Rosewood" Trotting Stud is not a listed heritage item, and has been assessed as having only local heritage values, it is concluded that the demolition of these items following archival photographic recording would not result in significant impacts.

"Old Thornycroft" Ruins (direct impact)

The "Old Thornycroft" Ruins would be required to be removed. OzArk (2021c) has determined that the ruins have no heritage value and no management measures are required.

6.12.7.2 Justification of Potential Heritage Impact

The Applicant contends that disturbance of these sites is unavoidable for the following reasons.

- "Rosewood" homestead – the "Rosewood" occurs within the footprint of the SAR Open Cut. Preservation of the homestead would result in reduced recovery of a State-owned resource. This would be contrary to Applicant's obligation to maximise recovery of the identified resource.
- Village of McPhail – the Newell Highway is required to be relocated to permit mining of the SAR Open Cut. The proposed design of the Highway is constrained by TfNSW design requirements for the Highway as well as the presence of Crown

Land, namely Lot 7003, DP1020605 and Lot 7300, DP1151814 (see **Figures 2.3** and **3.2.1**), either side of the proposed alignment. As a result, it is not feasible to design the realigned Highway in a manner that would avoid the former Village.

- "Old Thornycroft" ruins – The "Old Thornycroft" ruins are located within the footprint of the SAR Waste Rock Emplacement. The design of the Waste Rock Emplacement is constrained by high value native vegetation and the requirement for the Emplacement to be large enough to accept the required volume of waste rock.

In light of the above, the Applicant contends that it has, to the extent practicable, attempted to avoid or minimise impacts upon cultural heritage values within the SAR Mine Site.

6.12.8 Conclusion

The Project would not result in the disturbance of any listed historic heritage items. However, some items of potential local heritage significance would have the potential to be partially or would be partially or fully disturbed by the Project.

The management of impacts to identified heritage items where required would be in consultation with Heritage NSW and/or Narromine Shire Council in a manner that would ensure that historic heritage sites and values within the Project Site would be protected in accordance with the expectations of the wider community as well as the requirements of the NSW and local Government.

6.13 Hazards and Risks

The risk assessment undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in adverse environmental impacts from the use of hazardous materials or practices. No risk sources were assessed with risk of "medium" or above.

The SEARs for the Project require the EIS to include a detailed assessment of the likely hazards of the development, paying particular attention to:

- a Preliminary Hazard Analysis, covering an assessment of the likely risks to public safety, paying particular attention to potential geochemical and bushfire risks, and storage, handling, transport and use of any dangerous goods associated with the development;
- consideration of all findings from the *Preliminary Hazard Analysis* and *Final Hazard Analysis* prepared for the MP 09_0155 development consent; and
- on-going maintenance and safety management of the project, including potential impacts on and from bushfires and floods.

The assessment requirements of Narromine Shire Council were also considered during the preparation of the Preliminary Hazard Analysis. A summary of the SEARs and other Agency Requirements are listed in **Appendix 2**, together with a record of where each requirement is addressed in the EIS.

The Preliminary Hazard Analysis prepared in accordance with the requirements of *State Environmental Planning Policy 33 – Hazardous and Offensive Development* (SEPP 33) for the storage and use of hazardous materials for the Project was undertaken by RWC and is presented in **Appendix 17**. Previous SEPP33 assessments prepared for TGO include the following.

- *TGO SEPP 33 Risk Screening and Preliminary Hazard Analysis* prepared by RWC and dated November 2011. That document was presented as Appendix 3 of the original *Environmental Assessment* for TGO Mine.
- *Tomingley Mine Site Final Hazard Analysis*, referred to hereafter as Sherpa (2013) and presented as Annexure 1 of **Appendix 17**. As Sherpa (2013) post-dates RWC (2011), reliance has been placed on the later document.
- *Tomingley Mine Site Risk Assessment Proposed Liquid Oxygen Storage*, referred to hereafter as Sherpa (2014) and presented as Annexure 2 of **Appendix 17**. Sherpa (2014) presents an updated Final Hazards Analysis taking into account the additional of a liquid oxygen storage tank within the TGO Mine Site.

Flooding-related risks are addressed in Section 6.6. In summary, the SAR Mine Site is not flood prone and risks associated with flooding are negligible.

The following subsections provide a summary of the Preliminary Hazard Analysis and present a qualitative assessment of bushfire related impacts.

6.13.1 Hazardous Materials

6.13.1.1 Introduction

In accordance with SEPP 33, a "potentially hazardous industry" is defined as any development that, without the implementation of risk management or mitigation measures, would pose a significant risk to human health, life or property, and/or the biophysical environment. Industries or projects determined by the risk screening to be hazardous or potentially hazardous would require the preparation of a Preliminary Hazard Analysis in accordance with Clause 12 of SEPP 33.

6.13.1.2 Hazardous Materials within the Project Site

Risk Screening

Hazardous materials are defined by *Hazardous and Offensive Development Application Guidelines – Applying SEPP 33* (Applying SEPP 33) (NSW Government, 2011) as substances falling within the classification of the *Australian Code for the Transportation of Dangerous Goods by Road and Rail* (the Dangerous Goods Code) (Version 7.7). Based on this definition, the hazardous materials to be stored within the Project Site, their quantities and storage location are summarised in **Table 6.13.1**. Threshold limit criteria are in accordance with Table 3 and Figure 5 of Applying SEPP 33.

Risk Screening Results

Based on the risk screening results presented in **Table 6.13.1**, a Preliminary Hazard Analysis is required for the storage and use of the following hazardous materials within the TGO Mine Site.

- Class 1.1 explosives
- Liquefied Petroleum Gas
- Ammonium Nitrate Emulsion
- Sodium cyanide
- Hydrochloric acid

No changes to the existing, assessed and approved transport, storage and/or use of any of the above hazardous materials for the TGO Mine Site are proposed. Existing hazardous materials were addressed by Sherpa (2013 and 2014) through detailed, quantitative assessments. As a result, no further assessment of these materials has been undertaken.

Based on the risk screening results presented in **Table 6.13.1**, a Preliminary Hazard Analysis is required for the storage and use of the Ammonium Nitrate Emulsion within the SAR Mine Site.

Table 6.13.1
Hazardous Materials Storage with the Project Site

Material	Class	Description	Actual / Proposed Storage Quantity	Storage Location	Distance to Site Boundary[1]	Threshold Limit	Threshold Triggered
TGO Mine Site (Source: Sherpa (2013) – Appendix F, Table 2.1)							
Diesel Fuel	C1	Combustible liquids: flashpoint above 61°C but not exceeding 150°C	2 x 77 500L	Self-bunded fuel bay in the vicinity of the TGO Mine Site workshop	>500m	10m	No
Explosives, blasting, type B. Explosives, blasting, type E. Booster Cord detonating. Detonators, Non-electric.	1.1	Pre-packaged and bulk explosives	7 530kg[2]	TGO Magazine	>28.5m	280	**Yes**[3]
Liquified Petroleum Gas (LPG)	2.1	Flammable Gas: Gases which ignite on contact with an ignition source	4 x 7 500L tanks (30 000L)	Bunded location adjacent to the Processing Plant within the Processing Plant and Office Area	600m	16m^3	**Yes**
Liquid Oxygen	2.2	Non-flammable, non-toxic	60 000L tank		>500m	Non-hazardous	
Ammonium Nitrate Emulsion	5.1 PG II	Oxidising agent	68t	TGO Magazine	>500m	5t	**Yes**
Sodium Cyanide (solution)	6.1 PG I	Solution mixed on site	2x 100 000L	Bunded location adjacent to the Processing Plant within the Processing Plant and Office Area	>500m	0.5t	**Yes**
Hydrochloric Acid	8 PG II	Concentrated liquid	30 000L (23.6t)			25m^3	**Yes**
Caustic Soda (Sodium Hydroxide) (Solution)	8 PG II	Concentrated liquid	20 000L			25t	No
Acetic Acid	8 PG III	Reagent	2 000L			50m^3	No
Copper Sulphate (Solution)	9 PG III	Catalyst in cyanide detoxification process	20 x 1m^3 Intermediate Bulk Containers Tanks			Non-hazardous	
SAR Mine Site (Source: Tomingley Gold Operations Pty Ltd)							
Diesel Fuel	C1	Combustible liquids: flashpoint above 61°C but not exceeding 150°C	500 000L	Self-bunded fuel bay in the vicinity of the SAR Mine Site workshop	>500m	10m	No
Explosives, blasting, type B. Explosives, blasting, type E. Booster Cord detonating. Detonators, Non-electric	1.1	Pre-packaged and bulk explosives	20t[4]	SAR Magazine	800m	380[5]	**No**
Ammonium Nitrate Emulsion	5.1 PG II	Oxidising agent	200t[6]	SAR Magazine	800m	5t[7]	**Yes**

Note 1: Site Boundary = boundary of closest publicly accessible location, including public roads or surrounding private land.
Note 2: Total quantity of Class 1.1 explosives comprises 7 500 kg Class 1.1D explosive material and a nominal 30 kg for Class 1.1B detonators.
Note 3: The TGO Magazine was previously located within 28.5m of private land. However, the Applicant has now purchased surrounding land and the TGO Magazine is now >500m from publicly accessible land. Notwithstanding this, the previous Hazards Analysis completed by Sherpa (2013) remains valid.
Note 4: Assumed combined maximum total of Class 1.1D explosive material and Class 1.1B detonators.
Note 5: Based on Figure 5 of Applying SEPP33.
Note 6: Assumed maximum required storage capacity for SAR Mine Site during peak mining activity.
Note 7: Based on Table 3 of Applying SEPP33.

Source: **Appendix 17** – Table A17.1

6.13.1.3 Management and Mitigation Measures

For the purposes of the Preliminary Hazards Analysis, the following risk controls were identified for the use and storage of Ammonium Nitrate Emulsion (and Class 1.1 Explosives) within the SAR Mine Site.

- The SAR Magazine would comply with all relevant engineering and safety standards, including the latest version of *Australian Standard 2187: Explosives - Storage, transport and use*.
- The SAR Magazine and other landscape elements such as surrounding bunding and the southeast soil stockpile would provide barriers to suppress shrapnel or flying debris in the event of an uncontrolled explosion.
- The SAR Magazines would have a perimeter security fence and gate with access restricted to authorised personnel.
- All authorised employees managing explosives would have a Security Clearance.
- The use of explosives within the Project Site would be managed in accordance with a revised *Blast Management Plan*.

In addition, general hazard control measures would also be documented in the following management plans and strategies that would be revised following receipt of development consent.

- *Environmental Management Strategy*
- *Emergency Management Plan*
- *Pollution Incident Response Management Plan*
- *Blast Management Plan*

6.13.1.4 Preliminary Hazard Analysis

The Preliminary Hazards Analysis was undertaken in accordance with the following documents and guidelines.

- *Risk Criteria for Land Use Planning: Hazardous Industry Planning Advisory Paper No. 4* (NSW Government, 2011d).
- *Guidelines for Hazard Analysis: Hazardous Industry Planning Advisory Paper No. 6* (NSW Government, 2011e).
- *Multi-Level Risk Assessment* (NSW Government, 2011c).

The principal risk from the use and storage of explosive compounds is that of an uncontrolled explosion that results in damage or harm to people, property, infrastructure or the surrounding environment. In order to provide a conservative approach to the qualitative risk assessment, the Preliminary Hazard Analysis considered the cumulative impact of a combined explosion of both Ammonium Nitrate Emulsion and Class 1.1 Explosives.

Minimum separation distances to protected works were assessed against the *Code of Practice Ammonium Nitrate Emulsions, Suspensions or Gels – Ammonium Nitrate Emulsions* (UN3375) (the ANE Code) (Australian Explosives Industry and Safety Group Inc, 2012) which states that the storage of Ammonium Nitrate Emulsions must either adopt the same quantity distances as explosives as per *AS 2187.1 - Explosives—Storage, transport and use. Part 1: Storage*, or must be able to be evacuated in the event of an emergency which could potentially lead to an explosion.

Table 6.13.2 and **Figure 6.13.1** presents the minimum separation criteria for the SAR Magazine and the sensitive receptors and protected works that were identified in accordance with the ANE Code, based on the combined mass of Ammonium Nitrate Emulsion and Class 1.1 Explosives. Further information on the classification of sensitive receptors is located in Section A17.2.3.6.2 of **Appendix 17**.

Comparison of minimum and actual separation distances to key receptors showed compliance with the ANE Code and consequently, *AS 2187.1 Explosives – Storage, transport and use Part 1 Storage*. Therefore, the offsite risks associated with hazardous materials located within the SAR Magazine are considered to be acceptable.

Table 6.13.2
Minimum Separation Distance Criteria

Receptor	Details	Approximate Separation Distance (m)[1]	SAR Magazine	
			Minimum Separation Distance (m)[2]	Separation Distance Acceptable?
Protected Works Class A				
Property 44	Nearest private property	800	840	Yes
Realigned Kyalite Road	Nearest public road	1 600		Yes
Realigned Newell Highway	Nearest significant infrastructure	1 500		Yes
Protected Works Class B				
Residence R44	Nearest Project-related residence	2 300	1 260	Yes
Residence R43	Nearest non-Project related residence	2 600		Yes
SAR Administration Area	Building in which a person is employed in any trade or business	2 100		Yes
TGO Processing Plant	Depot for LPG and other dangerous goods	4 800		Yes
Vulnerable Facility				
Tomingley Village	Relatively high density of vulnerable facilities/receptors	5 650[3]	2 320	Yes
Associated Facilities				
SAR Explosives and Detonator Storage	Distance between SAR Ammonium Nitrate Emulsion and Class 1.1 Explosives storages	130	105	Yes
TGO Explosives and Detonator Storage	TGO Magazine	3 800	105	Yes

Note 1: Measured from closest point of the SAR Magazine
Note 2: For 180t Net Explosive Quantity
Note 3: Measured from nearest Tomingley building (Residence R3)

Source: **Appendix 17** – Table A17.5

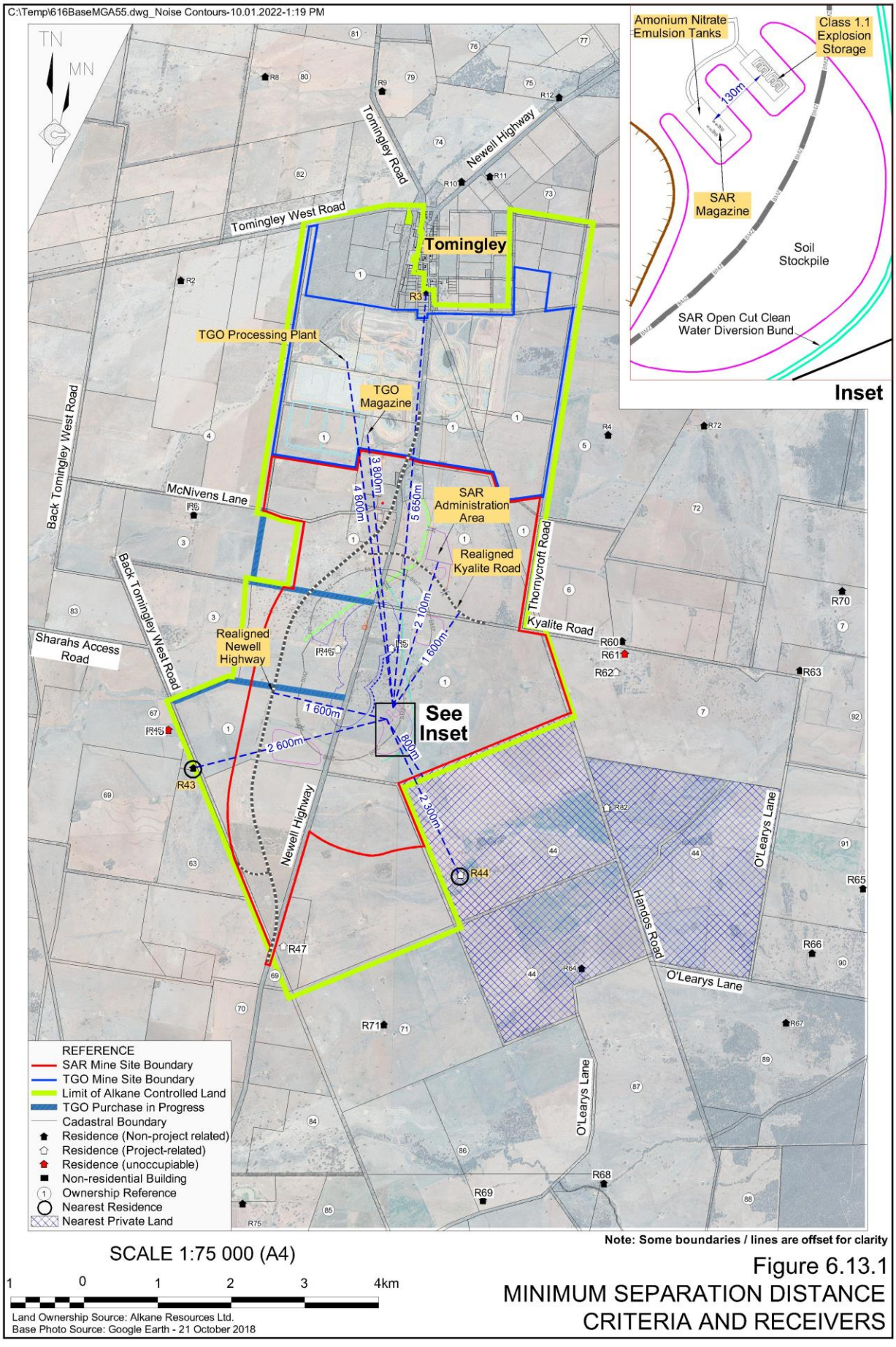

Figure 6.13.1
MINIMUM SEPARATION DISTANCE CRITERIA AND RECEIVERS

6.13.2 Bushfire

6.13.2.1 Introduction

The following sections present a qualitative Bushfire Assessment for the Project in consideration of previous assessments undertaken for the TGO Mine Site and *Planning for Bushfire Protection 2019* (NSW Rural Fire Service, 2019). **Figure 6.13.2** presents the bushfire prone land status of the Project Site and surrounds as taken from the NSW Rural Fire Service Bushfire Prone Land Map[12]. More information on the existing bushfire setting of the Project Site is located in Section 2.2.5.2.

The objectives of *Planning for Bushfire Protection*, considered in this assessment of bushfire management of the Project, are to:

- afford occupants of any building adequate protection from exposure to a bushfire;
- provide for a defendable space to be located around buildings;
- provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition;
- ensure that safe operational access and egress for emergency service personnel and residents is available;
- provide for ongoing management and maintenance of bushfire protection measures, including fuel loads in the Asset Protection Zone; and
- ensure that utility services are adequate to meet the needs of fire fighters (and others assisting in bush firefighting).

6.13.2.2 Existing Assessments and Management Plans

A Bushfire Assessment for the TGO Mine (the TGO Bushfire Assessment) was undertaken by RWC as part of the *Environmental Assessment* for the TGO Mine and is presented in Section 4.13.4 of that document. The TGO Bushfire Assessment was undertaken in accordance with *Planning for Bushfire Protection 2006* by the NSW Rural Fire Service and the Narromine Local Environmental Plan 1997. The results of the TGO Bushfire Assessment were used to develop the approved *Biodiversity Management Plan* and various emergency management procedures for the TGO Mine Site.

6.13.2.3 Existing Management and Mitigation Measures

All fire-related risk evaluation and management is conducted in consultation with or under the direction of the NSW Rural Fire Service.

[12] https://data.nsw.gov.au/data/dataset/nsw-bush-fire-prone-land

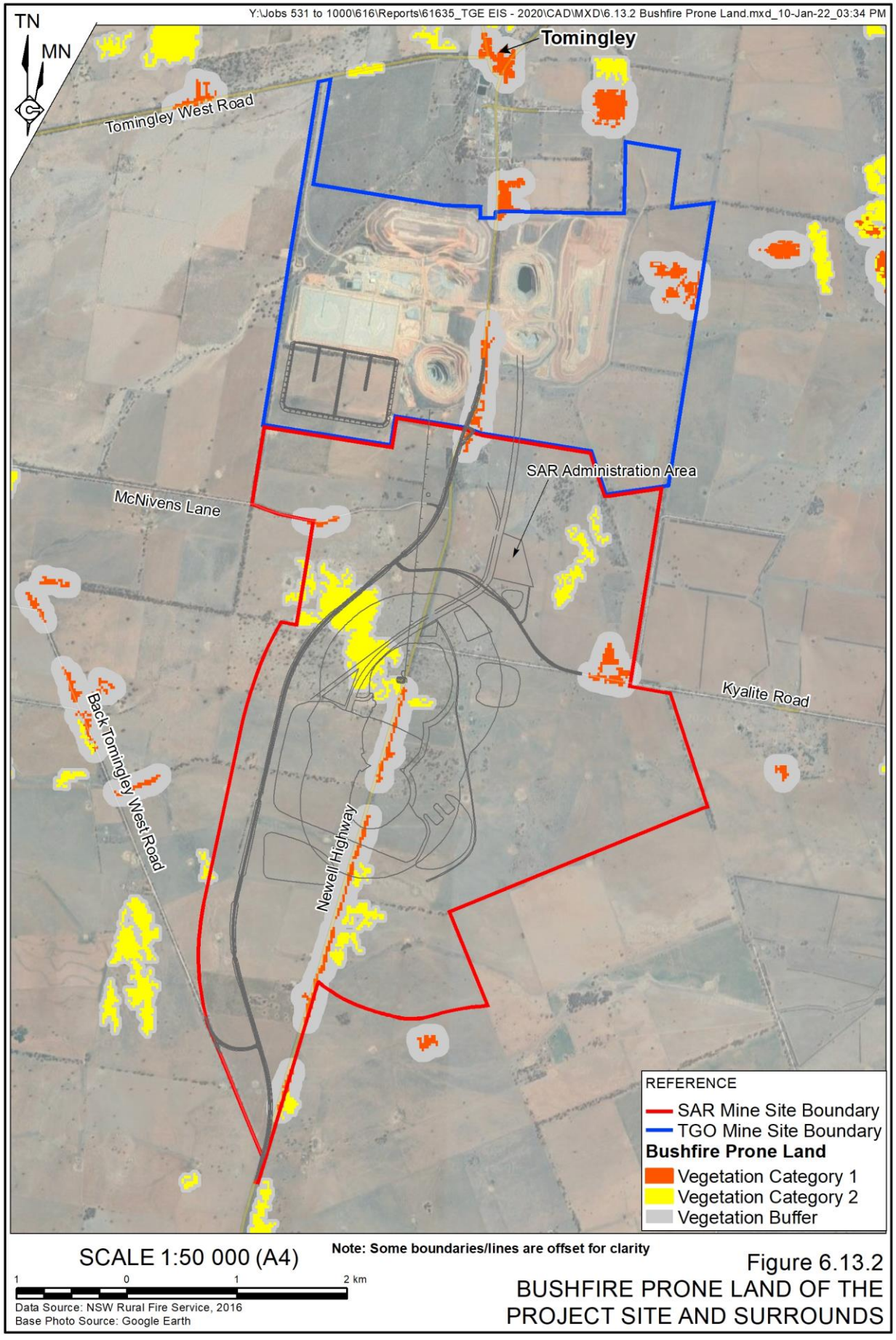

Figure 6.13.2
BUSHFIRE PRONE LAND OF THE PROJECT SITE AND SURROUNDS

Emergency fire response for the TGO Mine Site is outlined in the Applicant's *Emergency Management Plan*. In addition, the *Pollution Incident Response Management Plan* outlines the existing fire suppression infrastructure and equipment within the TGO Mine Site, including:

- fire extinguishers and suppression systems located throughout the processing plant and buildings, including fire extinguishers located in all mine-related vehicles;
- a water cart with a fire cannon and fire suppressant foam capability;
- a network of fire hydrants in a ring around the Processing Plant; and
- a system of firebreaks between the principal operational areas of the TGO Mine Site and local residences.

The TGO Incident Response Team provide limited fire-fighting capability within and in the vicinity of the TGO Mine Site. The objective of the team is to provide a 'rapid-response' measure to account for the anticipated time for the NSW Rural Fire Service to respond to incidents. Further reduction in fire-related risks is provided through general operational practices such as designated smoking areas and the maintenance of vehicles and plant to ensure they are operating in a safe a reliable manner.

All management of vegetation within the TGO Mine Site is conducted in accordance with the existing and approved *Biodiversity Management Plan*. The TGO Mine Site includes significant areas of vegetation that require management of fuel loads as part of ongoing fire-risk reduction. Fuel reduction, primarily through the use of controlled grazing by domestic stock, is used by the Applicant as an effective measure to control fuel loads.

6.13.2.4 Potential Impacts

Introduction

The following scenarios represent the key potential Project-related bushfire impacts.

- Change to the existing background risk from bushfire that would lessen the effectiveness of existing management measures.
- Project-related changes in operational practices within and in the vicinity of the Project Site that would result in impacts to the existing risk profile or fire-regime.

Review of Existing and Proposed Controls

The TGO Bushfire Assessment considered the following parameters when determining an appropriate Asset Protection Zone for the TGO Administration Area and Processing Plant.

- Fire Danger Index
- Predominant Vegetation Class
- Effective Slope

The Fire Danger Index (also known as the McArthur Fire Danger Index) for an area is determined by the NSW Rural Fire Service based on the Fire Weather District. The Narromine LGA is located within the Lower Central West Plains Fire Weather District, with a Fire Danger Index of 80. The Predominant Vegetation Class is used to determine available fuel loads within 140m of key infrastructure and are based on the vegetation class that presents the greatest hazard, rather than relative abundance. The Effective Slope relates to the ground under any hazard source (i.e. vegetation) within 100m of key infrastructure.

Based on the above, a minimum Asset Protection Zone of 50m was determined as appropriate for the TGO Administration Area and Processing Plant.

Based on the procedures identified in Appendix 1 of *Planning for Bushfire Protection 2019*, including Table A1.12.1 and the following assumptions, Applicant determined that the relevant Asset Protection Zone for the SAR Administration Area would be 50m.

- Vegetation Formation - Grassy and Semi-Arid Woodland (including Mallee).
- Effective slope – 0° to 5°

Changes to Land Management

The SAR Mine Site is located predominately within a landscape cleared of significant vegetation and therefore the overall risk of bushfire is not expected to be any greater from that of the surrounding environment. Notwithstanding the above, the Project would involve the following factors that may result in changes to existing fire regimes and bushfire risk both within and in the vicinity of the SAR Mine Site.

- The removal of grazing pressure by domestic stock during site construction and operations could result in an increase in fuel loads in these areas.
- The use and storage of explosives within the SAR Mine Site.
- The use and storage of hydrocarbons and other flammable materials within the SAR Administration Area.

6.13.2.5 Management and Mitigation Measures

The Applicant would undertake a full review and revision of the existing bushfire management operations and strategies in consultation with the NSW Rural Fire Service and in accordance with all relevant regulations, standards and guidelines.

The following management and mitigation measure would be implemented by the Applicant within the SAR Mine to reduce the risk of a local bushfire event.

- Establish and maintain an Asset Protection Zone of at least 50m around the buildings of the SAR Administration Area.
- Monitor and reduce fuel loads within the Asset Protection Zone as required.
- Undertake monitoring and reduction of fuel loads within the Project Site in accordance with existing programs.

- Maintain all roads and tracks within the Project Site to ensure safe access and egress in the event evacuation is required.
- Ensure training is provided to selected site personnel in relation to specific firefighting tasks and procedures.
- Develop site-specific Emergency and Evacuation Management Procedures for the SAR Mine Site to be integrated into the Applicant's emergency management procedures.
- Store all hydrocarbons, waste oils and explosives in accordance with the descriptions in Sections 3.3.2.6, 3.3.2.8 and 3.11.4.
- Facilitate access to the Project Site for Rural Fire Service equipment and personnel, including access to standpipes and water filling points, in the event of a fire emergency.
- Fully comply with the requirements of Rural Fire Service and other emergency services in the event of a fire emergency.
- Consult regularly with the Rural Fire Service.

6.13.3 Assessment of Impacts

The existing and approved management and mitigation measures that have been developed, implemented and refined for the TGO Mine Site have shown to be effective in the prevention and control of environmental hazards and risks from hazardous materials and/or bushfire. In addition, the results of the Preliminary Hazard Analyses undertaken for both the TGO and SAR Mine Sites show that residual environmental risks are able to be managed to an acceptable level. Therefore, the Project is unlikely to result in any unacceptable environmental risk from hazardous material or bushfire.

6.14 Economic Impacts

6.14.1 Introduction

The assessment of environmental risk undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in significant economic impacts. Risk sources with an assessed risk of "medium" or above after the adoption of standard mitigation measures included a downturn in gold price or increase in operating costs resulting in the project becomes uneconomic or closing prematurely. resulting in more challenging rehabilitation (medium risk).

The SEARs for the Project require the EIS to include a detailed assessment of the likely economic impacts of the development, paying particular attention to:

- the significance of the resource;
- the economic benefits of the Project for the State and Region;
- the demand for the provision of local infrastructure and services; and
- a Planning Agreement in relation to the demand for the provision of local infrastructure and services.

The assessment requirements of the Narromine Shire Council were also considered during the preparation of the economic impact assessment. A summary of the SEARs and the requirements of Narromine Shire Council are listed within **Appendix 2**, together with a record of where each requirement is addressed in the EIS.

The Economic Impact Assessment (EIA) for the Project was undertaken by Diana Gibbs and Partners and is presented as Part 12 of the *Specialist Consultant Studies Compendium* and hereafter referred to as Gibbs (2021). The following subsection draws on information presented in that report and presents the results of the cost benefit analysis and local effects analysis prepared for the Project.

6.14.2 Approach to the Economic Impact Assessment

In assessing the economic impacts of the Project, Gibbs (2021) considered:

- the economic efficiency of the Project, evaluated using a cost benefit analysis (CBA); and
- the Project's effects on the local economy, evaluated using a local effects analysis (LEA).

Information relied upon by Gibbs (2021) was provided by the Applicant and was current as of December 2021.

Gibbs (2021) considered the following guidelines and advisory documents in the preparation of the EIA for the Project.

- *Guideline for the Economic Assessment of Mining and Coal Seam Gas Proposals*, DPIE (2015);

- *Technical Notes Supporting the Guidelines for Economic Assessment of Mining and Coal Seam Gas Proposals* DPIE (2018); and
- *NSW Government Guide to Cost-Benefit Analysis*, NSW Treasury (2017).

6.14.3 Cost Benefit Analysis

6.14.3.1 Cost Benefit Analysis Methodology

Overview

The following key steps formed part of the CBA undertaken for the Project. Further details of the CBA methodology are provided in Section 4 of Gibbs (2021). It is noted that the CBA assesses the costs and benefits of the Project to the State of NSW as a whole, not to the Applicant or the community immediately surrounding the Project Site.

- Identification of the 'with' and 'without' Project scenarios. Gibbs (2021) states that it is the incremental changes between these scenarios that is relevant to the CBA.
- Identification of the incremental benefits and costs.
- Consolidation of value estimates using discounting to account for temporal differences.
- Sensitivity testing.

'With' and 'Without' Project Scenarios

The 'without' Project scenario forms the base case for the CBA against which the potential economic, environmental, social and cultural impacts of the Project are assessed. This scenario assumes the following.

- The current TGO Mine continues to operate until 31 December 2025.
- Agricultural production on land already purchased by the Applicant would continue under current management regimes, with no increase in carrying capacity.
- The resources within the SAR Mine Site would remain in the ground.

The 'with' Project scenario assumes that the Project is approved and developed as described in Section 3.

Identification of Incremental Benefits and Costs

Gibbs (2021) identified the following Project-related benefits to the State of NSW.

- New capital which is brought into the State for the construction of the proposed infrastructure as well as for the purchase of land associated with the Project.
- Net returns delivered to that proportion of Alkane's shareholders who reside in NSW, namely approximately 8.2% of the total shareholding.

- Annual operating expenses that would be spent in NSW, including salaries and wages paid to employees and operating expenses that would otherwise cease in the absence of the Project.
- Various taxes and other charges levied on Project activities by both the State and local governments, together with NSW's share of other taxes paid to the Australian Government in line with the State's share of the Australian population (assumed to be 32%).

Gibbs (2021) identified the following Project-related costs to the State of NSW.

- A loss of agricultural production on land to be disturbed by the Project.
- A loss of transport efficiency for users of the Newell Highway as a result of the increased travel distance (approximately 410m) and time (approximately 13 seconds).

Gibbs (2021) identifies that costs associated with impacts on surface water, groundwater, air quality and noise and vibration have been incorporated into the development costs for the Project and that costs associated with impacts on Aboriginal and historic heritage and visual amenity would be negligible.

In quantifying the above costs and benefits, Gibb (2021) has allowed for a 7%pa discount rate to convert future benefits and costs into a present value.

6.14.3.2 Cost Benefit Analysis Results

Table 6.14.1 presents an overview of the results of the CBA analysis over the life of the Project. Detailed results of the CBA are presented in Section 4.4 of Gibbs (2021). The estimated Net Present Value of the Project to NSW is $633.17 million. The Project can thus be considered as representing a worthwhile and economically efficient use of the resources employed.

Table 6.14.1
Overview of Cost Benefit Analysis Results

Category	Description	Value ($M)
Returns to NSW via shareholding	Total returns to shareholders attributable to the Project, divided by the proportion of total shareholding resident in NSW	18.15
Capital expenditure in NSW	Estimated capital expenditure of $115M,[1] allowing for 80% to be spent in NSW Actual $19.6M land costs. Estimated interest costs assuming 60% of capital costs raised via loans in NSW	100.58
Operating expenditure in NSW	Estimated total operating expenses of $788M, with 80% of mine-related operating expenses and 100% of ore processing costs sourced within NSW	432.31

Table 6.14.1 (Cont'd)
Overview of Cost Benefit Analysis Results

Category	Description	Value ($M)
NSW public receipts	Royalties – estimated at $43.8M Payroll tax – estimated at $14.08M Land tax – estimated at $1.3M Stamp duty – estimated at $0.854M Rehabilitation bond – estimated at $10M	90.94
Agricultural production externality[2]	Allowing for the permanent loss of 130ha, assumed negligible production from the SAR Waste Rock Emplacement (136ha) and temporary loss of 209ha as well as the proposed increase in agricultural productivity from an average of 3.1 dry sheep equivalent (DSE) per hectare to 6.0 DSE/ha.	1.62
Transport efficiency externality[2]	Allowing for an additional 410m travel distance and 13 seconds travel time over the anticipated 25 year life of the realigned Newell Highway.	(10.44)
	Net Present Value to NSW	**633.17**

Note 1: Capital costs assessed by the Applicant for the purpose of determining the feasibility of the Project are different to the methodology used to determine the Capital Investment Value of the Project (see Section 3.13.3).

Note 2: Externalities have been assessed for the period 2023 to 2048 to ensure consistency with the anticipated life of the realigned Newell Highway.

Note 3: Apparent arithmetic inconsistencies are due to rounding.

Source: Gibbs (2021) – after Section 4.4

6.14.3.3 Sensitivity Analysis

Gibbs (2021) undertook a sensitivity analysis for the following variables. In summary, under all scenarios examined, the Project would generate net benefits to NSW.

- The discount rate

  The sensitivity analysis assumed rates of 5%, 7%, and 10%. The Net Present Value (NPV) for the Project was determined to vary from $540 million to $708 million. Gibbs (2021) determined that the CBA was not particularly sensitive to assumptions made regarding the discount rate, and the Project would remain beneficial, in CBA terms, to the State of NSW at higher rates.

- The price of gold

  The sensitivity analysis assumed gold prices of A$1,600 and A$3,200. The analysis determined that the NPV would vary by A$9 million based on the higher and lower price assumptions, suggesting that the CBA is not sensitive to gold price fluctuations. It is noted, however, that decreases in the gold price below a certain point would likely make the Project non-viable and the anticipated benefits would likely not flow to NSW.

- The royalty rate

  The sensitivity analysis assumed royalty rates at 2.9% and 3.5%, with the lower rate resulting in a reduction in the NPV of $1.7 million and an increase of $3.5 million respectively. As a result, Gibbs (2021) determined that the CBA was not particularly sensitive to assumptions made regarding the royalty rate.

- The proportion of the operating costs attributed to NSW

  The sensitivity analysis assumed operating costs attributed to NSW at 60% and 100%, with the lower rate resulting in a reduction in the NPV of $79 million and an increase of a similar amount respectively.

6.14.4 Local Effects Analysis

6.14.4.1 Local Area Affected

The local area considered by Gibbs (2021) as part of the local effects analysis (LEA) for the Project comprised:

- the Tomingley village (within the Narromine Shire LGA); and
- the town of Peak Hill (within the Parkes LGA).

The Narromine, Parkes and Dubbo Regional Local Government Areas (LGA) represent the regional area in regards to the distribution of economic effects.

6.14.4.2 Economic Aspects of the Project Relevant to the Local Area

Gibbs (20201) identified the following aspects of the Project as being relevant to the LEA.

- Continuation and expansion of the existing TGO Mine.
- Purchase of additional land at rates that are higher than the present land valuation in the absence of the Project.
- Employment of up to approximately 363 persons, with an average of 179 additional positions over the life of the Project.
- Payment of $258.26 million in wages (excluding on-costs) over the life of the Project.
- Expenditure of approximately $115 million in capital costs.
- Expenditure of approximately $788 million in operation costs over the life of the Project, of which 50% are expected to be spent within the Local Area and 80% within NSW.

6.14.4.3 Local Effects Analysis Results

The following presents an overview of the results of the LEA for the Project. Detailed results of the LEA are presented in Sections 5.4 and 5.5 of Gibbs (2021).

- Employment

  The Project would provide an average of additional 179 fulltime equivalent (FTE) additional positions over the life of the Project. It is likely that most jobs would be provided to local residents or those relocating to the Local Area. **Figure 6.14.1**

presents the residential location of the Applicant's current workforce. In summary, 78% of the workforce lives within the Local Area. The Applicant anticipates that this would continue for the life of the Project.

- Wages and salaries

  The Applicant anticipates that approximately $258.26 million would be paid in wages and salaries over the life of the Project, with an average wage of approximately $144,078/year. This is considerably higher than the median weekly personal income of $512 recorded for Tomingley during the 2016 Census. This would both attract additional workers to the Local Area and generate additional economic activity as a substantial proportion of the wages paid would be spent within the Local Area.

- Project expenditure

  The capital costs associated with the Project are estimated at approximately $115 million. Approximately 80% of this amount would be spent within NSW, and so the demand for goods and services in NSW would be increased by a total of $92 million over the construction phase.

  Operating costs for the Project are estimated to total $788 million. Approximately 50% of total operating expenditure is expected to be spent within the Local Area, resulting in approximately $394 million in increased demand for local goods and services. This would be a significant boost to activity levels in all industrial sectors providing the required goods and services.

- Regional output

  Gibbs (2021) estimated based on forecast gold production and assumed gold prices that the Project would result in an average annual increase in regional output that of approximately $176.7 million over the period from 2024 to 2031 (inclusive). This compares with the estimated of the total annual value of agricultural production from the Narromine LGA of $210.7 million and the total annual output for the LGA of $780 million (NSC, 2018). The Project would therefore increase the value of output in the Narromine LGA by 22.7%.

- Payments to Local Councils

  In Financial Year 2020, the Applicant paid $468,700 in rates, payments under the Planning Agreement and other charges, **to local Government**. Of this total, 92% was paid to Narromine Shire Council.

  Narromine Shire Council has also benefitted from the presence of the TGO Mine via grants delivered by the State Government under the 'Resources for Regions' program. Council received $1.6 million in 2020 and is currently applying for further funding, with Council anticipating receipt of $1 million per year to be spent on community infrastructure and other public projects.

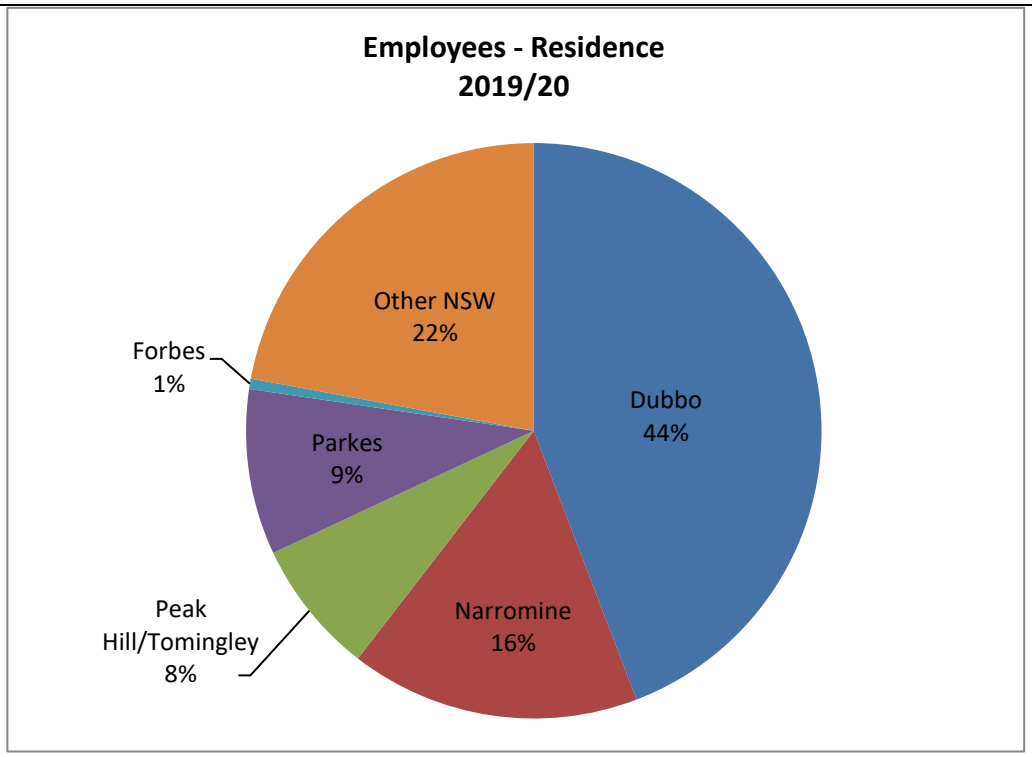

Figure 6.14.1
TGO Workforce Residential Location

Source: Gibbs (2021) – Figure 29

6.14.5 Management and Mitigation Measures

In addition to the environmental management and mitigation measures identified throughout Section 6, the Proponent would implement the following management and mitigation measures to ensure that economic benefits arising from the Project are maximised and adverse impacts are minimised.

- Extend the existing Planning Agreement with Narromine Shire Council for the life of the Project.
- Continue to implement the current local employment and procurement process that:
  - give preference when engaging new employees to candidates who live within the Narromine, Parkes and Dubbo Regional LGAs;
  - give preference to suppliers of equipment, services or consumables located within the Narromine, Parkes and Dubbo Regional LGAs;
  - encourage and support participation of potential locally-based employees and contractors in appropriate training or education programs to build capacity within the surrounding areas; and
  - encourage and support participation of Aboriginal people and organisations in Project-related employment and supply services.

6.14.6 Conclusion

The CBA undertaken by Gibbs (2021) indicates that the Project would generate a NPV benefit to NSW of $633.17 million. A sensitivity analysis indicates that even if a range of assumptions are altered substantially, the benefit to NSW would be overwhelmingly positive and is therefore desirable and justified from an economic efficiency perspective.

As well as providing net economic benefits to NSW, the Project would provide direct economic activity within the Local Area, including an average additional 179 FTE positions over the life of the Project, with the associated benefits for the local area economy and indirect economic activity to the local area via both wage and non-wage expenditure.

The main local environmental impacts are internalised into the production costs of the Applicant through mitigation, offset and compensation costs. Residual financial costs associated with local environmental impacts are likely to be immaterial.

6.15 Social Impacts

6.15.1 Introduction

The risk assessment undertaken for the Project (Section 2.2.5.1 and **Appendix 3**) identifies key risk sources with the potential to result in significant impacts to social amenity. These risk sources and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Construction and operation of the Project may result in:
  - changes to existing visual amenity for residents of surrounding properties (high risk); and
  - creation of noise, vibration and dust that reduces social amenity (medium risk).
- Land acquisitions leading to loss of community and generational properties resulting in changes in way of life (high risk).
- Population increases resulting in changes to the existing way of life (medium risk).

The SEARs for the Project require the EIS to include a detailed assessment of the likely social impacts of the development in accordance with the *Social Impact Assessment Guideline for State Significant Mining, Petroleum Production and Extractive Industry Development (2017)*, including the likely impacts of the Project on the local community and potential cumulative impacts with other mining developments in the locality.

The assessment requirements of the Narromine Shire Council were also considered during the preparation of the social impact assessment. A summary of the SEARs and the requirements of the Narromine Shire Council are listed within **Appendix 2**, together with a record of where each requirement is addressed in the EIS.

The Social Impact Assessment for the Project was undertaken by The Regional Development Company Pty Limited (RDC) and is presented as Part 13 of the *Specialist Consultant Studies Compendium* and hereafter referred to as RDC (2021). The following subsections provide a summary of the RDC (2021).

6.15.2 Social Locality

For the purposes of assessing the Project's social impacts and defining the social locality, RDC (2021) considered the following 'areas of social influence'.

- Local area of social influence – neighbouring properties and the communities of Tomingley and Peak Hill (the Local Area).
- Regional area of social influence – Narromine LGA, Parkes LGA and, to a lesser extent, the Dubbo LGA (the Regional Area).

The social baseline for the Project has been assembled through an interpretation/analysis of demographic data and research together with consultation with the surrounding community, a review of surrounding land uses, natural and built landscape feature, existing social infrastructure and the relationship between the Applicant and the surrounding community.

Section 5 of RDC (2021) presents the social baseline for the Project addressing each of the above localities. Socio-economic data from the Regional Area was used to supplement the limited available data for the Local Area. The main social indicators addressed include place of birth, multi-culturalism, employment, status of industry, income, education, community networks and the socio-economic indices. A further component of the social setting includes the social infrastructure that underpins the social wellbeing of the population surrounding the Project Site.

The social baseline presented in Section 5 of RDC (2021) also incorporates reference to the employees of the Applicant, an analysis of community values and the community investment provided by the Applicant within the Local and Regional Areas.

The key outcomes from the assembled information on the social setting of the Local Area includes the following.

- Mining has occurred intermittently since the 1880s, with mining at the time being viewed by community members as a viable supplementary source of income to support surrounding agricultural operations.
- The population of Tomingley and Peak Hill is forecast to decline into the future.
- The 2016 census identified that the median age or the residents of Tomingley and Peak Hill was 45 and 50 years respectively, higher than the NSW median of 43 years.
- The working population within Tomingley and Peak Hill declined between the 2006 and 2016 Censuses, while the number of people over 65 increased.
- The 2016 census identified that the participation rate[13] of residents within Tomingley and Peak Hill was approximately 55% and 45%, respectively, lower than the NSW participation rate of 59.2%.
- At the 2016 Census, 3.6% and 13% of those in the labour force within Tomingley and Peak Hill respectively identified themselves as "unemployed."
- The primary family composition is 'couple family without children'.
- Agriculture is the largest source of employment, however jobs in the service sector, particularly health and education, are becoming increasingly important, especially for women. Mining is a small but important industry of employment, with 6.6% of employed residents of the Tomingley village employed in the industry at the 2016 Census.
- At the 2016 Census, 27% and 25% respectively of the residents of Tomingley and Peak Hill were engaged in voluntary work, higher than NSW average of 20.8%.
- The Socio-Economic Indexes for Areas (SEIFA) index measures the relative socio-economic advantage and disadvantage. A low SEIFA score indicates relatively greater disadvantage. The SEIFA score for Tomingley in 2016 was 993, and it was ranked in Decile 5 (out of 10), indicating that the village is in the middle

[13] The workforce participation rate is the proportion of the population aged 15 years and over that wish to join the workforce – whether they are employed or not.

rankings for disadvantage. By contrast, the SEIFA score for Peak Hill was 848 and it was ranked in Decile 1, indicating that the town is amongst the 10% most disadvantaged communities in Australia

- The community values most important to the people of Tomingley, neighbours of the TGO Mine Site and surrounding landholders are peace and quiet, family, lifestyle, community, good farming land, and proximity to work and major towns.

The key outcomes from the assembled information on the social setting of the Regional Area includes the following.

- The population of the Narromine LGA is forecast to decline between 2016 and 2041 by 23%. Over the same period, the population of the Parkes LGA is expected to decrease by 2.3%.
- The 2016 census identified that the median age or the residents of the Narromine and Parkes LGAs was 42 and 41 respectively.
- Life expectance for Narromine Shire and Parkes LGAs is 75.5 and 82, respectively (lower than NSW average).
- The primary family composition is 'couple family without children'.
- In November 2020, the unemployment rate was just over 4% for both Narromine and Parkes LGAs.
- The SEIFA score for Narromine and Parkes LGAs in 2016 was 993 and 940 respectively, with both ranked in Decile 3, indicating that the LGAs are in the 30% most disadvantaged LGAs in Australia.

Table 6.15.1 presents the status of housing and housing affordability from the 2016 Census. Housing in Tomingley and Peak Hill was relatively affordable, and less than the regional NSW median in weekly rentals, or monthly median mortgage payments. The proportion of houses owned outright or owned with a mortgage were 78.5% and 65.4% respectively within Tomingley and Peak Hill. At the Regional level, the percentage of houses owned outright or with a mortgage were 67.6% and 66.4% respectively within the Narromine and Parkes LGAs.

Table 6.15.1
Housing within the Local and Regional Areas

	Tomingley Village		Peak Hill		Narromine Shire LGA		Parkes LGA		Regional NSW
Dwelling count									
Occupied private dwellings	105	88.2%	452	81.7%	2 311	87.9%	5 286	85.5%	
Unoccupied private dwellings	14	11.8%	101	18.3%	319	2.1%	895	14.5%	
Dwelling structure (occupied private dwellings)									
Separate house	105	100%	420	92.9%	2 162	93.6%	4 746	90.1%	-
Semi-detached, row house, townhouse	0	0.0%	5	1.1%	27	1.2%	142	2.7%	
Flat or apartment	0	0.0%	6	1.3%	89	3.9%	291	5.5%	
Other dwelling	0	0.0%	18	4.0%	11	0.5%	39	0.7%	

Table 6.15.1 (Cont'd)
Housing within the Local and Regional Areas

	Tomingley Village		Peak Hill		Narromine Shire LGA		Parkes LGA		Regional NSW
Dwelling tenure									
Owned outright	53	52.0%	211	47.4%	899	38.8%	1 971	37.2%	
Owned with a mortgage	27	26.5%	80	18.0%	667	28.8%	1 550	29.2%	
Rented	18	17.6%	126	28.3%	646	27.9%	1 539	29.0%	
Other tenure type	0	0.0%	9	2.0%	20	0.9%	50	0.9%	
Tenure type not stated	4	3.89%	19	43%	85	3.7%	195	3.7%	
Dwelling - mortgage and rent									
Median rent per week ($)	116		128		185		200		270
Rent <30% of household income	100%		91.8%		91.2%		91.2%		89.2%
Rent ≥ 30% of household income	0.0%		8.2%		8.8%		8.8%		10.8%
Median mortgage payments per month ($)	1 200		769		1 100		1 300		1 590
Mortgage <30% of household income	94.6%		97.1%		96.1%		96.4%		
Mortgage ≥ 30% of household income	5.4%		2.9%		3.9%		3.6%		

Source: RDC (2021) – modified after Tables 10 and 11

6.15.3 Issues Identified in Stakeholder Consultation

6.15.3.1 Introduction

Section 5 and **Appendix 16** provides a summary of the consultation undertaken with government, industry, local community and Aboriginal stakeholders. Stakeholder engagement for the Social Impact Assessment was iterative and adaptive and involved the following methods.

- Direct consultation through phone, email and one-on-one consultation with Tomingley residents and near neighbours, Tomingley businesses, Peak Hill businesses and community members, and Narromine Shire Council representative.
- Working with the Community Consultative Committee (CCC) to shape the consultation process and 'groundtruth' the information received.
- Community information sessions.
- Information provision through flyers and project summary information.
- Review of formal community submissions.

The following presents an overview of the key perceived benefits and concerns of the community in regard to the Project. Further information on the communities' perceived benefits and concerns in regard to the Project is located in Section 6.3 of RDC (2021).

6.15.3.2 Key Perceived Benefits

The key socio-economic benefits of the Project identified by the community are as follows.

- Economic benefits:
  - Land purchases of properties within and of the vicinity of the Project Site at above-market rates by the Applicant providing long-term financial stability for planning, retirement and/or relocation.
  - Employment opportunities from new positions that would be created by the Project.
  - Employment security through the continuation of existing positions at the TGO Mine.
  - Commercial opportunities from the leasing of Applicant owned land and through the Applicant's use of local contractors and businesses.
  - Benefits to the Local and Regional Area from State grants such as 'Resources for Regions'.
- Community Benefits:
  - Community cohesion through the continuation of social and community financial agreements and programs.
  - Enhanced amenity for the Local Area through the provision of long-term funding, permanent infrastructure and projects.
  - Increased employment and expenditure which could result in increased rural housing development.

6.15.3.3 Key Perceived Adverse Impacts

RDC (2021) undertook a social risk assessment for the Project based on information obtained during consultation with the surrounding community. The key perceived negative social impacts of the Project affecting way of life, social amenity and accessibility, including the associated assessed level of significance are as follows.

<u>Very High Significance</u>

- Visibility:
  - Views of the Project Site from public roads are a potential source of risk of driver distraction and may result in changes to existing scenic character and quality.
  - Project-related lighting as a source of driver distraction and reduction of night-time visual amenity.

<u>High Significance</u>

- Noise:
  - Noise from the operation of the Project resulting in a change to the existing levels of noise amenity.

- Visibility:
  - Key elements of the Project Site, namely the SAR Waste Rock Emplacement, would affect the existing scenic character and quality of the landscape, and would block views of significant natural features.
- Air Quality:
  - Dust generation from activities within the Project Site would potentially negatively affect air quality.
- Economic:
  - Potential for adverse impacts of the Project on local property values and saleability.
- Traffic and access:
  - Impacts of construction and operational traffic on Kyalite Road.
  - Changes to the local road network impacting on safe access to the Newell Highway.
- Consultation:
  - Lack of effective community consultation during planning and operation stage resulting in not being heard and not being able to have a say on decisions negatively affecting daily life.

6.15.4 Management and Mitigation Measures

6.15.4.1 Introduction

The Applicant, in consultation with surrounding landholders and the community, has identified a range of measures to minimise social Project-related impacts. The following subsections provide an overview of the management and mitigation measures that would be implemented by the Applicant to minimise those impacts. Management and mitigation measures presented for other environmental aspects of the Project would also assist to minimise social impacts, particularly those related to traffic, visual amenity, noise, blasting, air quality and Aboriginal heritage.

6.15.4.2 Avoidance and Mitigation through Project Design

Key infrastructure within the Project Site has been designed in consultation with the surrounding community and substantial amendments to the Project design have been incorporated into the Project, including the following.

- Construct the SAR Amenity Bund and outer face of the SAR Waste Rock Emplacement to obscure views of active sections of the Project Site.
- Construct the realigned Kyalite Road as close as possible to the existing alignment, including an overpass over the Haul Road and Services Road suitable for the largest class of vehicle likely to use the Newell Highway.

- Construct the SAR Waste Rock Emplacement using geomorphic design principles and avoid the construction of a "traditional" stepped Waste Rock Emplacement.
- Construct the Back Tomingley West Road, Kyalite Road and McNivens Lane intersections with the realigned Newell Highway with channelised turning lanes to minimise the risk for local traffic using those intersections.

6.15.4.3 Operational Management and Mitigation Measures

The Applicant would implement the following social management and mitigation measures throughout the life of the Project. These measures have been developed in light of consultation with the surrounding community.

- Develop and implement a *Community Engagement Plan* for the Project
- Negotiate commercial agreements with key affected landholders for the leasing of key dwellings for the life of the Project.
- Continue ongoing open and transparent consultation via regular open Community Consultative Committee meetings, consultation with individual landholders (initiated by the Applicant), 24-hour complaints process (transparently documented) and community information sessions.
- Establish and build upon existing frameworks to monitor and report on social impacts.
- Continue to preferentially engage local employees and/or suppliers, where available.
- Liaise with surrounding local Councils in regard to housing pressures and availability.
- Extend the Planning Agreement with Narromine Shire Council and advocate for the increased provision of resources to the immediate local area.
- Support the development of a community driven long-term development plan for Tomingley village, to ensure that the village continues to thrive following the completion of mining operations.
- Continue to provide support to local and Regional community groups, organisations and individuals to undertake community-based activities that support and benefit the Local and Regional communities.

6.15.5 Assessment of Impacts

6.15.5.1 Introduction

RDC (2021) assessed the social impacts of the Project firstly in accordance with the *Social Impact Assessment Guideline for State Significant Mining, Petroleum Production and Extractive Industry Development (2017)*. Section 7 of that report presents a detailed evaluation and discussion of that assessment. The following subsections presents a necessarily brief overview of that assessment.

6.15.5.2 Way of life

RDC (2021) determined that there would be very little change in the way for life for those within the Regional area, including the majority of residents of Narromine, Parkes or Dubbo LGAs. Residents of Narromine may experience reduced availability of rental housing, however, accommodation would likely be available in Dubbo and the Applicant would work with Narromine Shire Council should such housing pressures arise.

Residents of Tomingley village and neighbouring properties to the SAR Mine Site would experience changed traffic, visual, noise and air quality impacts. These changes would also be experienced by those neighbours adjacent to the SAR Mine Site. Consultation with immediate neighbours found that different individuals and households experienced these fears and perceptions to a different extent, and that the concerns are significant enough to affect their way of life. As a result, the Applicant has and would continue to consult closely with each of those neighbours and has or would enter into agreements with each to mitigate or ameliorate those impacts to the extent practicable.

During consultation, the potential for property devaluation was raised. Based on prior experience of RWC with mining operations in NSW, there is no clear evidence that property values are adversely impacted by mining-related Projects. While some potential purchasers may be put off by the presence of a mining operation in close proximity, others, including those employed by the operation, may see the proximity as a benefit. For other potential purchasers, the presence of a mining operation may not be relevant at all. Furthermore, a range of other factors unrelated to the Project are likely to be more influential on property values than the presence of a mining operation in the surrounding area.

6.15.5.3 Community

Consultation identified that there is a significant ‘sense of place’ for people within the Local Area with most residents living in the area for over 30 years. Many residents have family associations with the area for over 100 years. There is a strong sense of community cohesion which is demonstrated through community values, community connections, community volunteering and community events.

The population of the communities of Peak Hill and Tomingley are forecast to significantly decline. It is possible that the Project could assist to arrest the expected decline. RDC (2021) state that additional working age residents employed by the Applicant would have a beneficial effect on the community of Tomingley and would not overwhelm the current locals nor create significant changes to community character.

There are a range of views about the Project. For some businesses and residents of Tomingley and Peak Hill, there is a sense of optimism about the Project and its potential benefits. However, some rural and near neighbours have expressed that they wish the Project was not happening. Nonetheless, each of the neighbouring families have been working closely with the Applicant to understand and mitigate potential direct impacts. RDC (2021) state, this range of views does not seem to be creating division or tension within the community, rather there is a strong empathy for those most impacted.

6.15.5.4 Accessibility

RDC (2021) identified that key matters of concern re accessibility raised during consultation included:

- changes to the alignment of Kyalite Road;
- changes to the alignment of the Newell Highway; and
- arrangement for moving stock and machinery across the Newell Highway.

For users of Kyalite Road, the changes to Kyalite Road traffic flows would present a highly significant change to access and amenity. The Applicant has and would continue to consult with users of Kyalite Road.

Changes to the Newell Highway would affect the operators of a neighbouring family property (Properties 63, 69 and 71 – See **Figure 2.3**) who currently move livestock and machinery from one part of the property to another across the Newell Highway. The Applicant would consult with that family to ensure ongoing access to facilitate those movements.

6.15.5.5 Culture

The Project Site is located within lands identified as Wiradjuri Land. Approximately 24% of people living in Peak Hill identify as Aboriginal and Torres Strait Islander people with strong social and cultural connections to Country. OzArk (2021a) identifies that 12 sites of Aboriginal heritage significance would be disturbed by the Project. The Applicant would work with the local Aboriginal community to develop a management plan for the salvage and safe keeping of those sites to be disturbed and protection of those sites that would not be disturbed.

The predominant culture of rural farming and agriculture has been present since European settlement, with mining intermittently an intermittent feature of the area since 1883. The "Rosewood" homestead would be removed by the Project. An extended family within the area, including a neighbour, expressed a strong family cultural attachment to the property. During consultation, a sense of family sadness about the loss was expressed.

6.15.5.6 Health and Wellbeing

The health and wellbeing of the people within the Local Area was raised as a concern by rural and near neighbours in relation to air quality, potential for dust settling in water tanks, and concerns about cyanide in the air.

Section 6.5 presents an overview of the results of the air quality assessment for the Project. The results of that assessment, together with the proposed mitigation measures, including additional real-time air quality monitoring, have been presented to the community and surrounding neighbours.

The risk of cyanide in the air was raised as a concern by one neighbouring family during consultation. The Applicant explained it is required to protect its workforce from adverse impacts of cyanide exposure. By implementing measures to protect workers, the Applicant would also protect surrounding residents. As a result, RDC (2021) determined that the social impact significance risk rating for cyanide in the air is low.

Uncertainty and a sense of lack of control can impact on mental health and wellbeing, particularly over a prolonged time. A number of neighbours consulted expressed anxiety about the Project and stated that this is a future they did not ask for and wish was not happening. It was also stated that they would be reminded of the Project and its implications daily. It is acknowledged that the Project represents a substantial change for some individuals and families.

6.15.5.7 Surroundings

Section 6.3 presents the visual assessment for the Project. RDC (2021) identify the following social aspects of the proposed changes to the visual landscape.

- There would be a change in character and quality of the surrounding landscape.
- There is potential for static or moving lights to be visible from residences and elsewhere.
- For some neighbours the views from their residences would be permanently changed.
- Views from Kyalite Road and vantage points on private land to the east of the would be changed.

RDC (2021) identified that these changes have the potential to have a very high social significance impact because of changes to way of life and amenity. Following that assessment The Applicant presented the results of the visual assessment presented in Section 6.3 to key surrounding neighbours and no significant opposition regarding the proposed landforms was received.

Public safety and security concerns raised during consultation were limited to access and egress from the Newell Highway and safety of moving livestock and farm machinery across the Newell Highway. The Applicant proposes to construct all intersections with the realigned Newell Highway with channelised turning bays and would work with the landholder who raised concerns regarding moving livestock and farm machinery to ensure access is unchanged.

6.15.5.8 Livelihoods

Data from the 2016 Census identifies that agriculture is the dominant industry of employment, with an increasing influence of mining, and a significant shift in the structure of the local economy to jobs in the service sectors.

RDC (2021) determined that agricultural livelihoods for those on rural and neighbouring properties would be unlikely to be affected by the Project. However, some neighbours expressed concern about the Applicant removing some of its own land from agricultural production. Section 6.9 identifies that overall agricultural production would increase as a result of the Project. In addition, the Project would provide for opportunities to provide contract agricultural services to assist manage the Applicant's land. Furthermore, the Applicant has entered into commercial lease agreements for three residential houses on neighbouring agricultural land. This represents additional income to those property owners.

As identified in Section 6.14, the Applicant anticipates that approximately $258.26 million (in 2021 dollars) would be paid in wages and salaries over the life of the Project, considerably higher than the median income within the Local Area. While most employees may reside outside the Local Area, there would still be a likelihood of employees residing in the Local Area, with the resultant increase in weekly earnings.

The Applicant would also continue current local employment and procurement processes that preference local employment and goods and service providers. In addition, local businesses in the Tomingley area would be likely to benefit substantially from increased Project employees purchasing local goods and services.

During the consultation, it was pointed out that prospects for Aboriginal people to gain employment in the Project would represent a positive and significant opportunity.

In light of the above RDC (2021) identified the overall social significance rating on livelihoods as very high (positive).

6.15.5.9 Decision Making Systems

RDC (2021) identified that through the consultation process, different views were expressed about working with the Applicant. Positive comments included:

- "sensitive to local community needs;" and
- "not just an obligation, they have really good community input."

However, there were frustrations expressed about a perceived lack of consultation at the start of the Project investigations, and a sense that consultation was only taking place because it was obligatory and only at a time that it was required for meeting those obligations. In addition, some neighbours were concerned about how they would be heard and treated if lodging a complaint. The example of a previous neighbour, who has subsequently moved from the district, was raised by a number of those consulted. That person felt noise and vibration impacts of the TGO Mine affected their daily life, and yet noise monitoring at their residence showed compliance. There was a high degree of frustration from the former resident at their perceived inability to resolve this issue. Some neighbours have deep concerns following that experience that they may not be able to influence those matters which affect their lives. Indeed, they expressed a significant concern that they did not want the Project to be the dominating topic of their conversations and daily life.

Notwithstanding those concerns, individual neighbours were appreciative of being heard and of being provided with personalised responses and data that demonstrated modelled impacts, as well as their ability to jointly work on mitigations and monitoring process.

RDC (2021) also state that the members of the CCC felt able to freely discuss all aspects the current TGO Mine and its operations and impacts and felt well informed and up to date on the Project and able to contribute views and community sentiments. The CCC received regular updates and reports and felt that they have the ability to raise items and shape the agenda of their discussions with the Applicant.

The current complaints process is transparent with a log of community complaints on the Applicant's website. The Complaints Register is up to date and shows the last complaints received were in 2018.

In summary, RDC (2021) state that the Applicant has in place sound engagement and grievance processes which enable people to have access to lodge complaints and seek remedies. However, there is a concern that these processes are for compliance purposes and may not provide the necessary empathy and solutions-thinking to jointly find resolutions to arising issues. At a whole community level in the Local Social Area of Influence, the Applicant is perceived positively and open to engagement and responsive to community needs. At the individual level, there is still come concern about ability to have a say in decisions that affect their lives in relation to the Project.

6.15.5.10 Social Consequences of not Proceeding with the Project

RCD (2021) identify the social consequences of not proceeding with the Project as follows.

- No changes for lifestyle and amenity for rural and near neighbours.
- Population loss to the communities of Tomingley and Peak Hill.
- Continued ageing communities, with a high proportion of aged and non-workforce participating members of communities.
- Potential changes in community cohesion from retirement of locals to larger centres to access aged care services and facilities.
- Loss of non-Council funds to support the Tomingley community and village infrastructure.
- Significantly lower economic returns to the area (affecting regional output, and local businesses and employees).
- Loss of Planning Agreement community benefits and community sponsorships.

6.15.5.11 Cumulative Social Impacts

In assessing potential cumulative social impacts, RDC (2021) considered the operation of the Northparkes Mine and Dubbo Project (see Section 1.4.6). Cumulative social impacts are likely to include the following.

- The Northparkes Mine

  The Northparkes Mine is currently approved until 2032 and is largely serviced from Parkes. Additional employees for the Project would likely continue to choose to live in a similar pattern to current employees, namely with 44% living in Dubbo, 8% in Peak Hill and Tomingley and 9% in Parkes. Based on a peak of 363 employees, this could mean an additional 12 employees and families into the Parkes housing market, and an additional similar number shared between Peak Hill and Tomingley. These numbers are unlikely to create a social impact from housing and rental accommodation from the cumulative effects of Northparkes development and the Project.

- The Dubbo Project

  The Dubbo Project is an approved polymetallic development currently in the project finance and Front-end Engineering Design stage, with ground-disturbance activities anticipated to commence in 2022 and processing operations expected to commence in 2024. The Dubbo Project would be largely serviced from Dubbo and there may be some interaction between the Project and the Dubbo Project, particularly in relation to competition for skilled personnel and services.

  The Dubbo Project may present cumulative social impacts regarding competition for housing in both Dubbo and Narromine. The projected peaks of both the Dubbo Project and the Project are around the same time 2024-2025. Dubbo is a regional city with a large housing market and continued investment in new housing development.

  By contrast, Narromine has a smaller housing market with limited rental housing stock. Workers at the Dubbo Project would travel to and from site via Dubbo, with an additional travel time of approximately 30 minutes for those living in Narromine. As a result, RDC (2021) determined that it is unlikely that the cumulative social impacts of these two mines would impact on the housing market of Narromine.

6.15.6 Monitoring

Monitoring of ongoing potential social impacts would occur via:

- regular, proactive, adaptive and targeted community consultation with near neighbours, residents of Tomingley village and the wider community;
- regular meetings of the CCC, with agendas and formats determined by the Committee (not the Applicant) and all minutes published on the Applicants website; and
- the existing community complaints and feedback methods, namely the complaints line, operated 24/7, and the feedback form on the Applicant's website.

The Applicant will continue to maintain a consultation log where all key consultation activities are recorded.

6.15.7 Conclusion

RDC (2021) has assessed both the unmitigated and mitigated negative and positive social impacts of the Project. The predicted adverse impacts are primarily expected to be direct and localised relating to:

- way of life (how people work, rest and play); and
- surroundings including aesthetic values and/or amenity (social amenity).

The Applicant would seek to minimise these impacts through open, honest and proactive consultation with the local community and, where appropriate, adaptation of its operation or mitigation measures to address reasonable community concerns.

The Project would, however, result in very substantial positive impacts in the wider community in terms of continuation of employment, workforce and supplier expenditure, and community investment, with many of these benefits also expected to be experienced by the local community.