8 IMPACTS, MANAGEMENT AND MITIGATION

This section provides a summary of the environmental and social impacts that are predicted to occur as a result of the Modification. This section also outlines the management and mitigation measures that will be implemented to alleviate these impacts.

8.1 SUBSIDENCE

8.1.1 Background

A Subsidence Assessment for the Modification has been undertaken by SCT Operations Pty Ltd (SCT). The purpose of the Subsidence Assessment was to predict the subsidence effects that may result from the proposed longwall mining and to assess the impacts of these subsidence effects on the overlying natural and built features. The Subsidence Assessment is presented in full in **Appendix B** and summarised below.

8.1.2 Methodology

Identification of Surface Features

A Subsidence Assessment Area was used to identify the surface features that may experience subsidence effects. The Subsidence Assessment Area for the Modification was defined by a horizontal setback equivalent to the overburden depth (top of coal seam to the natural surface), with the setback being applied to the outermost edge of the goaf. The use of a setback equivalent to the overburden depth is considered to be a more conservative approach than the use of the 20 mm vertical subsidence contour, which has traditionally been used for similar subsidence assessments (see **Figure 16**).

The majority of the landform within the Subsidence Assessment Area has been significantly modified by surface mining activities associated with the MOC. This assessment has considered the potential impacts of subsidence on the remaining natural features within the Assessment Area, as well as the surface features associated with the MOC.

Table 9 identifies the natural and built features that are located within the Subsidence Assessment Area. These are the features that may experience subsidence effects resulting from the underground mining operations proposed by the Modification. The locations of these surface features in relation to the Modification are shown in **Figure 6**.

Subsidence Predictions

Predictions of subsidence effects are based on empirical data. This assessment has utilised the extensive subsidence monitoring data obtained from historical longwall mining operations at Integra Underground to forecast the subsidence effects that may be generated by the Modification.

Table 9
Surface Features within the Subsidence Assessment Area

NATURAL FEATURES
Bettys Creek
Natural dams (ponds)
Ravensworth State Forest
Southern Remnant Offset area
Bettys Creek Habitat Management Area
Natural vegetation
HERITAGE SITES
Aboriginal heritage sites
PUBLIC UTILITIES
Survey markers
RAIL INFRASTRUCTURE
Mt Owen Rail Spur & Loop
Service road
Rail bridge
Signal cabling
MINING RELATED INFRASTRUCTURE
Mt Owen North Pit (open cut mining area)
Ravensworth East – West Pit (open cut mining area)
Overburden emplacement areas
Bettys Creek Diversion
MOC Mine Infrastructure Area: Product coal stockpiles, dams, train loading infrastructure, rail spur and loop
Tailings emplacement areas – TP1, TP2, ERP
Gas drainage infrastructure
Overhead powerlines
Water pipelines
Haul roads
Road bridges

The subsidence monitoring undertaken at Integra Underground includes a series of cross panel (traverse) and long panel (longitudinal) monitoring lines. Data from subsidence monitoring lines B, G and H (see **Figure 11**) has been utilised to compare previous subsidence predictions with measured subsidence effects.

The Subsidence Assessment for the Modification was informed by previous subsidence assessments for Integra Underground, including:

- *Subsidence Assessment for Longwalls 10 - 17 at Glennies Creek Colliery* (SCT, 2006); and
- *Part 3A Subsidence Assessment for Mining in the Hebden, Barrett and Middle Liddell Seams at Integra Underground Mine* (SCT, 2009).

Comparisons of subsidence monitoring data with previous subsidence assessments enables a review of actual subsidence effects against the predictions made by previously approved environmental assessments. This provides a strong basis for predicting the subsidence behaviour associated with the Modification.

This assessment has been conducted for the two longwall layout options proposed for this Modification, namely the LWs 15-20 and LWs 15-19 layouts. The LWs 15-20 layout (see **Figure 12A**) comprises 246 m wide panels which result in void widths of approximately 257 m between the chain pillars. The LWs 15-19 layout (see **Figure 12B**) proposes a maximum panel width of 320 m, which will result in void widths of approximately 330 m between the chain pillars. Both longwall layouts feature 48 m inter-panel chain pillars and varying panel lengths. The assessment has assumed a maximum proposed mining height of 3.3 m.

Predictions of maximum subsidence are controlled primarily by panel geometries, consistent with the consideration of the subsidence mechanics. Predictions of strains and tilts are based on the empirical relationships developed by Holla (1985, 1987, and 1991) and adjusted for site-specific subsidence monitoring results. The historical monitoring data enables the subsidence predictions to be verified.

8.1.3 Impact Assessment

Subsidence Effects

Subsidence effects are divided into two categories: conventional subsidence and unconventional subsidence. Conventional subsidence effects include vertical subsidence, tilt, curvature, strain and horizontal movement. Conventional subsidence effects are predicted using subsidence profiles that are smooth in shape. Conventional subsidence effects are produced by the expected caving mechanisms associated with the overlying strata spanning the extracted void.

Unconventional subsidence effects include upsidence and valley closure, and are generally irregular movements associated with sudden changes in geological conditions.

Table 10 presents the maximum subsidence effects that are predicted to be induced by the two longwall layout options proposed for the Modification. The predicted maximum vertical subsidence contours are illustrated in **Figure 16**.

Table 10
Predicted Maximum Subsidence Effects

Layout	Maximum Vertical Subsidence (m)	Maximum Tilt (mm/m)	Maximum Tensile Strain (mm/m)	Maximum Compressive Strain (mm/m)
Areas of Natural Ground				
LWs 15-20	2.0	14	7	10
LWs 15-19	2.2	15	8	11
Emplacement Area				
LWs 15-20	2.8	14	14	20
LWs 15-19	3.0	15	16	22

As shown in **Table 10**, *e*mplacement areas are likely to experience greater subsidence effect than natural ground due to the composition of the backfilled material. However, tilts are not expected to be greater in emplacement area due to the softening effect of unconsolidated ground. Strains are expected to be double the magnitude of strains in natural ground. Tensile strains are may be particularly elevated at the interface of natural ground and backfilled material and at the crest of steep slopes in the backfilled material.

Open cut mining areas above the longwall layouts are predicted to experience greater subsidence effects as a result of reduced natural overburden thickness.

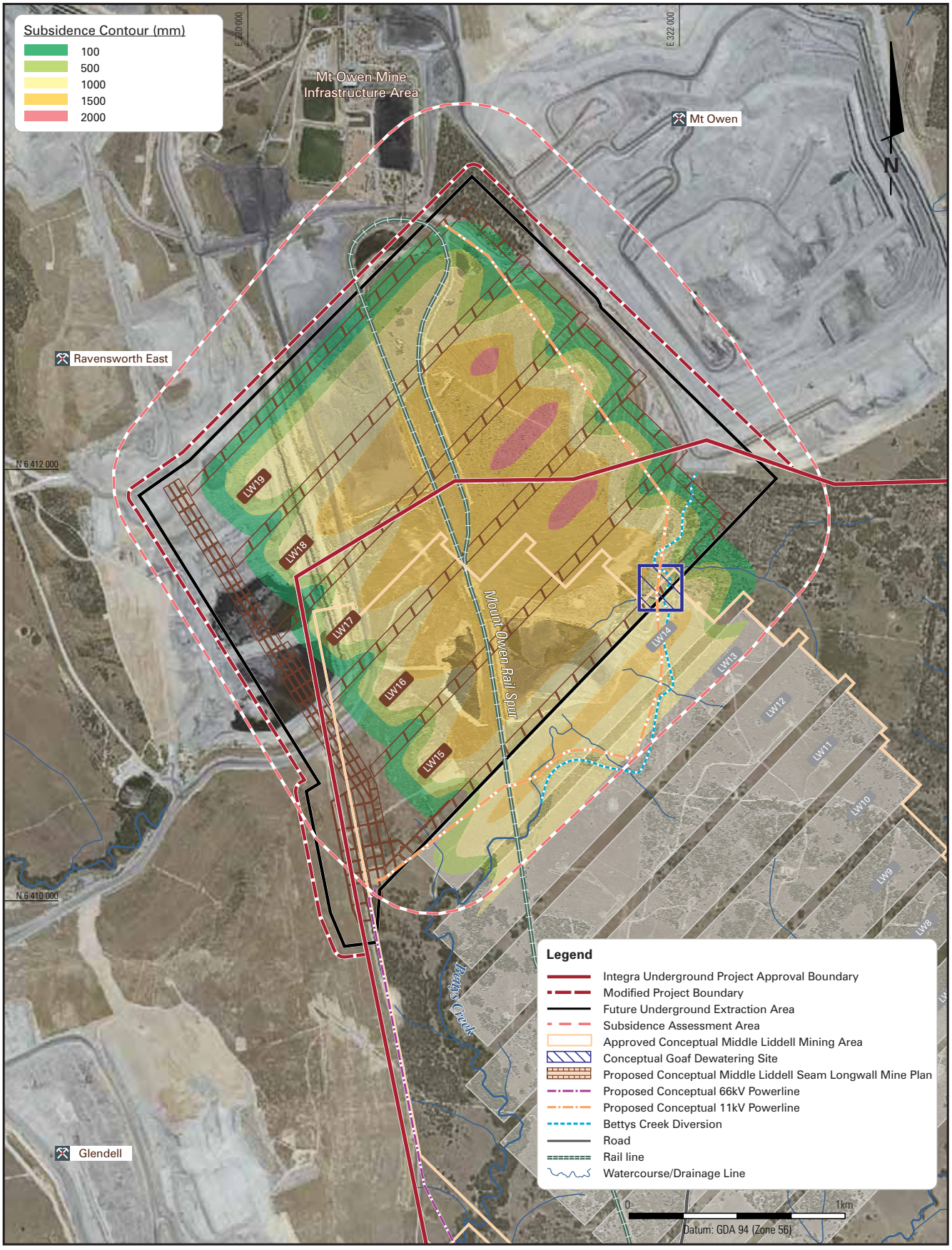
Table 10 shows that the LWs 15-19 layout is predicted to result in slightly greater subsidence effects than the LWs 15-20 layout. This is due to the wider longwall panels (320 m) for the LWs 15-19 layout. The predicted vertical subsidence represents approximately 65% of the assumed maximum mining height after consideration of the sag and strata compression components of the subsidence profile for the increased overburden depth and longwall panel widths.

Further discussion regarding the predicted subsidence effects (including vertical subsidence, tilt, strain and horizontal movements) is provided in **Appendix B**.

Multi-seam Subsidence Behaviour

This Modification seeks to amend the layout of the longwall panels in the Middle Liddell seam. PA 08_0101 allows for mining of the Middle Liddell, Hebden and Barrett coal seams. The Modification includes areas where the approved Hebden seam workings will overlie the approved Middle Liddell seam workings. Multi-seam subsidence behaviour is expected to occur in these areas.

The subsidence assessment (SCT, 2009) undertaken for the Integra Underground Coal Project predicted a maximum of 4.0 m of vertical subsidence as result of multi-seam mining. The proposed amendments to the Middle Liddell seam layout are not expected to increase the maximum subsidence beyond 4.0 m.



HB INTEGRA MOD8 1702 F16 Predicted Conventional Vertical Subsidence 22 11 2017

INTEGRA UNDERGROUND MINE

GLENCORE | Hansen Bailey ENVIRONMENTAL CONSULTANTS

Predicted Conventional Vertical Subsidence

FIGURE 16

Subsidence Impacts

The Subsidence Assessment has been undertaken in the context of the current surface landform and short term mine planning. The eastern portion of the Subsidence Study Area will be significantly altered in the future by the approved and further proposed open cut mining operations at MOC.

Bettys Creek

The natural flow path of Bettys Creek has been significantly modified both upstream and downstream of the Subsidence Assessment Area due to the construction of channel diversions, MOC's mining areas and the construction of the Mt Owen Rail Spur.

The approved LWs 13-14 will be extracted directly beneath the natural section of Bettys Creek. LWs 13-14 are predicted to result in up to approximately 1.2 m of vertical subsidence and less than 100 mm of valley closure. The Modification is predicted to increase the vertical subsidence along the natural section of Bettys Creek from 1.2 m to 1.4 m. The predicted subsidence is within the maximum values predicted by previous subsidence assessments (SCT, 2006; SCT, 2009).

The Bettys Creek Diversion has partially been intercepted by the MOC North Pit mining operations and will continue to be mined through by MOC. The approved LWs 13-14 are expected to result in up to 1.9 m of subsidence, with maximum subsidence occurring above LW 13. The maximum subsidence along the Bettys Creek Diversion is not expected to increase as a result of the Modification; however, the subsidence above LW 14 is predicted to increase from 1.4 m to 1.9 m. Potential impacts to Bettys Creek are predicted to be consistent with the predictions of previous subsidence assessments (SCT, 2006; SCT, 2009).

The Bettys Creek Diversion is likely to be removed or substantially altered during MOC's rehabilitation phase. Mt Owen is required to rehabilitate the Bettys Creek Diversion in accordance with Condition 24 under Schedule 3 of SSD-5850.

Impacts to surface water resources are discussed further in **Section 8.4**.

Natural Dams and Farm Dams

A number of natural ponds are present within the Subsidence Assessment Area. These ponds are located within the general floodplain of Bettys Creek. These natural ponds appear to be the remnants of old meandering channels. The predicted subsidence effects are expected to slightly increase the volume of each pond.

Several farm dams are present within the Subsidence Assessment Area and are located on the ephemeral drainage lines of Bettys Creek. These dams are generally small structures with dam wall heights of less than 2-3 m. Subsidence impacts are predicted to be minor and will not pose a safety risk to downstream capacities or to the underground mining operations.

Remnant Vegetation

An area of the Ravensworth State Forest and the Southern Remnant Biodiversity Offset Area are predicted to experience vertical subsidence of up to approximately 0.3 m, with low levels of tilt and strain. Impacts to native woodland are expected to be negligible. Further, there are no significant impacts predicted for the area of derived native grassland within and adjacent to the Mt Owen Rail Spur.

Impacts to natural vegetation are expected to be minor and no greater than the predictions of previous subsidence assessments (SCT, 2006; SCT, 2009). Impacts to the ecological environment are discussed further in **Section 8.8**.

Heritage

Potential impacts to Aboriginal heritage sites are discussed in **Section 8.9**. Potential impacts to historic heritage sites are discussed in **Section 8.10**.

Public Utilities

The only public utilities that are located within the Subsidence Assessment Area are three state survey control stations. All three state survey control stations will most likely require relocation due to the potential impacts of the Modification and the approved open cut mining operations at MOC.

Mine Infrastructure

As previously explained, the Modification underlies the approved open cut operations at MOC. Subsidence has the potential to generate safety and operational hazards for the open cut mining operations. These impacts will be managed cooperatively by HVCC, Mt Owen and Glendell (all of which are subsidiaries of Glencore). The predicted subsidence impacts to mining infrastructure and the measures that will be employed to manage and remediate these impacts are summarised in **Table 11**. Potential impacts to mine infrastructure are discussed further below.

Table 11
Summary of Predicted Subsidence Impacts and Management Measures

Surface Feature	Potential Impacts	Mitigation and Management Measures
North Pit	LW 15 is conceptually located beneath the North Pit highwall. There is the potential for rockfalls to occur along approximately 10% of the length of highwall that is directly mined beneath. Mining directly beneath the highwall also has the potential to result in tensile cracking. Cracking may occur along up to 50% of the length of highwall that is directly mined beneath. This can lead to slope instability if there is water ingress into the cracks. However, the ingress of surface water can be controlled through remedial earthworks. Unconventional subsidence effects may result in heaving of the floor of the North Pit. Heaving is not expected to pose a safety hazard. Longwall mining will result in fracturing of the overburden strata beneath the open cut mining area. Overburden fracturing has the potential to affect blasting efficiency (for open cut mining operations) and increase methane emissions into the open cut mining area.	An Extraction Plan will be developed in consultation with Mt Owen. The Extraction Plan will outline: - Further geotechnical studies to be undertaken prior to commencement of mining; - Revisions to the mine plan based on improved understanding of the geological structures in the vicinity; - Measures for adaptive management of subsidence impacts; and - Measures for remediating surface impacts. HVCC will consult closely with Mt Owen to manage potential impacts on operational efficiency.
West Pit	The Modification may involve secondary extraction beneath the highwall of the West Pit. Rockfalls have the potential to occur along 20% of the highwall being mined beneath. Cracking has the potential to occur along 70% of the highwall being mined beneath. The proposed longwall mining may also result in cracking or instability of the waste rock stockpiles in the West Pit.	The Extraction Plan will be developed in consultation with Mt Owen. The Extraction Plan will include specific asset management plans for the major mine infrastructure located above the proposed longwall panels. HVCC will consult closely with Mt Owen so that appropriate safeguards are implemented during

Surface Feature	Potential Impacts	Mitigation and Management Measures
	The West Pit is currently used for tailings emplacement and water storage. Given that it is not an active mining area, the potential instability is not expected to be a significant hazard. Nevertheless, warning signs and access restrictions will be used to manage these safety hazards.	secondary extraction beneath the West Pit.
Glendell Haul Road	The haul road from Glendell Mine to the Mount Owen CHPP traverses the Future Underground Extraction Area. The haul road is predicted to experience up to 1.6 m of vertical subsidence and associated strains and tilts. These subsidence effects may result in impacts to the serviceability of the road, such as localised changes in road grade and compression humps.	The Extraction Plan will be developed in consultation with Glendell. The Extraction Plan will include specific asset management plans for the major mine infrastructure located above the proposed longwall panels. Minor remediation measures may be required to maintain the serviceability of the road.
Eastern Rail Pit	The Eastern Rail Pit has been substantially rehabilitated. However, the highwall in the remaining void may experience some instability as a result of being directly mined beneath. Given that this void is being backfilled, rock falls are not considered to be an issue. Nevertheless, access restrictions will be imposed during the periods when instability may occur.	The Extraction Plan will be developed in consultation with Mt Owen. The Extraction Plan will include specific asset management plans for the major mine infrastructure located above the proposed longwall panels.
Mt Owen Rail Loop Tailings Dam (TP1)	TP1 is a prescribed dam under the Dams Safety Act. TP1 has substantially been capped. The remaining void space in the southern portion of TP1 acts as a water storage. The predicted subsidence effects are not expected to result in any impacts on the emplaced tailings or capping. There is the potential for transient tilting to occur. This will not pose any environmental impacts provided that the stored water in the remaining void is maintained at a low level.	The Extraction Plan will be developed in consultation with Mt Owen. The Extraction Plan will include specific asset management plans for the major mine infrastructure located above the proposed longwall panels. HVCC will consult closely with Mt Owen to enable management strategies to be implemented during mining beneath TP1.
Mt Owen Stage 5 Tailings Dam (TP2)	TP2 has been substantially rehabilitated. The remaining	The Extraction Plan will be developed in consultation with Mt Owen. The Extraction Plan will include specific

Surface Feature	Potential Impacts	Mitigation and Management Measures
	void acts as a water storage. The highwall in the remaining void may experience some instability as a result of being directly mined beneath. Given that this void is currently a water storage, rock falls are not considered to be an issue.	asset management plans for the major mine infrastructure located above the proposed longwall panels.
Rehabilitated OEAs	Rehabilitated OEA are expected to experience subsidence effects, as well as additional settlement of unconsolidated materials. Subsidence may result in cracking at topographic high points and at the bottom of steep sections. These cracks may lead to increased water ingress. However, these impacts are not likely to be significant. Sediment dams associated with the OEAs may experiences serviceability impacts dues to tilting and cracking. These impacts are able to be managed through remediation works.	The Extraction Plan will be developed in consultation with Mt Owen. The Extraction Plan will include specific asset management plans for the major mine infrastructure located above the proposed longwall panels. Minor works may be required to remediate surface cracking or restore the serviceability of sediment dams.
Bettys Creek Diversion	The approved LWs 13-14 are expected to result in up to 1.4 m of subsidence along the diversion channel. The Modification is predicted to increase the total vertical subsidence from 1.4 m to 1.9 m. The environmental consequences are expected to remain as predicted in the original EA for PA 08_0101.	The Extraction Plan will be developed in consultation with the relevant regulators and Mt Owen. The Extraction Plan will include a Water Management Plan that addresses impacts to stream geomorphology.
Mount Owen Mine Infrastructure Area	The product coal stockpile, reclaim conveyor, storage bin and train loading infrastructure are predicted to experience less than 50 mm of subsidence and low levels of tilt and strain. These structures are not expected to experience significant impacts. The dams with the Mt Owen Rail Loop may experience greater subsidence effects. The main dam is not expected to be significantly impacted by tilts or strains. The subsidiary dams (which feed the main dam) may experience loss of	Remedial works may be required for the subsidiary dams within the Mt Owen Rail Loop to restore flow paths.

Surface Feature	Potential Impacts	Mitigation and Management Measures
	serviceability due to transient tilts.	
Mt Owen Rail Spur	The Mt Owen Rail Spur has experienced subsidence from previous longwall mining in the Middle Liddell seam. The safety and serviceability of the rail spur was maintained during these mining operations. Subsidence induced tilt may cause localised increases in gradient along parts of the rail line.	Impacts to this structure are managed under the *Mt. Owen Railway and Bettys Creek Bridges Asset Management Plan*. Monitoring of rail stresses is undertaken on a regular basis. Re-stressing of the rail line is undertaken where required. Earthworks may be required to manage grades along the rail line (i.e. to combat the effects of tilting). Such earthworks will be undertaken in advance of mining.
Bettys Creek Bridges	The bridges are predicted to experience up to 1.1 m of vertical subsidence after mining of LWs 13-14. The Modification is predicted to increase subsidence of this structure to 1.3 m. The consequences of vertical subsidence are not expected to be significant. The bridges are predicted to experience up to 100 mm of valley closure due to LWs 13-14. The Modification is not expected to result in any significant closure movements.	Impacts to these structures are managed under the *Mt. Owen Railway and Bettys Creek Bridges Asset Management Plan*. Structural inspections of the bridges will be taken and structural modifications will be undertaken to mitigate the effects of tilt, strain and closure.
Communications Cables	The communications cables that support the Mt Owen Rail Spur are direct buried. The cables were not impacted by previous longwall mining activities. The cables are not expected to be impacted by the predicted subsidence effects for the Modification.	Impacts to the cables are managed under the *Mt. Owen Railway and Bettys Creek Bridges Asset Management Plan*. Rail operations will be temporarily suspended if there is a failure of the communications cables.
Maintenance Road	The maintenance road is a private road that runs adjacent to the Mt Owen Rail Spur. The predicted subsidence effects due to the Modification may result in minor cracks, compression humps and localised changes in grade. These	The road will be inspected on a regular basis. Remediation works will be undertaken to maintain the condition of the road (if required).

Surface Feature	Potential Impacts	Mitigation and Management Measures
	impacts will not significantly affect the serviceability of the road.	
Embankments and Cuttings	Embankments and cuttings for the Mt Owen Rail Spur may experience minor cracking due to subsidence. These cracks are not expected to lead to slope instability.	Impacts to the cuttings and embankments are managed under the *Mt. Owen Railway and Bettys Creek Bridges Asset Management Plan*. Regular inspections of these structures are undertaken.
Water Pipeline	The buried water pipeline that services Glendell and Mt Owen CHPP is not expected to be impacted by the predicted subsidence effects. The pipeline did not experience any impacts due to previous longwall mining.	Impacts to the pipeline will be managed under the *Mt. Owen Railway and Bettys Creek Bridges Asset Management Plan*.
Powerlines	A number of existing single pole transmission lines are located within the Subsidence Assessment Area. These powerlines are expected to experience the predicted subsidence effects; however, tilts and strains are not necessarily transferred fully to the pole structures. Tilts may affect the ground clearances of powerlines.	Prior to the proposed longwall mining, inspections of the powerline will be undertaken to confirm that the supporting poles are spaced closely enough to maintain sufficient ground clearances. If required, remediation works will be undertaken to restore the serviceability of the powerlines. These measures will be detailed in the Extraction Plan to be developed for the Modification.
Access roads and tracks	The predicted subsidence effects may result in impacts to the serviceability of the road, such as surface cracks, localised changes in road grade and compression humps.	Minor remediation will be undertaken, where required, to maintain the serviceability of access roads and tracks. Warning signs will be established where these impacts poses a safety hazard. These measures will be detailed in the Extraction Plan to be developed for the Modification.

MOC Mine Infrastructure Area

Part of the MOC Mine Infrastructure Area (MIA) is located within the northern portion of the Subsidence Assessment Area. Components of the MOC MIA that are located within the Subsidence Assessment Area include a portion of the product coal stockpile, dams, reclaim conveyor, storage bin and train loading infrastructure.

The infrastructure at MOC is predicted to experience vertical and horizontal movements of less than 50 mm, with very low levels of tilt and strain. The predicted subsidence effects are not expected to impact upon their ongoing operation.

The dams that are located within the Mt Owen Rail Loop have the potential to experience some temporary changes due to transient tilting of the surface during longwall mining. These impacts will be managed through a monitoring and maintenance regime.

Powerlines

Single-poled overhead electricity lines traverse the proposed longwall panels and supply power to water management installations for the TP1, TP2 and ERP dams and the current West Pit tailings storage facility. The powerlines are likely to experience the full range of predicted subsidence movements as a result of the Modification. However, maximum tilts and strains are not necessarily fully transferred to the poles. Experience form other mine sites indicates that single-poled powerlines are generally tolerant to subsidence effects. Therefore, the impacts associated with the Modification will be managed through a monitoring and maintenance regime.

Open Cut Mining Areas

The longwall panel layouts for the Modification proposes the direct undermining of the current, approved and proposed mining operations at MOC. Potential impacts to the open cut operations resulting from the simultaneous underground extraction may include:

- Highwall and slope instability;
- Potential reduction in the efficiency of blasting undertaken for the surface operations;
- Potential for floor heave on the floor of the open cut mining area
- Increased methane emissions to the open cut mining area; and
- Subsidence impacts (such as cracking) that will need to be remediated in order to facilitate operational efficiency.

These impacts will be managed through the Extraction Plan(s), which will be developed in close consultation with MOC.

Conversely, impacts to the underground operations due to open cut mining activities may include:

- Vibration associated with blasting;

- Disruption to underground operations during blasting events;
- Potential for additional water ingress to the underground working areas; and
- Reduced overburden depth between the underground workings and the modified land surface.

These impacts will be managed through the application of Water Management Plans, Blast Management Plans, monitoring programs and collaboration with MOC.

The MOC operations have proposed that a minimum overburden thickness of 250 m is to be maintained between the active Mt Owen North Pit and the roof of the Middle Liddell seam (Umwelt, 2015). This is a minimum depth and will occur in a limited area of interaction between the two mines.

The active North Pit highwall will be directly undermined by the Modification. Potential impacts on the stability of the highwall are discussed further in **Section 8.2**.

The residual Ravensworth East West Pit Void will also be undermined by the Modification. Rockfalls and cracking are predicted to occur along the section of the eastern highwall that will be directly mined beneath. The consequences of the instability are not considered significant in the context of the current and proposed usage of this void area.

The ERP was formerly an open cut excavation. Although this void is currently being filled and capped, sections of the northern and western highwalls are currently exposed. Minor instability of the exposed highwall is predicted. However, the potential for instability in this area is inconsequential due to the ongoing backfilling of this void.

Emplacement Areas

Two major emplacement areas are located within the Subsidence Assessment Area, being the West Dump and the Glendell/Ravensworth East area at MOC. Other minor emplacements include in pit overburden emplacements within the West and North Pits (discussed above), as well as on the rehabilitated areas of TP2 and the ERP.

Major emplacements are expected to experience higher levels of subsidence than those forecast for natural ground areas due to additional settlement of the unconsolidated fill material. Cracking may develop at the topographic high points and at the base of the steeper sections which may induce water ingress during periods of heavy rain and contribute to minor slope instability. However, the strain levels may be reduced due to the behaviour of the softer unconsolidated material. Subsidence impacts to the modified landforms and emplacement areas are expected to be insignificant and manageable.

Tailings Dams

Two tailings dams are located within the Subsidence Assessment Area, namely TP1 and TP2. Both dams were formerly open cut mining areas, which have subsequently been utilised as tailings dams and are now undergoing rehabilitation.

TP1 is a prescribed dam under the NSW *Dams Safety Act 1978* and is therefore subject to NSW Dams Safety Committee conditions. Tailings emplacement within TP1 has been completed and as such, TP1 is currently in the process of being capped. TP1 currently holds a small section of ponded water at its southern end. The subsidence effects resulting from the Modification are not expected to have any significant impacts to the tailings, capping or exposed highwall edges (if present).

TP2 has been partially backfilled, capped and rehabilitated. The remaining void area is currently utilised for water quality management purposes. The eastern highwall of the historical mining area is partially exposed. Subsidence impacts to the former highwall in the vicinity of TP2 are predicted to include additional settlement of fill material, and the formation of cracks at the top of the filled areas and the interface between fill material and natural ground surface along the buried highwall.

Both dams have sufficient vertical separation and overburden thickness to the proposed longwall mining operations proposed by the Modification to suggest there is a limited potential for increased vertical water ingress to the underground mining areas.

Mt Owen Rail Spur and Associated Infrastructure

The approved Integra Underground mining operations have previously undermined sections of the Mt Owen Rail Spur. Longwall mining operations are currently proposed as part of the extraction of Longwalls 13 and 14. The operation of the rail spur and loop is currently managed via monitoring and maintenance. The predicted tilts may result in localised increase in slope along parts of the rail spur. The Extraction Plan(s) will include measures to manage these impacts.

The corridor for the Mt Owen Rail Spur consists of embankments, cuttings and a causeway between TP2 and ERP. Minor surface cracking to the embankments and cuttings has the potential to occur as a result of subsidence. This is not predicted to result in significant instability of the rail formation. Similarly, the stability of the causeway is not expected to be significantly affected by subsidence effects resulting from the Modification.

An unsealed maintenance road, which currently provides access along the length of the Mt Owen Rail Spur, may experience minor cracking, compression humps and changes to grade as a result of subsidence. Furthermore, some sections of this private maintenance road may experience increased ponding following rain events. The serviceability of the road is not expected to be significantly affected and will be manageable by routine maintenance.

The rail corridor also contains buried rail communication cabling and a raw water pipeline that services the mining operations at MOC. All existing and proposed services infrastructure are predicted to be tolerant to the subsidence impacts, which is consistent with the experience from previously longwall mining.

Gas Drainage Infrastructure

Components of the Integra Underground gas management system are located within the Subsidence Assessment Area. The gas management system includes surface to seam boreholes with collar installations and surface pipeline networks for either the flaring of gas (to reduce greenhouse gas emissions) or delivery to a central gas drainage plant for power generation. Gas drainage equipment and infrastructure is designed to accommodate potential subsidence movements, and is equipped with monitoring and failsafe mechanisms.

Haul Roads and Access Roads

The haul road from the active Glendell Barrett Pit to the Mt Owen CHPP traverses the Modification is predicted to experience up to 1.6 m of vertical subsidence and corresponding tilts and strains. Potential impacts may include minor cracking, localised changes in grade and compression humps. These impacts may affect the serviceability of the road. The use of warning signs, regular inspections, and timely remediation of any impacts are considered appropriate measures to manage these potential impacts. These measures will also be appropriate for the management of potential cracks, compression humps and local grade changes to the various unsealed access roads and four-wheel drive tracks located within the Subsidence Assessment Area.

8.1.4 Mitigation and Management

Subsidence impacts relating to current operations at Integra Underground are managed by the implementation of Extraction Plans. Extraction Plans are required to be developed in consultation with the appropriate regulatory authorities. Extraction Plans include a number of component plans including:

- Land Management Plan;
- Built Features Management Plan;
- Subsidence Monitoring Program;
- Aboriginal and Non-Aboriginal Heritage Management Plans;
- Biodiversity Management Plan; and
- Water Management Plan.

Extraction Plans will be developed prior to the secondary extraction of the proposed longwall panels, and will be developed in consultation with relevant regulatory authorities. Extraction Plans will outline measures for managing subsidence impacts. Such measures may include:

- Refinement of the mine plan;
- Adaptive management based on subsidence and environmental monitoring results;
- Remediation of surface impacts; and
- Development of asset management plans.

Asset management plans will be developed in consultation with the owners of assets (Mt Owen and Glendell) that are predicted to experience subsidence effects induced by the Modification. The following asset management plans are included in the "Integra Underground Longwalls 13 and 14 Extraction Plan" (HVCC, 2017c):

- Bettys Creek Diversion Asset Management Plan;
- Mt Owen Railway and Bettys Creek Bridges Management Plan;
- Tailings Pit 2 Management Plan; and
- Eastern Rail Pit Management Plan.

These asset management plans will be updated and additional asset management plans will be developed for the Modification.

Extraction Plans also include a comprehensive subsidence monitoring program. Subsidence monitoring is undertaken to ensure compliance with regulatory commitments and to obtain an understanding of subsidence behaviour at Integra Underground.

HVCC will continue to consult closely with Mt Owen to adequately avoid, manage and monitor impacts resulting from the simultaneous mining operations and supporting infrastructure.

8.2 GEOTECHNICAL

8.2.1 Background

A Geotechnical Assessment for the Modification was undertaken by SCT. This assessment addresses the potential impacts of subsidence on the highwall of the MOC North Pit. The Geotechnical Assessment is provided in **Appendix C**. The Geotechnical Assessment was undertaken in consultation with Mt Owen.

8.2.2 Methodology

SCT reviewed the proposed mine plan geometries for the Modification, as well as estimates of the future North Pit highwall geometries. Estimated geometries for the North Pit highwall were obtained from MOC's Mine Operating Plans and Life of Mine End of Year Plans. SCT also reviewed geological sections showing the current interpretation of the Hebden Thrust.

A site inspection of the MOC North Pit was undertaken on 23 August 2017.

There are limited examples of underground mining being undertaken beneath the highwalls of active open cut mines. However, mining under highwalls is analogous to mining under natural cliff formations. As such, the known mechanics of subsidence resulting from longwall mining under natural cliff formations were used to predict potential impacts of longwall mining under a highwall.

8.2.3 Impact Assessment

Configuration of the North Pit

Mining in the MOC North Pit is approved to progress further south from the current position of the void. The southward extension of the North Pit is expected to result in interactions with the proposed longwall mining operations.

At the time of this assessment, the height of the MOC highwall was approximately 230 m, with an effective slope angle of approximately 38^{o} (with some sections having a slope of up to 60^{o}). The highwall features 50 m wide benches at 60 m to 80 m vertical intervals (SCT, 2017).

The mining method utilised at MOC involves in-pit waste rock backfilling. The north western side of the void is backfilled with waste rock from the open cut excavations. The backfill front advances to the south east by approximately 200 m per year. A haul road currently follows the rim of the highwall and enters the pit via a ramp down to the first bench, which is located approximately 60 m below the rim of the open cut excavation.

Subsidence Impacts

Longwall mining beneath cliff formations at other sites has been observed to result in rockfalls and/or perceptible cracking.

Past experience from the Southern Coalfield (where the depth of mining ranges from 200 m to 500 m) indicates that rock falls typically occur along 5% of the length of the cliffline that is mined beneath. Both rockfalls and cracking are applicable to the MOC North Pit.

The proposed mine plans for the Modification indicate that mining of LW 15 will occur directly under the North Pit highwall. Instability of the top 60 m of the highwall may occur due to compression movements above the longwall panel. The compression movements have the potential to result in rockfalls along the section of highwall that is directly mined beneath. Rockfalls are not expected to occur as a result of LWs 16-20, as these panels are not proposed directly beneath the highwall.

The proposed longwall mining has the potential to result in cracking along the top of the highwall. Cracking increases the potential for water ingress into the highwall, which may contribute to slope instability. There is the potential for cracking to occur in the vicinity of the haul road located along the rim of the highwall. Cracking of this nature can be remediated through regrading and crack infilling. Remediation measures will be included in the Extraction Plan(s) that will be developed for the Modification.

8.2.4 Mitigation and Management

Mitigation and management of the potential impacts to the North Pit highwall will be addressed in the Extraction Plan(s) that will be developed for the Modification. The Extraction Plan(s) will be prepared in consultation with Mt Owen. The Extraction Plan(s) will consider the following:

- Timing and progression of open cut mining operations at MOC;

- Timing and progression of underground mining at Integra Underground;
- Geological information obtained from mining operations, including information regarding the Hebden thrust; and
- Subsidence monitoring results.

The Extraction Plan(s) will include measures to remediate any impacts resulting from underground mining beneath the open cut mining areas at MOC.

8.3 GROUNDWATER

8.3.1 Background

A Groundwater Impact Assessment was undertaken by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to assess the potential impacts of the Modification on the regional groundwater regime. The Groundwater Impact Assessment is provided in **Appendix D**.

The purpose of the assessment was:

- To characterise the existing groundwater sources, regimes and water users;
- Predict the groundwater inflows to the underground mining areas during the Modification;
- Assess the impacts of the Modification and cumulative mining operations on these groundwater systems and other water users;
- Quantify the potential drawdown of groundwater sources throughout the life of the Modification; and
- Recommend any measures to monitor, mitigate and manage the identified impacts to the regional groundwater regime.

Existing Groundwater System

Two types of hydrogeological units are present in the vicinity of the Modification:

- Quaternary alluvium contained within the relatively thin Quaternary alluvial sediments along Glennies Creek, Main Creek and Bettys Creek; and
- The underlying Permian hardrock aquifers which are semi-confined and comprised of sandstones, siltstones and coal seams (AGE, 2017).

Groundwater recharge into the Permian strata generally occurs via rainfall to the ground surface infiltrating into the formations through the soil cover and weathered profile. Recharge to the coal seams may also occur within areas where the seams subcrop in localised zones underlying the alluvial sediments and where gradients promote this flow.

The alluvial sediments can either be recharged by seepage of surface water flow through the creek beds (when there is surface flow) or as upward flow from the underlying Permian hardrock strata to the base of the alluvium. This recharge would generally only occur where the stream bed sediments and the underlying hydrological conditions allow this to occur.

Quaternary Alluvium

The Quaternary alluvial aquifers associated with Glennies Creek, Main Creek and Bettys Creek are classified as 'shallow upriver' aquifers and are characterised by low permeability clay and sandy sediments overlaying basal clayey gravels (ERM, 2009). These alluvial sediments are the main groundwater bearing units occurring in the vicinity of the Modification.

A network of monitoring bores has been installed at Integra Underground and MOC to monitor groundwater levels, hydraulic conductivity and water quality within the Quaternary alluvium.

The thickness of the alluvium is typically in the order of 10 m thick within the Glennies Creek and Main Creek floodplains, and approximately 5 m in thickness along Bettys Creek. Bettys Creek alluvium is defined by thin horizons (generally no more than 2 m thickness) of clay, silt, sand and gravel. Water level monitoring has indicated that the Bettys Creek alluvium is predominantly unsaturated. Groundwater flow within the alluvium is a reflection of the surface topography. The hydraulic gradient of Bettys Creek is relatively steep and ranges from 1:100 to 1:200 (AGE, 2017).

Main Creek alluvium is comprised of 1 to 3 m thick clay horizons with associated sand and gravel, and occasional sand and gravel horizons with minor clays. The groundwater surface generally occurs approximately 6 – 7 m below the surface. The extent of saturation is variable across the alluvium. The greatest saturation (up to 9 m) generally occurs closest to the creek channel, whereas the edges of the Main Creek alluvial floodplain are unsaturated. The hydraulic gradient of Main Creek ranges from 1:100 to 1:200 (AGE, 2017).

Glennies Creek alluvium is characterised by horizons between 1 to 5 m in thickness, dominated by clays and gravels, with associated sand, silt and loam. The saturated thickness of the alluvium varies between 1.75 m to almost 6 m. The topographic gradient of Glennies Creek is lower than that of Main Creek and Bettys Creek which is reflected in a slighter hydraulic gradient of 1:1,000 (AGE, 2017).

Water levels in Glennies Creek are generally below the groundwater table, except during periods of high flow. In periods of stream flows within Bettys Creek and Main Creek, water is likely to seep into the neighbouring alluvial aquifers. It has previously been noted within the Hunter Valley that seepage or flow of Permian groundwater into the alluvial aquifers is a common process resulting in reduced groundwater pressures within the hardrock aquifers (Mackie, 2009). This process also contributes to salinity within the alluvial aquifers.

The general dominance of clays within the Bettys Creek and Main Creek alluvium suggests that these systems exhibit moderate to low hydraulic conductivities, with a measurement of 0.06 m/day within the Main Creek alluvium at bore GCP17. Similar lithology within Bettys Creek alluvium suggests this system would comprise consistent hydraulic conductivities within Main Creek. The presence of coarser sands and gravels within the Glennies Creek alluvium demonstrates slightly higher (and variable) hydraulic conductivities when compared to Bettys Creek and Main Creek, with measured conductivities ranging from 0.01 to 0.6 m/day (AGE, 2017).

Hardrock Groundwater Systems

The hardrock groundwater system is characterised by low yielding hard rock aquifers separated by aquicludes (mudstones and shales) and aquitards (sandstones). The hardrock groundwater system can be divided into the following three geological strata:

- Thin, generally dry and variable permeable weathered rock (regolith);
- Non-coal interburden that forms aquitards; and
- Low to moderately permeable coal seams that act as the most transmissive strata within the Permian hardrock coal measures sequence (AGE, 2017).

A network of monitoring bores and vibrating wire pressure sensors (VWPs) installed within the Permian geological sequence monitor water levels, pore pressures and water quality of the hardrock groundwater system.

In addition to the monitoring network, packer testing has been conducted to understand the hydraulic conductivity of the aquifer. The aquicludes and aquitards are characterised by very low hydraulic conductivities and have the effect of retarding groundwater flows. Typically, low hydraulic conductivities ranging from 9×10^{-6} to 1×10^{-2} m/day for the coal seams and 9×10^{3} to 1×10^{-6} m/day for the interburden strata have been recorded.

Water Quality and Beneficial Use

Salinity is the key restriction to groundwater resources being utilised for beneficial purposes within the vicinity of the Modification. Wide variability exists in the salinity levels of the Quaternary alluvium and the hardrock groundwater system. Water quality data indicates that Bettys Creek and Main Creek alluvium have salinity levels ranging from fresh to saline. The Quaternary alluvial aquifers are generally more saline than the surface flows in the associated streams.

Neither of the alluvium systems satisfies the criteria for “highly productive groundwater” under the NSW Aquifer Interference Policy (NSW DPI, 2012), namely:

- Total dissolved solids (TDS) concentration of less than 1,500 mg/L; and
- Has the potential to yield water at a rate of greater than 5 L/s.

In contrast, the monitoring results for Glennies Creek indicate lower salinity levels for both surface water and alluvial groundwater. Groundwater quality trends indicate that salinity within the alluvium generally increases with distance away from Glennies Creek. This is likely due to the lower permeability of the alluvial aquifer further from the creek channel that inhibits fresh surface water from percolating to these fringing alluvial areas.

Salinity within the hardrock aquifer is also highly variable, ranging from fresh (less than 500 mg/L) to highly saline (more than 15,000 mg/L). Comparison of water quality between the alluvial groundwater and that of the Permian system shows similarities in salinity range. This similarity suggests that seepage from the hardrock groundwater into the alluvium influences the salinity at the fringes of the alluvium, and recharge from fresher diffuse rainfall is relatively low.

Water quality monitoring and data analysis has concluded that groundwater from the Quaternary alluvium and underlying hardrock groundwater systems is not suitable for potable or irrigation uses.

Existing Groundwater Users

The NSW state government groundwater bore database identifies three registered bores on non-mine owned properties within the vicinity of the Modification. Of the three registered bores, only one bore is known to be active.

The only active registered bore is a well that is located on the northern bank of Glennies Creek, near the Middle Falbrook Road Bridge over Glennies Creek, approximately 6 km to the south east of the proposed longwall panels to be developed by the Modification. This non-mine owned well is drawing water from the Glennies Creek alluvium.

There are no records of any non-mine owned water bores extracting groundwater from the Permian strata within the vicinity of the Modification.

8.3.2 Methodology

Data Review

A desktop assessment was undertaken to review the available data resulting from the monitoring network within and surrounding the Modification. This review facilitated the development of the conceptual understanding of the regional hydrological system in order to appropriately feed into the development and updates to the groundwater modelling exercise. The desktop assessment also involved reviews of previous groundwater modelling and assessment exercises undertaken for the Integra Underground and the neighbouring mines to ensure consistency with previous work and to enable representation of the potential cumulative impact of surrounding mining and the Modification.

Model

A 3D numerical groundwater flow model was developed for the Modification using MODFLOW-USG. The numerical model was based on an existing regional model developed by Jacobs in 2014 for the Mount Owen Continued Operations Project EIS. The Jacobs model was reviewed and updated to predict the influence of the Modification on the regional groundwater regime. The model was updated with new geological information and to incorporate the proposed Modification mine schedule. To understand the potential cumulative impacts, the model included all currently approved and foreseeable mine plans within the region, including MOC, Ravensworth Operations, Liddell Mine, Rix's Creek North Mine, Ashton Underground and Hunter Valley Operations North mine.

The model represents the key geological units as 21 layers extending approximately 25 km from west to east and 26 km long in the north to south direction. It comprises up to 32,212 cells per layer, making it spatially a large model.

The model was calibrated using existing groundwater levels at monitoring bores. The volume of groundwater estimated to be pumped from Integra Underground was also used to guide the calibration of the model. The objective of the calibration was to replicate measured groundwater levels and mine inflows in accordance with the *Australian groundwater modelling guidelines* (Barnett *et al.* 2012). The transient calibration achieved a 6.1% scaled root mean square (SRMS) error, which is well within acceptable limits (i.e. 10% as recommended by the *Australian groundwater modelling guidelines* (Barnett *et al.* 2012)).

The calibrated model was run for the two conceptual longwall mine plan options proposed by HVCC (refer to **Section 4.2**). The model predicts impacts to the regional groundwater regime over an 18 year period from the date of the Modification approval, assuming mining operations continue from 2018 to 2035.

Peer Review

Dr Noel Merrick of HydroAlgorithmics conducted an independent peer review of the groundwater model in accordance with the *Australian groundwater modelling guidelines* (Barnett *et al*. 2012). A copy of the peer review report is provided as **Appendix E**.

The review was in accordance with the *Australian groundwater modelling guidelines* (Barnett et al. 2012). The peer review entailed input and involvement from Dr Merrick over the three main stages of numerical groundwater modelling process:

- Conceptualisation and model updates;
- Model calibration; and
- Model predictions.

8.3.3 Impact Assessment

The impact assessment is based on the impact predictions simulated by the calibrated groundwater model over the 18 year mining period. This following section presents the results for the longwall layout featuring 320 m wide panels, as this mine plan option provides a conservative assessment of the impacts of the Modification on the regional groundwater regime. The results of the narrower 246 m wide panels are provided in **Appendix D**.

Mine Area Inflow

The longwall mining operations associated with the Modification are predicted to result in groundwater inflows into the mine workings ranging from 30 ML/year in Year 1 of the simulated mine period to 257 ML/year (0.7 ML/day) in Year 5. The groundwater inflows predicted for the Modification alone accounts for approximately one third of the total inflows to the Integra Underground mine workings. The currently approved coal extraction at Integra Underground is predicted to result in up to 680 ML/year (1.9 ML/day) mine inflow throughout until 2035.

Due to the depth of longwall extraction at Integra Underground, mining of the proposed longwalls will not directly intercept water from the Quaternary alluvium. However, as the hardrock groundwater system becomes depressurised, an indirect impact or 'water take' will occur from the alluvium as discussed below.

Drawdown and Depressurisation

Drawdown and depressurisation of the groundwater systems has been calculated by comparing the pressures throughout the life of the Modification from the commencement of the corresponding WSPs. That is, changes in groundwater levels within the Quaternary alluvium have been calculated from the commencement of the Hunter Unregulated WSP in 2009. Changes in groundwater pressures within the Permian hardrock groundwater aquifers have been calculated from commencement of the North Coast Fractured and Porous Rock WSP in 2016.

Figure 17 shows the maximum extent of depressurisation within the Middle Liddell Seam resulting from the Modification alone and the Modification plus approved mining. The model predicts that the zone of depressurisation resulting from the Modification alone will extend approximately 4 km to the north-west of the Modification. It is noted that the depressurisation resulting from the Modification alone does not extend towards the south of the Future Underground Extraction Area, where extraction has previously been completed at Integra Underground. This explains the negligible drawdown which is experienced within the overlying alluvial groundwater systems of Main Creek, Bettys Creek and Glennies Creek as a direct result of the Modification.

Figure 17 also shows that the maximum extent of depressurisation (due to the Modification and the approved mining) is predicted to extend approximately 2 km to the south and 5 km to the east towards the Hunter thrust. Depressurisation resulting from the approved and previously mined Middle Liddell longwall panels is not shown, as the mining was conducted prior to the commencement of the North Coast Fractured and Porous Rock WSP.

The model predicts no measurable changes in drawdown within the Quaternary alluvium as a result of the Modification. Alluvial drawdown resulting from the approved mining is predicted to be less than 1 m within the Glennies Creek alluvium and the Main Creek alluvium.

Alluvial and Surface Water Fluxes

The indirect 'water take' from the alluvial systems (as the Permian strata becomes depressurised) was determined utilising different versions of the model (i.e. one version that contained the Modification and the second version that excluded the Modification) to compare the water budgets for the alluvial zones. The change in flux (or indirect water take) resulting from the Modification alone is predicted to be less than 1 ML/year from each alluvial and surface water system.

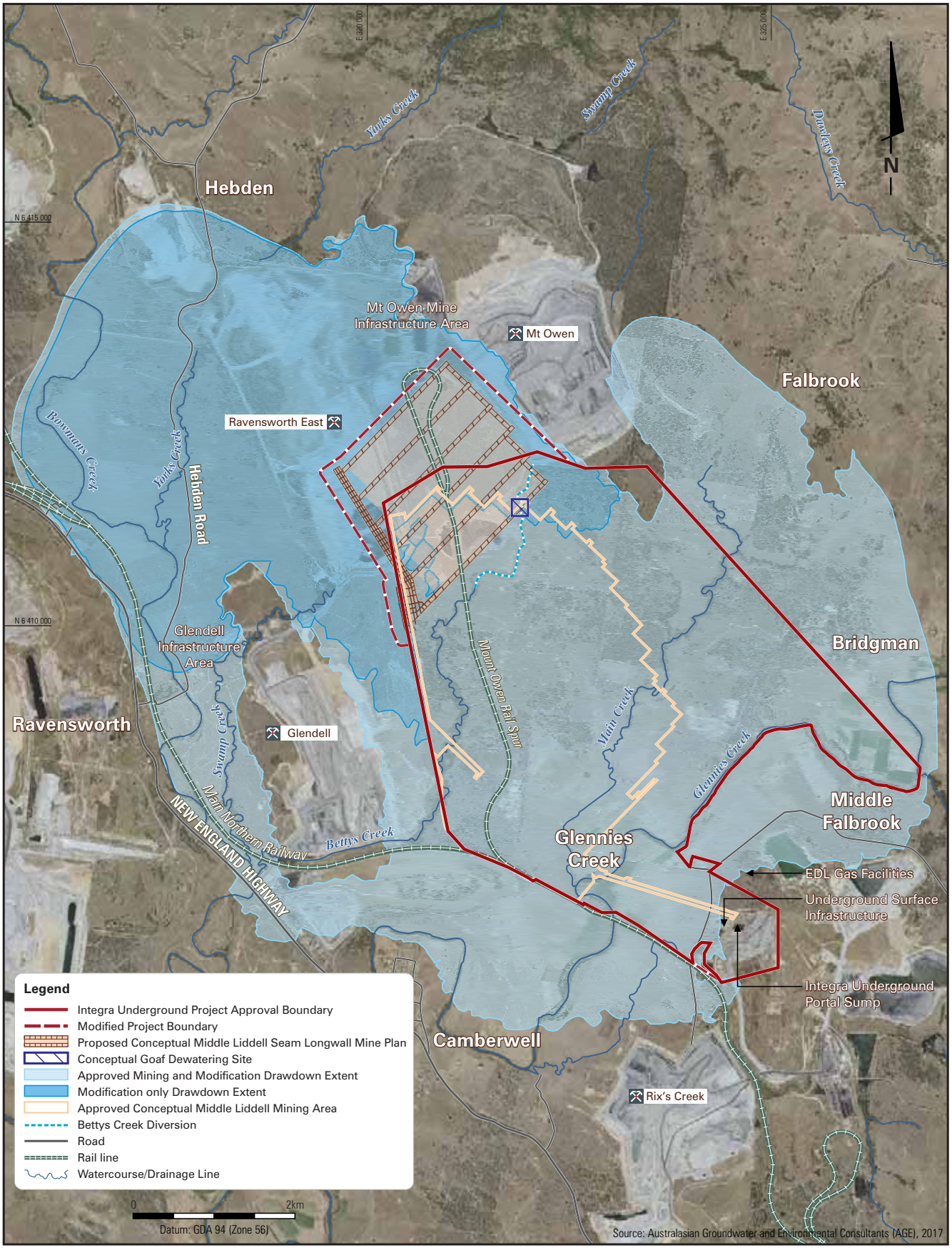
The change in groundwater flux to the alluvial systems, as a result of the Modification and approved mining operations, is predicted to peak at 36 ML/year in Glennies Creek alluvium and 4 ML/year in the Main Creek alluvium. This change in flux to the alluvium is also predicted to result in a change in the baseflow to Glennies Creek of 21 ML/year and to Main Creek of less than 1 ML/year. Glennies Creek has an average flow of 66,335 ML/year. Therefore the predicted change in groundwater baseflow of 21 ML/year is minor compared to the background stream flows. Main Creek is an ephemeral system with no recorded permanent baseflow.

Existing Groundwater Users

The numerical model does not predict a detectable decline in groundwater levels from the currently approved mining or the proposed Modification at the identified non-mine owned bore.

Groundwater Dependent Ecosystems

The Groundwater Dependent Ecosystems (GDEs) associated with the Modification are described in **Section 8.8**. As indicated earlier, there is no predicted change to the water levels within the alluvium as a result of the Modification alone. The model predicts a small drawdown within the alluvium of around 0.25 m in the vicinity of the GDEs as a result of cumulative mining activities (Integra Underground and surrounding mines). This predicted drawdown within the alluvium is not anticipated to dewater the alluvial sediments or materially change the saturated thickness of alluvium at the end of mining.



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Maximum Extent of Drawdown within Middle Liddell Seam

FIGURE 17

Water Licensing

Table 12 details the predicted annual volume of groundwater take for the approved duration of mining at Integra Underground.

Table 12
Groundwater Licensing Summary

Water Sharing Plan	Water Source / Management Zone	Type	Peak Volume Requiring Licensing During Mining (ML/year)		
			Approved mining	Approved and Modification	Modification only
North Coast Fractured and Porous Rock WSP	Sydney Basin – North Coast	Groundwater	647 (Year 12)	840 (Year 11)	257 (Year 5)
Hunter Unregulated WSP	Jerrys	Bettys Creek & Bowmans Creek Groundwater	-	-	-
		Bettys Creek Surface water	-	-	-
	Glennies	Main Creek Groundwater	4	4	0
		Main Creek Surface water	-	-	0
	Hunter Regulated River alluvium	Glennies Creek Groundwater	36	36	0
Hunter Regulated WSP	Management Zone 3A - Glennies Creek + Station Creek surface water	Surface water	21	21	0

HVCC holds Water Access Licences for 950 units of groundwater from the North Coast Fractured and Porous Rock WSP. Based on 1 ML per unit of allocation, the water allocations held by HVCC will sufficient accounts for the maximum of 840 ML/year that is predicted to be taken by Integra Underground (approved operations plus the Modification).

As shown in **Table 12**, the Modification is not expected to result in any measurable impacts to other water sources. Therefore, no additional water licences are required to account for the Modification.

Cumulative Drawdown

The groundwater model was used to understand the potential regional zone of depressurisation caused by the approved and proposed mining activities within the region including Integra Underground. Due to the highly modified landform surrounding Integra Underground, the zones of depressurisation from surrounding mines overlap with that of the Modification and approved mining at Integra Underground.

The depressurisation within the Middle Liddell Seam is predicted to be significant due to the cumulative impacts of mining operations within the local region. The model predicts that cumulative drawdown within the Quaternary alluvium systems will range from 0.1 m to 0.5 m. These predicted drawdowns will not result in any significant hydrological impacts.

8.3.4 Mitigation and Management

Groundwater impacts resulting from the currently approved mining operations at Integra Underground are managed in accordance with the Water Management Plan (WMP). The WMP provides measures which are deemed appropriate for mitigating the impacts predicted for the Modification. The WMP will be reviewed and updated as relevant to the Modification. This revision will allow for the inclusion of the following additional measures specific to minimising the potential impacts to groundwater resulting from the Modification:

- The existing groundwater monitoring network will be expanded to include additional sites to monitor the predicted impacts of the Modification. The sites will contain multilevel VWPs installed throughout the geological sequence to monitor depressurisation vertically through the sequence. Monitoring sites will be determined in consultation with DPI-Water;
- The full groundwater quality suite will be expanded in order to include key analytes to determine any changes in quality throughout the life of the mine;
- Continued reporting of groundwater levels and water quality results within the annual review; and
- Validation of the model predictions every five years. In the event that significant divergence from the model predictions is found, an updated groundwater model will be constructed for the simulation of mining related impacts.

8.4 SURFACE WATER

8.4.1 Background

A Surface Water Impact Assessment for the Modification was undertaken by Hansen Bailey. This assessment utilised water balance modelling to determine the impacts of the Modification on the Integra Underground Water Management System and the wider GRAWSS. The assessment also considered the potential impacts of the Modification on the catchments and streams within the Assessment Boundary. The Surface Water Impact Assessment is provided in **Appendix F**.

Water Management Systems

The existing Water Management System at Integra Underground is described in **Section 3.3.4** and conceptually illustrated in **Figure 18**. The Water Management System involves:

- Containment and reuse of:
    - Underground mine water (i.e. water captured in the underground workings);
    - Rainfall runoff from areas disturbed by open cut mining, including parts of the adjacent Rix's Creek North Mine;
    - Seepage from the Rix's Creek North Mine and surrounding catchment; and
    - Rainfall runoff from surface infrastructure areas, including the Rix's Creek North Mine Industrial Area.
- Use of an external raw water supply to meet operational water demands when mine water supply is insufficient; and
- Diversion of clean water around disturbed areas.

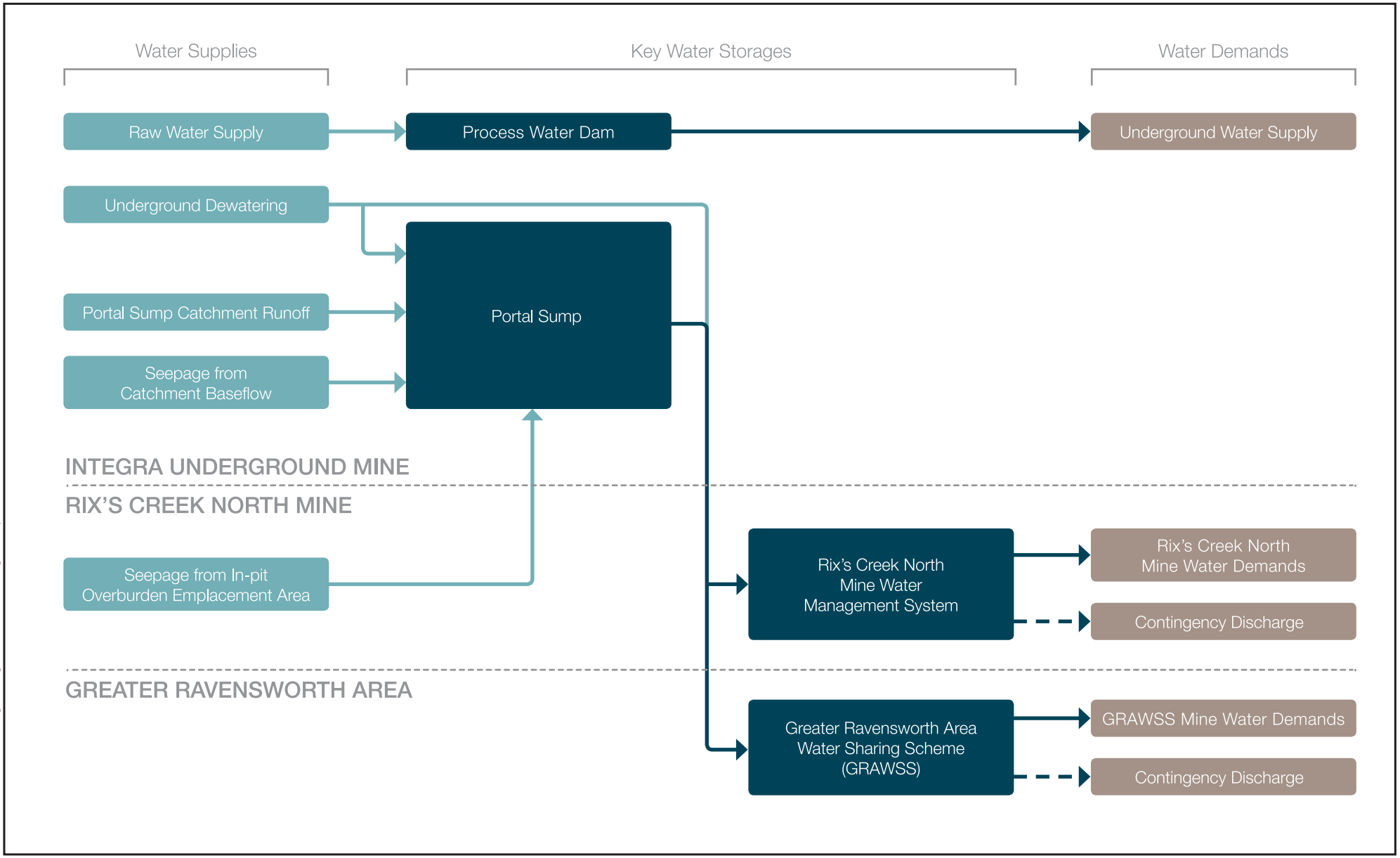
Raw water for operational purposes is sourced from Glennies Creek. Integra Underground typically takes up to 300 ML/year from Glennies Creek in accordance with its WALs under the WM Act.

To reduce the demand for raw water, recycled mine water is used for operational purposes wherever practicable. Surplus mine water within the Water Management System is transferred to either the GRAWSS or Rix's Creek North Mine.

8.4.2 Methodology

A water balance for Integra Underground was undertaken using the GoldSim modelling software. The water balance model determined the water management system inventory and storage requirements over the remainder of the Project duration (until the end of 2035). The model provides a dynamic simulation of the water management system based on the scheduled progression of longwall mine development, predicted groundwater inflows and catchment areas.

Catchment runoff was determined using runoff rates derived from the Australian Water Balance Model. Rainfall data was obtained from a long-term dataset (1889 to 2016) compiled by the BoM. Given that the dataset includes 126 years of rainfall data, the water balance model utilised 108 climate sequences, each containing rainfall data for 18 consecutive years. The duration of each climate sequence is equivalent to the number of years remaining in the Project duration (18 years). Therefore, the model has simulated the performance of the Integra Underground water management system for a wide range of climatic conditions.



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Integra Underground Mine Water Management System

FIGURE 18

Not all groundwater inflows will be dewatered from the underground mine. A portion of the inflows will be lost due to surface wetting, evaporation and infiltration. The water balance has assumed that 60% of the groundwater inflows will be dewatered from the mine workings.

A separate water balance model was developed for the GRAWSS as a whole. The GRAWSS water balance was utilised to determine the effects of additional water transfers from Integra Underground on the GRAWSS.

8.4.3 Impact Assessment

Water Balance

The results of the water balance model, including inflows to and outflows from the water management system, are shown in **Table 13**.

Table 13
Predicted Water Balance

Source	Annual Water Balance (ML/year)	
	Existing Operations	**Modification**
Water Supplies (Inputs)		
Underground Mine Dewatering:		
Dewatered Groundwater Inflows (Peak)	292	501
Recycled Raw Water Supply	208	208
Runoff from Portal Sump Catchment	96	96
Seepage from:		
In-Pit Overburden Emplacement Area	1,095	1,095
Pit Catchment	123	123
Total Supplies	**1,814**	**2,023**
Water Demands (Outputs)		
Transfer of surplus water to MOC*	1,798	2,004
Net Evaporation	16	19
Total Demands	**1,814**	**2,023**
Stored Water Volume Change	0	0

* A portion of this quantity may be transferred to Rix's Creek North Mine

The results of the water balance indicate that Integra Underground will generate a surplus of mine water. The surplus is predicted to increase from 1,798 ML/year to 2,004 ML/year. The greatest contributor to inflows is seepage from Rix's Creek North Mine, which accounts for approximately 1,218 ML/year. The volume of seepage from open cut mining areas (including in-pit OEAs) is not affected by the Modification.

The water balance predicts that the Portal Sump has sufficient capacity to contain the surplus mine water. HVCC has approval to transfer the surplus mine water to MOC or Rix's Creek North Mine (subject to a commercial agreement with Bloomfield Collieries).

Demand for External Water Supplies

The Modification is not anticipated to result in any increase in underground water requirements (approximately 208 ML/year). Therefore, the Modification will not result in any increase in abstraction of raw water from Glennies Creek.

The Modification proposes the use of the C4 Dam (at Rix's Creek North Mine) for the storage of raw water, in addition to the storage capacity provided by the Process Water Dam. The C4 Dam has a catchment area of approximately 25 ha and a storage capacity of 90ML. It is proposed that water captured with the C4 Dam will be used as the priority raw water supply for the Modification. The C4 Dam may also be utilised as a buffer storage for raw water taken from Glennies Creek.

GRAWSS Water Balance

As shown in **Table 13,** peak inflows to the Integra Underground Water Management System are predicted to increase by approximately 209 ML/year as result of the Modification. This increase is due to the additional mine dewatering that will be required for the Modification. All surplus mine water at Integra Underground must be transferred to either MOC or Rix's Creek North Mine. Of the additional 209 ML/year of peak inflows, the water balance predicts that approximately 206 ML/year will be transferred off-site, with the other 3 ML/year being lost through evaporation.

A water balance for the GRAWSS was undertaken to determine the potential impacts of receiving up to an additional 206 ML/year from Integra Underground. The GRAWSS water balance indicates that MOC generally experiences a deficit of process water during mining and coal processing operations. The additional 206 ML/year of mine water generated by the Modification will be utilised for mining and coal processing activities at MOC. Therefore, it is unlikely that additional transfers to the wider GRAWSS or additional discharges from currently licensed discharge points will be required during active operations at MOC.

After completion of mining operations at MOC, the additional mine water generated by the Modification will be utilised at Liddell Mine or Ravensworth Operations (where practicable). As a result, the storage inventory within the GRAWSS may increase by up to 206 ML/year (minus evaporative losses). During prolonged wet periods, it may be necessary to discharge excess mine water from the Licensed Discharge Point at Ravensworth Operations. The additional volumes generated by the Modification would represent a 2% increase in the total volume of water discharged from the GRAWSS. However, the discharge volumes would remain within the discharge limits permitted under the EPL for Ravensworth Operations (EPL 2652).

Catchment Yield

The surface infrastructure and post-mining drainage arrangements for the Modification have the potential to impact upon runoff volumes in the Bettys Creek and Glennies Creek catchments. However, the parts of the Bettys Creek catchment that are predicted to be affected by the Modification are also within the catchment of the approved MOC water management system. Therefore, the Modification will not result in any additional reduction to the Bettys Creek catchment.

The Modification is predicted to result in containment of approximately 0.1 ha of the Glennies Creek catchment. This represents a minor decrease (<0.001%) to the Glennies Creek catchment and will result in a proportionate decrease in catchment yield. No third party water users are located along Glennies Creek downstream of Integra Underground. Therefore, the predicted decrease in catchment yield will not impact upon any downstream water users.

Direct Impacts to Watercourses

Surface infrastructure required for the Modification has been designed to avoid, wherever practicable, encroachment on the identified creeks and their 1 in 100 year flood extents. However, the proposed electricity transmission lines and distribution lines will require crossings of Bettys Creek. These powerlines will span the creek channel and therefore will not result in disturbance to the stream bed or bank. All proposed works within 40 m of watercourses will be undertaken in accordance with the "Guidelines for Controlled Activities on Waterfront Land" (DPI, 2007).

The proposed 11 kV powerline and Goaf Dewatering Site will be located adjacent to Bettys Creek Diversion. Previous flood modelling undertaken by WRM in 2009 and 2017 indicates that the 1 in 100 year flood extent for the Bettys Creek Diversion is confined to the diversion channel. Therefore, the 11 kV powerline and Goaf Dewatering Site will not encroach upon the 1 in 100 flood extent of Bettys Creek.

All other surface infrastructure associated with the Modification will not be located in close proximity to any watercourses.

Erosion and Sediment Control

Surface disturbance will be required for the construction of the surface infrastructure components of the Modification, including:

- Goaf Dewatering Site;
- Surface auxiliary fans;
- Electricity transmission lines and distribution lines (and their associated easements);
- Store facility; and
- Access road and intersection.

The Goaf Dewatering Site and the proposed powerline easements are the only infrastructure components located in proximity to a watercourse, namely Bettys Creek.

Appropriate erosion and sediment controls will be implemented for all construction works. Diversion drains and/or bunds will be established to divert clean water runoff away from infrastructure sites (where practicable). Sediment laden runoff will be adequately captured and contained prior to passive discharge from the site. Sediment and erosion controls will be designed in accordance with *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).

Runoff from the Goaf Dewatering Site or surface auxiliary fan sites will be discharged into the catchment of the MOC water management system. Runoff from the Main Surface Facilities (which will include the relocated store and access road) will be discharged into the Integra Underground Water Management System.

Water Quality

The existing approvals for Integra Underground do not allow for controlled discharges from the site. Surplus mine water generated by Integra Underground will be transferred to either MOC (under the GRAWSS) or Rix's Creek North Mine. Controlled discharges may be undertaken by the receiving mine operators in accordance with their EPLs. Controlled discharges from the GRAWSS are undertaken in accordance with the EPL for Ravensworth Operations (EPL 2652).

Runoff from disturbed sites is managed in accordance with the Integra Underground Erosion and Sediment Control Plan, which is a component of the WMP.

Subsidence Impacts

The Bettys Creek Diversion is predicted to experience subsidence as a result of the Modification, particularly the section of the diversion channel overlying LW 15. Subsidence effects are predicted to result in bed lowering. Indirect impacts resulting from potential sedimentation, water pooling and erosive processes within the creek will be short term and localised.

Subsidence effects may result in localised increases to flow velocities and shear stresses. Flow velocities and shear stresses along the Bettys Creek Diversion are predicted to increase by less than 0.5 m/s and 20 Newtons/m^2, respectively. These increases have the potential to increase localised bank instability within the Bettys Creek Diversion above chain pillars. Given that the Bettys Creek Diversion is located within the MOC final landform, the diversion channel is likely to be removed or substantially altered during the rehabilitation process. Mt Owen is required to rehabilitate the Bettys Creek Diversion in accordance with Condition 24 under Schedule 3 of SSD-5850.

8.4.4 Mitigation and Management

Surface water and mine-affected water is currently managed and mitigated through the implementation of the WMP. The WMP includes the following management and control plans relevant to surface water:

- Creek Diversion Management Plan;
- Erosion and Sediment Control Plan;
- Surface Water Management Plan; and
- Surface Water Response Plan.

The existing management and mitigation measures prescribed by the WMP are sufficient to address the potential impacts of the Modification. The plans will be updated to address the potential impacts of the Modification.

The Surface Water Management Plan includes a surface water monitoring program for the Glennies Creek, Bettys Creek and Main Creek catchments. The existing monitoring program will be expanded to include surface water monitoring locations specific to the Modification.

During the construction phase, appropriate erosion and sediment controls will be implemented in accordance with the Erosion and Sediment Control Plan. Erosion and sediment controls will be designed in accordance with *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).

If the C4 Dam (at Rix's Creek North Mine) is to be incorporated into the Integra Underground Water Management System, the necessary commercial agreement with Bloomfield Collieries will be entered into.

8.5 NOISE

8.5.1 Background

An Acoustic Impact Assessment for the Modification was undertaken by Bridges Acoustics. This assessment predicted the construction and operational noise levels that would be generated by the Modification at the nearest sensitive receptor. The Acoustics Assessment is provided in **Appendix G**.

8.5.2 Methodology

Noise Management Levels

Potential noise impacts during the construction phase were assessed in accordance with the *Interim Construction Noise Guideline* (EPA, 2009) (ICNG). The ICNG prescribes two noise management levels for the assessment of construction noise impacts:

- The 'noise affected level' (10 dBA above the background level); and
- The 'highly noise affected level' (75 dBA).

The 'noise affected level' represents the level above which there may be some community reaction to noise. If construction noise levels are predicted to exceed the 'noise affected level', all reasonable and feasible noise controls should be implemented to minimise noise impacts.

The 'highly noise affected level' represents the level above which there may be a strong community reaction to noise. Restrictions on construction work may be required if construction noise levels are predicted to exceed the 'highly noise affected level'.

The background levels specified in the *Integra Underground Mine Noise Management Plan* (NMP) were adopted for this assessment. The NMP specifies a background level of 30 dBA for the nearest private residence. Therefore, the 'noise affected level' for this residence is 40 $L_{Aeq,15min}$.

The ICNG identifies standard construction hours to be 7 am to 6 pm Monday to Friday and 8 am to 1 pm Saturday, excluding public holidays. Any construction work occurring outside standard construction hours would be subject to the noise limits prescribed by Condition 2 under Schedule 3 of PA 08_0101 (as modified). For the nearest private residence, the applicable noise criteria are 38 $L_{Aeq,15min}$ during the evening period, and 36 $L_{Aeq,15min}$ and 46 $L_{A1,1min}$ during the night period.

Nearest Sensitive Receptor

A number of mine owned rural properties are located within the vicinity of the existing operations at Integra Underground. The nearest sensitive receptor is the private residence identified as Residence 80 in PA 08_0101 (as modified). The location of this receptor is identified on **Figure 7**. All other private residences are located further from the Modification and are less affected by noise enhancement due to prevailing winds and will therefore, experience lower noise levels than the nearest sensitive receptor. The assessment has focused on the nearest sensitive receptor because this location will experience the worst case noise levels generated by the Modification.

Pursuant to Condition 1 under Schedule 3 of PA 08_0101 (as modified), the receptor is subject to acquisition upon request from the owner. As such, PA 08_0101 (as modified) does not contain operational noise criteria for the receptor. However, if the receptor was not subject to acquisition, it would have been included within Noise Assessment Group (NAG) 1 under PA 08_0101 (as modified). Accordingly, the noise criteria for Noise Assessment Group (NAG) 1 have been adopted for the assessment:

- 38 $L_{Aeq,15min}$ during the day and evening; and
- 36 $L_{Aeq,15min}$ and 46 $L_{A1,1min}$ during the night.

Noise Predictions

Noise levels were predicted for construction and operation of the following infrastructure associated with the Modification:

- Goaf Dewatering Site;
- Additional surface auxiliary fans and associated shafts;
- Gas drainage boreholes and associated gas pipelines;
- Increased use of gas flares;
- Electricity transmission lines and distribution lines;
- Relocation of the store facility; and
- An access road off Middle Falbrook Road.

The surface auxiliary fans and gas drainage boreholes will be located within the Future Underground Extraction Area. However, exact locations within the Future Underground Extraction Area will not be confirmed until the mining operations for the Modification have commenced. To ensure that the noise level predictions are representative of the worst case, it was assumed that these infrastructure components would be located at the part of the Future Underground Extraction Area that was nearest to the receptor.

For each construction task, the necessary equipment was identified. The sound power level (SPL) generated by each task was calculated by adding the indicative SPLs for the items of equipment involved in that task. The noise level at the receptor was calculated by subtracting a correction factor from the SPL to account for the distance from the source to the receptor. This simplified calculation procedure is permitted by Section 6.3 of the NSW *Industrial Noise Policy* (EPA, 2000) and results in calculated noise levels similar to those that would occur under prevailing wind conditions. A distance correction of 79 dBA was adopted for the surface auxiliary fans and Goaf Dewatering Site to reflect the setback of approximately 3.4 km from the receptor. For the relocated store and new access road, a distance correction of 74 dBA was subtracted, based on a setback of approximately 1.9 km. For a 66 kV powerline, a distance correction of 72 dBA was subtracted, based on a minimum setback of approximately 1.4 km.

Operational noise levels were predicted using a similar methodology, except using the SPLs generated by the operation of the infrastructure.

The predicted noise levels at the sensitive receptor represent the worst case noise levels that would occur under noise enhancing (prevailing) weather conditions.

8.5.3 Impact Assessment

Construction Noise

Construction noise levels at the receptor are predicted to remain within the 'noise affected' level of 40 $L_{Aeq,15min}$ (as recommended by the ICNG) during construction of the surface infrastructure associated with the Modification. **Table 14** displays the SPLs associated with each construction task and the resulting noise level at the receptor. Construction noise levels at all other private residences will be lower than the predicted levels at the receptor, and will be within the 'noise affected' level of 40 $L_{Aeq,15min}$.

Table 14
Predicted Construction Noise Levels

Modification Component	Predicted Construction SPL (dBA)	Predicted Noise Level at Receptor ($L_{Aeq,15min}$)	Comment
Surface auxiliary fans and associated shafts	111 – 113	32 – 34	Assumed to be at the nearest part of the Future Underground Extraction Area, approximately 3.4 km north-west of the receptor.
Goaf Dewatering Site	111 – 113	32 – 34	Assumed 3.7 km north-west of receptor
Gas drainage boreholes and associated gas pipelines	NA	NA	The additional gas drainage boreholes for the Modification will be a greater distance from the receptor than the boreholes for the currently approved operations. As such, there will be no increase in noise levels due to the Modification
Electricity transmission lines and distribution lines	111	39	The 66 kV powerline will be approximately 1.4km west of the receptor. The predicted noise levels for the 11 kV powerlines will be less than the 66kV powerline due to greater separation distance to sensitive receptor and smaller construction footprint
Relocation of the store facility and construction of new access road	111 – 113	37 – 39	Approximately 1.9km south-east of the receptor

NA = Not Assessed

Operational Noise

Analysis of the predicted operational noise levels indicates that the Modification is not expected to result in any exceedances of the operational noise criteria at the nearest sensitive receptor. The Modification is proposing to extend longwall mining in a north-west direction, which would be progressing further away from the nearest receptor compared to the current approved operations.

The operation of surface auxiliary fans, dewatering boreholes, gas drainage boreholes and electricity transmission and distribution lines is not expected to be audible at the nearest receptor due to the significant separation distances. The use of gas flares for the Modification is not expected to increase the current operational noise levels generated by flaring associated with the existing operations at Integra Underground.

Vehicular movements at the relocated Store Facility and new access road are predicted to result in a noise level of 29 $L_{Aeq,15min}$ at the nearest receptor, which is below the operational noise criteria of 38 $L_{Aeq,15min}$. Given that the Modification will comply with the operational noise criteria at the nearest receptor, noise levels at more distant private receptors will also be within the criteria.

Operational noise levels for the surface infrastructure components of the Modification are predicted to be low. As such, the Modification is not expected to significantly increase the operational noise levels generated by Integra Underground as a whole.

8.5.4 Mitigation and Management

Noise impacts from current operations at Integra Underground are managed through the implementation of the Noise Management Plan. The Noise Management Plan includes performance measurements and criteria, preventative and corrective measures, evaluation via a comprehensive noise monitoring system and complaint handling procedures. The noise monitoring system includes real time unattended monitoring stations (operated by MOC) and attended monitoring locations.

The Noise Management Plan will be updated to include the activities proposed by the Modification. If alternative temporary construction noise limits are sought, HVCC will develop a Construction Work Noise Protocol in accordance with Condition 2B under Schedule 3 of PA 08_0101 (as modified).

8.6 AIR QUALITY

8.6.1 Background

An Air Quality and Greenhouse Gas Assessment for the Modification was undertaken by Jacobs. This assessment identified the potential air quality risks that may arise as a result of the Modification and recommended measures to mitigate these risks. The Air Quality and Greenhouse Gas Assessment is provided in **Appendix H**.

8.6.2 Methodology

Construction Phase

An environmental risk assessment was undertaken for all potential air quality hazards associated with the construction phase of the Modification. The environmental risk was determined using qualitative criteria for the likelihood and consequences of adverse impacts. The likelihood rating criteria, consequence rating criteria and risk rating matrix adopted for this risk assessment are presented in **Table 15**, **Table 16** and **Table 17**.

Table 15
Likelihood Rating Criteria

Likelihood Rating	Criteria
Rare	The event is unlikely to occur but may occur in exceptional circumstances
Unlikely	The event may occur under unusual circumstance but is not expected
Possible	The event may occur once within a five-year timeframe
Likely	The event is likely to occur several times within a five-year timeframe
Almost Certain	The event is almost certain to occur one or more times a year

Table 16
Consequence Rating Criteria

Consequence Rating	Criteria
Negligible	Undetectable changes to ambient air quality, beyond the site boundaries.
Minor	Detected changes to air quality, but no exceedances of the air quality criteria detected beyond the site boundaries.
Moderate	Detected changes to air quality, with emissions from site causing less than 5 exceedances per year of air quality criteria beyond site boundaries.
Major	Detected changes to air quality, with emissions from site causing exceedances of air quality criteria beyond the site boundaries.
Severe	Detected changes to air quality, with emissions from site causing exceedances of air quality criteria. Emission from the project cause clearly observed air pollution that causes air quality impacts leading to increased hospital admissions.

Table 17
Risk Rating Matrix

Likelihood Rating	Consequence Rating				
	Negligible	Minor	Moderate	Major	Severe
Rare	Very Low	Very Low	Low	Medium	Medium
Unlikely	Very Low	Low	Low	Medium	High
Possible	Low	Low	Medium	High	High
Likely	Low	Medium	Medium	High	Very High
Almost Certain	Low	Medium	High	Very High	Very High

Each hazard was subjected to an initial risk assessment, which assessed the risk in the absence of dust controls and mitigation measures. Integra Underground's *Air Quality and Greenhouse Gas Management Plan* and MOC's *Air Quality and Greenhouse Gas Management Plan* were reviewed to identify the existing dust controls that can be adopted for the Modification. The risk was then re-assessed with the implementation of suitable controls.

The risk assessment considered the locations of sensitive receptors relative to the proposed construction activities and the prevailing wind conditions.

Operational Phase

Air quality impacts during the operational phase of the Modification were assessed by preparing an emissions inventory and comparing the predicted emissions to those of nearby mining operations. The assessment of operational impacts was limited to activities that are conducted at Integra Underground, namely extraction, handling and stockpiling of ROM coal. The coal extracted from Integra Underground is processed and loaded onto trains at Rix's Creek North Mine. These activities were not considered in the assessment of operational impacts as they are undertaken pursuant to PA 08_0102 (the Project Approval for Rix's Creek North Mine).

8.6.3 Impact Assessment

Existing Air Quality

Air quality monitoring data for the period 2012 - 2016 was reviewed to determine the existing air quality in the vicinity of the Modification. The annual average PM_{10} concentrations for this period were below the criterion of 30 µg/m^3 (as prescribed by PA 08_0101) as well as the EPA assessment criteria for annual average PM_{10} of 25 µg/m^3.

Construction Phase

The main air quality risks associated with the Modification are related to emissions of dust (TSP, deposited dust, PM_{10} or $PM_{2.5}$). The main air quality hazards during the construction phase include:

- Dust generated by earthworks and handling of excavated materials;
- Dust generated by grading of unsealed surfaces;
- Wheel generated dust (from vehicle movement on unsealed surfaces); and
- Dust generated by drilling of boreholes.

The initial risk assessment determined that without dust controls, these hazards would result in a 'medium' or 'low' risk of air quality impacts. When the appropriate dust controls (see **Section 8.6.4**) are implemented, all risks were reduced to 'low'. The risk assessment is presented in full in **Appendix H**.

Operational Phase

The main air quality hazards during the operational phase are associated with the handling and stockpiling of ROM coal. Dust emissions during the operational phase are primarily determined by the quantity of coal that is handled. The Modification will not change the approved maximum ROM coal production rate. Total operational dust emissions have been estimated by analysing the material handling schedule, equipment listing and mine plans. The potential locations and intensity of dust generating activities were also considered. Estimated annual dust emissions during the operational phase of the Modification are provided in **Table 18**.

Table 18
Estimated Annual Dust Emissions during Operations

Activity	Annual Emissions		
	TSP	PM_{10}	$PM_{2.5}$
Transport ROM coal by conveyor to ROM stockpile	230	109	16
Dozers on ROM coal stockpiles	65,732	20,954	1,446
Wind erosion from ROM coal stockpiles	2,190	1,095	164
Ventilation outlet(s)	31,536	15,768	1,577
Total	**99,688**	**37,925**	**3,024**

These predicted emissions associated with the Modification are an order of magnitude lower than the annual emissions from neighbouring operations. This indicates that underground mining operations are not a significant contributor to dust emissions in the local area. The Modification will result in similar emissions to the existing operations at Integra Underground.

Therefore, air quality impacts will not be significantly greater than those currently approved under PA 08_0101.

8.6.4 Mitigation and Management

HVCC currently manages impacts to air quality through the implementation of its approved Air Quality and Greenhouse Gas Management Plan. The dust controls that will continue to be implemented for the Modification include:

- Treatment of unsealed roads using water or chemical stabilisers (where required);
- Restricting vehicle speeds on unsealed roads that have not been treated with water or chemical stabilisers;
- Development of access tracks will be limited and where required, tracks will be clearly defined;
- Rehabilitation of obsolete roads;
- Minimisation of disturbance areas;
- Establishment of cover crops, where practicable, to rapidly establish groundcover until desirable species have established;
- Clear and accurate marking of the limits of vegetation clearing;
- Ensuring that appropriate surface water controls are in place prior to clearing;
- Clearing of vegetation is undertaken with a raised blade to retain groundcover;
- Inspections of work areas and implementing additional controls where necessary;
- Minimising double handling of material; and
- Visual monitoring of dust levels and modifying or ceasing works whenever elevated dust levels are observed (e.g. during adverse weather conditions).

The Air Quality and Greenhouse Gas Management Plan will be updated to include the construction and operational activities associated with the Modification.

8.7 GREENHOUSE GAS

8.7.1 Background

An Air Quality and Greenhouse Gas Assessment for the Modification was undertaken by Jacobs. This assessment estimated the greenhouse gas (GHG) emissions that may arise as a result of the Modification. The Air Quality and Greenhouse Gas Assessment is provided in **Appendix H**.

8.7.2 Methodology

An inventory of GHG emitting activities was developed for both the construction and operational phases of the Modification. The GHG inventory was calculated in accordance with the principles of the GHG Protocol and includes Scopes 1, 2 and 3 as defined in the GHG Protocol. As dictated by the GHG Protocol, reporting of Scope 1 and 2 emissions is mandatory, whereas reporting of Scope 3 emissions is optional. This GHG assessment has included all significant sources of GHGs that may be generated by the Modification (including Scopes 1, 2 and 3).

The Carbon Gauge tool (developed by the Transport Authorities Greenhouse Group in 2013) was used to estimate the GHG emissions resulting from key construction activities, including earthworks, vegetation clearing and paving of access roads. The input parameters from Carbon Gauge included earthworks estimates and an indicative construction schedule (including an assumed duration of 8 weeks for earthworks). The GHG emissions related to vegetation clearing include both fuel consumption and loss of the carbon sink. It was assumed that all fuel used during construction activities would be diesel fuel.

Operational GHG emissions, including fugitive emissions, were estimated for the additional ROM coal (up to 9.9 Mt) to be extracted from 2018 to 2023. The operational emissions were projected utilising existing data reported in accordance with the *National Greenhouse and Energy Reporting Act 2007.*

8.7.3 Impact Assessment

The key sources of GHG emissions during the construction phase were determined to be:

- Vegetation clearing;
- Fuel consumption for equipment and plant used in earthworks;
- Material handling during earthworks; and
- Embedded emissions in materials used in pavement areas.

Carbon Gauge estimated that the earthworks and site establishment for the Modification will generate approximately 3,401 tCO_2e of GHG emissions. The greatest contributor to these emissions (56%) is the loss of carbon sink due to vegetation clearing.

Key sources of GHG emissions during the operational phase were determined to be:

- Fugitive emissions from coal extraction;
- Fugitive emissions from post mining activity;
- Diesel fuel consumption from operational activities; and
- Electricity consumption.

The estimated emissions generated by the additional mining operations associated with the Modification are detailed in **Table 19**.

Table 19
Estimated Operational and Fugitive GHG Emissions

Emission Source	Greenhouse Emissions per ROM t (tCO2e / ROM coal t)	Projected typical annual average greenhouse gas emission (tCO2e)	Total projected greenhouse gases 2018-2023 (tCO2e)
Fugitive emissions from the extraction of coal	0.346	571,275	3,427,650
Combustion of diesel fuel from equipment/plant	0.003	1,686	10,119
Combustion from flares	0.027	44,220	265,320
Fugitive emissions from post mining activities	0.017	28,050	168,300
Purchase of Electricity from grid	14.4 (kWh / t ROM Coal)	22,714	136,282
Total assessed operational sources	**-**	**667,945**	**4,007,671**

The fugitive emissions from the extraction of coal account for approximately 86% of the total projected operational GHG emissions for the Modification.

To understand the potential impacts on a state and national level, the predicted emissions were compared to the recorded emissions on the National Greenhouse Gas Inventory (DoEE, 2015). The average annual GHG emissions from the Modification (667,945 tCO_2e) represents approximately 0.12% of the total Australian GHG emissions and 0.50% of the total NSW emissions for 2015 (the most recent year for which data is available).

8.7.4 Mitigation and Management

HVCC currently manages GHG emissions through the implementation of its approved Air Quality and Greenhouse Gas Management Plan. This Plan will be updated to include the activities associated with the Modification.

GHG emissions from Integra Underground are substantially reduced by the transfer of methane gas to the Glennies Creek Power Station for beneficial use in electricity generation. Surplus gas that cannot be converted to electricity is managed through flaring, which converts methane to carbon dioxide (a less potent greenhouse gas). Reuse of methane gas for electricity generation and flaring will continue to be implemented for the Modification.

HVCC will continue to implement measures to improve energy efficiency such as:

- Installation of variable speed drives on pumps in the underground mining areas;
- Management of compressed air leaks;
- Speed reductions on underground conveyors;

- Lighting efficiency measures (low energy fittings and management improvement);
- Utilising plant and equipment that is energy efficient; and
- Providing training to personnel regarding the efficient use of plant and equipment, including proper maintenance of equipment to retain high levels of energy efficiency.

8.8 ECOLOGY

8.8.1 Background

An Ecological Impact Assessment for the Modification was undertaken by Cumberland Ecology. This assessment identified the potential impacts to flora, fauna and ecological communities (including threatened species and communities) that may arise as a result of the Modification. The Ecological Impact Assessment is provided in **Appendix I**.

Since the application is a modification application under Section 75W of the EP&A Act, for which an EIS is not required, and given that the Secretary has not issued any environmental assessment requirements in respect of the Modification, the *NSW Biodiversity Offsets Policy for Major Projects* (OEH, 2014a) and the *Framework for Biodiversity Assessment* (OEH, 2014b) do not apply to the Modification.

8.8.2 Methodology

Desktop Assessment

Cumberland Ecology conducted a search of the "Atlas of NSW Wildlife – Bionet" (OEH, 2017) database to identify the listed threatened species under the BC Act and EPBC Act that have been recorded within a 10 km radius of the Assessment Boundary. The Bionet database includes threatened species records from 1990 onwards. The Protected Matters Search Tool (PMST) was also used to identify listed species and ecological communities (under the EPBC Act) that have the potential to occur within the Assessment Boundary.

The desktop assessment also included a literature review of previous ecological studies undertaken for Integra Underground and MOC.

Field Survey

The area within the Assessment Boundary was surveyed by an ecologist and botanist on 6 July 2017. The field survey focused on areas that are outside of the approval boundaries for Integra Underground and MOC, as there is existing vegetation mapping for the land within these boundaries.

Flora quadrats were conducted within each of the vegetation communities present within the Assessment Boundary, except for rehabilitation and exotic grassland. The quadrats were located in areas that were most representative of the condition and composition of vegetation within the Assessment Boundary. The flora quadrats were undertaken in accordance with the Biodiversity Banking Assessment Methodology (BBAM).

8.8.3 Impact Assessment

Vegetation Communities

The following native woodland communities were identified within the Assessment Boundary:

- Central Hunter Ironbark – Spotted Gum – Grey Box Forest (which is listed under the BC Act and EPBC Act);
- Central Hunter Bulloak Forest Regeneration;
- Central Hunter Swamp Oak Forest; and
- Planted Vegetation.

The Central Hunter Ironbark – Spotted Gum – Grey Box Forest is listed as an Endangered Ecological Community (EEC) under the BC Act and as a Critically Endangered Ecological Community (CEEC) under the EPBC Act. All surface infrastructure associated with the Modification will be sited such that disturbance to EEC and CEEC vegetation is avoided. The distribution of forest and woodland communities within the Assessment Boundary is shown in **Figure 19**.

As the Modification is a proposal for underground mining, the direct disturbance required for the construction of surface infrastructure will be relatively minor. **Table 20** shows the areas of woodland vegetation present within the Assessment Boundary and quantifies the approximate areas that may be disturbed for the construction of the Goaf Dewatering Site and powerlines. The Modification is predicted to result in direct disturbance to approximately 5.40 ha of woodland. Approximately 3.45 ha of this area is approved to be disturbed by the MOCO Project. Therefore, the Modification is predicted to result in disturbance to approximately an additional 1.95 ha of native woodland. The proposed Goaf Dewatering Site is located entirely within the approved disturbance area for the MOCO Project. The additional disturbance required for the Modification will occur due to the construction of powerlines.

Table 20
Existing Vegetation and Potential Disturbance

Vegetation Community	Area present within the Assessment Boundary (ha)	Area Proposed to be Disturbed by the Modification (ha)	
		Within MOCO Disturbance Area	Additional Disturbance
Central Hunter Ironbark - Spotted Gum - Grey Box Forest (EEC/CEEC)	33.97	0.00	0.00
Central Hunter Bulloak Forest Regeneration	6.53	0.00	1.80
Central Hunter Swamp Oak Forest	17.46	1.86	0.15
Planted Ironbark – Spotted Gum –	17.30	0.00	0.00

Vegetation Community	Area present within the Assessment Boundary (ha)	Area Proposed to be Disturbed by the Modification (ha)	
		Within MOCO Disturbance Area	Additional Disturbance
Grey Box Forest			
Rehabilitation	9.02	1.59	0.00
Total Woodland	**84.27**	**3.45**	**1.95**
Grassland	386.07	6.53	6.24
TOTAL	**470.34**	**9.98**	**8.19**

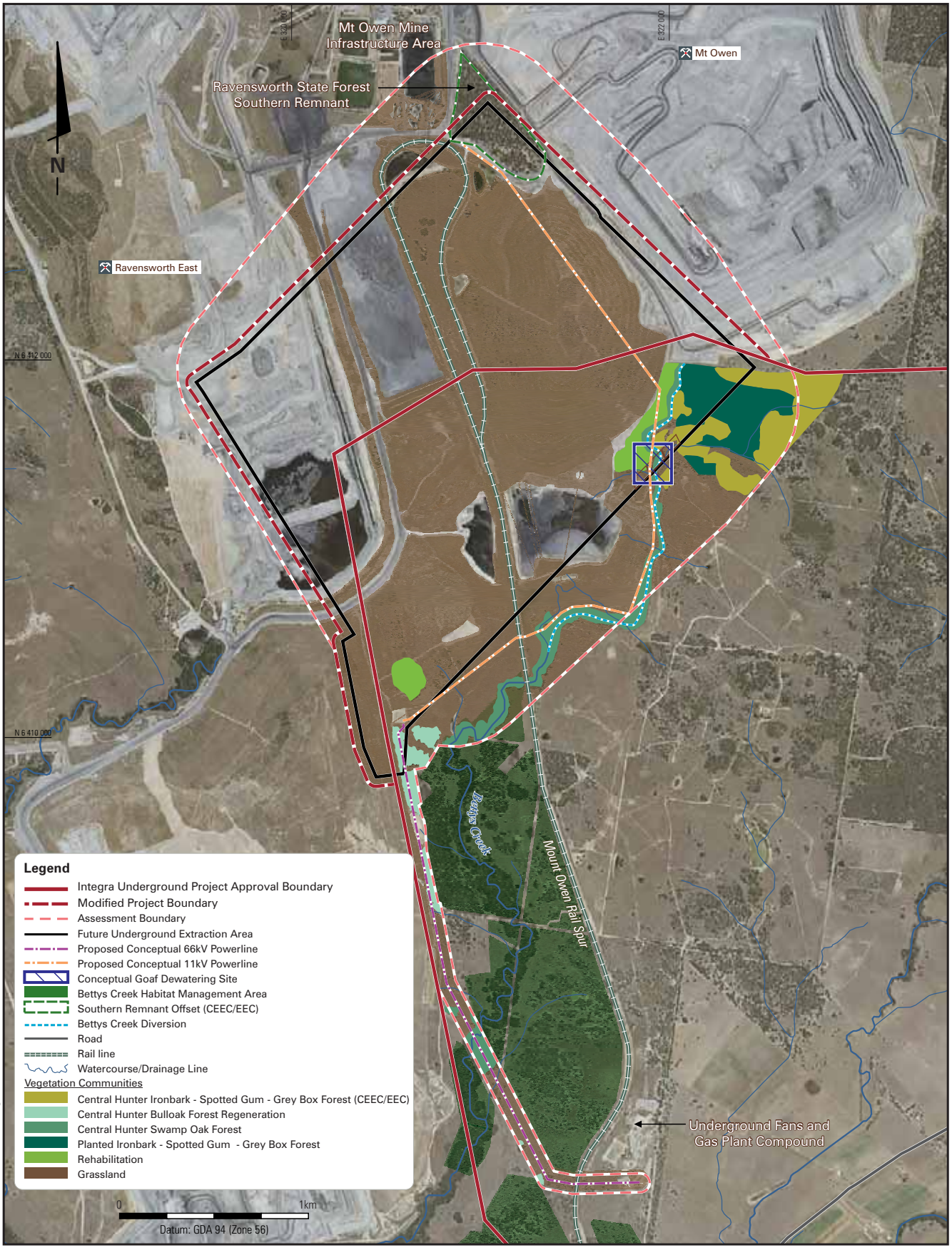
The proposed surface auxiliary fans will be sited in areas of grassland. The gas drainage boreholes will be located in either areas of grassland or within the approved disturbance area for MOCO. Therefore, the proposed surface auxiliary fans and gas drainage boreholes will not result in any additional disturbance of native woodland (i.e. beyond areas that are currently approved to be disturbed).

Threatened Flora

No threatened flora species were recorded within the Assessment Boundary during the field survey. Seven listed flora species are considered as having the potential to occur within the Assessment Boundary:

- *Ozothamnus tesselatus*;
- *Acacia pendula*;
- *Eucalyptus glaucina* (Slaty Red Gum);
- *Cymbidium canaliculatum*;
- *Asperula asthenes* (Trailing Woodruff);
- *Thesium australe* (Austral Toadflax); and
- *Pterostylis gibbosa* (Illawarra Greenhood).

The patches of intact and regenerating woodland present within the Assessment Boundary provide marginal habitat for the threatened flora species that have the potential to occur. The likelihood of occurrence for these flora species is assessed in **Appendix I**.



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INTEGRA UNDERGROUND MINE

GLENCORE | Hansen Bailey ENVIRONMENTAL CONSULTANTS

Vegetation Communities

FIGURE 19

Threatened Fauna

No threatened fauna species were recorded within the Assessment Boundary during the field survey for the Modification. However, a number of threatened fauna species have previously been recorded within and surrounding the Assessment Boundary. Most of the potential habitat for these fauna species has been cleared under existing project approvals.

Seventeen listed species are considered likely to occur within the Assessment Boundary, including 10 birds and seven mammals. An additional 18 listed species are considered as having the potential to occur, including a further 10 birds, seven mammals and one amphibian. The species that have the potential to occur are described in **Appendix I**.

The Assessment Boundary does not support a high diversity of fauna species, mostly due to the simplified and highly modified nature of the habitat present. The patches of habitat within the Assessment Boundary are relatively isolated from more intact woodland. The integrity of the habitats is further compromised by the presence of feral animals, which prey upon or compete with native fauna. Assessments of Significance for the listed fauna species that have potential to occur within the Assessment Boundary are provided in **Appendix I**.

Groundwater Dependent Ecosystems

Central Hunter Swamp Oak Forest (see **Figure 19**) is a riparian vegetation community and occurs within the Assessment Boundary along Bettys Creek. An area of Hunter Valley River Oak Forest occurs immediately adjacent to the Assessment Boundary. Central Hunter Swamp Oak Forest and Hunter Valley River Oak Forest are classed as "Terrestrial Vegetation' Groundwater Dependant Ecosystems (GDEs).

Some disturbance of Central Hunter Swamp Oak Forest is predicted to occur due to the construction of powerlines across Bettys Creek. Surface disturbance will be limited within to a 30 m wide corridor for the 66 kV powerline and a 15 m wide corridor for the 11 kV powerline. The predicted disturbance due to the construction of powerlines is included in the disturbance areas shown in **Table 20**.

Underground mining has the potential to alter hydrological regimes, which are of importance to GDEs. However, due to the significant depth of the proposed mining activities, the Modification is not predicted to induce any measurable drawdown of alluvial aquifers (including the Bettys Creek alluvial aquifer). Similarly, impacts on stream baseflow are predicted to be negligible (as explained in **Section 8.3.3**). Therefore, the Modification is not expected to result in any significant indirect impacts to GDEs.

Investigations into the presence of stygofauna were undertaken by EcoLogical (2017) as part of the environmental assessments associated with the proposed modification to MOC (refer to **Section 2.7.1**). Samples were extracted from bores within the Permian coal seams, shallow rock and Quaternary alluvial aquifers of Swamp Creek, Main Creek, Bettys Creek and Yorks Creek. Five taxa were classified as stygofauna; however no stygofauna were collected from

the shallow hard rock aquifers, coal seam aquifers, or Bettys Creek and Main Creek alluvial aquifers.

Indirect Impacts

Indirect impacts to biodiversity values may occur as a result of subsidence, alteration of hydrological regimes, habitat fragmentation, edge effects and erosion and sedimentation. Terrestrial vegetation is generally not sensitive to subsidence effects. GDEs have the potential to be affected by subsidence; however, as explained in **Section 8.3.3**, the Modification is not predicted to result in any measurable drawdown of alluvial aquifers. Therefore, the Modification is not expected to result in any significant indirect impacts to biodiversity values.

8.8.4 Mitigation and Management

HVCC currently manages potential impacts to ecological values through the implementation of:

- Longwalls 13 and 14 Extraction Plan; and
- Biodiversity Management Plan.

In addition, indirect impacts associated with subsidence are managed through the implementation of the following management plans, procedures and monitoring programs:

- Subsidence Monitoring Program;
- Subsidence Monitoring and Repair Procedure; and
- Water Management Plan.

The Biodiversity Management Plan will be updated to include the potential impacts of the Modification. In addition to the mitigation measures that are currently implemented at Integra Underground, the following mitigation measures are proposed to ensure that the direct and indirect ecological impacts of the Modification are minimised:

- Include an additional subsidence monitoring location within the Ravensworth State Forest and Southern Remnant area to monitor impacts from subsidence;
- Vegetation communities identified as CEEC/EEC will be avoided;
- Removal of hollow-bearing trees, proximate stags and larger trees (trunk diameter > 10 cm) will be avoided wherever practicable;
- Clearing of intact woodland and forest patches will be avoided wherever practicable;
- Pre-clearance assessments will be conducted and vegetation removal for the construction of surface infrastructure will be supervised;
- Hydrological function and fauna passage in the creeks and riparian zones will be maintained during construction activities;

- Existing tracks will be utilised and the creation of temporary access tracks (during construction) will be minimised as far as practicable;
- Topsoil will be reinstated to disturbed areas as soon as practicable after construction; and
- All measures will be communicated to all employees and contractors to ensure that the measures are understood and observed.

HVCC will undertake like-for-like planting to compensate for the removal of established trees within areas that are only predicted to be impacted by the Modification (i.e. excluding areas that are approved to be disturbed by MOC).

8.9 ABORIGINAL HERITAGE

8.9.1 Background

An Aboriginal and Historic Heritage Impact Assessment for the Modification was undertaken by OzArk Environmental and Heritage Management (OzArk). This assessment identified the Aboriginal archaeological values present within the Assessment Boundary and recommended measures to avoid impacts to items of Aboriginal heritage significance. The Aboriginal and Historic Heritage Impact Assessment is provided in full in **Appendix J**.

Numerous heritage studies have been undertaken in the vicinity of the Assessment Boundary, including previous assessments undertaken for Integra Underground and MOC. The findings of previous studies were considered in this Assessment.

Aboriginal stakeholders were consulted through the Aboriginal Cultural Heritage Working Group, which held a meeting on 24 August 2017 (see **Section 6.1**).

8.9.2 Methodology

The assessment was undertaken in accordance with the "Code of Practice for the Investigation of Aboriginal Objects in New South Wales" (DECCW, 2010) and the "Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW" (OEH, 2011).

Desktop Assessment

A number of archaeological studies have been undertaken in the vicinity of the Modification, including previous assessments for approved developments at Integra Underground and MOC. In addition, a number of archaeological salvage programs for MOC have been undertaken within and surrounding the Assessment Boundary. These archaeological studies and salvage programs were reviewed to gain an understanding of the regional archaeological context.

Searches of the following registers were conducted to identify previously recorded heritage sites within the Assessment Boundary:

- Commonwealth heritage registers;
- National Native Title Claims Search;

- Aboriginal Heritage Information Management System (AHIMS) database; and
- Singleton LEP.

A predictive model was used to determine the likelihood of Aboriginal sites being present within the Assessment Boundary. The Aboriginal Sites Decision Support Tool (ASDST) (OEH, 2014) was used to predict the likelihood of Aboriginal sites being present prior to European settlement. The ASDST provides separate likelihood ratings for each type of site: stone quarries, scarred trees, burial sites, stone artefacts and grinding grooves. These likelihood ratings do not account for the effects of land disturbance in the period following European settlement. However, the ASDST does provide "accumulated impacts" ratings, which indicate the extent that Aboriginal sites have been impacted by post-settlement land uses.

Field Survey

A survey of the area within the Assessment Boundary was undertaken by an archaeologist on 6 July 2017. The archaeologist assessed all archaeologically sensitive landforms such as the areas adjacent to Bettys Creek, the remaining portion of Ravensworth State Forest and landforms in which sites have been previously recorded. The field survey included a representative sample of all landforms within the Assessment Boundary.

8.9.3 Impact Assessment

Predictive Model

The ASDST predicted that stone artefacts (isolated finds and artefact scatters) have the potential to occur in any landform and are the predominant site types occurring in the region. Whilst there is potential for these sites to occur within the Assessment Boundary, previous assessments, salvage programs and historic land disturbance are likely to have uncovered the larger occurrences of these sites.

The ASDST predicted that scarred trees and burial sites have the potential to be present within the Assessment Boundary. However, due to the extensive land disturbance that has occurred as a result of historic land uses, these site types are considered a rare site type and unlikely to be present within the Assessment Boundary.

The ASDST predicted that stone quarries had the potential to be present within the Assessment Boundary. However, these sites require suitable rock outcrops, which have a low probability of occurring within the Assessment Boundary.

Field Survey

The Assessment Boundary does not contain any items of Aboriginal cultural heritage that are listed under the Commonwealth heritage register or the Singleton LEP.

The search of the AHIMS database identified six sites that are recorded as being within the Assessment Boundary (see **Table 21** and **Figure 20**). One of these sites (37-3-0668) is located in a highly modified area and is assumed to have been salvaged. The locations of the other five sites were inspected during the field survey. Although the survey did not identify any

surface artefacts at these locations, the sites are regarded as remaining extant within the landscape.

The field survey did not identify any new sites within the Assessment Boundary. In addition, the field survey did not identify any landforms within the Assessment Boundary that have the potential to contain further subsurface archaeological deposits.

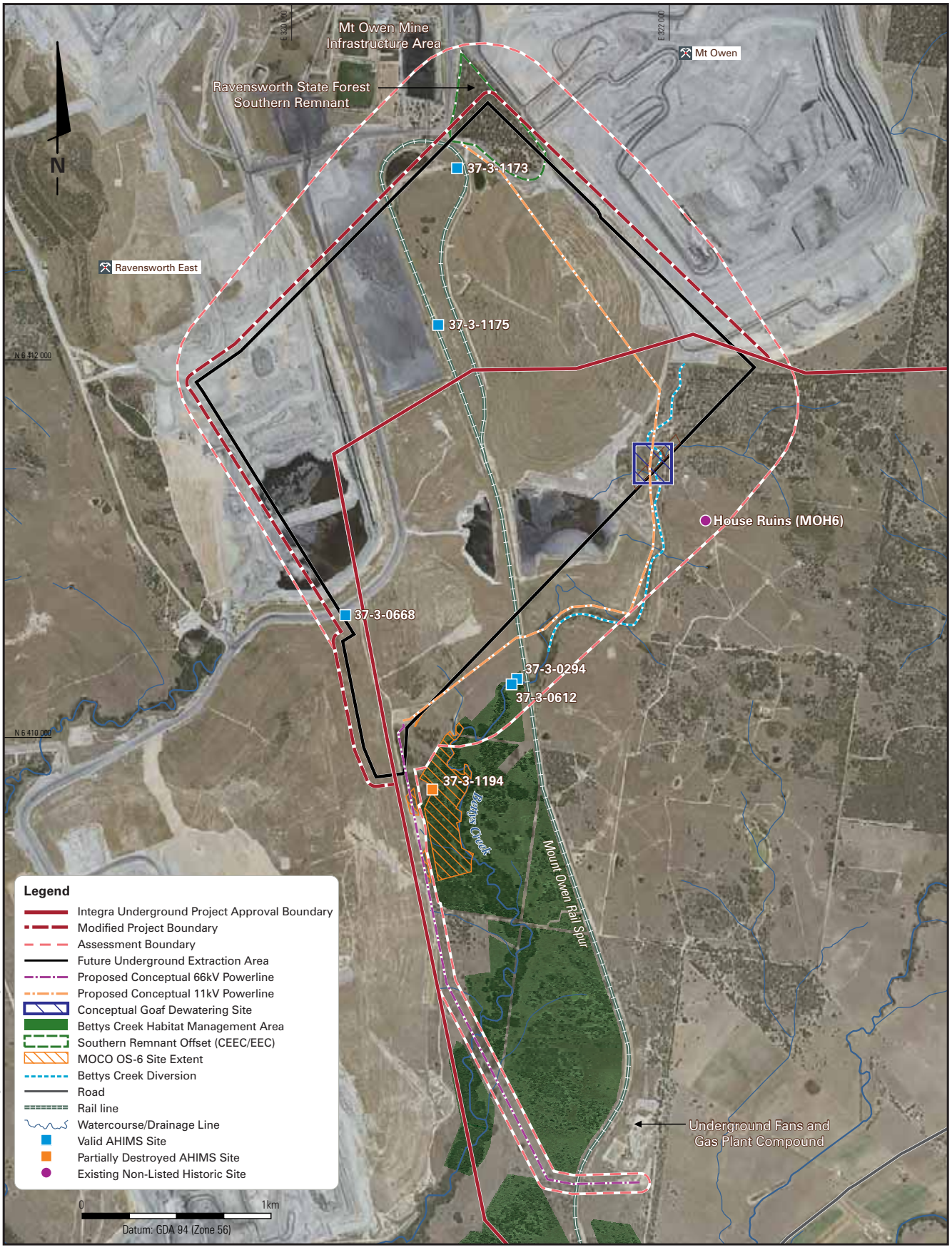
Potential Impacts

MOCO OS-6 (37-3-1194) is located to the east of an existing access track which is within the indicative easement for the 66 kV powerline. **Figure 20** shows an indicative location of the site however the full extent of site extends west to the access track. Avoidance of the site could be achieved by siting the powerline to the western side of the access track and within an existing disturbed area. None of the other AHIMS sites within the Assessment Boundary are expected to be impacted by surface disturbance.

Four of the recorded Aboriginal heritage sites are expected to experience subsidence movements. Indirect impacts due to subsidence may include surface cracking and/or water pooling. However, the types of sites located within the Assessment Boundary (artefact scatter or isolated find) are generally not sensitive to subsidence effects.

Table 21
AHIMS Sites Located Within the Assessment Boundary

AHIMS ID	Site Name	Site Type	Field Survey Validation	Nature of Potential Impacts
37-3-1173	MOCO IF-4	Isolated find	Not visually identified	Indirect impacts due to subsidence
37-3-1175	MOCO IF-6	Isolated find	Not visually identified	Indirect impacts due to subsidence
37-3-0668	Swamp Creek PAD	Unknown	The recorded location of this site is within a highly modified landform. The site is assumed to have been salvaged.	N/A
37-3-0294	MORL 2	Artefact scatter	Not visually identified however protective fencing depicts location	Indirect impacts due to subsidence
37-3-1194	MOCO OS-6	Artefact scatter	Partially destroyed Not visually identified	Direct impact due to the 66 kV powerline easement
37-3-0612	Bettys Creek 22	Isolated find	Not visually identified	Indirect impacts due to subsidence



HB INTEGRA MOD8 1702 F20 Aboriginal and Historic Heritage Sites 23 11 2017

INTEGRA UNDERGROUND MINE

GLENCORE | Hansen Bailey ENVIRONMENTAL CONSULTANTS

Aboriginal and Historic Heritage Sites

FIGURE 20

8.9.4 Mitigation and Management

Impacts to Aboriginal heritage are currently managed and mitigated through the implementation of the Aboriginal Heritage Management Plan (AHMP). The AHMP details the following:

- A system of identifying and protecting items and areas of cultural value;
- Procedure for consulting with Aboriginal stakeholders;
- Procedure for recording, salvaging and monitoring Aboriginal sites; and
- Measures to be implemented if an unexpected find is identified.

The AHMP will be updated to address the potential impacts of the Modification. The AHMP will be updated in consultation with relevant regulatory authorities and Aboriginal stakeholders.

Direct impacts to MOCO OS-6 will be avoided if practicable. If avoidance of the site is practicable, the site will be suitably demarcated to prevent disturbance during the construction of the 66 kV powerline. If direct impacts are unavoidable, surface collection of the remaining artefacts will be undertaken in accordance with the AHMP. Monitoring of site condition will continue to be undertaken in accordance with the AHMP to determine if there are any impacts due to subsidence.

8.10 HISTORIC HERITAGE

8.10.1 Background

An Aboriginal and Historic Heritage Impact Assessment for the Modification was undertaken by OzArk. This assessment identified the archaeological sites present within the Assessment Boundary and recommended measures to avoid impacts to these sites. The Aboriginal and Historic Heritage Impact Assessment is provided in full in **Appendix J**.

8.10.2 Methodology

The assessment was undertaken in accordance with the *Historical Archaeology Code of Practice* (Heritage Council, 2006).

Searches of the following registers were conducted to determine whether any listed heritage items are present within the Assessment Boundary:

- National and Commonwealth heritage registers;
- State heritage register; and
- Singleton LEP.

A field survey of the area within the Assessment Boundary was undertaken by an archaeologist on 6 July 2017.

8.10.3 Impact Assessment

OzArk conducted searches of the relevant heritage registers and determined that there are no listed heritage items within the Assessment Boundary.

One non-listed site (MOH6) is located within the Assessment Boundary, as recorded by Umwelt in 2014 (see **Figure 20**). The site is not expected to be directly impacted by the Modification; however, it is approved to be disturbed by the MOCO Project. Site MOH6 is a former house which was previously assessed as having no heritage significance or research potential. As such, the Modification will not result in any impacts to historic heritage values.

The field survey did not identify any additional historic sites within the Assessment Boundary. In addition, the landforms within the Assessment Boundary are not considered as having the potential to contain subsurface archaeological deposits due to the highly modified landscape and generally thin soils.

A number of non-listed historical sites are located to the west of the Modification. These sites will not be impacted by the Modification.

8.10.4 Mitigation and Management

Given that there are no sites of heritage significance within the Assessment Boundary, no additional mitigation and management measures are required for the Modification. However, the Non-Aboriginal Heritage Management Plan will be implemented in the event of an unanticipated discovery of a potential historical archaeological material, site or item.

8.11 TRAFFIC

8.11.1 Background

A Traffic Impact Assessment for the Modification was undertaken by WSP. This assessment reviewed the existing condition of the road network in the vicinity of Integra Underground and assessed the impacts of the potential traffic volumes generated by the Modification. The Traffic Assessment is provided in **Appendix K**.

8.11.2 Methodology

The existing condition of the road network was assessed through traffic surveys of the key roads and intersections that will be utilised by traffic associated with the Modification. The existing performance of key intersections was assessed through traffic modelling. The safety of the existing network was assessed through a review of crash data provided by NSW Roads and Maritime Services (RMS).

The incremental impacts of the Modification on the performance of key roads and intersections were assessed by comparing the projected construction traffic to existing traffic volumes. Given that the Modification will not alter the operational workforce or the approved duration of mining operations, an assessment of impacts during the operational phase was not required.

Traffic Surveys

Intersection traffic surveys were undertaken by Austraffic on Wednesday 28 June 2017 at the key intersections for this assessment, namely:

- The New England Highway and Bridgman Road;
- Bridgman Road and Stoney Creek Road; and
- The New England Highway and Glennies Creek Road.

Further mid-block tube surveys were undertaken by Austraffic between 26 June and 2 July 2017 for a total of 24 hours over 7 days at the following locations:

- Middle Falbrook Road between Nobles Lane and the existing Integra Underground access road;
- Stoney Creek Road near the intersection with Middle Falbrook Road; and
- Glennies Creek Road north of Nobles Lane.

SIDRA

Traffic modelling (using the SIDRA 7 model) was undertaken to assess performance of the key intersections under existing conditions. Intersection performance is expressed through the Level of Service (LoS) provided by the intersection.

Background traffic volumes (including both mining and non-mining related traffic) were assumed to increase by up to 2% per annum. Increases in traffic volumes due to mining proposals at Ashton Coal Mine and Rix's Creek Coal Mine were also included in background traffic volumes.

8.11.3 Impact Assessment

The Traffic Impact Assessment predicted the potential impacts to road network capacity, intersection performance and road safety during both the construction and operational phases of the Modification.

Traffic Generation during Construction

During the construction phase of the Modification, vehicles will access the site via Middle Falbrook Road (the existing access), Hebden Road (via MOC), Glennies Creek Road and Forest Road. During peak periods in the construction phase, the Modification is predicted to generate approximately 68 vehicles/day, with approximately 14 vehicles/hour occurring during the AM and PM peak hours.

Construction activities will generally be carried out within the standard work hours prescribed by the Interim Construction Noise Guideline (DECC, 2009).

Traffic Generation during Operations

Given the Modification will not increase the operational workforce or the approved duration of mining at Integra Underground, no additional traffic is anticipated to be generated during the operational phase of the Modification. Access to the site during the operational phase will be via the new and existing access roads off Middle Falbrook Road.

Road Intersection Performance

The results of the traffic modelling indicate that all of the key intersections are performing at satisfactory levels of service under existing conditions. The current LoS for the key intersections, during both the AM and PM peak periods, are presented in **Table 22**. **Table 22** also shows the predicted increase in traffic at the key intersections as a percentage of the total traffic during the weekday AM and PM peak periods.

The New England Highway / Bridgman Road and New England Highway / Glennies Creek Road intersections currently carry large volumes of vehicles during peak periods. **Table 22** shows the predicted increase in traffic due to the Modification (14 vehicles/hour during peak hours) represents a negligible increase to existing traffic volumes, and will not significantly affect the performance of these intersections.

Table 22
Predicted Impacts on Key Intersections

Intersection	AM Peak Period		PM Peak Period	
	Level of Service	Increase in total intersection traffic (%)	Level of Service	Increase in total intersection traffic (%)
New England Highway / Bridgman Road	D	0.6	B	0.5
Bridgman Road / Stoney Creek Road	A	11	A	10
New England Highway / Glennies Creek Road	C	0.9	B	1.2

The Bridgman Road / Stoney Creek Road intersection currently carries approximately 132 vehicles during the AM peak (6:15–7:15) and 146 vehicles during the PM peak (15:45–16:45). The predicted traffic movements generated by the Modification represent an 11% increase during the AM peak and 10% increase during the PM peak. The Bridgman Road / Stoney Creek Road intersection has ample capacity to accommodate the additional vehicle movements generated by the Modification.

Although no traffic counts were conducted at the New England Highway / Hebden Road intersection, the addition of 14 vehicles/hour during peak hours is not expected to have a material impact on the performance of that intersection.

Mid-block Performance

The results of the mid-block surveys indicate that all of the key roads are exhibiting good mid-block performance (LoS "A") under existing conditions. The small volumes of traffic generated by the Modification will not materially affect the mid-block performance of these roads.

Road Safety

Impacts on road safety are predicted to be negligible. The construction of a new intersection along Middle Falbrook Road will improve road safety and traffic operation during both the construction and operational phases of the Modification.

Public Transport

Hebden Road is utilised by school buses that service the schools in Singleton. No other public transport services operate along Bridgman Road, Middle Falbrook Road, Stoney Creek Road, Glennies Creek Road or Hebden Road. Due to the low traffic volumes that will be generated during construction, the Modification is not expected to significantly impact upon school bus services.

Freight, coal and passenger rail services utilise the Main Northern Rail Line which crosses Hebden Road, Glennies Creek Road and Middle Falbrook Road via level crossings. Given level crossings are controlled by traffic signals and road signs, vehicle movements associated with Modification will not impact upon train services.

8.11.4 Mitigation and Management

Impacts on the road network during the construction period of the Modification are expected to be negligible. The additional construction traffic will be temporary in nature and will not impact upon the performance of the road network.

The construction of a new intersection along Middle Falbrook Road will improve the operational efficiency and safety of this road. The new intersection and access road will be designed and constructed in accordance with the relevant Austroads standards. HVCC will implement suitable traffic controls during the construction of this intersection to maintain traffic flows. That is, the proposed intersection will be constructed without the requirement for temporary road closures. The proposed works along Middle Falbrook Road will be undertaken pursuant to the consent of SSC under Section 138 of the Roads Act (see **Section 5.3.8**).

To ensure the safe operation of all services during the construction phase, the following measures are proposed:

- Minimise the use of level crossings on Hebden Road and Glennies Creek Road during periods of known rail movements;
- Information regarding the safe use of level crossings will be provided to construction personnel; and
- Where possible, construction traffic is to scheduled outside the hours of school pick up and drop off time on Hebden Road where school bus services are provided.

8.12 ECONOMICS

8.12.1 Background

An Economic Impact Assessment was undertaken by Cadence Economics to assess the net benefits (both direct and indirect) of the Modification on the regional and NSW economies. The Economic Impact Assessment is provided in **Appendix L**.

8.12.2 Methodology

The assessment was undertaken in accordance with the NSW Government's economic assessment framework set out in the *Guidelines for the economic assessment of mining and coal seam gas proposals* (2015) (the Economics Guidelines).

The assessment included a Cost Benefit Analysis (CBA), which provides an estimate of the net benefits and costs of the Modification to NSW. The CBA assumed total capital expenditure of $59.5 million, and average coal prices of $160 per tonne and $112 per tonne for hard coking coal and semi-soft coking coal, respectively.

A Local Effects Analysis (LEA) was undertaken to estimate the potential costs and benefits of the Modification to residents in the region. The Lower Hunter Statistical Area Level 3 (Lower Hunter SA3), as defined by the Australian Bureau of Statistics, was adopted as the region for this analysis.

The economy-wide impacts of the proposed Modification were further assessed using a Computable General Equilibrium (CGE) model. The CGE analysis was used to estimate the net benefit of the Modification on economic activity and the standard of living for residents in the Lower Hunter SA3 and more broadly in NSW.

The financial assumptions on which the economic assessment is based are detailed in **Appendix L**.

8.12.3 Economic Analysis

Cost Benefit Analysis

In accordance with the Economics Guidelines, the analysis was categorised into direct and indirect benefits, and direct and indirect costs. The categories are detailed below.

Direct Benefits

The direct benefits are those paid by the proponent to the government and are derived from three sources:

- The net producer surplus generated by the Modification that is attributable to NSW;
- The share of company tax payments that are attributable to NSW; and
- Other tax payments (such as royalties and payroll tax) that are payable to the NSW and local government.

Table 23 provides a summary of the direct benefits of the Modification attributable to NSW. The total direct benefits to NSW generated by the Modification are estimated to be approximately $80.9 million (NPV).

Table 23
Summary of Direct Benefits to NSW

Net Financial Direct Benefit Source	NPV* ($ million)
Net producer surplus attributable to NSW	-
Company income tax attributable to NSW	25.3
Payments to the NSW and local Government	55.6
Total direct financial benefit attributable to NSW	**80.9**

** NPV in 2017 Australian dollars based on a 7 % real discount rate*

The net producer surplus attributable to NSW has been assumed to be zero (as per **Table 23**), due to Integra Underground being 100% foreign owned.

Benefits payable to the NSW State government and local government (SSC) include coal royalties, payroll tax, council rates and land taxes. These benefits are estimated at approximately $55.6 million (NPV).

The Modification has been estimated to generate $220.8 million (NPV) in total profit over the period from 2018 to 2023. At the company tax rate of 30%, the Modification is predicted to generate $79.1 million (NPV) in company tax. The share of company tax that is attributable to NSW is 32%, which is equivalent to NSW's share of the national population. Therefore, the company tax attributable to NSW is estimated at $25.3 million (NPV).

Indirect Benefits

The indirect benefits are generated by parties that engage with the proponent and are derived from three sources:

- The net economic benefit to workers in NSW;
- The net economic benefit to suppliers in NSW; and
- Any land owner premiums attributable to the Modification.

Table 24 provides a summary of the indirect benefits of the Modification attributable to NSW. The total indirect benefit to NSW is estimated at approximately $124.6 million (NPV).

Table 24
Summary of Indirect Benefits to NSW

Net Economic Benefit (Indirect)	NPV*($ million)
Net economic benefit to workers	54.1
Net economic benefit to suppliers	70.5
Land owner premiums (land sales made above market rates)	-
Total indirect benefit attributable to NSW	**124.6**

** NPV in 2017 Australian dollars based on a 7 % real discount rate*

The net benefit to workers was calculated based on the difference between the average annual wage of a mining employee and the average annual wage prevailing in NSW. It has been assumed that in the event the Modification did not proceed, persons currently employed at Integra Underground would find alternative work within NSW at the average annual wage. It has also been assumed that the disutility of working within the mining sector is zero. Disutility is further discussed in the Sensitivity Analysis summary below. Under these assumptions, the net benefit to workers has been estimated at $54.1 million (NPV).

The economic benefit to suppliers resulting from the Modification is estimated as a producer surplus generated from goods and services provided by NSW businesses. The total supplier benefits were estimated at $70.5 million (NPV), based on the estimated $349.6 million (NPV) in intermediate inputs that will be required for the Modification over its duration.

Indirect Costs

The indirect costs are those generated by the proponent through environmental, social or public infrastructure costs, that are borne by the NSW community. The indirect costs of the Modification, consistent with the Economics Guidelines, are categorised as follows:

- Net public infrastructure costs;
- Estimated loss of surplus to other industries;
- Net environmental, social and transport-related costs; and
- Net environmental costs.

The Modification will not impact upon off-site infrastructure. The Modification includes infrastructure upgrades including additional electricity transmission lines and distribution lines and an additional access from Middle Falbrook Road, all of which will be funded by HVCC.

The industries surrounding the Modification consist of mining operations that are owned and managed by Glencore's subsidiary companies. Mining extraction and operation will be collaboratively managed by Glencore's subsidiary companies. A small area of Ravensworth State Forest is located within the Assessment Boundary and may experience minor subsidence impacts. The potential indirect costs to public infrastructure or neighbouring industry are negligible.

Environmental costs of the Modification to NSW were also assessed. The only indirect cost attributable to NSW is GHG emissions. The total global cost of GHG emissions was determined to be $31.7 million (NPV). Of this total cost, approximately $33,384 (NPV) is attributable to NSW, assuming that NSW's share is proportionate to its share of the global population.

Net Benefit

The CBA estimated that the Modification will generate a total net benefit to NSW of $205.5 million (NPV). The total net benefit is comprised of $80.9 million and $124.6 million (NPV) in direct and indirect benefits, respectively.

Local Effects Analysis

The LEA is used to measure the benefits and costs of the Modification on the local community. The Lower Hunter SA3 includes the regional centres of Singleton and Cessnock. However, the Modification is located within the central west of the Lower Hunter SA3 which is sparsely populated. Coal mining has been, and continues to be, a significant contributor to the economy of the Lower Hunter SA3.

The major regional centres of Newcastle and Maitland lie within the broader Hunter region. The Modification has assumed that 50% of inputs will be supplied from these regional centres. Therefore, the Modification will generate economic benefits to these areas, even though the broader Hunter region has not been included in the LEA.

Direct and Indirect Benefits

Table 25 summarises the direct and indirect benefits attributable to the local community based on the LEA.

Table 25
Summary of Benefits to the Local Community

Net Direct Economic Benefit	NPV*($ million)
Net producer surplus attributable to local community	-
Royalties, payroll tax and Council rates	0.8
Company tax	-
Total direct benefit	**0.8**
Net Indirect Economic Benefit	
Net economic benefit to landholders	**-**
Net economic benefit to local workers	**51.4**
Net economic benefit to local suppliers	**26.5**
Total indirect benefit	**77.9**

** NPV in 2017 Australian dollars based on a 7 % real discount rate*

The total net benefit to the Lower Hunter SA3 is estimated to be $78.7 million (NPV) with the major contribution provided by indirect benefits resulting from the Modification. The economic benefit of $51.4 million (NPV) to local workers is based on the assumption that 95% of the direct employees of Integra Underground will continue to be drawn from the Lower Hunter SA3. The economic benefit to local suppliers is estimated at $26.5 million (NPV), based on the assumption that 37.5% of the inputs to the Modification are sourced from the Lower Hunter SA3. Local council rates payable to SSC are estimated at $800,000 (NPV).

Direct and Indirect Costs

The Modification will not generate direct costs to the Lower Hunter SA3, and indirect costs (including GHG emissions) will be negligible.

CGE Analysis

The CGE analysis enables the impacts of projects to be assessed comprehensively across an economy-wide framework. Cadence Economics utilised their internal General Equilibrium Model for the CGE Analysis. The CGE analysis was based on the following two assumptions:

- Capital expenditure of $70.3 million (NPV terms); and
- Coal revenue of $816.1 million (NPV terms).

Three labour market assumptions were modelled to test the responsiveness of the NSW labour market to the increase in expenditure (the labour supply elasticity). Labour supply elasticities of low (0), medium (0.15) and high (0.3) were modelled (refer to **Appendix L**).

Gross Regional and State Income

The Modification is projected to increase the Gross Regional Income (GRI) in the Lower Hunter SA3. GRI is a measure of economic welfare and is related to the projected employment generated by the Modification. The Modification is predicted to increase GRI in the Lower Hunter SA3 by approximately $834 million to $876 million (NPV), depending on the labour supply response.

The projected employment is predicted to average 195 full time equivalent (FTE) workers under the high labour response and 109 FTE workers under the medium labour response assumption. The increase in employment is expected to peak at 202 FTE workers in the year 2020.

The Gross State Income (GSI) is a measure of economic welfare at a state level. The Modification is predicted to increase GSI by $1,201 million to $1,268 million (NPV), depending on the labour supply response. The associated employment effects (across NSW) are predicted to average 272 FTE workers under the high labour response scenario and 150 FTE workers under the medium labour response scenario.

Sensitivity Analysis

In accordance with the Economics Guidelines, a sensitivity analysis of the results provided by the CBA, LEA and CGE modelling was undertaken. The sensitivity analysis helps to identify the key variables that are major influences on the costs and benefits of the Modification and determines how sensitive these cost and benefits are to changes in economic variables. The sensitivity analysis is provided in full in **Appendix L**.

The CBA and LEA sensitivity analysis comprised:

- Revenue sensitivity;
- Cost-base sensitivity;
- Worker and supplier assumptions; and
- Discount rate sensitivity.

The sensitivity analysis did not consider changes to the predicted environmental impacts as the indirect costs of these impacts are projected to be minor. A worst case estimate of net benefits and best case estimate of net benefits were also undertaken.

The sensitivity analysis of the CBA determined that the estimated net benefits are robust. That is, the net benefits remain positive after testing all key assumptions of the CBA analysis. The robustness of the sensitivity analysis is a reflection of the Modification's high value coal product, low capital costs required to extract the resource and low indirect costs attributable to NSW. The worst case estimate of net benefits generated a net benefit of $153.6 million (NPV) compared to the best case estimate of $249.1 million (NPV).

Similarly, the sensitivity analysis of the LEA resulted in robust estimated net benefits. Regional growth within the local community is driven by benefits to the supplier and employees. Sensitivities that change the supplier benefits, through lower operational costs or lower supplier or economic benefit, have the greatest impact on the Lower Hunter SA3. The worst case estimate of net benefits generated a net benefit of $62.8 million (NPV) compared to the best case estimate of $85.3 million (NPV).

The sensitivity analysis demonstrates that the net benefits of the Modification are expected to remain strongly positive after analysis of all economic assumptions. Therefore, the Modification will generate net benefits to the Lower Hunter SA3 and NSW as a whole.

8.13 OTHER ENVIRONMENTAL ASPECTS

8.13.1 Soils and Agriculture

The proposed surface infrastructure will predominantly be located on land that has previously been disturbed by mining activities. There is an area of undisturbed land within the Mt Owen Rail Spur. HVCC has obtained a Site Verification Certificate which certifies that this land is not BSAL (see **Section 5.1.3**). The BSAL assessment supporting the application for a Site Verification Certificate is provided in **Appendix M**.

Topsoil disturbance will be limited to the construction of the following infrastructure:

- Goaf Dewatering Site;
- 66 kV and 11 kV powerlines;
- Surface auxiliary fans; and
- Gas drainage boreholes.

Topsoil disturbance will occur over a short construction period and will be undertaken in accordance with the EAMSIMP, Rehabilitation Management Plan and Biodiversity Management Plan. Undisturbed land that is not required to facilitate the safe operation of the proposed longwall mining operations will be reinstated to achieve a stable landform.

Colinta Holdings utilises the land overlying Integra Underground for cattle grazing enterprises. The conceptual alignment of the 66 kV powerline traverses land that is used for grazing operations. Surface disturbance will be limited to an access track for construction of the powerline and operational maintenance, and small construction footprints for the erection of the power poles. Topsoil will be reinstated to ensure a stable environment is maintained. Therefore, the construction of this powerline will be undertaken without disrupting existing cattle grazing operations.

8.13.2 Visual

The surface infrastructure for the Modification will be located on land that is owned by subsidiaries of Glencore and will be within the boundary of MOC. As such, the proposed infrastructure will be consistent with the existing visual character of the landscape in which they are located.

The only components of the proposed surface infrastructure that possess a significant height dimension are the proposed powerlines. The other infrastructure components are unlikely to be visible to the public due to their small size.

The proposed 66 kV powerline alignment follows the eastern extent of Glendell Mine before entering the Forest Road Ventilation Site. The 66 kV powerline may be visible from Forest Road. However, Forest Road is a local road that is generally used only for access to mine infrastructure.

8.13.3 Decommissioning and Mine Closure

The Rehabilitation Management Plan will be updated prior to the cessation of mining activities at Integra Underground. The Rehabilitation Management Plan will include rehabilitation and completion criteria, which will be developed in consultation with Mt Owen, Glendell and the relevant government authorities.

All mining infrastructure and salvageable infrastructure items will be decommissioned and removed from the site, unless that infrastructure is required for post-mining purposes (such as other industrial or community purposes). Infrastructure that may be beneficial for post-mining land uses may be retained, subject to commercial arrangements with future land owners.

Integra Underground is committed to creating a final landform that is safe, free draining and stable form a geomorphology perspective.

9 SUMMARY OF MANAGEMENT AND MITIGATION MEASURES

Table 26 lists the key management and mitigation measures that will be undertaken to minimise the potential environmental impacts of the Modification.

Table 26
Management and Mitigation Measures

Ref.	Commitment	Relevant Sections
1.	Extraction Plans will be prepared prior to undertaking longwall mining associated with the Modification. The Extraction Plans will include measures to monitor, mitigate and remediate subsidence impacts. Extraction Plans will also include various environmental management plans and asset management plans to manage impacts to built and natural features. Extraction Plans will be developed in consultation with the relevant regulatory authorities, land owners and asset owners.	**Section 8.1.4** **Section 8.2.4** **Section 8.8.4**
2.	The Water Management Plan (WMP) will be updated to include mitigation measures relevant to the Modification. The update to the WMP will include additional water monitoring measures required for the Modification. The WMP will be updated in consultation with the relevant regulatory authorities.	**Section 8.3.4** **Section 8.4.4**
3.	HVCC will continue to consult with Bloomfield Collieries regarding the proposed use of the C4 Dam at Rix's Creek North Mine.	**Section 4.3.6**
4.	All proposed works within 40 m of watercourses will be undertaken in accordance with the "Guidelines for Controlled Activities on Waterfront Land" (DPI, 2007).	**Section 8.4.4**
5.	The Biodiversity Management Plan will be updated to include mitigation measures relevant to the Modification. The Biodiversity Management Plan will be updated in consultation with the relevant regulatory authorities.	**Section 8.8.4**
6.	Direct disturbance of threatened ecological communities (EECs and CEECs) will be avoided.	**Section 8.8.4**
7.	Planting of like-for-like trees will be undertaken to compensate for the removal of established trees due to the Modification alone (i.e. not including areas that are approved to be disturbed by MOC)	**Section 8.8.4**
8.	Consultation with Forestry Corporation of NSW will continue during the development and finalisation of the mine plan for the Modification, as well as during the operational phase.	**Section 6.3**
9.	Appropriate erosion and sediment controls will be implemented in accordance with *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).	**Section 8.4.3**
10.	Existing tracks will be utilised wherever possible and the creation of temporary access tracks (for construction purposes) will be minimised as far as practicable.	**Section 8.8.4**
11.	Topsoil will be reinstated to disturbed areas as soon as practicable.	**Section 8.8.4**
12.	The Noise Management Plan will be updated to include mitigation measures relevant to the Modification. The Noise Management Plan will be updated in consultation with the relevant regulatory authorities.	**Section 8.5.4**
13.	A Construction Work Noise Protocol will be prepared if alternative temporary construction noise limits are sought.	**Section 8.5.4**

Ref.	Commitment	Relevant Sections
14.	The Air Quality and Greenhouse Gas Management Plan will be updated to include mitigation measures relevant to the Modification. The management plan will be updated in consultation with the relevant regulatory authorities.	**Section 8.6.4**
15.	The Aboriginal Heritage Management Plan will be updated to include mitigation measures relevant to the Modification. The management plan will be updated in consultation with the relevant regulatory authorities and Aboriginal stakeholders.	**Section 8.9.4**
16.	Avoidance of direct impacts to MOCO OS-6 will be achieved if practicable. If direct impacts are unavoidable, surface collection of the remaining artefacts will occur in accordance with the ACHMP.	**Section 8.9.4**
17.	An archaeologist will be present during land disturbance associated with the powerline crossing of Bettys Creek. In the event that heritage items are identified, the chance finds protocol in the AHMP will be followed.	**Section 8.9.4**
18.	The chance finds protocol in the Historical Heritage Management Plan will be followed if a potential historical site or item is identified.	**Section 8.10.4**
19.	The new intersection along Middle Falbrook Road will be designed in accordance with Austroads standards and to the satisfaction of Singleton Shire Council.	**Section 8.11.4**
20.	The EAMSIMP will be updated with measures to manage the construction of surface auxiliary fans and gas drainage boreholes.	**Section 4.3.3** **Section 4.3.4**

10 CONCLUSION

HVCC (a subsidiary of Glencore) acquired Integra Underground in December 2015. Given that HVCC and Mt Owen Pty Limited are both subsidiaries of Glencore, HVCC's acquisition of Integra Underground has given rise to the opportunity to recover the coal resources beneath the surface mining operations at MOC. The Modification will facilitate the recovery of up to an additional 9.9 Mt of ROM coal from the Middle Liddell seam, which represents the proper and economic development of the available coal resource.

The Modification is located in the vicinity of existing mining operations and is a significant distance from the nearest privately owned residence. This residence is subject to acquisition rights under PA 08_0101. Air quality and acoustic impacts at this residence are predicted to be negligible. Other private receptors (which are not subject to acquisition rights) are located a significant distance from the Modification and are not predicted to experience any exceedances of the regulatory air quality or noise criteria.

Five Aboriginal heritage sites are located within the Assessment Boundary. One site (MOCO OS-6) is located within the indicative corridor for the 66 kV powerline. Direct impacts to this site will be avoided where practicable. If avoidance of direct impacts is unavoidable, surface collection of the artefacts will be undertaken in accordance with the AHMP. No sites of historic heritage significance are located within the Assessment Boundary.

There will be no increase in operational traffic given that the Modification does not seek to increase the currently approved workforce of 280 personnel. A peak of 68 vehicles/day is predicted for the peak construction period. The vehicle movements generated by the short-term construction works are not expected to have a significant impact on the performance of the road network. The new intersection proposed for Middle Falbrook Road will improve safety and access to Integra Underground.

The Ravensworth State Forest is located near the northern extent of the Modification. Subsidence monitoring will be undertaken in the Ravensworth State Forest and ongoing consultation with the Forestry Corporation will be undertaken during further mine planning and the operational phase.

The Assessment Boundary consists predominantly of land disturbed by previous mining and agricultural land uses. Areas of woodland communities occur along drainage lines, associated with Ravensworth State Forest and surrounding the extents of MOC. The Modification is predicted to result in direct disturbance of up to 5.40 ha of native woodland vegetation, including 1.80 ha of Central Hunter Bulloak Regeneration, 2.02 ha of Central Hunter Swamp Oak Forest and 1.59 ha of rehabilitation. The majority of this disturbance, 3.45 ha, will occur within areas that are approved to be disturbed by the MOCO Project (SSD-5850). The Central Hunter Ironbark - Spotted Gum - Grey Box Forest vegetation community (listed as an EEC under the BC Act) is also present within the Assessment Boundary. However, direct disturbance of this vegetation community will be avoided. Vegetation within the Assessment Boundary has been identified as potential habitat for

threatened species. However, no areas of significance (e.g. roosting sites) were identified during the field survey. Impacts to GDEs are predicted to be negligible, as the Modification is not expected to result in any measurable drawdown of alluvial aquifers.

Subsidence impacts resulting from the proposed longwall extraction are expected to remain within the previous subsidence predictions for Integra Underground. The potential interactions between Integra Underground and the MOC North Pit will be addressed in the Extraction Plan(s) that will be developed for the Modification. The Extraction Plan(s) will be developed in close consultation with Mt Owen Pty Limited.

The water balance undertaken for the Modification has confirmed that there is sufficient capacity within the GRAWSS to accommodate the additional mine water accumulated by the Modification. The additional mine water make is expected to be utilised at MOC to satisfy its process water requirements. The water balance also determined that no additional raw water will be required from Glennies Creek. The use of C4 Dam (at Rix's Creek North Mine) as an additional raw water storage will further optimise water management at Integra Underground.

The impacts to alluvial groundwater systems as a result of the Modification are predicted to be negligible. The indirect water take from the alluvial and surface water systems is predicted to be less than 1 ML/year. The Modification is predicted to generate additional groundwater inflows of up to 257 ML/year (primarily from the hardrock aquifer). The hardrock aquifer has limited beneficial use due to its poor water quality and low yield rates. Therefore, the Modification will not significantly reduce the utility of the water resource.

The Modification will facilitate the more efficient extraction of the coal resource within the Middle Liddell seam. The additional coal extraction is predicted to generate direct net benefits to NSW valued at $80.9 million (NPV). The Modification is also predicted to generate substantial indirect benefits in the form of economic benefits to workers and suppliers. Given the positive net benefits to the local region and NSW, the Modification is justifiable from an economic efficiency perspective.

The impacts resulting from the Modification are similar in nature to the impacts of the existing operations (as approved under PA 08_0101). The implementation of the management and mitigation measures outlined in this EA will ensure that the potential environmental impacts of the Modification are appropriately managed.

* * *

For
HANSEN BAILEY

Andrew Wu
Senior Environmental Engineer

James Bailey
Director

11 ABBREVIATIONS

Term	Definition
µg/m^3	Micrograms per cubic metre
AGE	Australasian Groundwater and Environmental Consultants
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal Heritage Impact Permit
AHMP	Aboriginal Heritage Management Plan
AIP	*Aquifer Interference Policy*
ASDST	Aboriginal Sites Decision Support Tool
Assessment Boundary	The area that may be impacted by the Modification and includes the subsidence footprint and
BCA	Benefit Cost Analysis
Bloomfield Collieries	Bloomfield Collieries Pty Limited – the owner of Rix's Creek North Mine
BoM	Bureau of Meteorology
BC Act	*Biodiversity Conservation Act 2016*
BC Regulation	*Biodiversity Conservation Regulation 2017*
BSAL	Biophysical Strategic Agricultural Land
CBA	Cost Benefit Analysis
CCC	Community Consultative Committees
CCL	Consolidated Coal Lease
CEEC	Critically Endangered Ecological Community
CHPP	Coal Handling and Preparation Plant
CGE	Computable General Equilibrium
CO_2-e	Carbon Dioxide Equivalent
DA 80/952	Development approval for Glendell Mine
dB	Decibels
dBA	The peak sound pressure level, expressed as decibels (dB) and scaled on the '*A-weighted*' scale, which attempts to closely approximate the frequency response of the human ear
DoEE	Department of the Environmental and Energy (Commonwealth)
DP&E	Department of Planning and Environment
DPI	Department of Primary Industries
DRG	Division of Resources and Geoscience
DSC	NSW Dams Safety Committee
EA	Environmental Assessment
EAMSIMP	Exploration Activities and Minor Surface Infrastructure Management Plan
EC	Electrical Conductivity
EEC	Endangered Ecological Community
EL	Exploration Licence
EMS	Environmental Management Strategy
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*

Term	Definition
EPA	Environmental Protection Authority
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth)*
EPL	Environment Protection Licence
ERP	Eastern Rail Pit
FTE	Full-time equivalent (employee)
g/m^2/month	Grams per square metre per month
GDE	Groundwater Dependent Ecosystem
GHG	Greenhouse Gas
Glencore	Glencore Coal Pty Limited
Glendell	Glendell Tenements Pty Limited
GRAWSS	Greater Ravensworth Area Water Sharing Scheme
GRI	Gross Regional Income
GSI	Gross State Income
GWh	Gigawatt hour
ha	Hectare
HMA	Habitat Management Area
Hunter Regulated WSP	Water Sharing Plan for the Hunter Regulated River Water Source 2016
Hunter Unregulated WSP	Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009
HVCC	HV Coking Coal Pty Limited
ICNG	*Interim Construction Noise Guideline 2009*
Integra Coal Complex	Collective name for the Integra Underground Mine and Integra Open Cut Mine
kV	kilovolt
LA_1	The noise level exceeded for 1% of the time
LA_{eq}	The A-weighted equivalent continuous, or logarithmic average, noise level over a defined time period either measured or predicted at a specific location
LEA	Local Effects Analysis
LGA	Local Government Area
Lower Hunter SA3	Lower Hunter Statistical Area Level 3
LoS	Level of Service
LW	Longwall
MIA	Mine Infrastructure Area
Mining Act	*Mining Act 1992*
ML	Mining Lease
ML/Year	Megalitre per year
MNES	Matters of National Environmental Significance
MOC	Mount Owen Complex
MOCO Project	Mt Owen Continued Operations Project
MOD	Modification
Mount Owen Complex	Collective name for the Mt Owen, Ravensworth East and Glendell Mines.
MPL	Mining Purpose Lease
Mt	Million tonnes

Term	Definition
Mt Owen	Mt Owen Pty Limited
Mtpa	Million tonnes per annum
NAG	Noise Assessment Group
NMP	Noise Management Plan
North Coast Groundwater WSP	Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016
NPV	Net present value
NPW Act	*National Parks and Wildlife Act 1974*
NT Act	*Native Title Act 1993*
OEA	Overburden Emplacement Area
OEH	Office of Environment and Heritage
PA 08_0101	Project Approval 08_0101 for the Integra Underground Coal Project
PM	Particulate Matter
PM_{10}	Particulate Matter with a diameter less than 10 µm
$PM_{2.5}$	Particulate Matter with a diameter less than 2.5 µm
PMST	Protected Matters Search Tool
POEO Act	*Protection of the Environment Operations Act 1997*
Roads Act	Roads Act 1993
ROM	Run of Mine
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SEPP Mining	*State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*
Singleton LEP	*Singleton Local Environmental Plan 2013*
SPL	Sound Power Level
SRMS	Scaled Root Mean Square
SSC	Singleton Shire Council
SSD-5850	Development Consent for the Mount Owen Continued Operations Project
SVC	Site Verification Certificate
TDS	Total Dissolved Solids
TEOM	Tapered Element Oscillating Microbalance
TLO	Train Load Out
TP1	Tailings Pit 1
TP2	Tailings Pit 2
TSC Act	*Threatened Species Conservation Act 1995*
TSP	Total Suspended Particulates
VWP	Vibrating Wire Piezometers
WAL	Water Access License
WMP	Water Management Plan
WM Act	*Water Management Act 2000*
WSP	Water Sharing Plan

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