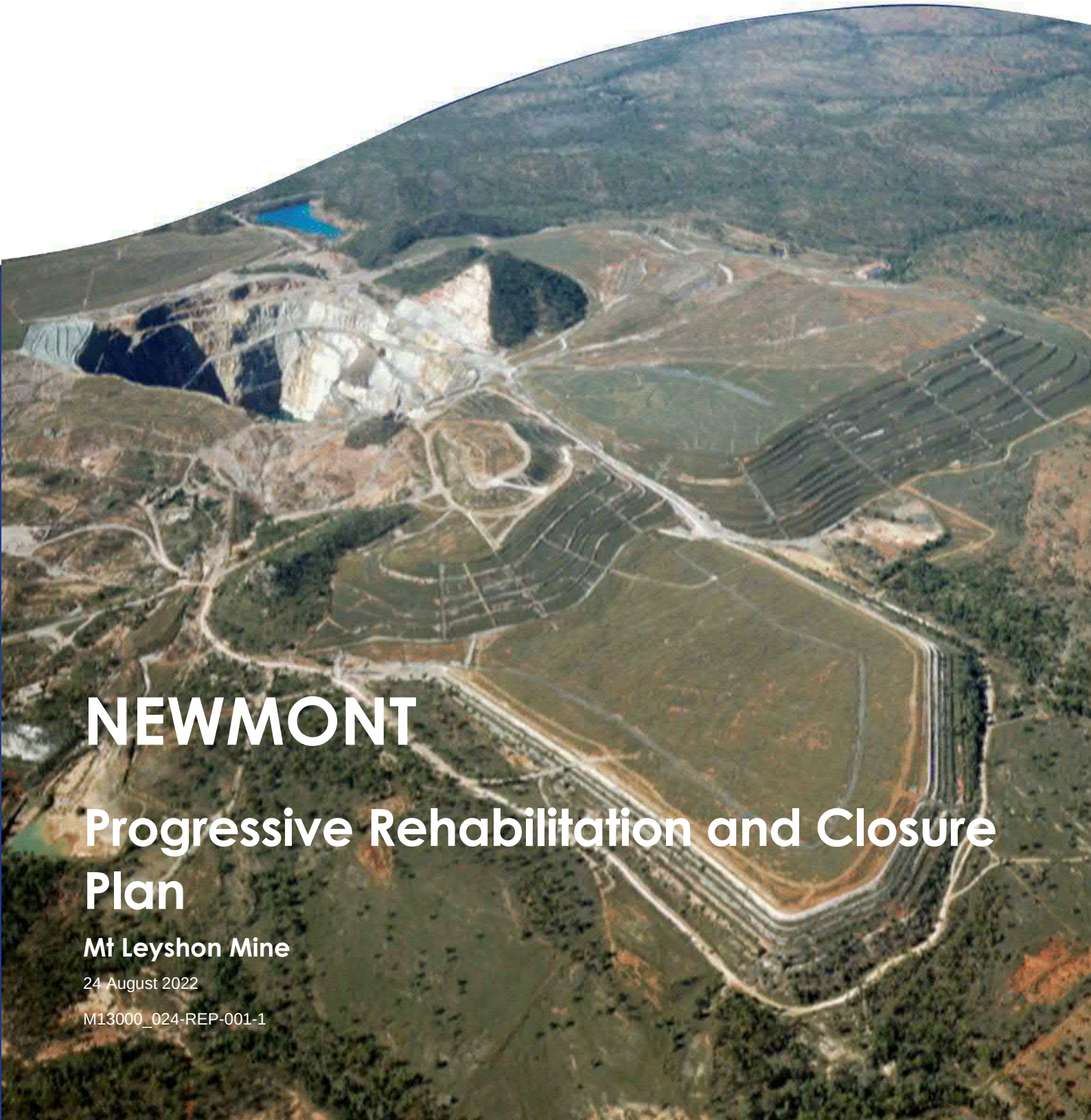

NEWMONT

Progressive Rehabilitation and Closure Plan

Mt Leyshon Mine

24 August 2022

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1 REHABILITATION PLANNING PART

1.1 PROJECT PLANNING

1.1.1 Project Description

In accordance with Sections 126(1)(b) and (c)(iii) of the *Environmental Protection Act 1994* (EP Act), this section includes a description of the Mt Leyshon Mine.

Mining Operation

Historical mining occurred in the Mt Leyshon area dating back to the late 1880s and consisted of small scale hard-rock mining operations which occurred sporadically until the beginning of World War I (with some further re-processing of tailings during World War II).

The Mt Leyshon Mine is an open pit gold mine located 24 km south of Charters Towers, which has been in closure since 2002. Modern large scale open cut mining operations commenced at the Mt Leyshon Mine in September 1986. It produced gold and silver, initially as a heap leach operation of oxide ore, and then via carbon in pulp (CIP) processing of primary un-oxidized ore commencing in 1989. Heap leaching of oxide ore was terminated in 1992, due to the oxide ore being exhausted. Processing of supergene ore via a two-stage leaching process was undertaken during 1992. The CIP plant was originally installed with a capacity of 2 million tonnes per annum (Mtpa) and was upgraded during the mining period to reach a maximum of 5.4 Mtpa. Open pit mining ceased due to depletion of the ore body in early 2001 after which mill feed was sourced from low grade stockpiles which were processed until March 2002.

Final closure designs for nearly all the facilities have been fully implemented and the mine is now primarily in a post-closure monitoring and maintenance phase which is being undertaken by Newmont Landco Pty Ltd (Newmont). Activities that are being undertaken during the post-closure monitoring and maintenance phase include:

- Monitoring and reporting to meet the requirements of the Environmental Authority (EA) EPML00863713.
- Water management operations to ensure that water that is not suitable for release to the environment is intercepted and pumped to the final void pit lake in accordance with the post-closure water management strategy.
- Maintenance of previously rehabilitated areas.
- Additional rehabilitation works.

No further mining or processing operations are proposed to occur at the Mt Leyshon Mine. It is noted that the Scats Stockpiles have been recognized to contain ore that may become commercially viable and may be subject to treatment processes if viable. The duration of the post-closure monitoring and maintenance phase is not able to be accurately predicted, due primarily to the need to continue to manage water that comes into contact with the mine landforms. For the purpose of the PRC plan development, a nominal 99-year future post-closure monitoring and maintenance period has been assumed until relinquishment of the mining leases can occur.

Ownership of the Mt Leyshon Mine has a complicated history. Exploration of the Mt Leyshon orebody was undertaken from the 1960s to the 1980s by Mount Isa Mines Ltd (MIM), Marathon Petroleum Australia Ltd, and Noranda Australia Ltd. The mine was developed in the 1980s by Pan Australian Mining Ltd, after purchasing a 50% interest in the operation from Noranda Australia and becoming the sole owners in 1986. In June 1989, Pan Australian Mining Ltd became part of the Normandy Poseidon Group of companies. During the mining period, in June 1991, the holder of the mining leases was changed to Mt Leyshon Gold Mines Ltd. In 1997, the company changed its name to Normandy Mt Leyshon Ltd. In 2002, Newmont outbid Anglogold to acquire all of the Normandy Mining operations, including the Mt Leyshon Mine. Under the conditions of the takeover, the Mt Leyshon mining leases and rights to the resource remained with a company called Leyshon Resources Ltd (LRL). A management agreement was enacted, in which LRL appointed Newmont to manage the low-grade stockpiles, and to implement the remainder of the site closure and rehabilitation plan. In 2016, Newmont acquired all Mt Leyshon mining leases and rights to resources from LRL.

1.2 MINING TENEMENTS

The Mt Leyshon Mine is comprised of five mining leases (MLs) (refer to Table 1.1 and Figure 1.1).

Table 1.1: Mining Leases

Mining Lease	Area (ha)	Operational Activities	Environmentally Relevant Activity
ML 10144	2,485	Mining, stockpiling, reserves, waste disposal, tailings disposal, plant, heap leach pads, water storage	33-Crushing, milling, grinding or screening >5000t yr. 8-(3a) Chemical storage >10m^3 but <500m^3 class C1 or C2 Mining – ML gold ore – 16, site specific
ML 10148	36	Access for water quality monitoring	
ML 10172	1	Satellite reserve, waste disposal	
ML 10173	18	Satellite reserve, waste disposal	
ML 1546	9	Satellite reserve, waste disposal	

1.3 PRIMARY MINE FEATURES/INFRASTRUCTURE

The primary features/infrastructure at the Mt Leyshon Mine are described in Table 1.2 and mapped in Figure 1.3). The location of environmentally relevant activities authorised under the EA are shown in Figure 1.4.

Third party infrastructure located within the Mt Leyshon mining lease area includes:

- Ergon Energy 66kV power transmission network (situated in the western parts of the mining lease outside of the mine disturbance area) and substation (located next to the mine office).
- Pump station and buried water pipeline to the Pajingo Mine which is owned by Minjar Gold Pty Ltd (situated in the western parts of the mining lease outside of the mine disturbance area and follows the Ergon Energy power transmission corridor through the majority of the mining lease).

The power corridor alignment for the proposed Copper String Project is planned to run through the northern part of the mining lease. If the project occurs, then electrical transmission masts and conductors will be located within the power corridor.

The Mt Leyshon Mine PRC Plan does not identify rehabilitation requirements for third party infrastructure located within the Mt Leyshon mining leases.

Table 1.2: Primary Mine Features/Infrastructure

Mine Feature / Infrastructure	Description
Waste Rock Storage Facilities (WRSF)	Southern WRSF, Northern WRSF and Eastern WRSF, all covered and vegetated.
Tailings Storage Facilities (TSFs)	Southern TSF, Old Northern TSF and New Northern TSF, all covered and vegetated.
Scats Stockpiles	Stockpiles of scats material (low grade ore determined too hard to process during mining period) at angle of repose, not covered or vegetated.
Processing Area	Remnant run-of mine (ROM), heap leach and low-grade ore stockpiles situated to the south-west of the final void, generally covered and revegetated. All processing equipment has been removed from the processing area with the exception of the substructure of a jaw crusher.
Pit Void	Final void for the original open cut mine pit situated in the centre of the mine site, partially filled with water.

Mine Feature / Infrastructure	Description
Water Containment and Storage Dams	Water containment and storage dams generally distributed around the perimeter of the mine disturbance footprint. The majority of the dams are still operational, while several dams were previously decommissioned and rehabilitated during the operating phase of the mine.
Seepage Sumps	A network of seepage sumps located typically downgradient of the tailings storage facilities and water containment dams.
Spine Drain	Engineered final landform drainage channel located between the Eastern WRSF and the Southern WRSF and Southern TSF.
Mine Facility Area	Remaining mine facilities including workshops, office, fuel storage, core shed and electrical substation. Other mine facilities that existed during mine operating phase have been decommissioned and rehabilitated including the blast and magazine compound and the Stores buildings.
Mine Quarry and Borrow Pit	Source of rock and growth material for drainage protection and rehabilitation works to be used for remaining rehabilitation efforts and then rehabilitated when no longer relied upon (note not yet disturbed and omitted from Figure 1.3).
Access Roads and Tracks	Sealed access road into the mine from the northern mining lease boundary. A number of internal access tracks are also used to access the dams, sumps, pumps, monitoring equipment, firebreaks and other parts of the mining leases and background pastoral properties.
Electrical Power Distribution Infrastructure (not mapped)	Internal electrical power supply network to the workshops and office and to the pumping infrastructure. Typically comprising overhead transmission lines suspended on either timber or concrete posts.
Natural Features	Several natural steep hills with rocky outcrops including Mt Mawe (situated on the south-eastern corner of the final void) and Wallaby Tail Hill (situated to the north-west of the Southern WRSF) as well as several drainage gullies and creeks between the mine disturbance footprint and the mining lease boundary.

Figure 1.1: Location of Mt Leyshon Mine

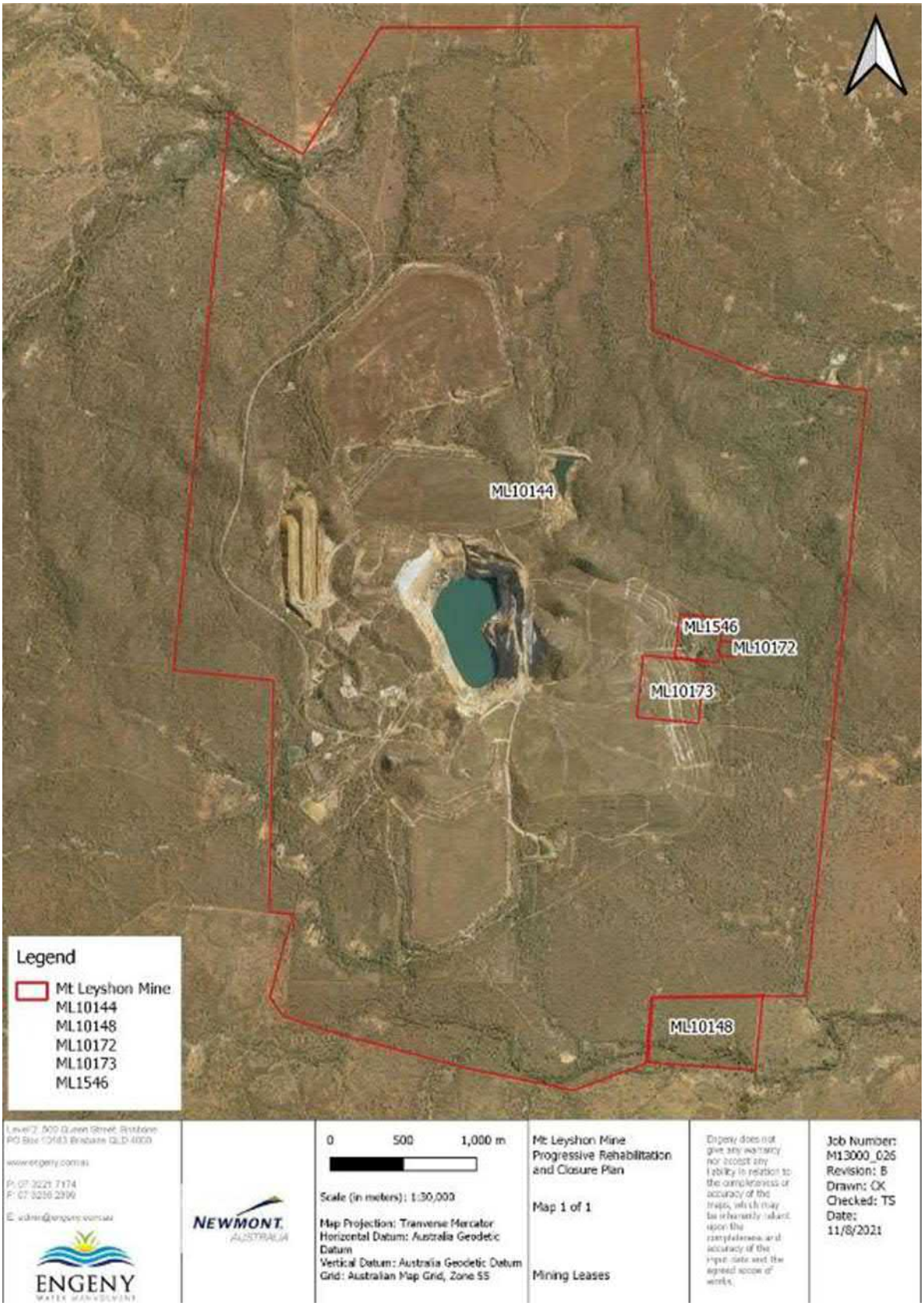


Figure 1.2: Mt Leyshon Mining Leases

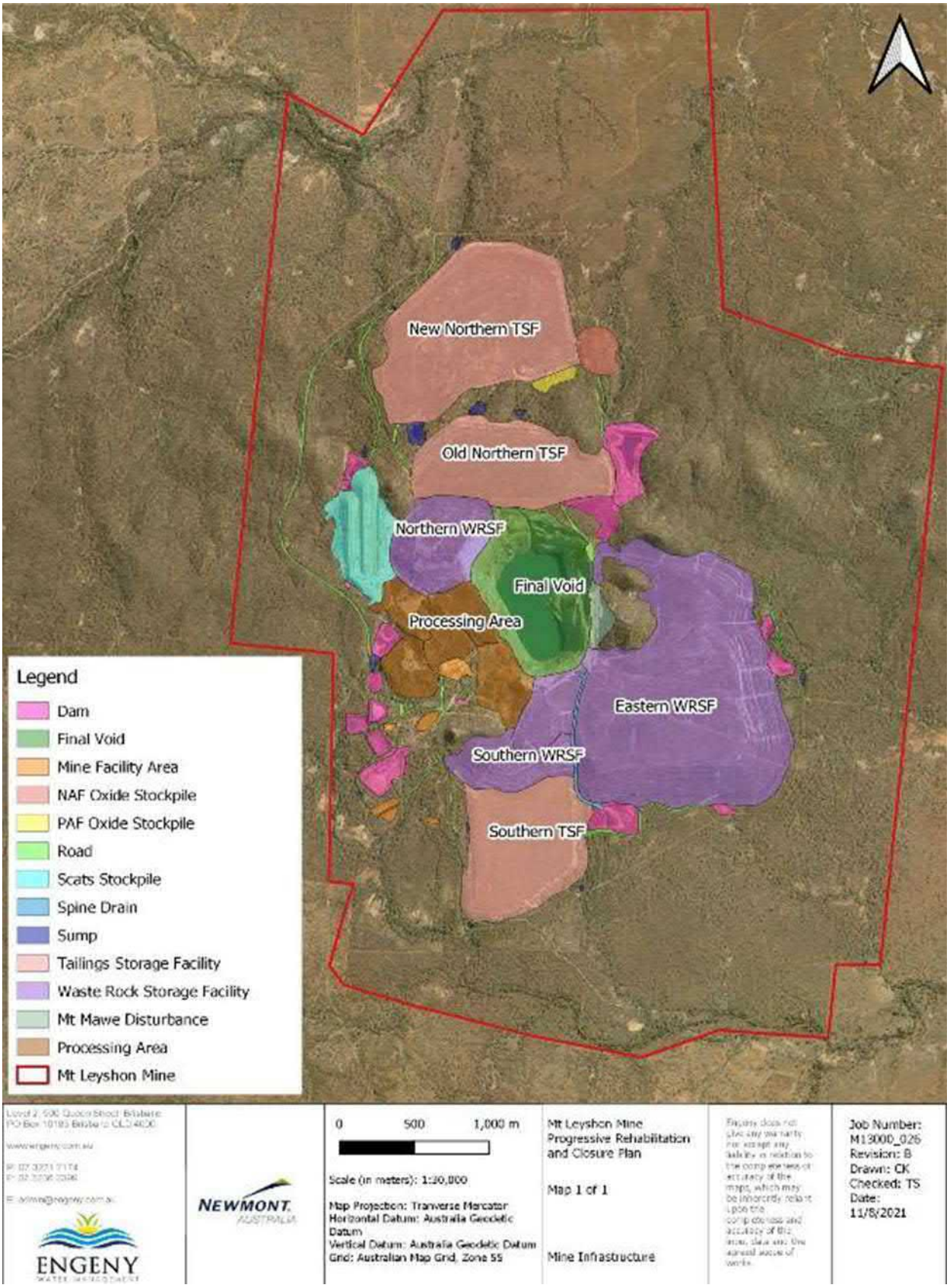


Figure 1.3: Mt Leyshon Primary Mine Features/Infrastructure

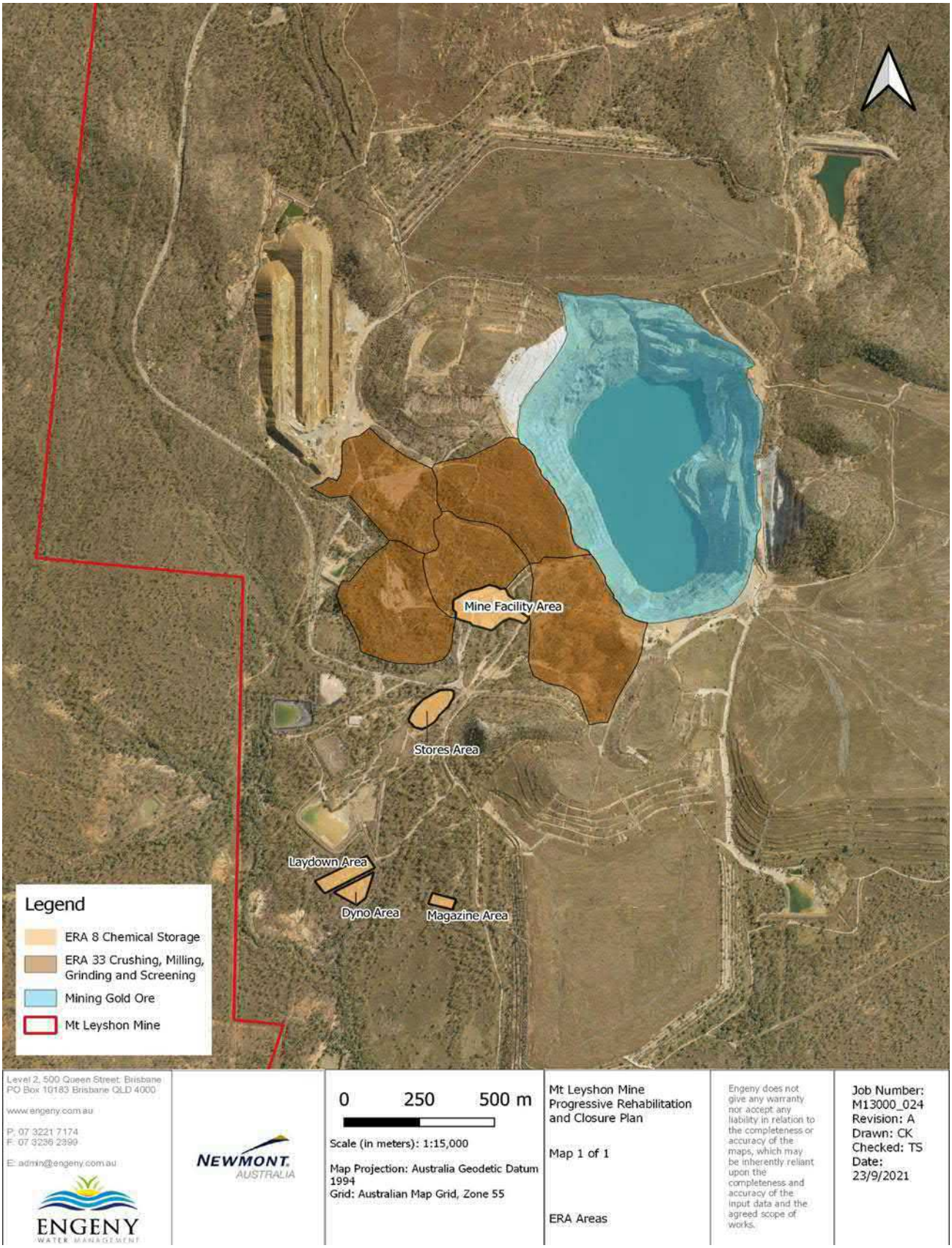


Figure 1.4: Environmentally Relevant Activities

1.4 BASELINE INFORMATION

1.4.1 Topography

Site Topography

The original topography at Mt Leyshon Mine prior to mining was dominated by steep hills with rocky outcrops (including Mt Leyshon and Mt Mawe). These hills formed a regional topographic high and coincided with several catchment boundaries, with natural surface water drainage being directed to the north (towards Clarke Creek), south (towards Puddler Creek) and east (towards Two Mile Creek). The topography and landforms that existed at the Mt Leyshon Mine prior to the modern mining operations are shown in Figure 1.5. The original Mt Leyshon (shown in the centre of Figure 1.5) was the highest landform in the area, while there were a number of smaller hills surrounding Mt Leyshon, including Mt Mawe which is located immediately to the east of the original Mt Leyshon (landform to the left of Mt Leyshon in Figure 1.5).

Figure 1.5: Topography and Landforms at Mt Leyshon Mine Prior to Modern Mining Operations (view to the south-east)

The original topography at the mine has been altered by the modern mining activities. The open-cut pit removed much of the original Mt Leyshon, and the western side of Mt Mawe was reprofiled to a steeper, benched profile to enable the open cut extent to safely expand. The waste rock and tailings storage facilities are new landforms which are consistent with the local pre-mining and regional elevated features and have been constructed within the original catchments draining the site. These waste emplacement facilities have been constructed over or against a number of the smaller pre-mining hills surrounding the original Mt Leyshon. The post-closure topography and landforms at the Mt Leyshon Mine are shown in Figure 1.6 to Figure 1.8.

Figure 1.6: Landforms at Mt Leyshon Mine ~2005 (view to the south)

Figure 1.7: Landforms at Mt Leyshon Mine 2021 (view to the north)

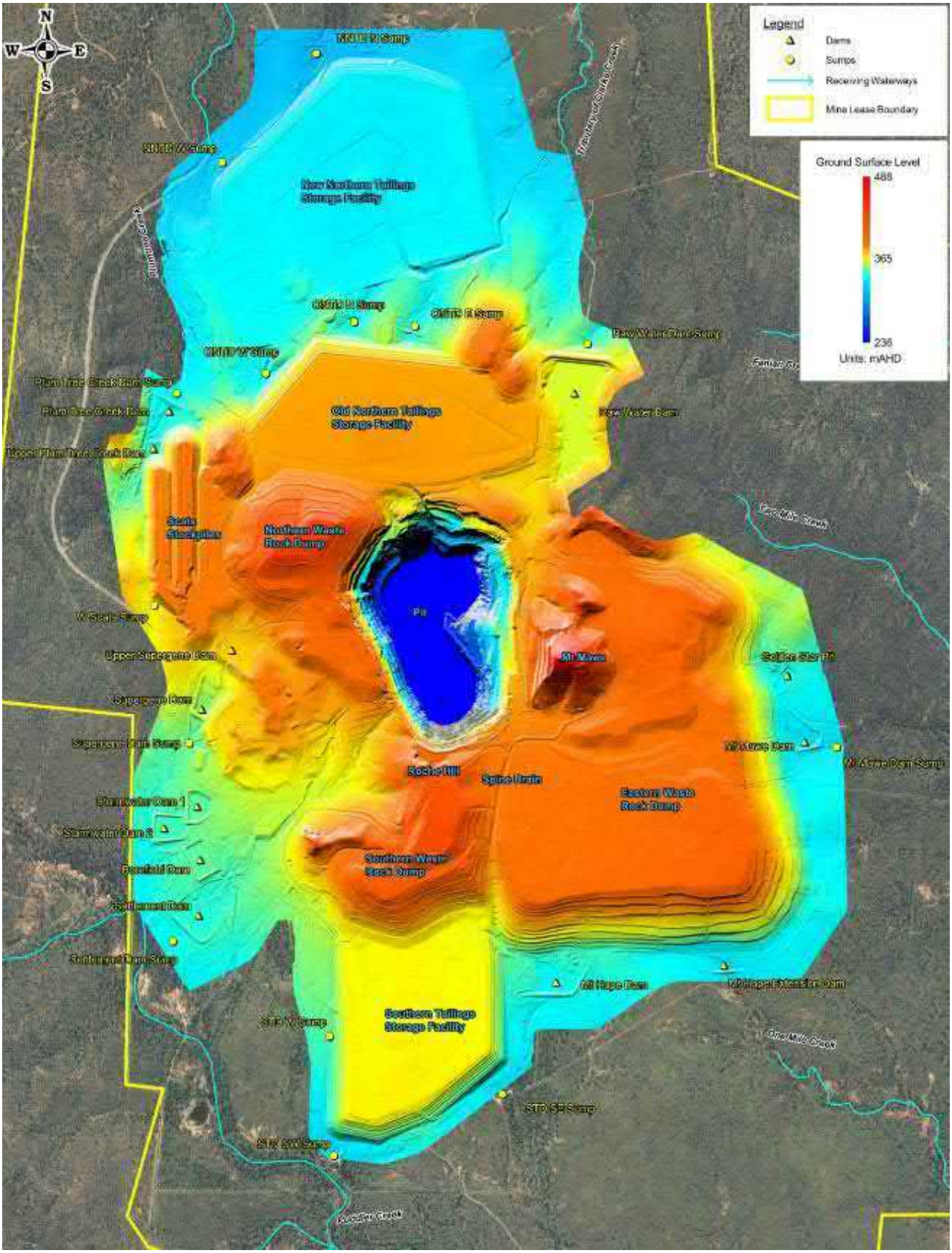


Figure 1.8: Current (post-closure) Topography at Mt Leyshon Mine

Current ground elevations at the mine are shown in Figure 1.8 and summarized in Table 1.3. The highest elevation is 488mAHD on the top of Mt Mawe while the lowest elevation is in the open cut pit, below the pit lake level.

Table 1.3: Ground Elevations on Top of Mine Landforms

Landform	Top Ground Elevation (m AHD)
Mt Mawe	488
Northern Waste Rock Storage Facility (NWRSF)	435
Southern Waste Rock Storage Facility (SWRSF)	425
Eastern Waste Rock Storage Facility (EWRSF)	409
Old Northern Tailings Storage Facility (ONTSF)	382
New Northern Tailings Storage Facility (NNTSF)	340
Southern Tailings Storage Facility (STSF)	367
Scats Stockpiles	394
Water Containment Dams	332 to 374[1]
Clarke Creek at Downstream Lease Boundary	290
Puddler Creek at Downstream Lease Boundary	310
Two Mine Creek at Downstream Lease Boundary	315
Pit Lake Level (May 2021)	253
Pit Floor (after in-pit tailings deposition)	165

[1] At embankment crest elevation.

Regional Topography

The surrounding regional topography consists of the Seventy Mile Range directly south of the mine (shown in top-right corner of Figure 1.6) which reaches 500 mAHD with Mount Windsor to the southeast and Mount Farrenden to the east reaching between 581 mAHD and 490 mAHD respectively. Mt Leyshon and Mt Mawe formed part of the steep isolated hills with rocky outcrops. The surrounding regional area is relatively flat, hence its suitability for agriculture and grazing land uses.

Climate

Mt Leyshon Mine is located in the dry tropics and has a climate characterized by relatively hot summers and mild winters. The area has a summer-dominant wet season, typically occurring between the months of December and March. The majority of the wet season rainfall typically occurs in a relatively small number of short durations, high intensity rainfall events. As a result, the surface water features within and down-gradient of the mine are ephemeral, flowing only during the wet season. During the dry season, these features may be completely dry or reduced to small, disconnected surface water pools.

The long-term projections as outlined by the State of the Climate 2020 highlights that Australia is likely to experience warmer air temperatures with increased extreme heat events (CSIRO & BOM, 2020). The future rainfall is likely to be reduced throughout the cooler season resulting in prolonged drought conditions. The eastern parts of Australia may experience heavier and more intense storms with fewer tropical cyclones (CSIRO & BOM, 2020).

Average climate statistics for Charters Towers are shown in Table 1.4.

Table 1.4: Average Climate Data Statistics for Charters Towers (Bureau of Meteorology, 2013)

Month	Mean Rainfall (mm)	Mean No. of Days of Rain >1mm	Mean Maximum Temperature (ºC)	Mean Minimum Temperature (ºC)	Pan Evaporation (mm)[1]
Jan	136.9	8.8	33.7	21.9	198
Feb	130.1	8.3	32.6	21.7	161
Mar	103.5	6.4	31.6	20.5	170
Apr	43.4	3.5	29.9	17.9	140
May	24.0	2.4	27.2	14.8	113
Jun	26.5	2.5	24.8	21.1	92
Jul	16.8	1.9	24.5	11.0	101
Aug	13.0	1.1	26.6	12.1	130
Sep	14.8	1.4	29.6	14.7	171
Oct	22.0	2.1	32.4	17.6	215
Nov	41.4	3.4	34.1	19.9	219
Dec	86.9	5.6	34.8	21.2	219
Annual	659.2	47.4	30.2	17.1	1,930

[1] Data obtained through SILO data drill.

Geological Setting

Regional Geology

The northern part of the Charters Towers region is dominated by the Ordovician-Devonian Ravenswood Granodite Complex. The neoproterzoic basement schists were intruded by this granite complex approximately 100 million years ago. Further south towards Mt Nolan, surficial Quaternary alluvium and Tertiary campaspe beds are more prevalent. The alluvium is comprised of silt, sand and gravel, while the Campaspe beds consist of sands and gravels (SKM & SMI, 2010).

For more information, refer to Appendix A: Mt Leyshon Groundwater Management Plan.

Local Geology

The geology underlying Mt Leyshon Mine is characterized by the following (in order of depth):

- Thin clayey soil cover.
- Alluvial material surrounding the creeks located on the mine which becomes more significant down-gradient.
- Significant thickness of weathered basement material being either sandy or gravely material or where relict structural features remain less weathered material. This provides higher permeability below the clayey soil cover. Adjacent to some of the existing surface water drainages there is shown to be preferentially developed weathered zones.
- Granite and dolerite country rock of significant depth. Originally the country rock surrounded the ore body, which the pit void has now replaced. There are fewer structures and limited faulting throughout the country rock compared to the weathered zone and ore body.

For more information, refer to Appendix A: Mt Leyshon Groundwater Management Plan.

Hydrology and Fluvial Networks

Site Drainage

Stormwater runoff from disturbed areas at Mt Leyshon Mine is generally directed outwards from the rim of the open-cut pit. Stormwater runoff flows are conveyed from the top of the mine landforms to the edge of the mine disturbance area via a network of open drainage channels. Surface runoff and seepage flows that are not suitable for direct release to the receiving environment are intercepted by water containment dams and seepage sumps that are located around the perimeter of the mine disturbance area and pumped into the pit. Stormwater runoff from natural and successfully rehabilitated areas is discharged at the edge of the mine disturbance area and flows to the receiving waterways via natural ephemeral drainage gullies and minor creek systems.

Figure 1.9 and Figure 1.10 shows the primary surface drainage paths within the mine disturbance area, catchment boundaries for the water containment dams, and flow paths that drain to the edge of the mine disturbance area.

For more information, refer to Appendix B: Mt Leyshon Water Management Plan.

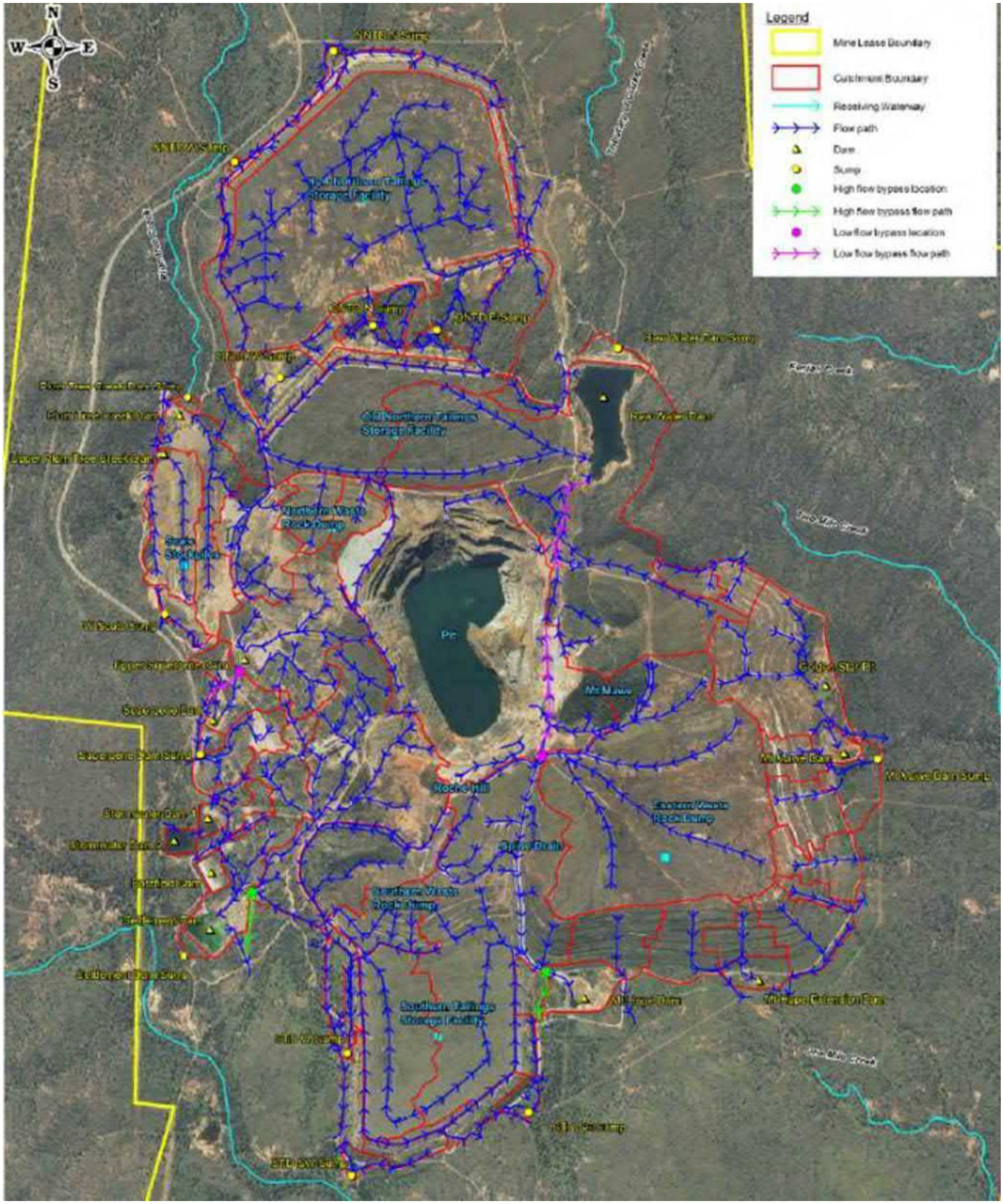


Figure 1.9: Current Catchments and Flow Paths

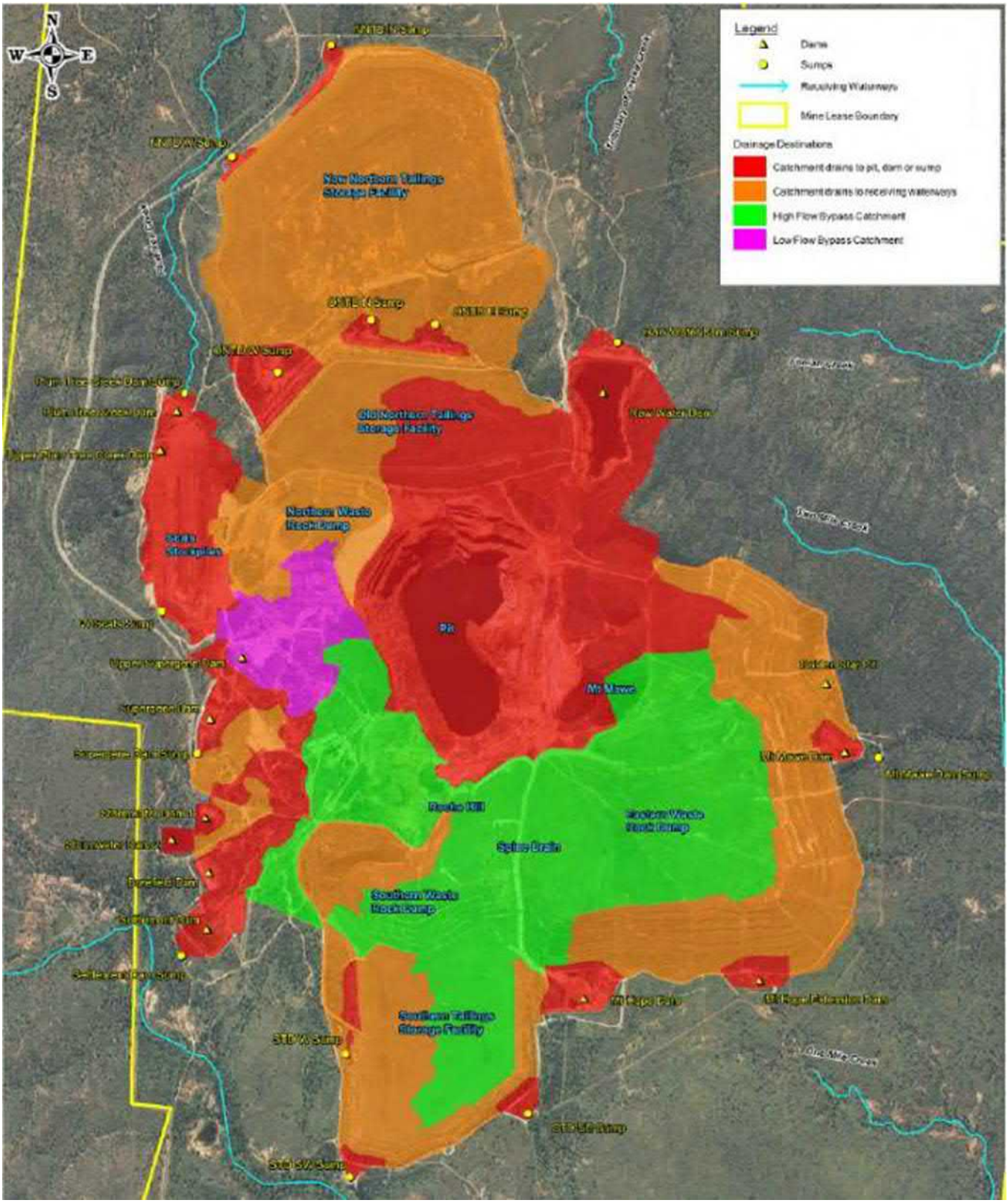


Figure 1.10: Current Drainage Destinations

Local Receiving Waterways

Ephemeral waterways between the edge of the mine disturbance area and the mine lease boundary are identified in Figure 1.11.

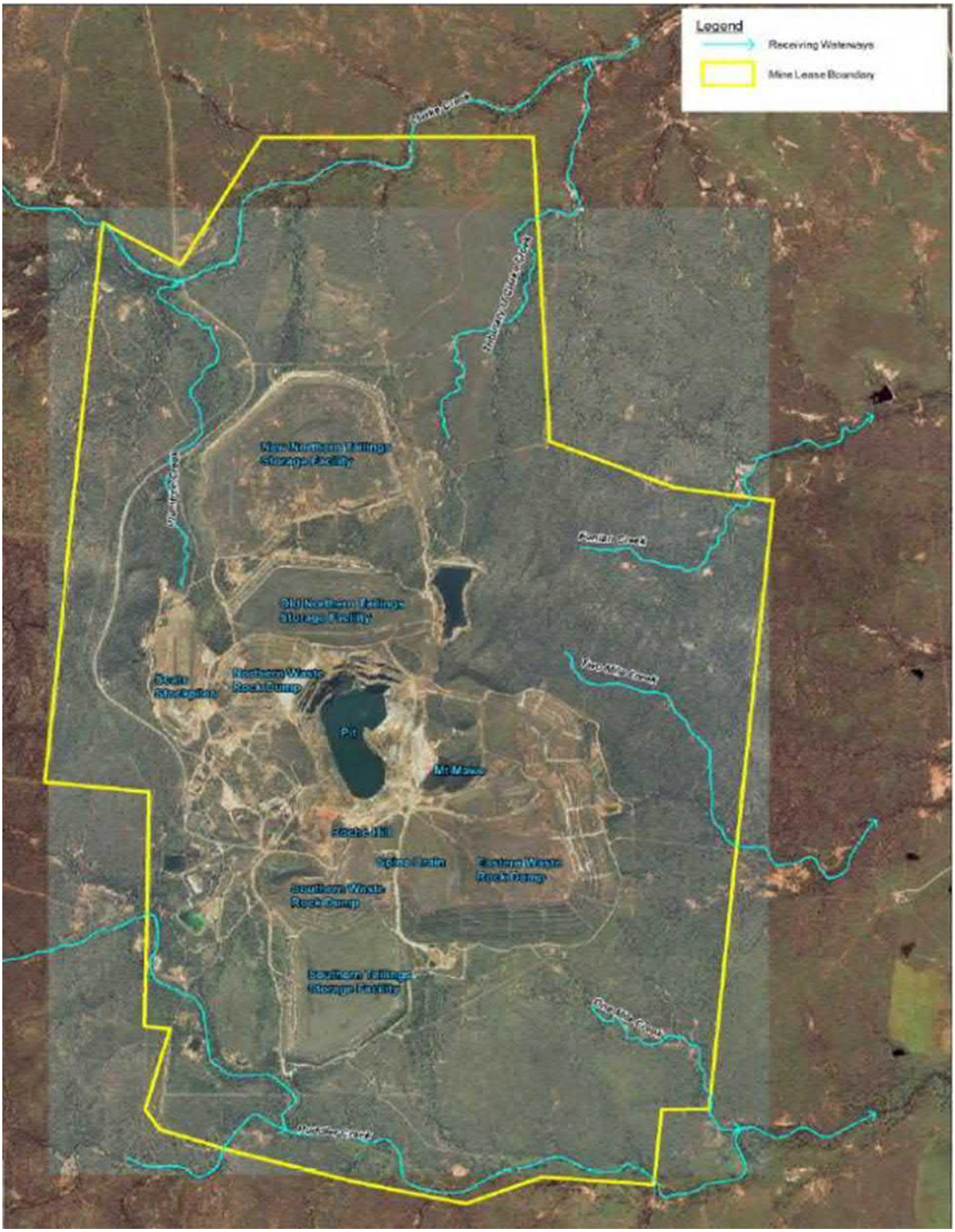


Figure 1.11: Local Receiving Waterways

In the limited periods when runoff occurs, the topography within the mine lease area drains to:

- The north towards Clarke Creek (flows in an easterly direction along the northern mine lease boundary) – stream order 4 drainage system.
- To the south towards Puddler Creek (flows in an easterly direction along the southern mine lease boundary) – stream order 3 drainage system.
- To the east towards Two Mile Creek (flows in an easterly direction across the eastern mine lease boundary) – stream order 2 drainage system.
- To the south-east towards One Mile Creek (flows in a south-easterly direction across the eastern mine lease boundary) – stream order 2 drainage system.
- To the north-east towards Schreiber's Creek (flows in a north-easterly direction across the eastern mine lease boundary) – stream order 2 drainage system.

Clarke Creek and Puddler Creek are the two largest waterways in the immediate vicinity of the mine. Clarke Creek and Puddler Creek flow along the northern and southern boundaries of the mine lease area respectively. The upstream catchments of these two waterways extend to the west of the mine. All other site waterways originate within the mine lease area.

Plum Tree Creek (downstream of the scats stockpiles and Plum Tree Creek Dam) receives runoff from the Northern Waste Rock Storage Facility and the Old Northern Tailings Storage Facility. Plum Tree Creek discharges into Clarke Creek within the mine lease area.

Schreibers Creek is located downstream of the Raw Water Dam and discharges across the north-east corner of the mine lease boundary, in the periods when flow occurs. The New Northern Tailings Storage Facility drains to Schreibers Creek. Schreibers Creek discharges into Clarke Creek a short distance downstream of the lease boundary.

The southern part of the mine disturbance area drains to Puddler Creek via a number of drainage features. One Mile Creek is located downstream of the Mt Hope Extension Dam and receives runoff from the southern batter slopes of the Eastern Waste Rock Storage Facility. One Mile Creek discharges across the south-eastern corner of the mine lease boundary before discharging into Puddler Creek.

Two Mile Creek flows across the eastern boundary of the mine lease area in the wet season. This waterway receives runoff from the eastern batter slopes of the Eastern Waste Rock Storage Facility.

The Fenian Creek catchment is located to the north of the Two-Mile Creek catchment and also flows across the eastern boundary of the mine lease area. A topographic ridge is located between the rehabilitated mine facilities on the eastern side of the mine and Fenian Creek.

Regional Receiving Waterways

The receiving waterways downstream of the mine lease area are shown in Figure 1.12. All of the local receiving waterways eventually discharge into the Broughton River, which flows into the Burdekin River 25 km to the north-east of the mine site (straight line distance).

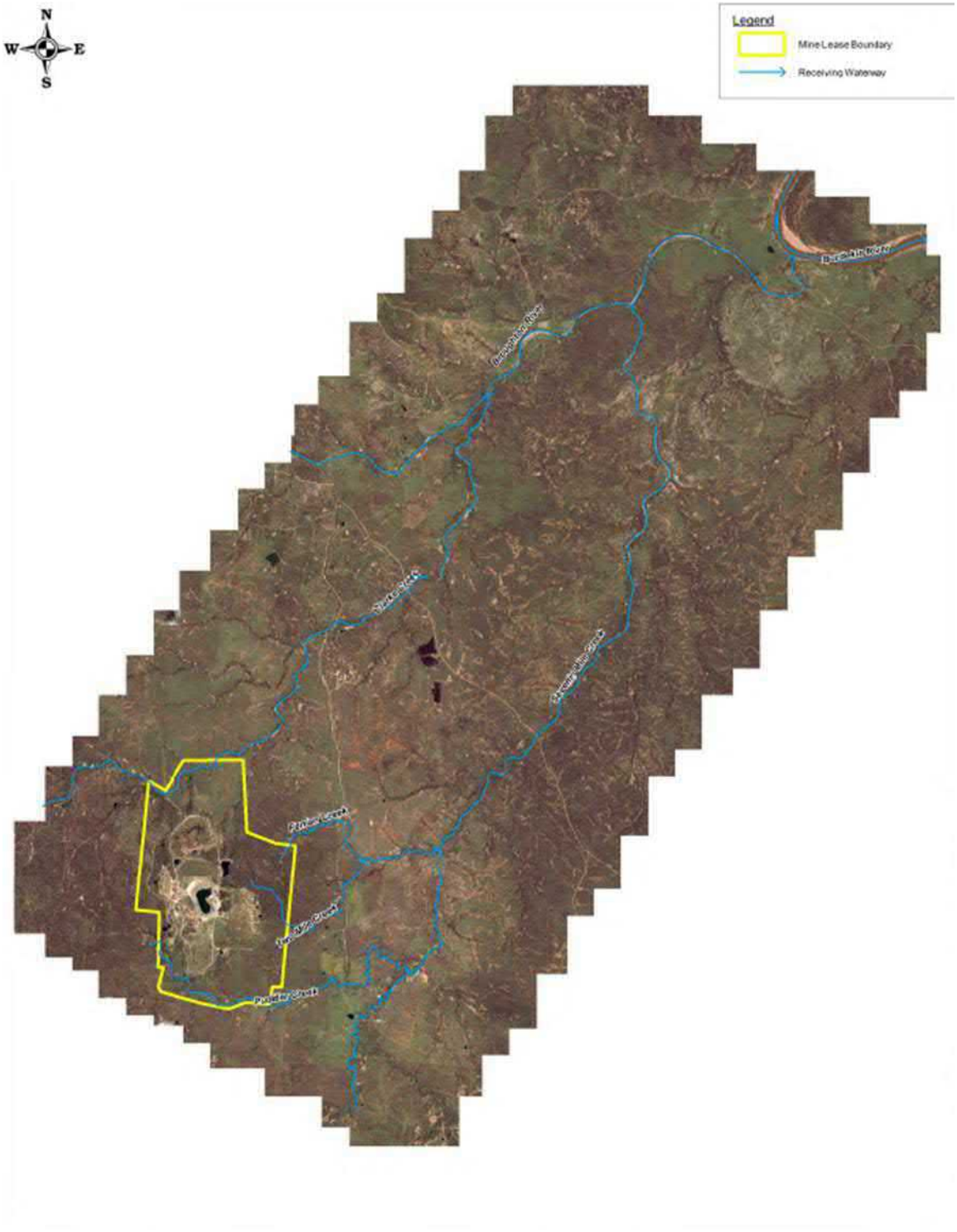


Figure 1.12: Regional Receiving Waterways

Stream flow gauging data for the Broughton River (Gauging Station No. 120014A Broughton River at Oak Meadows) indicates that the Broughton River flows approximately 16% of the time upstream of the Clarke Creek confluence.

The Burdekin River is a perennial waterway, with stream flow gauging data upstream of the Broughton River confluence (Gauging Station No. 120002C Burdekin River) at Sellheim indicating the river flows more than 95% of the time.

The sequence and connectivity of waterways downstream of the mine lease area is summarised in Table 1.5. Sections of the larger waterways downstream of the Mt Leyshon Mine (e.g., Clarke Creek, Puddler Creek, Seventy Mile Creek and the Broughton River) receive groundwater contributions to stream flows. This typically occurs as baseflow during and immediately following significant rainfall events and spring-fed recharge of waterholes during the dry season.

Table 1.5: Connectivity of Receiving Waterways Downstream of the Mine Lease Area

Waterway	Receiving Waterway
Clarke Creek	Broughton River
Two Mile Creek	Fenian Creek
Fenian Creek	Seventy Mile Creek
Puddler Creek	Seventy Mile Creek
Seventy Mile Creek	Broughton River
Broughton River	Burdekin River

Groundwater Levels and Properties

Regional Groundwater Systems

The two main hydro stratigraphic units of the Charters Towers region are the alluvial aquifer and the fractured rock aquifer. The alluvial aquifer consists of Tertiary and Quaternary gravel, sand and silt. The fractured rock aquifer consists of the basement schist and the younger intrusive granites. Groundwater flow within fractured rock units is facilitated mainly via secondary porosity such as faults and fractures. This aquifer underlies the alluvial aquifer in the south of the region and is present at the surface where the alluvial aquifer is absent in the north of the region. The degree of hydraulic connection on a regional scale between the two aquifers is largely unknown (SKM & SMI, 2010).

Groundwater beyond the Mount Leyshon mining lease and Newmont owned properties is extracted by pastoral properties in the Charters Towers region.

Local (On-Lease) Groundwater Systems

Characterization of the groundwater systems at the Mt Leyshon Mine has been undertaken by Schlumberger Water Services (2012) and Big Dog Hydrogeology (2017) based on several geophysical surveys, and the results from drilling and collecting monitoring data at over 100 groundwater monitoring locations.

There are two main groundwater transmission systems at Mt Leyshon Mine, being:

- The shallow groundwater system.
- The deep groundwater system.

Shallow Groundwater System

The shallow groundwater system has been defined to comprise the upper weathered and fractured surface of the basement rocks, typically occurring between around 5 and 25m below ground level (m BGL). It takes the form of either; sandy and gravely weathered basement material or less weathered material where relict structural features remain.

Recent groundwater investigations (Schlumberger Water Services, 2012 & Big Dog Hydrogeology, 2017) have identified that:

- Precipitation is the primary input of water to the Mt Leyshon Mine site, driving intermittent runoff flows in the surface water systems, and seasonal recharge to the groundwater systems. Groundwater elevations respond to the larger daily precipitation events, to seasonal conditions, and also to long term trends in annual precipitation totals.

- Groundwater flow directions follow the general surface topography and the main watercourses, being to the northeast (towards Clarke Creek), to the east (following Two Mile Creek), and to the southeast (following Puddler Creek). Very little groundwater flow occurs to the west.
- Groundwater likely leaves the shallow groundwater system as surface discharge into the surface drainage systems down-gradient of the mine facilities, where structures are present which allow vertical movement of groundwater.
- Groundwater elevations near the pit are in the range 368 mAHD to 375 mAHD, which is more than 100m higher than the pit lake elevation. This suggests there is minimal depressurization within the shallow groundwater system associated with groundwater flow towards the open pit, with most flow being radially away from the pit.
- Despite the hydraulic conductivity of the shallow groundwater system being locally variable, there is regional continuity of hydraulic connection within the system.
- The shallow groundwater system represents the primary means by which groundwater flows away from the Mt Leyshon Mine.

Deep Groundwater System

The deep groundwater system comprises fracture zones within the deep unweathered basement rocks, which include the breccias close to the open pit, and the surrounding dolerite and granite country rocks. Most of the basement rocks across the Mt Leyshon Mine demonstrate relatively high resistivity, consistent with a low degree of fracturing (porosity) and limited presence of pore waters. Fracturing may be present in the basement rocks at depths of up to 200m, but is limited to the area close to, and to the northeast of the open pit. This is consistent with observations during mining that the main structural feature in the area was the Mine Fault, which was primarily identified within the open pit. The available data indicate that there is little development of fracturing beyond about 1km to 2 km from the open pit, and the granite/dolerite country rocks in the surrounding area have limited fracturing.

Groundwater responses within the deep groundwater system have been monitored through the use of vibrating wire piezometer (VWP) sensors. Most sensors display a smoothed response to seasonal precipitation trends, indicative of wet season recharge, which may occur as direct infiltration to exposed fractured basement rocks in the pit area, or as downward leakage from the shallow groundwater system.

VWP sensors indicate that within the deep groundwater system:

- In locations more than around a few hundred meters from the margins of the open pit, and at most depths, hydraulic gradients indicate groundwater flow directions are away from the pit. The drawdown cone within the deep groundwater system surrounding the pit is relatively steep and close to the pit, consistent with the inferred relatively low hydraulic conductivity in this system.
- A fracture zone intersected northeast of the pit at around 200 mAHD contains groundwater at lower pressures. The depressurized area potentially extends up to 500m from the pit boundary.
- VWP sensors installed at depths equivalent to the base of the pit demonstrate high groundwater pressures, comparable to pressures measured at shallow depths, and consistent with groundwater flow towards the pit for the basement rocks at depth and close to the pit.

The shallow groundwater system is present in all locations at Mt Leyshon Mine, other than in the open pit, or at localized discrete locations where unweathered basement rocks may crop out at surface. The deep groundwater system is limited in occurrence to the area close to the open pit (typically within 1km to 2 km), and the greatest extent of fracturing occurs at around 200 mAHD, within 500m of and northeast of the open pit.

In locations where both the shallow groundwater system and the deep groundwater system are present (near the open pit), these two groundwater transmitting systems are separated vertically by unweathered and mostly unfractured breccia, granite and dolerite. Mechanisms which may act to provide vertical connection through these basement rocks potentially include pervasive zones of fracturing associated with major structural features, or artificial connection created by un-grouted drill holes installed near the ore body during the development and mining periods.

Based on the groundwater elevations measured in the VWP sensors, in all locations vertical groundwater gradients act downwards, with the groundwater elevation being higher in the shallow groundwater system. In any locations where vertical

hydraulic connection is present, this suggests the occurrence of downward seepage from the shallow groundwater system into the deeper groundwater system. There are no locations in which the groundwater pressure in the deep system suggests that discharge could occur into the shallow system where pathways are present.

Soil Types, Properties, and Productivity

The Atlas of Australian Soils (Queensland) soil mapping (scale of 1:2,000,000) was used to determine soil types and properties within and surrounding the Mt Leyshon Mine outlined in Figure 1.13.

Figure 1.13: Landscape Units (Queensland Government, 2021)

The mapping shows that the majority of the mine and its surrounds is mapped as landscape unit Qa14, which is defined by moderately/less commonly undulating lands surrounded by dissected steep slopes and isolated hills. The dominant surface soil type is Chromosol described as Red Duplex Soil which occurs in shallow to moderate depth (Bureau of Rural Sciences, 2009). Chromosols have a strong contrasting texture. They are not strongly acidic or sodic in the upper B horizon. The parent material of Chromosols ranges from highly siliceous, siliceous to intermediate in composition (Australian Soil Club, 2021).

These soils have moderate agricultural potential with moderate chemical fertility and water-holding capacity. They can be susceptible to soil acidification and soil structure decline.

There is a small area of landscape unit LK18 mapped to the west of the mine, which is defined by strong undulating marginal slopes with low hilly to hilly lands. The dominant surface soil type within this landscape unit is Tenosol which is described as shallow stony loams. Figure 1.14 outlines the soil types at Mt Leyshon Mine. Tenosols have a weakly developed soil profile which is typically very sandy and without obvious horizons. Tenosols form from highly siliceous parent material and where rainfall is from 0 to 1400mm.

Generally, Tenosols have a very low agricultural potential with very low chemical fertility, poor structure and low water-holding capacity.

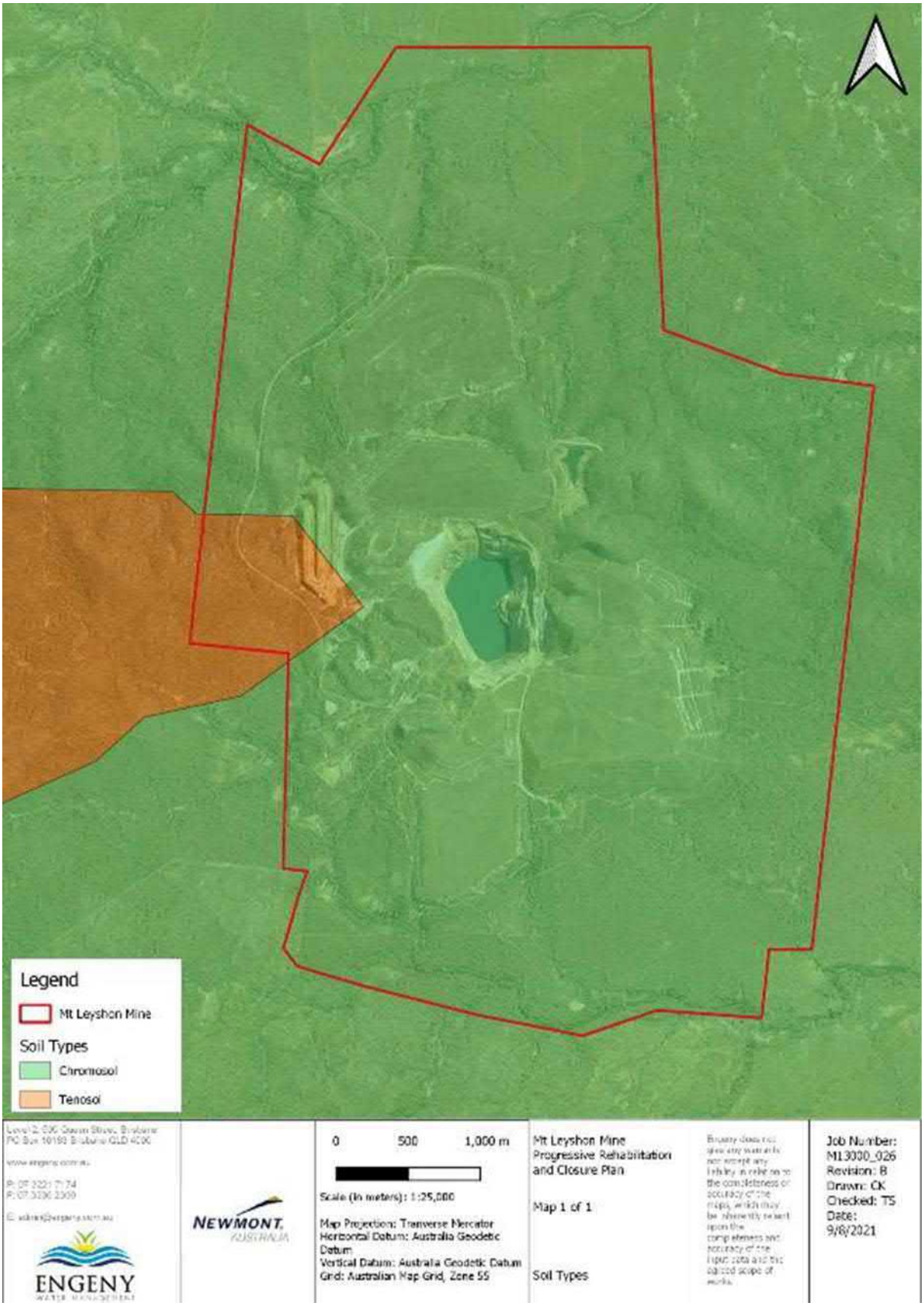


Figure 1.14: Soil Types (Queensland Government, 2021)

The dominant soil type underlying the Mt Leyshon Mine is Red Duplex Soil, a non-sodic, texture-contrast soil with a high base status (i.e., Eutrophic) in the major part of the red clayey B2 horizon. This soil type is widespread in subcoastal eastern Australia, typically associated with sparse cattle grazing of native pastures (Queensland Government, 2021). It is generally well-drained with a hardsetting surface. The available water storage is moderate, and infiltration is rapid; however, compaction and surface sealing restrict water entry. The Queensland Government Strategic Cropping Land is not located within the surrounding area. Queensland Government Agricultural Land Classification has identified the area in the vicinity of and including the Mt Leyshon Mine as class C3, which is described as having native pastures with light grazing in accessible areas.

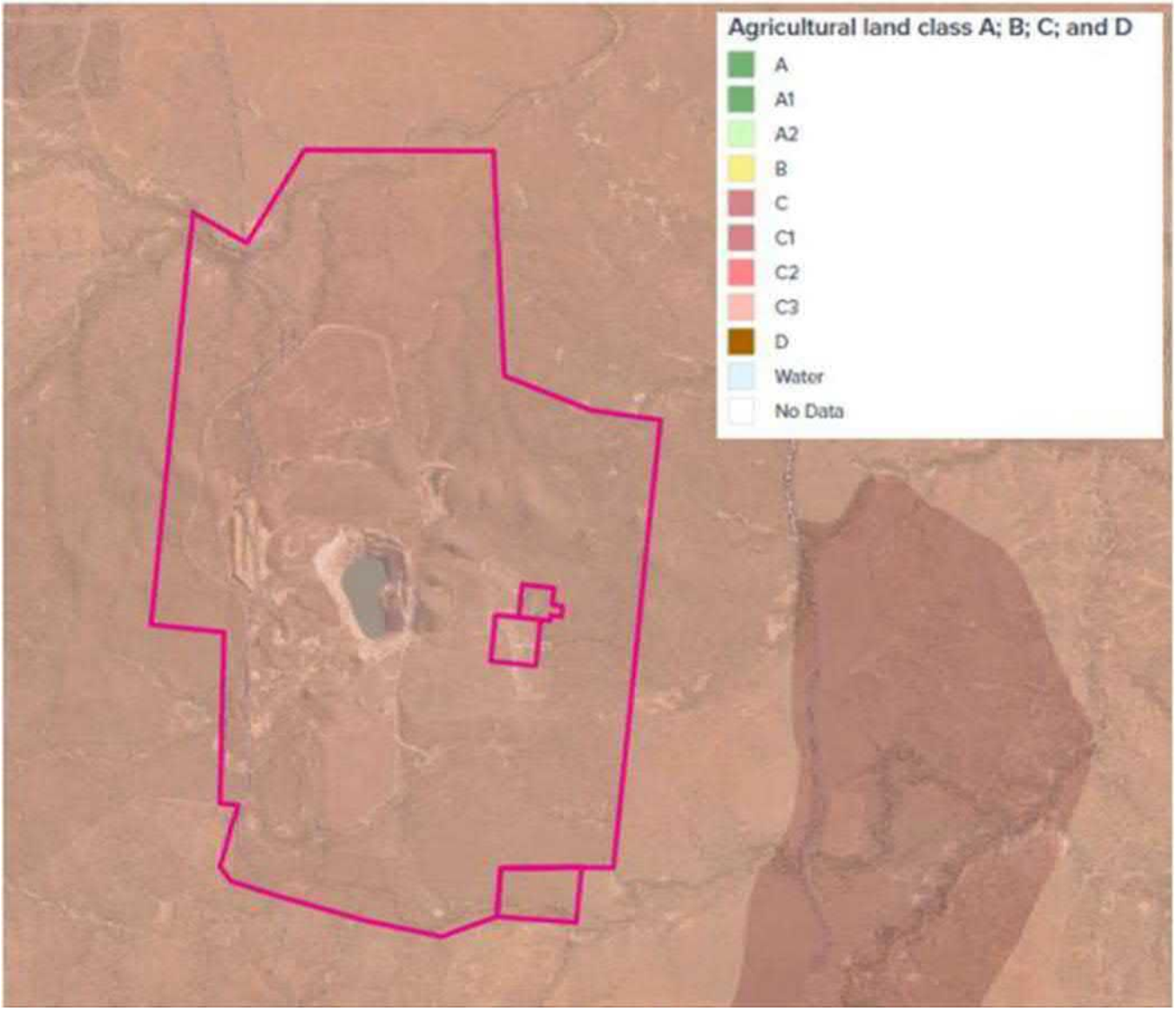


Figure 1.15: Agricultural Land Classification (Queensland Government, 2021)

The physical and chemical properties of Red Duplex Soil, based on a sample from the Charters Towers District, are summarized in Table 1.6 below.

Table 1.6: Red Chromosol Chemical & Physical Properties[1,2]

Horizon	Sample Depth	pH H_2O	Elect. Cond. dS/m	Org C %	Extr. P Mg/kg	Tot. P %	Tot. K %	Cation exchange properties cmol(+)/kg					Particle Size %			
								Ca	Mg	K	Na	CEC	CS	FS	Silt	Clay
A1	0.00-0.13	6.8	0.06	1.6	40	0.039	1.58	10.6	2.8	0.5	0.1	13	27	27	16	29
B21	0.13-0.33	6.6	0.04	0.7	2	0.027	1.23	13.2	4.5	0.5	0.1	19	11	12	25	54
B22	0.33-0.56	6.7	0.04		4	0.022	1.41	11.0	4.0	0.4	0.1	16	22	17	23	40
B3	0.56-0.80	7.0	0.05		107	0.041	1.21									
Cr	0.80-1.04	7.0	0.04		275	0.068	1.30									

[1] Sourced from Queensland Government (2016).
2 Blank fields denote no results available

Erosional Stability

The region has subdued relief, dominated by gently undulating plains that lack an integrated stream network. The upper reaches of the plains terminate in incised hills dominated by bedrock, or in breakaways that merge into erosional tracts of rapidly migrating streams (Aspandiar et al., 2003). Evidence of these types of erosion and landscape features prior to mining is shown in Figure 1.5.

The pre-mining capability of Mt Leyshon Mine was subject to severe gully and rill erosion which is due to the widespread overgrazing of pasture (Newmont, 1993). Further information on pre-mining land stability is outlined in Appendix C: Environmental Management Overview Strategy 1993.

The post closure soil surface stability from the selected analogue and rehabilitation sites at Mt Leyshon Mine has been assessed during annual land rehabilitation monitoring and has found that overall due to the high density of grasses and high degree of rock that is incorporated into the topsoil, the soil surface stability of the rehabilitated mine landforms is generally very stable (Stantec, 2021). There are a number of generally localized areas on the rehabilitated landforms where surface erosion has occurred, typically on steeper slopes with less grass cover, such as batter areas on the waste rock and tailings storage facilities. Rehabilitation works to remediate these existing erosion areas are included in the rehabilitation schedule. Erosion repair and ground stabilisation works were previously performed on a 45 ha steeply sloped area on Roche Hill (part of Processing Area) in 2017 and these rehabilitation works have been successful at preventing further erosion of this area.

Geotechnical Stability

Slope failure (fault zone) of the northern pit wall occurred in January 2009. A geotechnical assessment undertaken at the completion of mining determined that failure of the northern pit wall (West Mine Fault) was inevitable, but it was predicted that failure would not encroach further than 70m from the pit rim. The existing extent of the failure surface is similar to what was predicted. In the 20 years following the completion of mining there has not been any geotechnical instability issues identified on any of the landforms other than that identified on the pit north wall above.

The western face of Mt Mawe was blasted and benched to achieve a stable feature that permitted access to the open cut pit. The resultant surface of Mt Mawe is competent rock that is stable and has not experienced any geotechnical instability over the last 30 years.

For further information refer to Appendix D: Mt Leyshon Rehabilitation and Pastoral Lease Condition Monitoring 2021.

Land Suitability and Land Capability

There was no detailed survey of the land suitability or the land capability before development of the mine. However, it is noted that approximately 65% of the land within the area covered by the mining leases has not been disturbed by the mining activities and will therefore maintain the pre-mining land capability/suitability classifications.

The DME 1995 *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* – Section 4.0 of Land Suitability Assessment Techniques defines land capability and land suitability as:

Land Capability classifications provide a ranking of the capacity of each part of a land resource to sustain broad land use classes (with lower number classes suited to more intense uses, and higher number classes suited only to low intensity rural use, conservation and the like. Land capability assessment is more appropriate to broad hectare areas where the land use choices are farming, grazing or non-agricultural.

Land Suitability rankings are more refined and apply to the capability of land resources to sustain particular forms of land use such as arable farming, irrigated agriculture, forestry. Such rankings can be applied to smaller land units and are thus more useful in determining post mining land use options. For this reason, land capability assessments and (sic) are recommended for use in the mining industry."

A study by AGC Woodward Clyde (1990) identified that the pre-mining land capability classifications for the area covered by the Mt Leyshon mining leases fell mainly into the following Classes:

- Class VI - Land that is not suitable for cultivation but is well suited to pastoral use and on which pasture improvement involving the use of machinery is practicable
- Class VII - Land that is not suitable for cultivation but on which pastoral use is possible only with careful management; pasture improvement involving the use of machinery is not practicable and
- Class VIII - Land that has such severe limitations that it is unsuited for either cultivation or grazing.

There have not been any previous assessments of the pre-mining land suitability classes for the area covered by the Mt Leyshon mining leases. Based on the criteria used to assess land suitability (DME, 1995), and in recognition of the land capability assessment, it is considered likely that the pre-mining land suitability classes for the Mt Leyshon Mine would have been a combination of:

1. Class 3 – Agricultural – Suitable land with moderate limitations. Land which is moderately suited to a proposed use but requires significant inputs to ensure sustainable use.
2. Class 4 - Agricultural – Marginally suitable land. Land which is marginally suited for a proposed use and would require major inputs to ensure sustainability.
3. Class 5 – Agricultural – Unsuitable land with extreme limitations. Land which is unsuited and cannot be sustainably used for a proposed use.

The principal factors considered limiting to pastoral development in the pre-mining landscape were shallow low nutrient soils with considerable areas of rockiness and stoniness, steep topography in places, lack of groundwater resource and lack of permanent surface water (AGC Woodward Clyde, 1990). These ratings indicate that most of the site was unsuitable for cultivation, and that some areas were well suited for pastoral use, but other areas have severe limitations for any agricultural use (Newmont, 1993).

The Guidelines for Agricultural Land Evaluation in Queensland (QDPI, 1990) gives agricultural land classification (ALC) classes based on soil and landscape characteristics. ALC mapping (Queensland Globe) indicates the general area in and around the Mt Leyshon Mine has an ALC class of C3. ALC class C3 is defined as "suitable for light grazing of native pastures in accessible areas and includes steep land more suited to forestry or catchment protection".

Prior to mining, the higher numbered land suitability and capability classes of land (i.e., classes 4 and 5 and VII and VIII) were associated with steeper topography and rockier terrain around Mt Leyshon, Mt Mawe and the other smaller surrounding hills, with the higher suitability/capability land (i.e., classes 3 and VI) located on the more gently undulating (i.e., relatively flatter) land around the outer edges of the mining lease area. It is noted however that physical and chemical characteristics of soils, and water availability may have introduced limitations to these landforms.

While mining has altered the pre-mining landscape via the removal of Mt Leyshon as part of the open cut mining and construction of the tailings and waste rock storage facilities, the post-closure land suitability and capability is generally similar to that of the pre-mining landscape. The domed tops of the tailings and waste rock storage facilities are relatively flat areas that provide a similar landform to that which existed pre-mining. The steeper batters of the tailings and waste rock storage facilities are consistent with the steeper terrain and higher numbered land suitability and capability classes (i.e., classes 4 and 5 and VII and VIII) which existed in the pre mining landscape, with many of these natural landforms still present in the post-closure landscape.

Vegetation Communities and Ecological Data

According to publicly available databases and mapping, the Mt Leyshon Mine is situated within the Einasleigh Uplands Biogeographic Region where Eucalypt woodlands heavily dominate this bioregion. The rehabilitation and pastoral lease condition monitoring found that all landforms had pasture grasses present which was mostly the introduced intentionally sown *Cenchrus ciliaris* (Buffel Grass) and the herbaceous legume *Stylosanthes* sp (Secca stylo) (Stantec, 2021). All landforms have native herbaceous species present which provide low or patchy cover (Stantec, 2021). There was generally low to moderate cover of woody species (<1.5 m and >1.5 m tall) across all landforms with the most common woody species for both height classes being the *Acacia holosericea* (Stantec, 2021).

For further information refer to Appendix D: Mt Leyshon Rehabilitation and Pastoral Lease Condition Monitoring 2021.

Two regulated vegetation types, Category R (GBR riverine regrowth) and defined watercourse and wildlife habitat (special least concern animal) were identified as Matters of State Environmental Significance within the Mt Leyshon Mine shown below in Figure 1.16. Much of the mapped Category R regulated vegetation existed pre-mining and was removed as part of the mining activities, with rehabilitated landforms now present in the mapped locations.

Queensland Regional Ecosystem mapping displayed six regional ecosystems within the Mt Leyshon Mine general area as displayed in Figure 1.17 and Table 1.7. A significant area of the 9.12.1/9.12.4b regional ecosystems were also removed as part of the mining activities, with rehabilitated landforms now present in these locations.

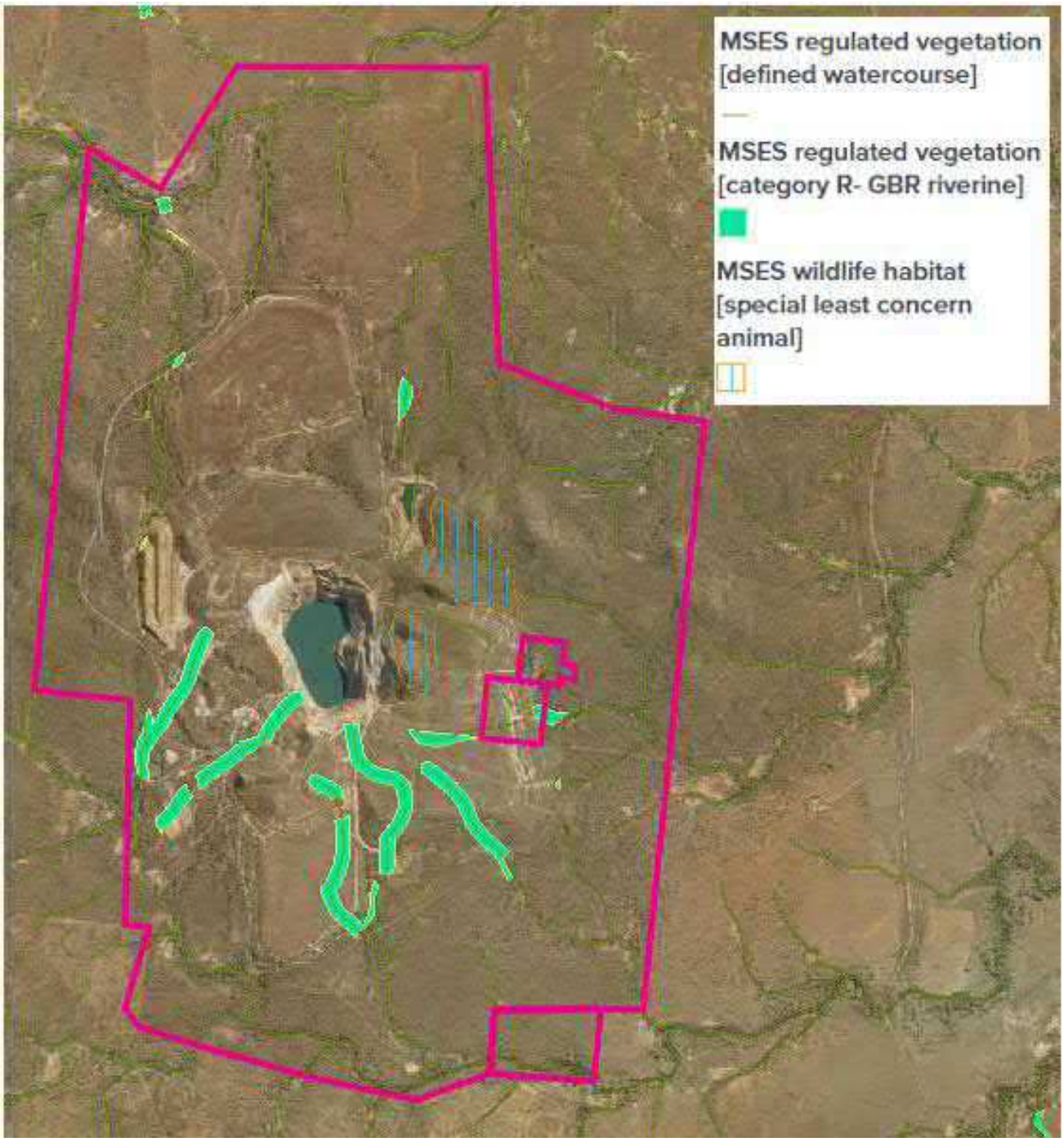


Figure 1.16: Matters of State Environmental Significance (Queensland Government, 2021)

Table 1.7: Identified Regional Ecosystems within the Mt Leyshon Mine

Regional Ecosystem	Short Description	VM Class[1]	Biodiversity Status
9.3.1	Eucalyptus camaldulensis and/or E. tereticornis +/- Melaleuca spp. +/- Casuarina cunninghamiana fringing woodland on channels and levees	Least Concern	Of Concern
9.12.1a	Eucalyptus crebra and/or E. xanthoclada and/or E. drepanophylla low open woodland on igneous rocks.	Least Concern	No Concern at present
9.12.1b	Eucalyptus crebra and/or E. xanthoclada and/or E. drepanophylla low open woodland on igneous rocks.	Least Concern	No concern at present
9.12.4b	Eucalyptus shirleyi and/or E. melanophloia and/or Corymbia peltata and/or Callitris intratropica low open woodland on igneous rocks	Least Concern	No concern at present
9.12.32	Eucalyptus persistens woodland on rhyolites and granites	Least Concern	No concern at present
9.3.3b	Corymbia spp. and Eucalyptus spp. dominated mixed woodland on alluvial flats, levees and plains	Least Concern	Of Concern

[1] *VM – Vegetation Management Act 1999 Classification

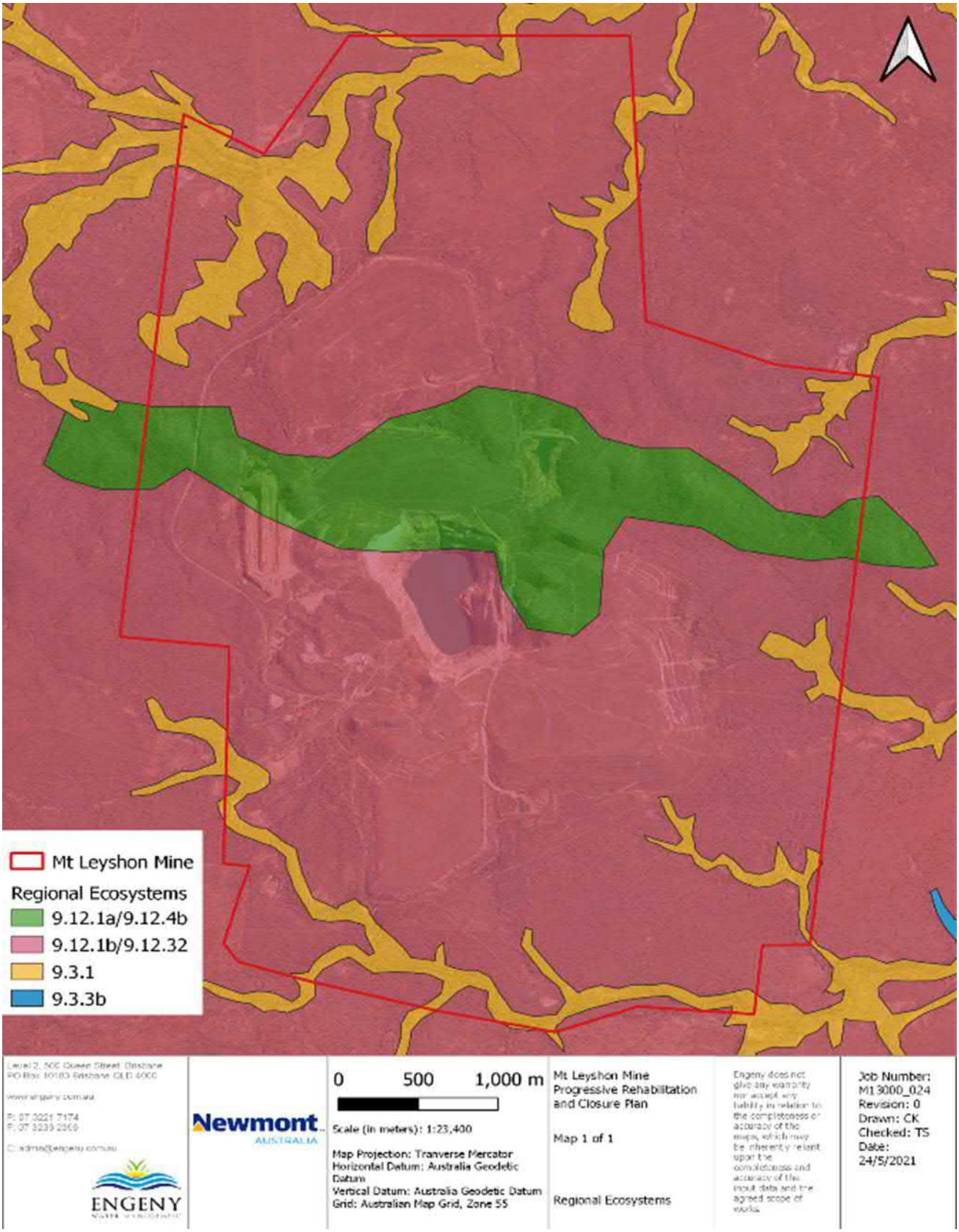


Figure 1.17: Regional Ecosystems

Fauna Presence and Populations

The *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST) was used to identify Matters of National Environmental Significance within a 5 km radius of the Mt Leyshon Mine. There were 15 threatened species and 10 migratory species identified as threatened species. There were no threatened ecological communities (TECs) displayed. Table 1.8 outlines the 15 listed threatened species, their relevant EPBC status and the presence type.

Table 1.8: Threatened Species Listed under the EPBC Act

Species Name	Common Name	EPBC Status	Presence
Birds			
Calidris ferruginea	Curlew Sandpiper	Critically Endangered	May occur
Erythrotriorchis radiatus	Red Goshawk	Vulnerable	Likely to occur
Falco hypoleucos	Grey Falcon	Vulnerable	May occur
Neochmia ruficauda	Star Finch (eastern), Star Finch (southern)	Endangered	Likely to occur
Poephila cincta	Southern Black-throated Finch	Endangered	Likely to occur
Rostratula australis	Australian Painted Snipe	Endangered	Likely to occur
Tyto novaehollandiae Kimberli	Masked Owl (northern)	Vulnerable	May occur
Mammals			
Dasyurus hallucatus	Northern Quoll	Endangered	May occur
Macroderma gigas	Ghost Bat	Vulnerable	Likely to occur
Phascolarctos cinereus	Koala	Vulnerable	Likely to occur
Phinolophus robertsi	Large-eared Horseshoe Bat, Greater large-eared Horseshoe Bat	Vulnerable	May occur
Plants			
Dichanthium setosum	Bluegrass	Vulnerable	Likely to occur
Reptiles			
Denisonia maculata	Ornamental Snake	Vulnerable	Likely to occur
Egernia rugosa	Yakka Skink	Vulnerable	Likely to occur
Lerista vittate	Mount Cooper Striped Skink, Mount Cooper Striped Lerista	Vulnerable	May occur

The 2020 rehabilitation monitoring assessment identified fauna at both rehabilitation and analogue sites such as cattle, kangaroos, birds, and dingos/ dogs (Stantec, 2021).

For further information refer to Appendix D: Mt Leyshon Rehabilitation and Pastoral Lease Condition Monitoring 2021.

Pre-Mining Land Use

The Mt Leyshon Mine is within the Charters Towers Regional Council local government area and is zoned Rural under the Charters Towers Planning Scheme. This regional area is mostly dominated by rural practices such as agriculture, grazing and other rural activities as outlined by the Charters Towers Planning Scheme. The current surrounding land use comprises of predominantly grazing of intentionally sown pastures with very small-scale cropping activities undertaken to the southeast of the Mine, however this does not appear to be the dominant land use. Other mining leases exist in the surrounding area. The Environmental Management Overview Strategy 1993 states that the underlying area has been exposed to mining activity since 1871 (Newmont, 1993). The rehabilitation, fencing, water access for stock and weed management commitments in the compensation agreements between Mt Leyshon Gold Mines (a former holder of the Mt Leyshon resource tenures) and underlying landowners confirm a pre-mining land use of grazing.

Underlying Landholders

As shown in Figure 1.18, Newmont owns the properties within the Mt Leyshon Mine mining leases, with some portions accessible under access arrangements for other requirements. Newmont allows the agistment of cattle on the background pastoral properties on areas outside of the mining leases.

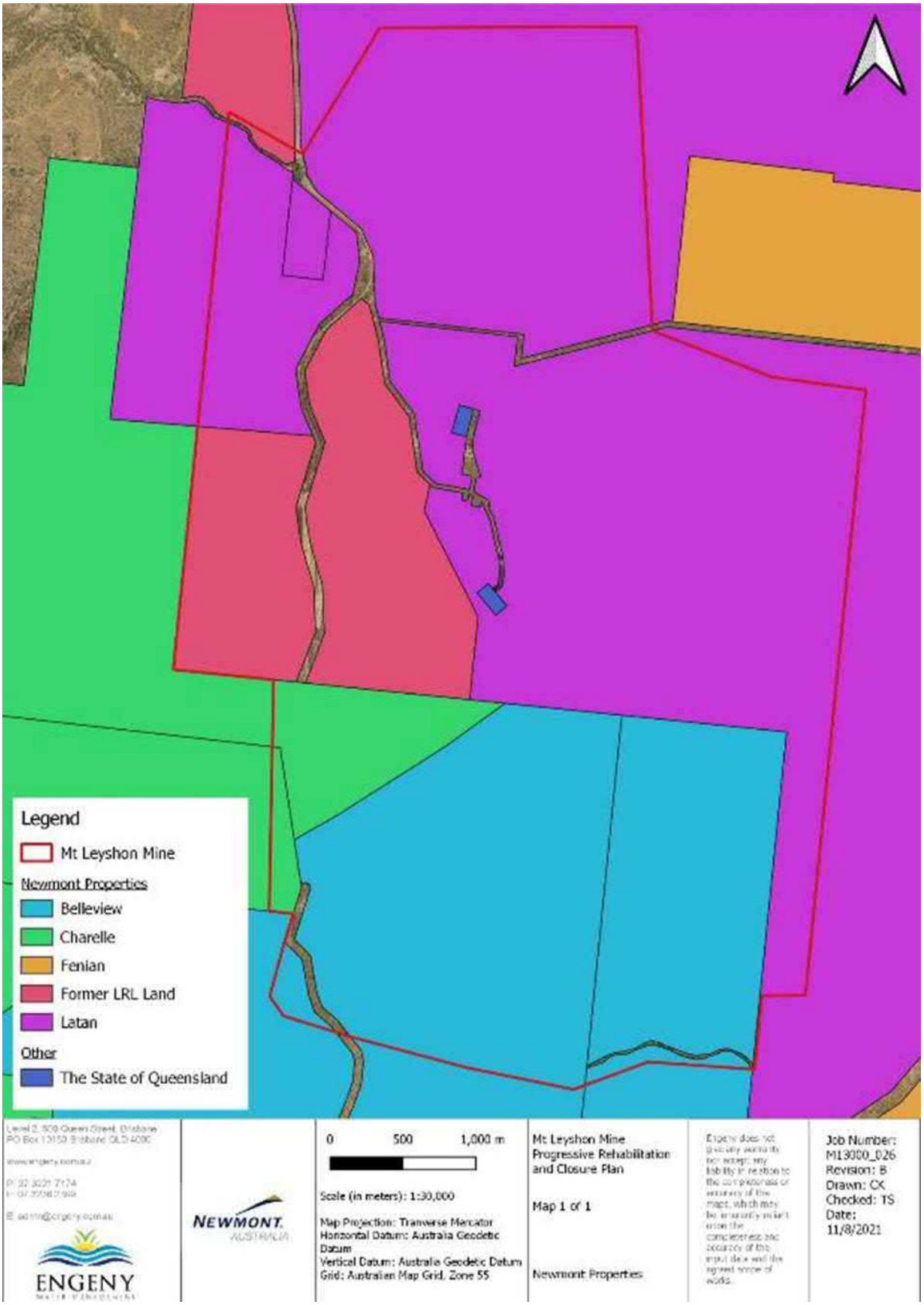


Figure 1.18: Underlying Landholders

1.4.2 Design for Closure

The initial design and development of the Mt Leyshon Mine was implemented in the 1990's and rehabilitation of the mine was undertaken progressively during the active mining phase and in campaigns post active mining. The development of the mine was informed by proximity to resource, sensitive receptors, and services and as rehabilitation of most of the mine is complete, designing for closure does not align to the mine's current status. Early rehabilitation works primarily focused on the waste rock storage facilities and tailings storage facilities which commenced in 1992 and were completed by 2002. Once mining was completed, rehabilitation of the majority of the remainder of the mine disturbance area was undertaken. As such, the majority of the final landform has been constructed and rehabilitated as shown in Figure 1.6.

Mine disturbance areas that have not yet been rehabilitated or have only been partially rehabilitated and require further rehabilitation works include:

4. Scats stockpiles – not rehabilitated at closure due to its potential value as it contains low grade ore. The scats stockpile is located on the western site of the mine adjacent to the NWRSF approximately 1.5 kilometers from the void (See Figure 1.20)
5. Eastern face of NWRSF – compacted porphyry waste rock capping system and surface drainage installed but no growth media and vegetation installed over the capping system. Final cover of this small area of the facility was not contemplated due to concerns over safe construction access. The relief of this feature is consistent with surrounding landforms and pre mining landscape.
6. Remaining infrastructure that has been required during the post-closure monitoring and maintenance phase (e.g., access roads, dams, pumps, pipelines, power, offices and workshops).

In addition, monitoring of historical rehabilitation areas has identified sections of poorly performing rehabilitation that are not trending towards meeting the rehabilitation completion criteria that will require further rehabilitation works.

No sensitive receptors have been identified within reasonable proximity to Mt Leyshon Mine as Newmont owns the underlying and adjacent properties. Figure 2.1 in Appendix E (Mt Leyshon Community Engagement Plan) shows the surrounding landholders and Newmont owned properties.

The current rehabilitation areas are outlined in Table 1.9 and Figure 1.19. Rehabilitation areas have been selected based on features, purpose (in terms of supporting the operation), and extent of rehabilitation works required. The areas where future rehabilitation works are planned to be undertaken are shown on Figure 1.20. These areas correspond with that contained in the PRCP schedule. The Improvement Area (IA1) for the open pit Non-Use Management Area (NUMA) is also shown in Figure 1.19.

Table 1.9: Rehabilitation Areas of Disturbance

RA	Areas of Disturbance
1	Eastern Waste Rock Storage Facility
2	Northern Waste Rock Storage Facility
3	Southern Waste Rock Storage Facility
4	New Northern Tailings Storage Facility
5	Old Northern Tailings Storage Facility
6	Southern Tailings Storage Facility
7	Stockpiles (RoM, 'B', Low Grade, and Heap Leach)
8	All dams and sumps
9	All roads and all mine infrastructure not required to be retained for the PMLU by the underlying landholder

RA	Areas of Disturbance
10	Northern Borrow Pit
11	Quarry
12	Scats Stockpile

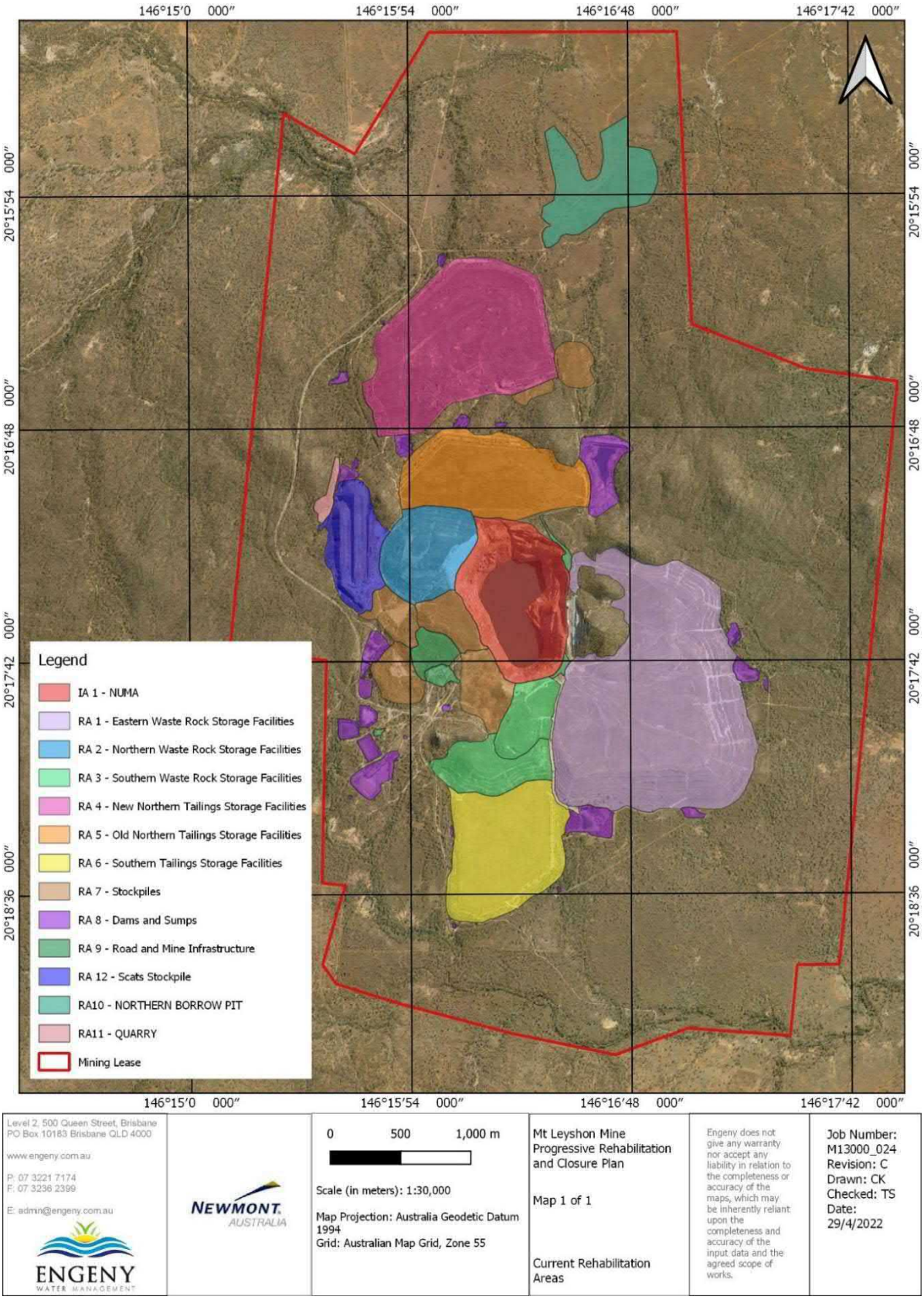


Figure 1.19: Current Rehabilitation Areas

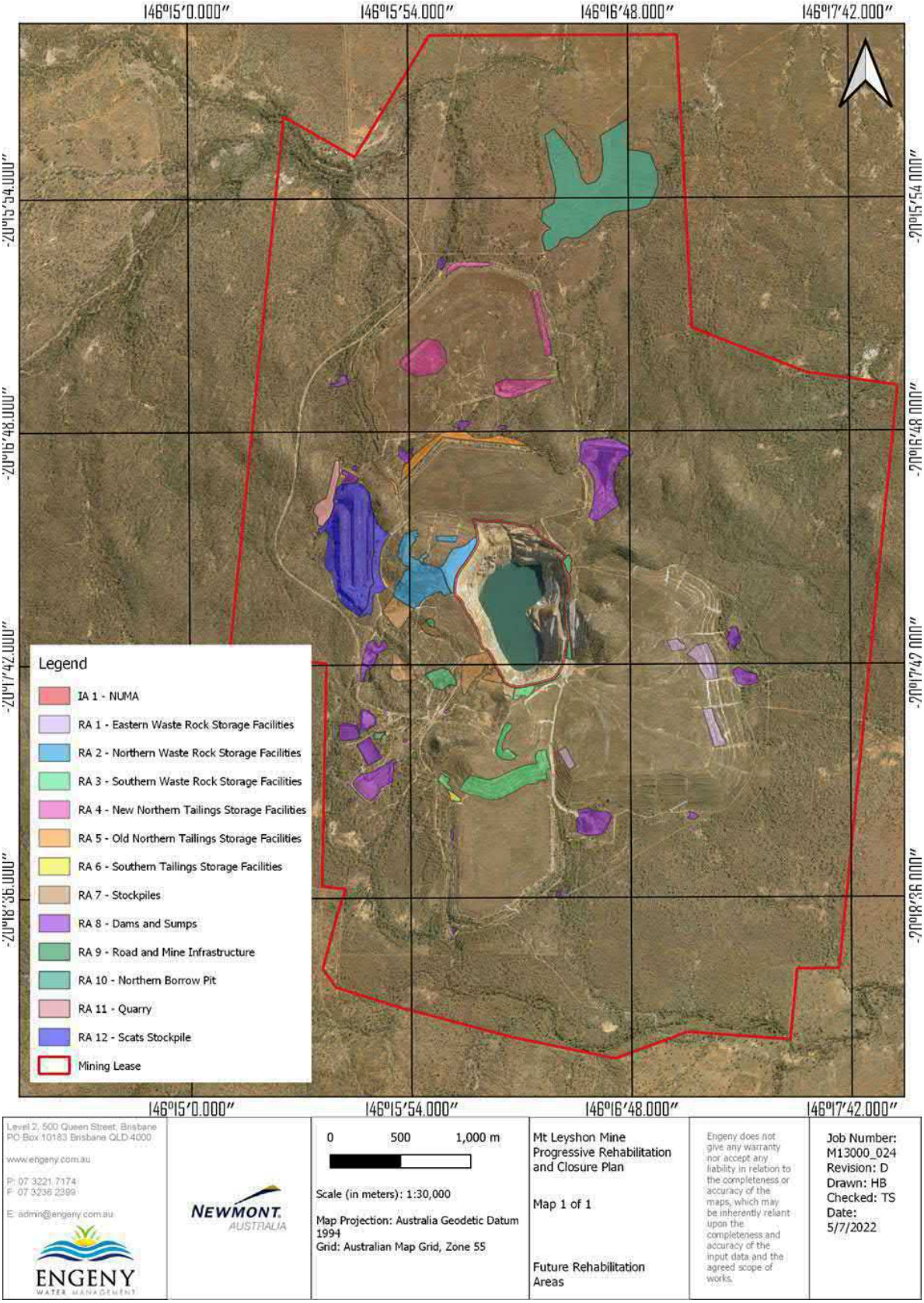


Figure 1.20: Areas Where Rehabilitation Works are to be Undertaken

The closure of the mine was designed to minimize any long-term environmental impacts. This has been achieved by:

- Minimising the quantity of mine impacted water (e.g., capping of waste rock facilities and tailings storage facilities, constructing a free draining final landform, directing "clean" surface water around the mine site and implementing a surface water management system to collect mine-affected water and pumping mine-affected water to the pit void lake).
- Predicting the long-term geotechnical stability of the open cut pit benches and monitoring and reviewing accordingly.
- Constructing a stable post mining landform that is suitable for the PMLU of grazing.
- Minimising the overall disturbance footprint of the mine.

1.4.3 Rehabilitation and Improvement Planning

Newmont will undertake reasonable measures to progressively rehabilitate all remaining disturbed land, as it becomes available for rehabilitation. As Mt Leyshon Mine is a non-operational site, a rehabilitation program based on available resources (rather than a mining schedule) has been included in the schedule section of this plan. This section describes when rehabilitation will be undertaken and identifies and justifies when land will become available for rehabilitation.

Identification of Relevant Activities

The relevant activities are consistent with the those listed in the PRCP schedule, being:

- Waste Rock Storage Facilities.
- Stockpiles.
- Tailings Storage Facilities.
- Dams and Sumps.
- Mine Infrastructure.
- Pit void (Non-Use Management Area).

No further mining activities are planned to occur at the Mt Leyshon Mine, although some borrow earthworks will be required within the mining leases outside of the current mine disturbance footprint to source materials (primarily topsoil and rock) for the planned future rehabilitation works. Materials testing has confirmed the suitability of these borrow sources and the Environmental Authority authorizes these additional future disturbance areas.

Size and Extent of Relevant Activities

The size and extent of the relevant activities are shown in Table 1.10. The majority of these areas are currently available for rehabilitation. The exception being:

- Dams, sumps, pump and power infrastructure required for the ongoing management of water not suitable for release to the receiving environment.
- Roads, offices and workshops to support the ongoing rehabilitation monitoring and maintenance of the mine.
- Monitoring installations required for the ongoing monitoring of the rehabilitation works and to comply with the requirements of the Environmental Authority.

Table 1.10: Size and Extent of Relevant Activities

Relevant Activity	Area Previously Rehabilitated (ha)	Area Requiring Further Rehabilitation or Improvement (ha)	Total Rehabilitation or Improvement Area (ha)
Pit Void (NUMA)	*N/A*	5.04	*70.38**
Eastern Waste Rock Storage Facility	*190.72*	6.95	*197.67*
Northern Waste Rock Storage Facility	*23.50*	14.98	*38.48*
Southern Waste Rock Storage Facility	*28.89*	12.54	*41.42*
New Northern Tailings Storage Facility	*103.35*	13.33	*116.68*

Relevant Activity	Area Previously Rehabilitated (ha)	Area Requiring Further Rehabilitation or Improvement (ha)	Total Rehabilitation or Improvement Area (ha)
Old Northern Tailings Storage Facility	*60.10*	5.20	*65.30*
Southern Tailings Storage Facility	*67.5*	0.69	*68.19*
Stockpiles	*49.59*	11.36	*60.94*
Scats stockpile	*1.31*	28.71	*30.02*
Dams and Sumps	*16.50*	33.69	*50.19*
Road and Mine Infrastructure	*11.69*	4.08	*15.77*
Northern Borrow Pit	*0*	40.10	*40.10*
Quarry	*0*	3.30	*3.30*

**Total NUMA Area*

Rehabilitation works are typically undertaken during the dry season (i.e., April to October). Newmont propose to undertake the remaining rehabilitation works progressively, as outlined in the schedule, at a rate that is safe and practical based on the resources available to supervise and coordinate the rehabilitation works for a mine that has been closed for over 20 years.

The maximum disturbance extent from mining activities including the creation of future borrow pits for sourcing of rehabilitation materials is shown in Figure 1.21 below.

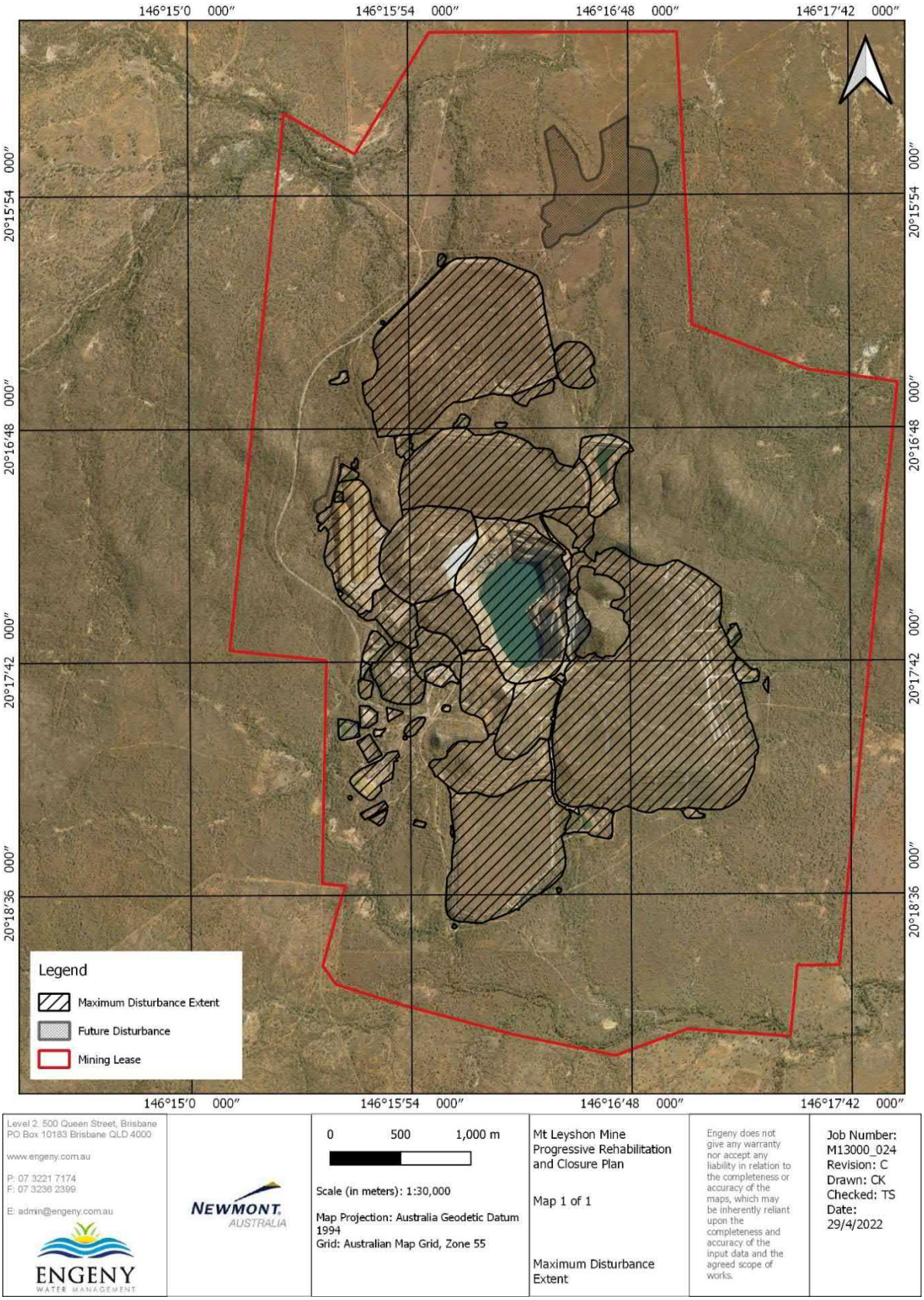


Figure 1.21: Maximum Disturbance Extent

Likely Duration of Relevant Activities

No mining or processing activities have occurred at the Mt Leyshon Mine since the mine closed in 2002. No further mining activities are planned to occur at the Mt Leyshon Mine.

Rehabilitation of the mine commenced in 1992 and was primarily completed by 2002. Approximately 76% of the land disturbed by mining has already been rehabilitated (see Table 1.10). The proposed rehabilitation (i.e., the physical works (e.g., earthworks, surface preparation and seeding)) timing of the remaining areas will be undertaken as outlined in the PRCP schedule. The PRCP schedule and timing of the rehabilitation works will occur in a series of discrete phases being:

- **Phase 1:** Mobilisation and site establishment of plant and resources required to undertake works, and the undertaking rehabilitation and/or rectification works across all waste rock storage facilities and tailings storage facilities as per Table 1.10.

  Given the discrete locations and relatively small size of the rehabilitation areas the completion of this program is expected to be feasible based on the equipment requirements along with the resources available to supervise and coordinate the rehabilitation works for a mine that has been closed since 2002.

- **Phase 2:** This phase involves the rehabilitation of the stockpiles (including the scats stockpile). The scats stockpile has an average gold content of 0.22 g/t and therefore contains a significant amount of gold and inherent value. Previous options studies for the scats stockpiles by Newmont indicated that it may become economical to re-process the scats stockpiles to recover gold if the gold price increases to US$2,000/oz. Newmont is not currently planning to re-process the scats stockpiles and the rehabilitation of the scats stockpiles has been included in the PRCP schedule after the rehabilitation works for the waste rock storage facilities, tailings storage facilities and other stockpile areas. This delayed scheduling of the scats stockpile rehabilitation allows for potential technological changes and market factors which may see the recovery of this potential resource before the area is rehabilitated. Investigations by Newmont have also confirmed that the scats stockpile represents an acceptable level of risk with respect to environmental harm in their current configuration (uncovered and at angle of repose), despite being classified as PAF material, because:

  – The stockpile slopes are geotechnically stable at the natural angle of repose.
  – The stockpiles slopes are resistant to erosion at the natural angle of repose because of the coarse particle size of the scats material and the high permeability of the scats material, with the majority of incident rainfall infiltrating into the scats stockpiles and negligible surface runoff occurring.
  – Although incident rainfall that comes into contact with the scats material becomes AMD, the downgradient water containment dams (Upper Plum Tree Creek Dam and Plum Tree Creek Dam) provide a very effective containment system (water pumped to the pit void lake) because of the high infiltration capacity of the stockpiles and the slow rate of drainage of pore water contained within the stockpiles into the containment dams.
  – Groundwater investigations have not identified any evidence of a seepage pathway below the base of the stockpiles into either the adjacent shallow or deep groundwater systems or into Plum Tree Creek downgradient of the Plum Tree Creek Dam.

  The PRCP will be amended if the rehabilitation strategy for the scats stockpile needs to be revised to reclassify the stockpiles as land not available for rehabilitation (in accordance with the EP Act) because of a future decision to re-process the scats stockpile. Otherwise, this rehabilitation work will be typically undertaken during the dry season (i.e., April to October) over a period of three years.

- **Phase 3:** The rehabilitation works undertaken in Phases 1 and 2 will require material to be sourced from onsite borrow pits. The materials for the remaining rehabilitation works will be taken from the borrow pits as required, allowing for the borrow pits to be rehabilitated over a two-year period once they are no longer relied upon. Some of this material will be stockpiled for use in the Phase 5 rehabilitation works to enable the rehabilitation of borrow pit areas.

- **Phase 4:** This phase involves monitoring and maintenance of the available rehabilitated areas. Qualitative and quantitative monitoring across a range of aspects (i.e., surface water, groundwater, rehabilitated landforms)) will be undertaken to track the performance of the rehabilitation area against the milestone criteria. The rehabilitation works undertaken in Phases 1-3

are designed to improve the pasture grass species coverage and surface water and groundwater quality. Water currently collected and pumped to the pit lake will be released off site (i.e., returned to the local creek systems) once the monitoring demonstrates the milestone criteria has been achieved. The redundant water management infrastructure (e.g., dams, sumps and drainage channels) will be subsequently removed and rehabilitated/used to support the grazing PMLU as part of this phase. Newmont may also progressively seek certification of rehabilitation areas from DES in accordance with the EP Act.

Based on Newmont's experience with post-closure monitoring and maintenance of previously rehabilitated landforms at Mt Leyshon Mine, the following timeframes have been assumed for the duration of the monitoring and maintenance phase for each rehabilitation area in the PRC Plan schedule:

- Scats stockpile rehabilitation area: 10 years.
- Rehabilitation areas that do not currently rely on the surface water/seepage interception system since the surface runoff/seepage water quality is suitable for discharge to the receiving environment: 20 years.
- Rehabilitation areas that currently rely on the surface water/seepage interception system since the surface runoff/seepage water quality is not currently suitable for discharge to the receiving environment: 100 years.

The installation of a cover system on the Scats Stockpile is targeting an outcome where no active water management is required in the medium or long-term. These rehabilitation works will significantly reduce the volume of water required to be pumped to the pit lake since rainfall infiltration through the un-covered Scats Stockpile (intercepted by the Plum Tree Creek Dam) represents the largest single source of water pumped to the pit lake.

The repairs of discrete sections of the existing rehabilitation areas with poor vegetation establishment or surface erosion is targeting an outcome with improved surface runoff water quality where no active interception of surface water is required and where shallow seepage flows reduce in magnitude to a level at which passive release can occur without harm to the identified environmental values (i.e., can be assimilated within the down-gradient surface water and groundwater systems).

A further period of monitoring will be required to assess the effectiveness of the repairs to the existing rehabilitation areas included in the PRCP on minimising and ultimately eliminating the requirement for ongoing active water management operations. It is expected that the confirmation of improvements to surface water quality and cessation of surface water interception/pumping will be able to occur within a relatively short timeframe (e.g. 5 to 10 years); however, a longer period of time is expected to be required to assess the effectiveness of the rehabilitation works on the shallow seepage flows and the potential assimilative capacity of the receiving environment (noting that previous surface water and groundwater investigations and receiving environment monitoring have identified that the receiving environment has an appreciable assimilative capacity for surface runoff and seepage flows emanating from the rehabilitated mine landforms as described in other parts of this RFI response).

The period of ongoing active water management adopted for the PRCP is 100 years. The conservative nature of this approach is considered appropriate given the uncertainty in the timeframes to achieve relinquishment.

- **Phase 5:** This phase involves the removal and rehabilitation of the remaining mine infrastructure used to support the rehabilitation works in Phases 1-4. Material will be sourced from the borrow pits to rehabilitate these remaining areas. The borrow pits will also be rehabilitated to create a natural free draining landscape during this phase.

- **Phase 6:** This phase involves monitoring and maintenance of the rehabilitation areas undertaken in Phase 5. Qualitative and quantitative monitoring across a range of aspects (i.e., surface water, groundwater, rehabilitated landforms) is undertaken to track the performance of the rehabilitation area against the milestone criteria.

  The vegetation cover and composition will be the key driver which will determine the duration of this monitoring and maintenance phase. A monitoring and maintenance period of 20 years has been assumed in the PRC plan schedule for this phase.

During the post-closure maintenance and monitoring period it has been necessary to continue to intercept surface runoff and seepage flows from some of the rehabilitated mine landforms (impacted water is pumped to the pit void) to comply with EA conditions and to prevent environmental harm from occurring. While many of the planned future rehabilitation activities are

targeting an outcome of improved water quality, it is expected that ongoing interception and pumping of impacted water may still be required for a long timeframe before all of the rehabilitation completion criteria can be achieved and the land considered stable as defined in section 111A of the EP Act. For this reason, some infrastructure will be required to support the ongoing rehabilitation monitoring and maintenance activities (e.g., offices, workshops, dams, sumps, pumps, power and road infrastructure are all required for the ongoing management of impacted water). Decommissioning of this infrastructure will be undertaken once the relevant rehabilitation milestone(s) have been achieved.

1.5 COMMUNITY CONSULTATION

In accordance with section 126C(1)(c)(iii) and (iv) of the EP Act, this section of the PRC plan details:

- Consultation undertaken in developing the PRC plan; and
- How ongoing consultation in relation to the rehabilitation to be carried out under the PRC plan will be undertaken.

1.5.1 Community Consultation Undertaken

Based on discussions with the landowners of the area covered by the mine leases (land now owned by Newmont), Newmont understands that community consultation occurred throughout the life of Mt Leyshon Mine with the intent of ensuring that anyone with the potential to be impacted by activities at the mine, including rehabilitation and closure, had an opportunity to voice their needs and concerns and provide input to mine planning processes.

Additional community consultation may have been undertaken, however due to the complex ownership of the mine, lack of transfer of information, and change of personnel, and record keeping of interactions not being a common practice at the time, records for interactions were limited and further details are not able to be provided. Where reasonable and practicable, community consultation has informed the outcomes stated in this PRC plan, for example, the identification and justification of pre-approved PMLUs and NUMAs.

Other relevant community consultation in relation to rehabilitation and closure includes the submission of documents to state government agencies during the operational and closure phases of the mine. This includes the submission of Plans of Operations, management plans, Closure Plans and other documentation required under the Environmental Authority conditions.

Newmont has provided periodic updates of post-closure surface water and groundwater management and rehabilitation status for the Mt Leyshon Mine to the Department of Environment and Science. Dates of consultation are as follows:

- 16 May 2017.
- 29 October 2018.
- 4 March 2021.

Despite land parcels having changed ownership from those that the original landholder compensation agreements were made with, The Environmental Management Overview Strategy (Mount Leyson Gold Mine, 1993), notes that compensation agreements were established with the following background landholders:

- John Brownson (Bellevue).
- Charles Hughes (Charelle).
- Phillip Knuth (Latan Station).

These agreements contain rehabilitation conditions being:

- “Satisfactory rehabilitation of the mining lease land in accordance with the Act (Mining Act and Mineral Resources Act) and the Queensland Department of Primary Industry”.
- “The landowner will be consulted regarding the particular requirements for grasses and revegetation of disturbed areas”.
- “Removal of Parthenium weed and rubber vine at the time of surrender”.
- “Mt Leyshon agrees that the landowner shall be entitled to use and occupy for grazing purposes that part of the Mining Lease Land subject to additional ML’s….”

References in the agreements to restricting stock from accessing an existing water source and the fencing of the mining lease boundary clearly show that the land prior to the mine was used for grazing. Rehabilitating the mine to a PMLU of grazing is consistent with its prior mine use.

Table 1.11 is a record of community consultation previously undertaken in relation to rehabilitation and closure of Mt Leyshon Mine.

Table 1.11: Community Consultation Register for Rehabilitation and Closure of Mt Leyshon Mine

Consultation Dates	Community Members	Consultation Type	Information Provided to the Community	Issues Raised/Discussed by the Community	How Issues Have Been Considered	Decisions/Outcomes of Engagement	Commitments Made
7th October 1991	*Phillip Cook Knuth*	Land Compensation Agreement	Land outcomes of Mt Leyshon Mine	The mining lease land be attended to for the removal of Parthenium weed at the time of surrender of the Mt Leyshon Mining Lease	Incorporated into the agreement.	Landowner will be consulted regarding the requirements for grasses and revegetation of disturbed areas.	All parties agreed to the land outcome.
27th November 1991	*John Richard Brownson*	Land Compensation Agreement	Land outcomes of Mt Leyshon Mine	The mining lease land be attended to for the removal of Parthenium weed and rubber vine at the time of surrender of the Mt Leyshon Mining Lease	Incorporated into the agreement.	Landowner will be consulted regarding the requirements for grasses and revegetation of disturbed areas.	All parties agreed to the land outcome.
12th January 1993	*Phillip Cook Knuth*	Land Swap / Compensation Agreement	N/A	N/A	N/A	N/A	Agreement executed
15th January 1993	*John Richard Brownson*	Land Compensation Agreement	Land outcomes of Mt Leyshon Mine	The Company shall pay compensation to the Landowner for any loss at market value of any livestock injured or killed as a direct consequence of the activities of the Company within the Lease Lands	Compensation clause incorporated into the agreement.	Compensation clause incorporated into the agreement.	Agreement executed

1.5.2 Ongoing Community Consultation

For the purposes of the PRCP the primary stakeholders for consultation are:

- Newmont as they are the underlying landowner.
- Landholders adjoining properties owned by Newmont.
- Parties with lease agreements to use Newmont land.
- Charters Towers Regional Council.
- Department of Environment and Science.
- Department of Resources.
- Traditional Owners (Jangga People).
- Local interest groups.

A key element of proactive engagement with the community is the description of former and upcoming rehabilitation efforts as part of progressive rehabilitation in accordance with the publicly available Progressive Rehabilitation Closure Plan (PRCP). Access to the PRCP will be facilitated during proactive engagement sessions by way of including methods for stakeholders to access the PRCP (e.g., print, online, etc.). Descriptions of key items relating to upcoming works identified in the PRCP schedule and their timeframes for completion/progression to the next milestone will be incorporated into engagement sessions which provide an opportunity for the community to directly provide feedback which is proposed to be incorporated into PRCP updates as required. The frequency of ongoing consultation will reflect underlying and adjoining land ownership (Newmont owned) and the limited potential for impacts of the former operation, rehabilitation works already undertaken, and the remaining rehabilitation works to return the land to its pre-approved post mining land use of grazing. Mt Leyshon's Community Engagement Plan is provided as Appendix E, Section 3.3 of that Plan includes an Action Plan that describes the stakeholders, methods and frequency of engagements. Methods/topics of updates include technical updates, site inspections, developments that impact stakeholders, and site tours. Mount Leyshon's PRCP including the schedule and the carrying out of rehabilitation will be communicated as part of these topics, with opportunities for feedback. It is noted that Newmont own the underlying and adjoining pastoral properties to the mine and community consultation occurs with stakeholders that are beyond the immediate location of the mine (through the Dalrymple Landcare Committee) which is the primary consideration for the nominated methods and frequencies of engagements. Specifically, PRCP scheduling, and rehabilitation planning is included in the method and content descriptor for engagement with stakeholders in the action plan contained in Appendix E.

1.6 POST-MINING LAND USE

A post-mining land use (PMLU) is defined under Section 112 of the EP Act as the purpose for which the land will be used after all relevant activities for the PRC plan carried out on the land have ended. It is noted that a PMLU does not include third-party activities or assets that continue to exist once mining activities have ceased, such as third-party pipeline easements, power easements or overlapping tenures for other EAs (DES, 2017).

In accordance with section 126C(1)(d) of the EP Act, this section of the PRC plan identifies the PMLU that is proposed for the Mt Leyshon Mine and describes the extent to which it is consistent with:

- The outcomes of community consultation; and
- Any strategies or plans for the land of a local government, the State or the Commonwealth.

This section of the PRC plan does not include the information required by section 126C(1)(j) of the EP Act as sites with a PMLU that has previously been identified in a land outcome document and is able to be transitioned into the PRCP schedule are exempt from having to address this section of the EP Act (DES, 2017).

1.6.1 Post-Mining Land Use Description

A single PMLU of grazing is pre-approved for all disturbed areas within the Mt Leyshon Mine resource tenures except for the pit void which is a Non-Use Mining Area (NUMA) (refer to Section 1.4). Grazing will take the form of light grazing in accessible areas, acknowledging that the resource tenures include steep, rocky land (which also existed in the pre-mining landscape, and

is also present within the surrounding land). This is consistent with the Agricultural Land Classification for land within the resource tenures (C3) and the pre-mining and surrounding land uses as discussed in Section 1.1.2 and throughout the PRCP.

Rehabilitation and closure work that was undertaken prior to closure were designed to achieve a grazing PMLU. For example, rehabilitated waste rock storage facilities and TSFs have primarily been revegetated with buffel grass which is widespread and valued as fodder for grazing stock in Northern Queensland and across Australia.

Where practicable, existing tracks within the resource tenures will remain in place and form part of the PMLU. This will provide a benefit to the grazing PMLU in terms of access within the resource tenures. Newmont is the owner of the properties on which the resource tenures are located.

1.6.2 Post-Mining Land Use Justification

Pre-Approved PMLU Status

Grazing is a pre-approved PMLU for the purpose of the PRC plan because it has been identified as a PMLU in the Mt Leyshon Closure Plan (Newmont, 2019) which is a land outcome document for the Mt Leyshon Mine (required by Condition F4-1, and F10-1 and 2 of Mt Leyshon's EA). The Closure Plan notes historical compensation agreements between Mt Leyshon Gold Mines (a former holder of the Mt Leyshon resource tenures) and underlying landowners which committed to returning land disturbed by mining to grazing land. It also notes that during rehabilitation and closure works, buffel grass was the primary vegetation species applied to rehabilitated waste rock storage facilities and TSFs. Figure 1.22 outlines the PMLU and NUMA extent and maximum disturbance extent for Mt Leyshon Mine.

Grazing also satisfies relevant rehabilitation and closure conditions from Schedule F of the Mt Leyshon Mine Environmental Authority (EA) which is the primary land outcome document for the Mt Leyshon Mine. The relevant conditions are:

- Schedule F – Table F1 Rehabilitation Requirements – All mine features (except for the final void) have a rehabilitation goal of safe, non-polluting, stable and self-sustaining, with rehabilitation objectives, indicators and completion criteria per the Closure Plan.

The rehabilitation and closure works undertaken to date at the mine have been designed to achieve the rehabilitation goals of safe, non-polluting, stable and self-sustaining PMLU and have been undertaken in accordance with the Closure Plan. Monitoring and maintenance of the rehabilitated areas has occurred and will continue to occur during the post-closure phase of the mine to track progress against the rehabilitation goals as part of relinquishment process.

- Condition F2-4 – All land subject to mining activities must be rehabilitated to:
  - A stable landform and with a self-sustaining vegetation cover and species that are similar to adjoining undisturbed areas.

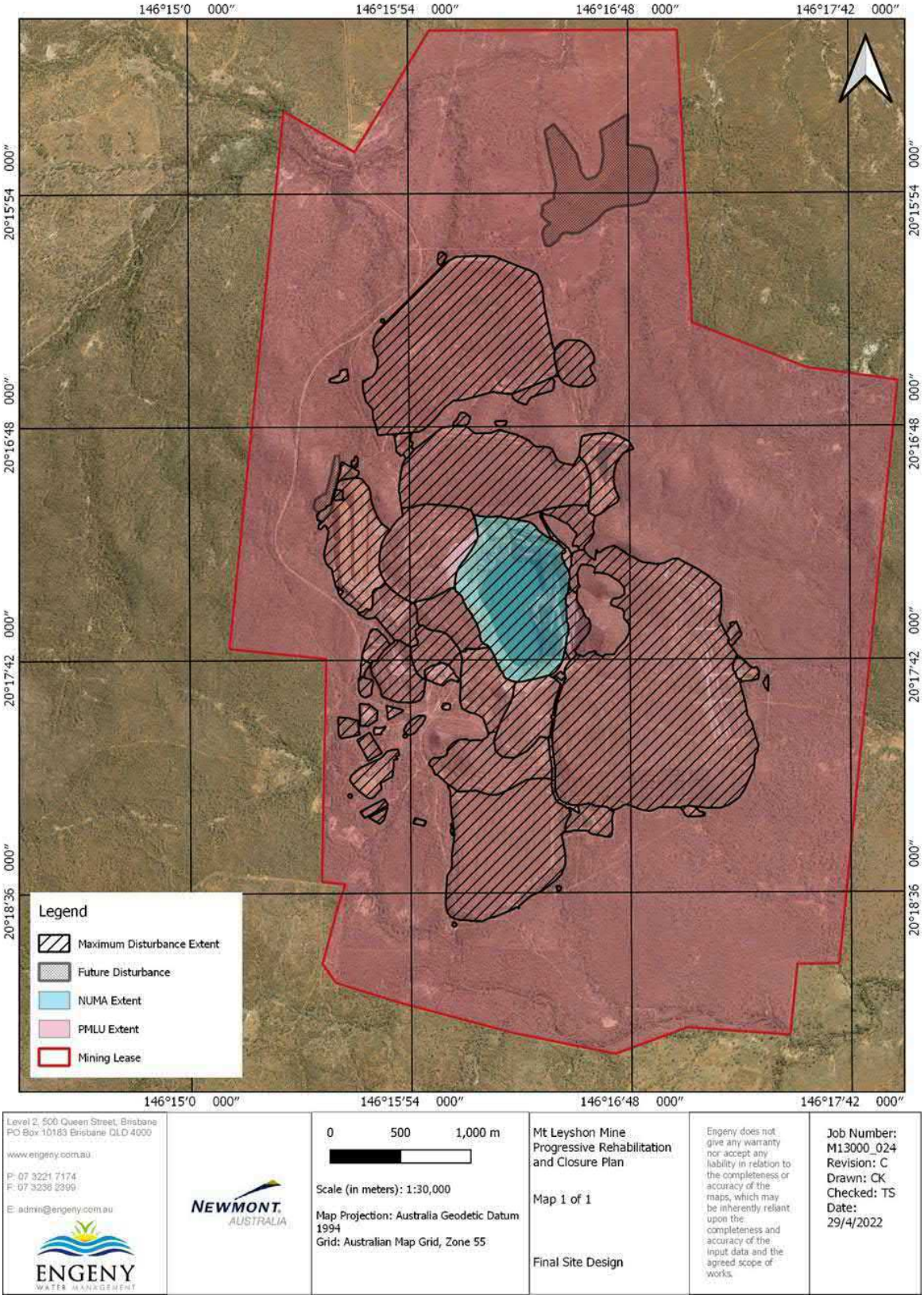


Figure 1.22: PMLU and NUMA Extent

The rehabilitation and closure works undertaken to date at the mine have been designed to achieve the rehabilitation goal of stable. The rehabilitated waste rock storage facilities and TSFs have primarily been revegetated with buffel grass which is highly tolerant of grazing and occurs in analogue areas (Stantec, 2020).

- A safe landform, which is non-polluting, geo-chemically and geo-technically stable.

The mining, rehabilitation and closure works undertaken to date at the mine have been designed to achieve the rehabilitation goals of safe, non-polluting and stable and have been undertaken in accordance with the Closure Plan. Monitoring and maintenance of the rehabilitated areas will occur during the post-closure phase of the mine to track progress against the rehabilitation goals. Further rehabilitation works are planned and included in the PRCP schedule to rehabilitate the remaining disturbed areas that were not rehabilitated at closure (relatively small fraction of the original disturbance area) and to improve the performance of the existing rehabilitation areas in terms of their ability to achieve the rehabilitation completion criteria.

- Ensure that all land is reinstated to the pre-disturbed land use and suitability class (Land Suitability Assessment Techniques).

The Mt Leyshon Mine has been subject to mining activity since 1871 (Newmont, 1993). Prior to modern large scale mining activities which commenced in 1986, the topography of the mine was characterised by relatively flat land interspersed with steep hills and rocky outcrops which accommodated grazing activities undertaken by pastoralists and in combination with commitments made in landholder compensation agreements, was the foundation of rehabilitation efforts to return the land disturbed by mining to a land use that supports grazing. As shown in Figure 2.4, the original Mt Leyshon was the highest landform at the mine. It was surrounded by a number of smaller hills including Mt Mawe which is located immediately to the east of the former Mt Leyshon (now the open cut pit void).

A land suitability class assessment in accordance with the Land Suitability Assessment Techniques was not completed prior to commencement of modern mining activities however a land capability assessment was completed prior to the operation of Mt Leyshon Mine as outlined in Section 2.1.2. It is estimated that the land suitability falls mainly into three classes:

- Class 3 – Agricultural – Suitable land with moderate limitations. Land which is moderately suited to a proposed use but requires significant inputs to ensure sustainable use.
- Class 4 - Agricultural – Marginally suitable land. Land which is marginally suited for a proposed use and would require major inputs to ensure sustainability.
- Class 5 – Agricultural – Unsuitable land with extreme limitations. Land which is unsuited and cannot be sustainably used for a proposed use.

During modern mining activities, the open-cut pit removed much of Mt Leyshon, the western side of Mt Mawe was reprofiled to a steeper, benched profile to enable the open-cut pit to safely expand, and waste emplacement facilities were constructed over or against a number of the smaller pre-mining hills surrounding the original Mt Leyshon.

The current topography and land capability and suitability of the mine is considered to be representative of the pre-mining conditions. The rehabilitated waste emplacement facilities have relatively flat tops that would be suitable for grazing. However, the batters of the waste emplacement facilities and reprofiled Mt Mawe have a steeper gradient and would be marginally suitable or not suitable for grazing, but still representative of natural landforms within the mining leases. This is consistent with a light grazing land use scenario, which reflects the pre-mining land use and the Queensland Government Agricultural Land Classification mapping for the area in the vicinity of the Mt Leyshon Mine.

- Ensure that the maintenance requirements for rehabilitated land is no greater than that required for the land prior to its disturbance by mining activities.

As described above, the resource tenures will be rehabilitated to a safe, non-polluting, stable and self-sustaining condition that is consistent with the pre-disturbed land use and suitability class, and with vegetation cover and species similar to adjoining undisturbed areas. Therefore, the maintenance requirements for the grazing PMLU will be no greater than that required for the land prior to its disturbance.

- Condition F7-1 – All infrastructure, mining equipment and processing plant constructed by or for the environmental authority holder during the mining activities including water storage structures must be removed from the site prior to mining lease surrender, except where agreed to in writing by the post-mining landholder.

The majority of the infrastructure required during the operating phase of the mine was removed at closure. Infrastructure remaining at the mine is typically required to support the post-closure monitoring and maintenance activities and includes roads, dams, pumps, pipelines, power, offices and workshops. The remaining sub-structure of a jaw crusher is located to the west of the pit void and is planned to be removed and rehabilitated as part of the future rehabilitation works for the mine.

All infrastructure will be removed from the resource tenures except for existing tracks and the mine access road. Existing access tracks will be retained to provide a benefit to the background pastoral properties in terms of access within the pastoral properties. The mine access road will be retained since it is required to provide road access to the Bellevue property to the south of the mine. Newmont is both the EA holder and post-mining landholder for the resource tenures, therefore in accordance with Section 3.2 of the PRCP guideline, retention of this infrastructure is considered to be a part of the PMLU as it is consistent with the land use. Further to this, a written landowner agreement is not required for the PRC plan as there will be no transfer of ownership of the infrastructure.

Community Consultation

The grazing PMLU is consistent with the outcomes of community consultation because:

- Historical compensation agreements between Mt Leyshon Gold Mines (a former holder of the Mt Leyshon resource tenures) and underlying landowners committed to returning land disturbed by mining to grazing land.
- The Mt Leyshon Closure Plan (Newmont, 2019) implies that the land disturbed by mining will be returned to grazing land. The Closure Plan has been submitted to and reviewed by Queensland government departments on multiple occasions over the course of mining.
- Newmont owns all of the pastoral properties underlying the Mt Leyshon Mine. At the time of purchase of the pastoral properties by Newmont, it was understood that the land would be returned to grazing at the completion of mining.

Local, State and National Strategies and Plans

The extent to which the grazing PMLU is consistent with local, State and National strategies and plans is outlined in Table 1.12 below.

Table 1.12: Consistency of the PMLU with Local, State and Commonwealth Strategies and Plans

Strategy or Plan	Purpose	PMLU Consistency
Local/Regional		
Charters Towers Regional Town Plan Version 2 (Town Plan) (Charters Towers Regional Council, 2020a)	The Town Plan has been prepared in accordance with the *Planning Act 2016* (Planning Act) as a framework for managing development in a way that advances the purpose of the Planning Act. It forms the basis for ensuring appropriate development occurs in the Town Plan area for the life of the Town Plan.	The Mt Leyshon Mine is situated in the rural land use zone under the Town Plan. The 'Charters Towers places model' summarises how development within the rural land use zone is acknowledged and anticipated. It states that the rural land use zone is to be used for agriculture, **grazing** and complementary tourism, agribusiness and rural activities.
Charters Towers Economic Development & Innovation Strategy (Charters Towers Regional Council, 2020b)	The Economic Development & Innovation Strategy reflects the Charters Towers Regional Council's commitment to delivering sustainable economic growth, increasing living standards, broadening personal opportunity attracting new talent and providing greater amenity to the region.	The Economic Development & Innovation Strategy emphasises that leveraging Charters Towers' natural assets is key to delivering growth in the agricultural sector, particularly in low-impact agricultural sector (which may include low-intensity **grazing**) which, according to the Strategy is emerging and has high growth potential. Through the Strategy, the Charters Towers Regional Council is committed to supporting investment in high-value, low-impact agriculture, as well as encouraging diversification of agriculture to meet future national and international demand.

Strategy or Plan	Purpose	PMLU Consistency
North Queensland Regional Plan (Queensland Government, 2020)	The North Queensland Regional Plan (NQ Regional Plan) is a 25-year strategic, statutory planning document for the local government areas of Burdekin, Charters Towers, Hinchinbrook, Palm Island and Townsville. It has been prepared to support the established and emerging industries in the region and to address changes expected to occur within the region.	A goal of the North Queensland Regional Plan is for North Queensland to be a leading economy in regional Australia, building upon the region's primary strengths which includes agriculture. The Plan contains seven regional policies for agriculture. Most are specific to Priority Agricultural Areas and Agricultural Land Classes A and B which do not apply to the Mt Leyshon Mine. The two policies that are more general in nature and do apply to the Mt Leyshon Mine are: • New and expanding agriculture developments protect and enhance vegetation in riparian corridors and wetlands – the **grazing** PMLU will achieve this through the incorporation of best practice farm management techniques. • The integrity and the purpose of the stock route network within the region is not compromised – presently there are no stock routes within or adjacent to the Mt Leyshon Mine.
State		
State Planning Policy (SPP) (Department of Infrastructure, Local Government and Planning, 2017)	The SPP expresses the state's interests in land use planning and development. A state interest is defined under the Planning Act as an interest that the Planning Minister considers affects an economic or environmental interest of the state or a part of the state, or affects the interest of ensuring that the purpose of the Act is achieved. Under the Planning Act, local governments must integrate relevant state interests into the planning scheme for their local government area.	• The SPP overlays have been referenced and incorporated in the Charters Towers Regional Town Plan. The SPP overlays that apply to the Mt Leyshon Mine are: • Bushfire hazard overlay – areas within and surrounding the Mt Leyshon Mine mining leases are mapped as medium and very high bushfire intensity. • Natural environment overlay – drainage lines and associated riparian vegetation within the mining leases are mapped as regulated vegetation (intersecting a watercourse) and regulated vegetation (category R) respectively. There are also two wildlife habitat (special least concern animal) areas mapped in the north-east of the mining leases. • Regional infrastructure overlay – an Ergon powerline runs north-south through the western half of the mining lease. • The **grazing** PMLU will achieve the state interest in the land that is the Mt Leyshon Mine mining leases, having regard to the above listed SPP overlays, through the incorporation of best practice farm management techniques. For example, appropriate siting, design and management practices to avoid intensifying the bushfire risk and clearing regulate vegetation. The Ergon powerline is not associated with mining and will be retained within the PMLU.
North Queensland Regional Economic Development Plan 2014-2031 (NQ2031) (North Queensland Regional Organisation of Councils, 2014)	NQ2031 is an initiative of the Regional Economic Development sub-committee of the North Queensland Regional Organisation of Councils (RED-ROC). Its purpose is to foster a greater level of regional unity and collaboration to drive economic development in North Queensland between the City of Townsville, Charters Towers Regional Council, Burdekin Shire Council, Hinchinbrook Shire Council and Palm Island Aboriginal Shire Council.	A key theme of the NQ2031 is 'growing agriculture'. Although the NQ2031 is primarily focussed on irrigated cropping, it does acknowledge that North Queensland has a tremendous opportunity to build on its established comparative strengths in agriculture, particularly by enhancing access to and utilisation of productive agricultural land.
A Strategic Blueprint for Queensland's Northwest Minerals Province	A Strategic Blueprint for Queensland's Northwest Minerals Province contains a suite of actions to secure the long-term future of Northwest Queensland. It will facilitate a strong and prosperous future by building on existing economic and community strengths in collaboration with	The Strategic Blueprint acknowledges that Queensland's Northwest has a strong agricultural base in **grazing**, with unique prospects for further agricultural development. In recognition of this, the Queensland Government has committed, through the Blueprint, to developing an

Strategy or Plan	Purpose	PMLU Consistency
(Strategic Blueprint) (Queensland Government, 2017)	industry, business and community leaders.	integrated Northwest Queensland agriculture plan. The Blueprint also acknowledges that mining output levels in Queensland's Northwest may be lower than expected over the medium term. Therefore, the Queensland Government has also committed, through the Blueprint, to facilitating a smooth economic and social transition towards a strong and more diversified economy, building on existing economic and community strengths, which may include **grazing**.
Commonwealth		
Our North, Our Future: White Paper on Developing Northern Australia (Australian Government, 2015)	The White Paper sets out how the Commonwealth Government will address challenges to development in northern Australia by: • Making it easier to use natural assets, in close consultation with, and the support of Indigenous communities. • Providing a more welcoming investment environment. • Investing in infrastructure to lower business and household costs. • Reducing barriers to employing people; and • Improving governance.	The White Paper speaks to grazing through the lens of pastoral land rights. Presently, leaseholders of pastoral land are generally restricted from using their land for activities other than grazing. The Australian Government is committed to removing unnecessary restrictions on pastoral leases to enable leaseholders to use their land for broader forms of economic activity, thereby attracting more investment to the north and creating a more resilient and diversified northern economy. Although the land underlying the Mt Leyshon Mine is of freehold and not Crown, the discussion in the White Paper supports the **grazing** PMLU by acknowledging that grazing is integral to the economic, environmental and cultural fabric of northern Australia.
Charters Towers: A Living Transitions Roadmap (CSIRO & BOM, 2020)	The Living Transitions Roadmap is a living roadmap designed to support the Charters Towers Region secure a prosperous and sustainable future. It is developed as part of the Communities in Transition (CiT) project through active participation of the Council and community members.	The Living Transitions Roadmap outlines three broad pathways for Charters Towers, one being 'Charters Towers as a hub for supply/processing/transport and low impact agriculture. This pathway is consistent with and will support the **grazing** PMLU by improving the efficiency and resilience of existing and new supply chains, particularly in the context of expanding and creating new opportunities for the agricultural sector.

1.6.3 Post-Mining Land Use Completion Criteria

Completion criteria for determining whether PMLU has been achieved for the Mt Leyshon Mine are based on the EA, and Land Outcome Documents; Mt Leyshon Closure Plan (Newmont, 2019), Groundwater Management Plan, and REMP and are incorporated into rehabilitation milestones in the monitoring and maintenance and scheduling part of this PRCP. It is noted that the Rapid Assessment Framework (RAF), based on Landscape Function Analysis and Ecological Function Analysis (LFA/EFA) and is utilized to assist determination of rehabilitation success and is further discussed in section 1.10.3, along with a discussion on surface and ground water completion criteria. The completion criteria define the final PMLU rehabilitation milestones in the PRCP schedule.

1.7 NON-USE MANAGEMENT AREAS

A non-use management area (NUMA) is defined under Section 112 of the EP Act as an area of land the subject of a PRC plan that cannot be rehabilitated to a stable condition after all relevant activities for the PRC plan carried out on land have ended.

One NUMA has been identified for the Mt Leyshon Mine PRC plan: the open cut pit void which is a final void.

In accordance with section 126C(1)(d) and (i) of the EP Act, this section of the PRC plan describes:

- The extent to which the final void is consistent with the outcomes of community consultation.
- The extent to which the final void is consistent with strategies or plans for the land of a local government, the State or the Commonwealth; and

- Management of the final void to support the management milestones under the PRCP schedule.

It is noted that this section of the PRC plan does not include the information required by section 126C(1)(g), (h) or 126D(2) or (3) of the EP Act as sites with a NUMA that has previously been addressed in a land outcome document and is able to be transitioned into the PRCP schedule are exempt from having to address this section of the EP Act (DES, 2017).

1.7.1 Non-Use Management Area Description

As seen in Figure 1.23, the final void left by the open cut mine pit is situated in the center of the Mt Leyshon Mine, within ML10144. It is approximately 210 m deep, has `pit wall slope angles between 35 and 50 degrees, and has a storage capacity of approximately 63 GL (Newmont, 2018; Engeny Water Management, 2020). The total surface area of the final void is 70.4 ha as per Schedule A – Table A1 in the EA.

When open pit mining terminated in 2001, the pit void was acting as a groundwater sink due to the dewatering operations undertaken during mining. The pit void was therefore identified as the preferred location for storage of tailings when processing ore stockpiles which was completed between early 2001 and March 2002. This allowed closure and rehabilitation of the NNTSF and STSF to be commenced while the site was still in an operating phase.

The pit void has been managed as a final void since the closure of the mine in 2002.

Currently, the pit void plays a critical role in the post-closure water management system at the mine, with mine-affected seepage and runoff from the surrounding rehabilitated waste rock storage facilities and tailings storage facilities collected in dams and sumps around the perimeter of the mine and then pumped into the pit void. This has resulted in the formation of a void lake within the pit void. The pit void lake currently has a maximum depth of approximately 90 m, with a pit lake surface level of RL 253 m AHD.

Comprehensive groundwater modelling and investigations have identified the following pit lake elevations at which the pit void is likely to transition from a groundwater sink to a groundwater source (Schlumberger Water Services, 2012):

- Deep basement groundwater system – RL 295 m AHD: and
- Regional shallow groundwater system – RL 365 m AHD.

The deep basement groundwater system at 295m is a discrete deep fracture which is localized to the pit lake. In order to avoid impacts on groundwater beyond the discrete deep fracture zone, investigations have concluded that the maximum safe elevation for the final pit lake is 340 m AHD and a management milestone as part of the PRCP schedule is to maintain pit lake levels below RL 340 m AHD (Newmont, 2018).

Human, livestock and wildlife access to the final void is restricted via:

- Fencing around the external mining lease boundary.
- A restricted access/safety bund around the perimeter of the final void itself.

Figure 1.23: Extent of Pre Approved Non-Use Management Area

1.7.2 Non-Use Management Area Justification

Pre-Approved NUMA Status

During the operating phase of the mine, the rehabilitation outcome for the pit void was defined in the EMOS as "non-use" (refer to Table 2 on Page 11 of the EMOS (Newmont, 1993)). The EMOS also states that, following mine closure, access to the pit void would be restricted by the construction of a bund around the full perimeter of the void to exclude access by humans, livestock and wildlife (refer to pages 27 and 39 of the EMOS (Newmont, 1993)).

For the purpose of the PRC plan, the pit void is a pre-approved NUMA because it has closure objectives that are consistent with it being a NUMA in the Closure Plan (Newmont, 2019) which is a land outcome document for the Mt Leyshon Mine (required by Condition F4-1, and F10-1 and 2 of the EA), as well as the Final Void Decommissioning Strategy (Newmont, 2018) which is also a land outcome document for the Mt Leyshon Mine (required by Condition F9-3 of the EA). Both of these documents establish that ongoing management is needed to achieve the rehabilitation outcome for the pit void, in particular management of the pit void lake elevation to prevent seepage from the pit void into the regional groundwater system, and maintenance of the abandonment bund to prevent humans, livestock and wildlife from accessing the pit void.

The non-use rehabilitation outcome for the pit void is supported by the EA which is the primary land outcome document for the Mt Leyshon Mine. The EA conditions that relate to rehabilitation of the pit void are as follows:

- Schedule A, Table 1 – Authorized Mining Activities.

Table 1 outlines the authorized maximum disturbance area and location of the pit void. This has been carried forward to the PRC plan (i.e., Figure 1.19 on previous page).

- Schedule F, Table F1 – Rehabilitation Requirements.

Table F1 defines the rehabilitation goals for the pit void as safe, non-polluting and stable. Unlike the other mine domains listed in Table F1, self-sustaining is not a rehabilitation goal for the pit void in recognition of the fact that it cannot sustain a PMLU.

- Condition F2-4(e) - Ensure that the water quality of any residual void or water bodies constructed by mining activities does not have potential to cause environmental harm.
- Condition F9-1 - Residual voids must not cause any serious environmental harm to land, surface waters or any recognized groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself.

The Final Void Decommissioning Strategy (Newmont, 2018) contains an analysis of pit void lake water quality. As the main input to the pit void lake was/is mine-affected seepage and runoff from the surrounding mine facilities, the pit lake is acidic (pH 4.1) and has elevated concentrations of sulphate and metals. The Final Void Decommissioning Strategy concludes that the pit lake water quality would not meet the Australian and New Zealand Environment and Conservation Council (ANZECC) criteria for animal consumption which further supports the pit void's NUMA status when compared to Mount Leyshon's PMLU of grazing.

To prevent any environmental harm as a result of the pit void lake water quality, a key management/completion criterion for the pit void is to maintain the pit void lake level below RL 340 m AHD. This will ensure that the pit void will not overflow to land or surface water features, as well as ensure that there is no seepage from the pit void into the regional groundwater system.

Community Consultation

The final void NUMA is consistent with the outcomes of community consultation because:

- Rehabilitation and closure documents developed over the course of mining at the Mt Leyshon Mine have consistently noted a final void and stated or inferred that the final void will be a non-use area post-relinquishment. For example, the Environmental Management Overview Strategy (EMOS) states that the final void and its surrounds will be "non-use" post-relinquishment (Newmont, 1993). Also the Closure Plan (Newmont, 2019) and Final Void Decommissioning Strategy (Newmont, 2018) refer to a final void that requires ongoing management including prevention of access and storage of contaminated materials that is consistent with a feature that does not support a PMLU and is consistent with a NUMA.

These documents have been submitted to and reviewed by Queensland government departments on multiple occasions over the course of mining.

- Newmont owns all of the pastoral properties underlying the Mt Leyshon Mine. At the time of purchase of these properties, Newmont understood that the pit void would be a non-use area post-relinquishment.

Local, State and National Strategies and Plans

The extent to which the final void NUMA is consistent with local, State and National strategies and plans is outlined in Table 1.13 below.

Table 1.13: Consistency of the NUMA with Local, State and Commonwealth Strategies and Plans

Strategy or Plan	Purpose	NUMA Consistency
	Local/Regional	
Charters Towers Regional Town Plan Version 2 (Town Plan) (Charters Towers Regional Council, 2020a)	The Town Plan has been prepared in accordance with the *Planning Act 2016* (Planning Act) as a framework for managing development in a way that advances the purpose of the Planning Act. It forms the basis for ensuring appropriate development occurs in the Town Plan area for the life of the Town Plan.	The region has a long history of mining and Town Plan the urban area of Charters Towers will act as a gateway supporting **major mining activities** in the region and further afield. Final voids are a common occurrence with open cut mining operations. As such the existing of a final void (i.e., NUMA) is not inconsistent with the Town Plan.
Charters Towers Economic Development & Innovation Strategy (Charters Towers Regional Council, 2020b)	The Economic Development & Innovation Strategy reflects the Charters Towers Regional Council's commitment to delivering sustainable economic growth, increasing living standards, broadening personal opportunity attracting new talent and providing greater amenity to the region.	The Economic Development & Innovation Strategy recognises that **mining** has and will continue to be industry in the region. As final voids are typical with open cut mining operations, a final void NUMA is not inconsistent with this strategy.
North Queensland Regional Plan (Queensland Government, 2020)	The North Queensland Regional Plan (NQ Regional Plan) is a 25-year strategic, statutory planning document for the local government areas of Burdekin, Charters Towers, Hinchinbrook, Palm Island and Townsville. It has been prepared to support the established and emerging industries in the region and to address changes expected to occur within the region.	Managing and facilitating **mining and extractive resource activities** within and beyond the region is identified as an economic opportunity by the North Queensland Regional Plan. Open cut mines typically include a final void. As such, a final void NUMA is not inconsistent with this plan.
	State	
State Planning Policy (SPP) (Department of Infrastructure, Local Government and Planning, 2017)	The SPP expresses the state's interests in land use planning and development. A state interest is defined under the Planning Act as an interest that the Planning Minister considers affects an economic or environmental interest of the state or a part of the state or affects the interest of ensuring that the purpose of the Act is achieved. Under the Planning Act, local governments must integrate relevant state interests into the planning scheme for their local government area.	The inclusion of a final void NUMA does not compromise the SPP overlays that apply to the Mt Leyshon mine being: • Bushfire hazard. • Natural environment. • Regional infrastructure.

Strategy or Plan	Purpose	NUMA Consistency
North Queensland Regional Economic Development Plan 2014-2031 (NQ2031) (North Queensland Regional Organisation of Councils, 2014)	NQ2031 is an initiative of the Regional Economic Development sub-committee of the North Queensland Regional Organisation of Councils (RED-ROC). Its purpose is to foster a greater level of regional unity and collaboration to drive economic development in North Queensland between the City of Townsville, Charters Towers Regional Council, Burdekin Shire Council, Hinchinbrook Shire Council and Palm Island Aboriginal Shire Council.	One of the key regional themes in NQ2031 is **Unlocking Resources Wealth**. As the resources sectors is seen as a target growth area, the inclusion of a final void NUMA at Mt Leyshon is not inconsistent with NQ2031.
A Strategic Blueprint for Queensland's Northwest Minerals Province (Strategic Blueprint) (Queensland Government, 2017)	A Strategic Blueprint for Queensland's Northwest Minerals Province contains a suite of actions to secure the long-term future of Northwest Queensland. It will facilitate a strong and prosperous future by building on existing economic and community strengths in collaboration with industry, business and community leaders.	The Strategic Blueprint acknowledges that mining industry has been the primary driver for regional employment and economic growth in the province. The Blueprint also notes that a Northwest Minerals Province Taskforce has been established to identify issues affecting the Province's mining industry and to help plan a strategic way forward. The Queensland Government has also committed, through the Blueprint, to facilitating a smooth economic and social transition towards a strong and more diversified economy, building on existing economic and community strengths, includes **mining**. A final void is typical for open cut mining operations and therefore a NUMA is not inconsistent with the Strategic Blueprint.
Commonwealth		
Our North, Our Future: White Paper on Developing Northern Australia (The White Paper) (Australian Government, 2015)	The White Paper sets out how the Commonwealth Government will address challenges to development in northern Australia by: • Making it easier to use natural assets, in close consultation with, and the support of Indigenous communities. • Providing a more welcoming investment environment. • Investing in infrastructure to lower business and household costs. • Reducing barriers to employing people; and • Improving governance.	The White Paper identifies the Australian Government's aspirations for **resources** as a diverse portfolio of mining across the north including existing large-scale resources such as iron ore, base metals and gold, and new mines for strategic minerals such as rare earths. A final void is typical for open cut mining operations and therefore a NUMA is not inconsistent with the White Paper aspirations.
Charters Towers: A Living Transitions Roadmap (CSIRO, 2019)	The Living Transitions Roadmap is a living roadmap designed to support the Charters Towers Region secure a prosperous and sustainable future. It is developed as part of the Communities in Transition (CiT) project through active participation of the Council and community members.	The Living Transitions Roadmap outlines three broad pathways for Charters Towers, one being 'Dynamic business ventures and sector development'. This pathway is expected to play into urban renewal of Charters Towers as well as regional agriculture, tourism and mining. This pathway is consistent with and will support the **grazing** PMLU by improving the efficiency and resilience of existing and new supply chains, particularly in the context of expanding and creating new opportunities for the agricultural sector.

1.7.3 Non-Use Management Area Management Milestones

The following management milestones have been incorporated into the PRCP schedule for the pit void NUMA:

- Water balance model verification after decommissioning of the water interception system (pumping ceases into void) that the pit lake level will remain below RL 340 m AHD in perpetuity:
  - This activity is proposed to occur after 100 years and represents the duration of the 'operation' as a whole for the purpose of PRCP.
  - Complemented as part of the 'duration' of the operation as a whole through maintaining pit lake level below RL 340 m AHD through operational staff/monitoring systems in conjunction with operational Trigger Action Response Plans. Note the reaching of this level is not anticipated due to fill rates, evaporation rates, etc. and monitoring is deemed suitable with interventions made/reviews to practices if required.
- Maintaining of exclusion bund and signage.
  - To continue for the duration of the 'operation'.
- Certification from appropriately qualified person that the water level and quality in the void will not cause environment harm to the surrounding level
- Certification from appropriately qualified person that the void is safe to humans and livestock
  - Continuation and review/improvement of geotechnical stability of the pit void NUMA to monitor displacement of materials and potential encroachment of NUMA extents on PMLU areas.

The management milestones are designed to achieve best practice management and minimize environmental harm in the period prior to achieving the pit void NUMA completion criteria.

1.7.4 Non-Use Management Area Completion Criteria

Completion criteria for the final void at the Mt Leyshon Mine are defined in the Closure Plan (Newmont, 2019) and reproduced in Table 1.14. The completion criteria define the final management milestones for the pit void NUMA in the PRCP schedule and are designed to minimize:

- The risk of the final void collapsing, eroding and subsiding.
- The need to actively manage the final void.
- Access to the final void.

Table 1.14: Non-Use Management Area Completion Criteria

NUMA Goal	Completion Criteria
Safe, Stable, Non-Polluting	• After decommissioning of water interception system (pumping ceases due to water quality meeting EA release requirements) • Water balance model verification that RL340 will not be reached through inputs into void (catchment water flows, localised seepage, rainfall) • Construction of hard control barrier (around perimeter of NUMA at minimum of 1m high) • Warning signage posted every 100 m of the perimeter • Certification from an appropriately qualified person that the water level and quality in the void will not cause environmental harm to the surrounding environment • Certification from an appropriately qualified person that the void is safe to humans and livestock

1.8 REHABILITATION MANAGEMENT METHODOLOGIES

1.8.1 General Rehabilitation Practices

Hydrogeology

Background

The hydrogeology of the Mt Leyshon Mine is well understood from a range of groundwater investigations conducted during the exploration, development and operating periods for the mine, along with extensive groundwater investigations undertaken during closure. Key results from these studies along with conceptual models of groundwater flow, and or groundwater/surface water interactions were incorporated into the rehabilitation of Mt Leyshon Mine and its pre-approved PMLU and NUMA and are described in detail in the Mt Leyshon Groundwater Management Plan (BDH, 2017a). These investigations included:

- geophysical surveys (both shallow and deep Electrical Resistivity Tomography (ERT) surveys),
- the installation and collection of monitoring data from over 100 monitoring bores, of which 68 were installed from 2009 to 2011 (during the closure period),
- hydraulic testing of bores to define hydraulic characteristics, and
- the construction of a calibrated numerical groundwater model simulating groundwater elevations and sulphate transport.

The locations of investigation bores are illustrated in Figure 1.24 and a groundwater elevations and flow direction shown in Figure 1.25.

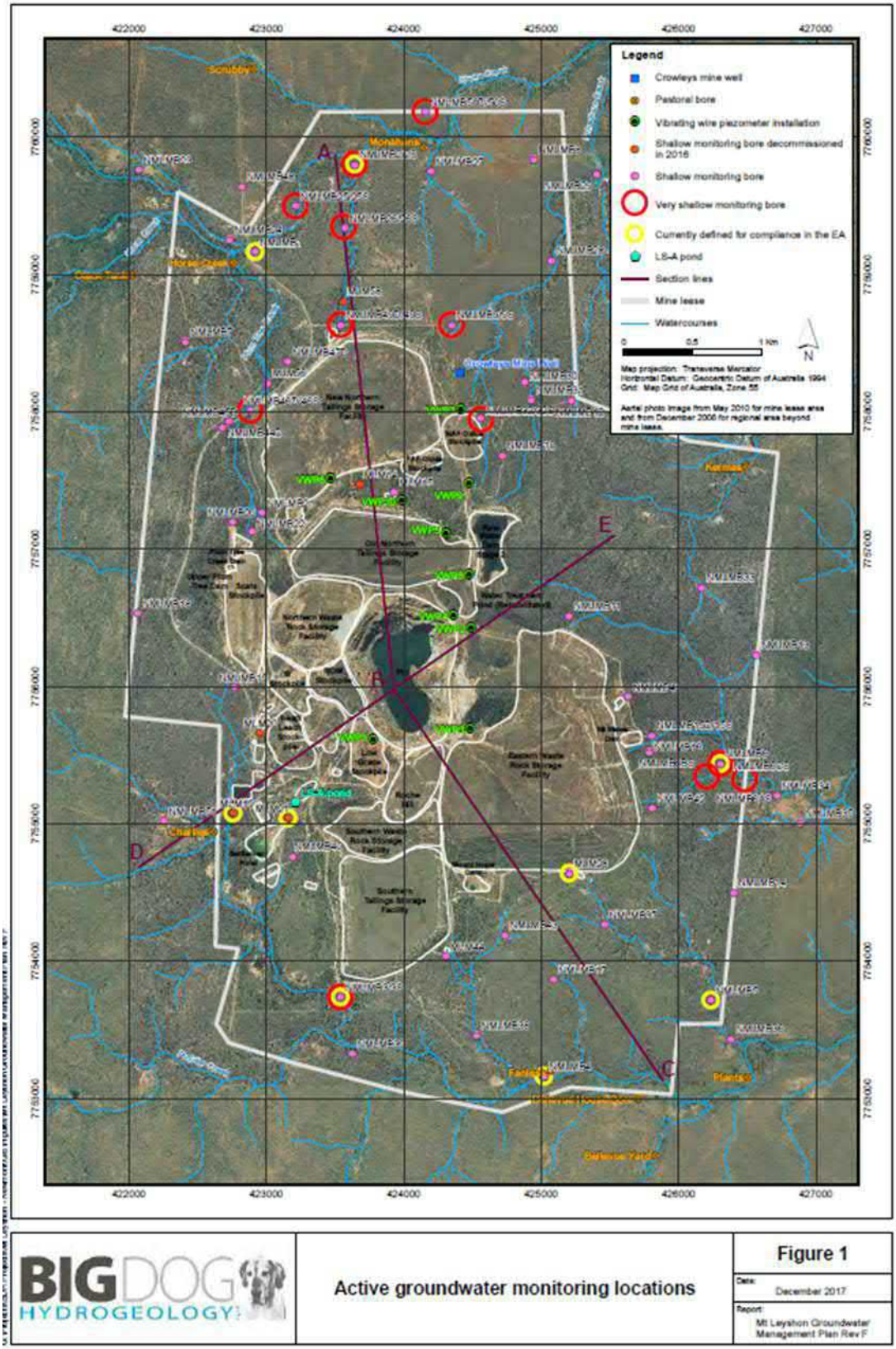


Figure 1.24: Groundwater Investigation Bores (Source: BDH, 2017a)

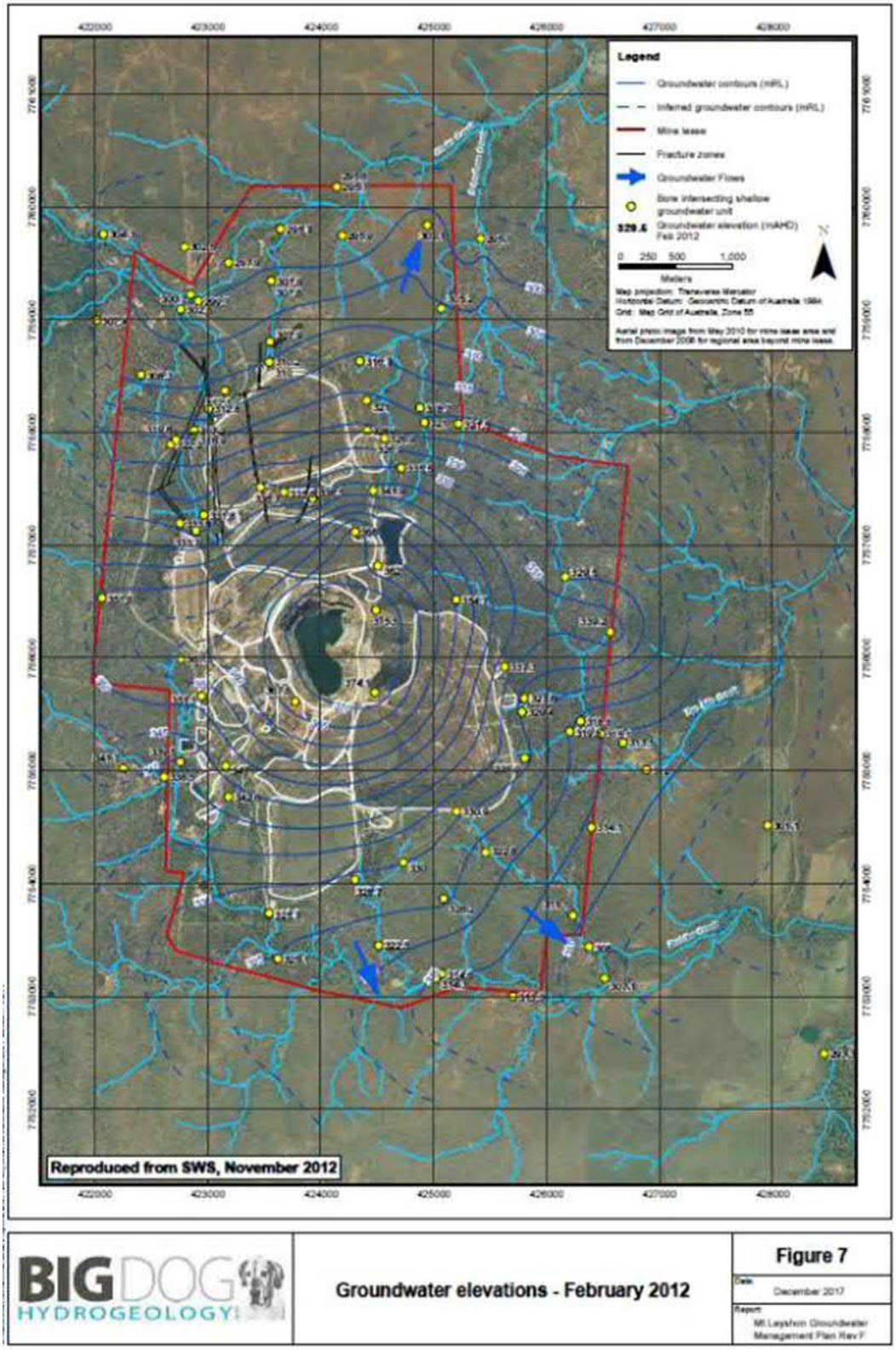


Figure 1.25: Groundwater Elevations and Flow Directions (Source: BDH, 2017a)

Groundwater Occurrence

At the Mt Leyshon Mine groundwater is present within two systems, the shallow groundwater system and the deep groundwater system.

The shallow groundwater system has been defined to comprise the upper weathered and fractured surface of the basement granitoid rocks, typically occurring between around 5 m and 25 m below ground level (mBGL). It takes the form of either sandy and gravely weathered basement material or less weathered material where relict structural features remain.

The deep groundwater system comprises fracture zones within the deep unweathered basement rocks, which include the breccias close to the open pit, and the surrounding dolerite and granite country rocks. The deep groundwater system typically occurs from 50 mBGL to 200 mBGL and is separated from the overlying shallow groundwater system by unfractured basement. Most of the basement rocks across the Mt Leyshon Mine have a low degree of fracturing (porosity) and limited presence of pore waters. Fracturing may be present in the basement rocks at depths of up to 200 m, but is limited to the area close to, and to the northeast of the final void. The available data indicate that there is little development of fracturing beyond about 1 km to 2 km from the final void, and the granite/dolerite country rocks in the surrounding area have limited fracturing. The deep groundwater system therefore is a localised discrete groundwater zone, which does not extend into the receiving environment beyond the lease boundary. Cross sections shown in Figure 1.24 conceptualising Mt Leyshon's groundwater system is shown in Figure 1.26 and Figure 1.27.

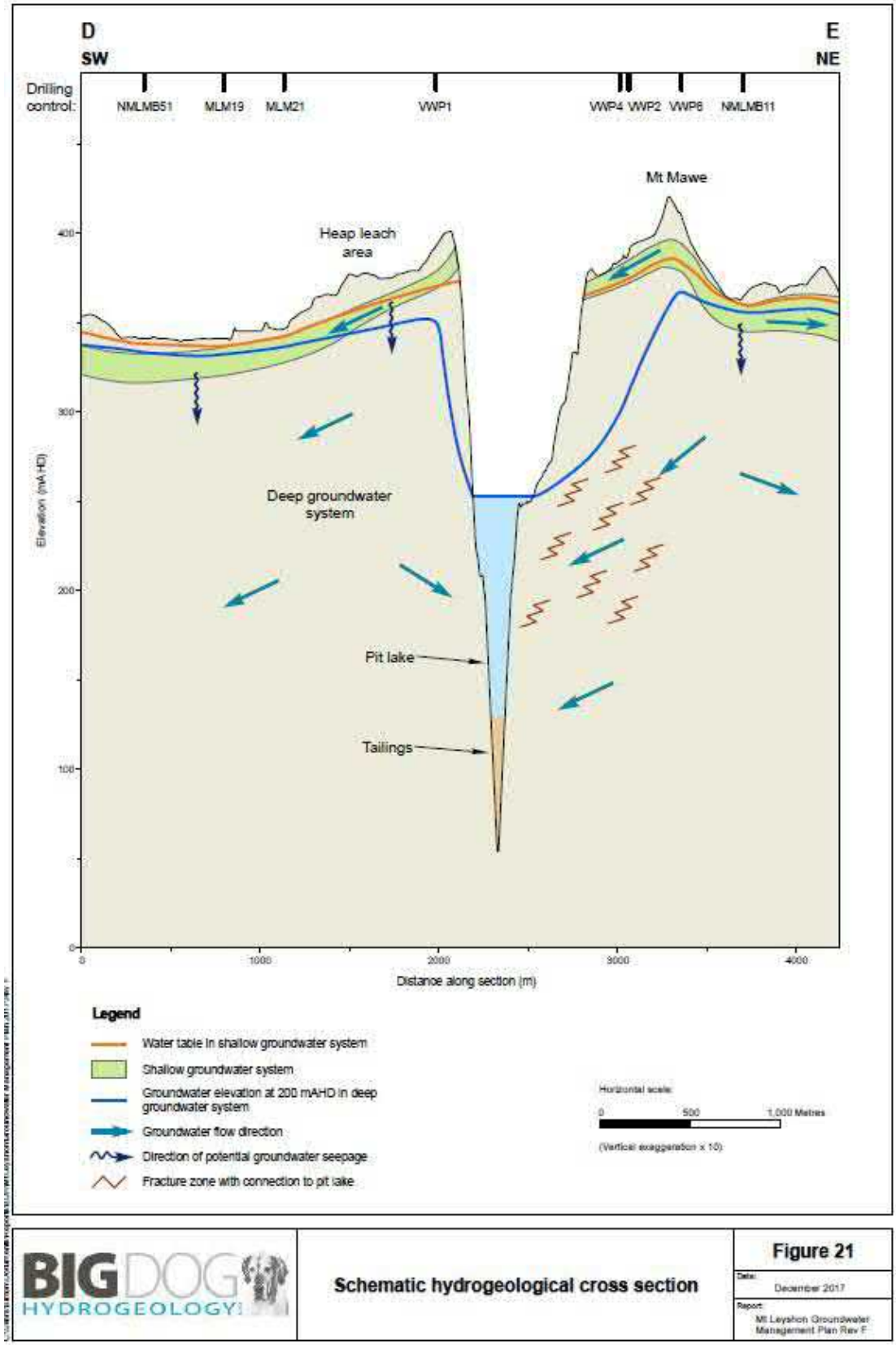


Figure 1.26: Schematic Hydrogeological Cross Section (Source: BDH, 2017a)

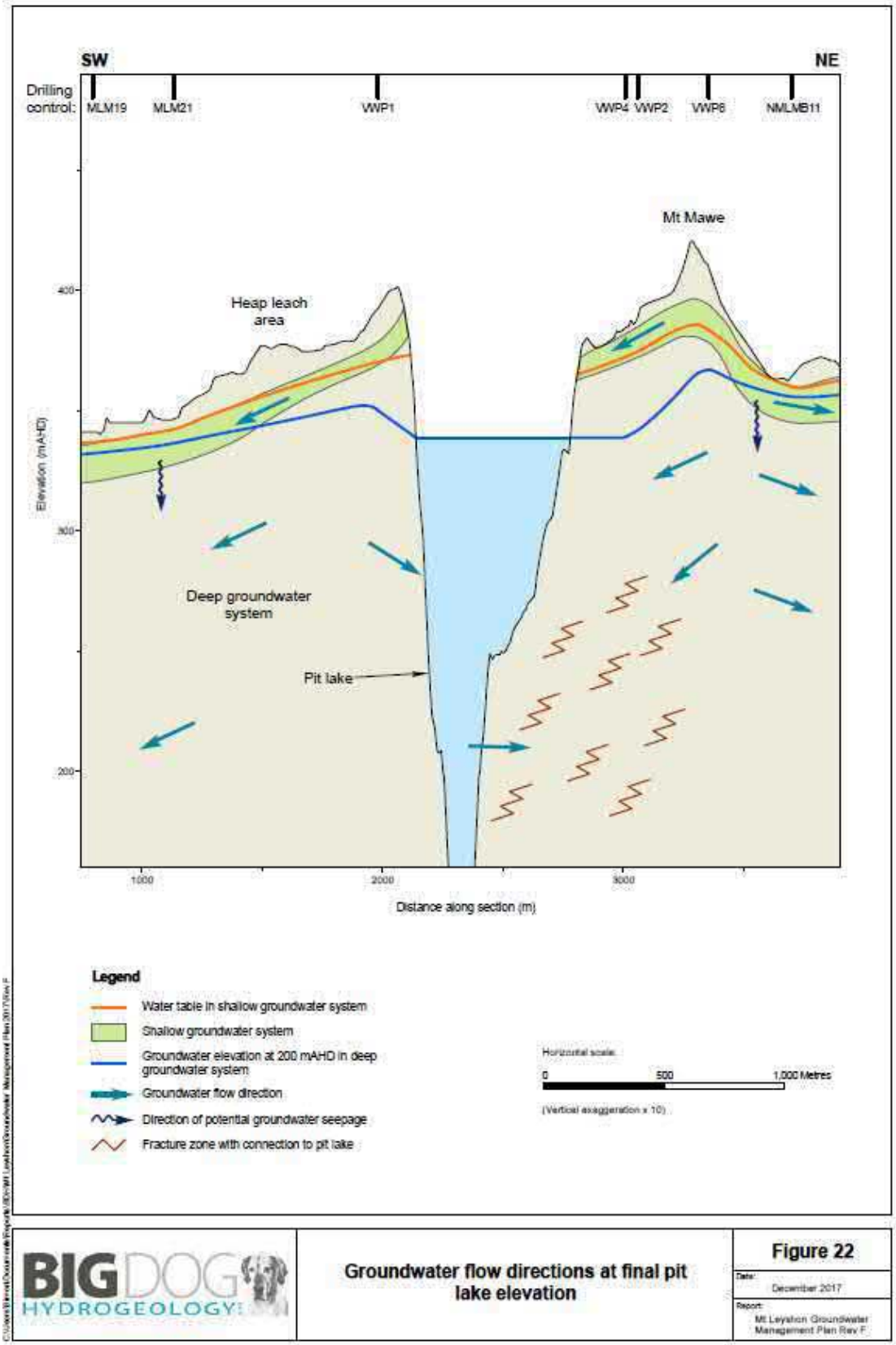


Figure 1.27: Groundwater Flow Directions at Final Pit Lake Elevation (Source: BDH, 2017a)

Recharge and Discharge

The deep groundwater system receives low rates of recharge via downward leakage from the shallow groundwater system. Discharge from the deep groundwater system occurs only to the lake in the final void, which acts as a groundwater sink, due to the rate of evaporation from the pit lake being much higher than the rate of groundwater discharge.

The shallow groundwater system is naturally recharged by surface infiltration during the wet season, and also receives seepage migrating into the ground from the closed and rehabilitated mine facilities. Discharge within the shallow groundwater system occurs as downgradient throughflow, which eventually migrates into the receiving shallow groundwater system beyond the lease boundary. Discharge also occurs into the intermittent surface water streams in locations where the groundwater elevation approaches the topographic surface. Discharge does not take the form of springs or seeps, and no springs or seeps are mapped downgradient of the Mt Leyshon Mine. Discharge from the shallow groundwater system takes the form of diffuse low rates of seepage towards the surface, which evaporates leaving solutes behind, and these solutes are subsequently washed into the intermittent streams in runoff events.

Locations in the vicinity of the Mt Leyshon Mine where there is potential for groundwater discharge from the shallow groundwater system to occur are illustrated in Figure 1.28 which demonstrates zones where groundwater elevations approach the natural surface at the end of the wet season (areas shaded yellow and red).

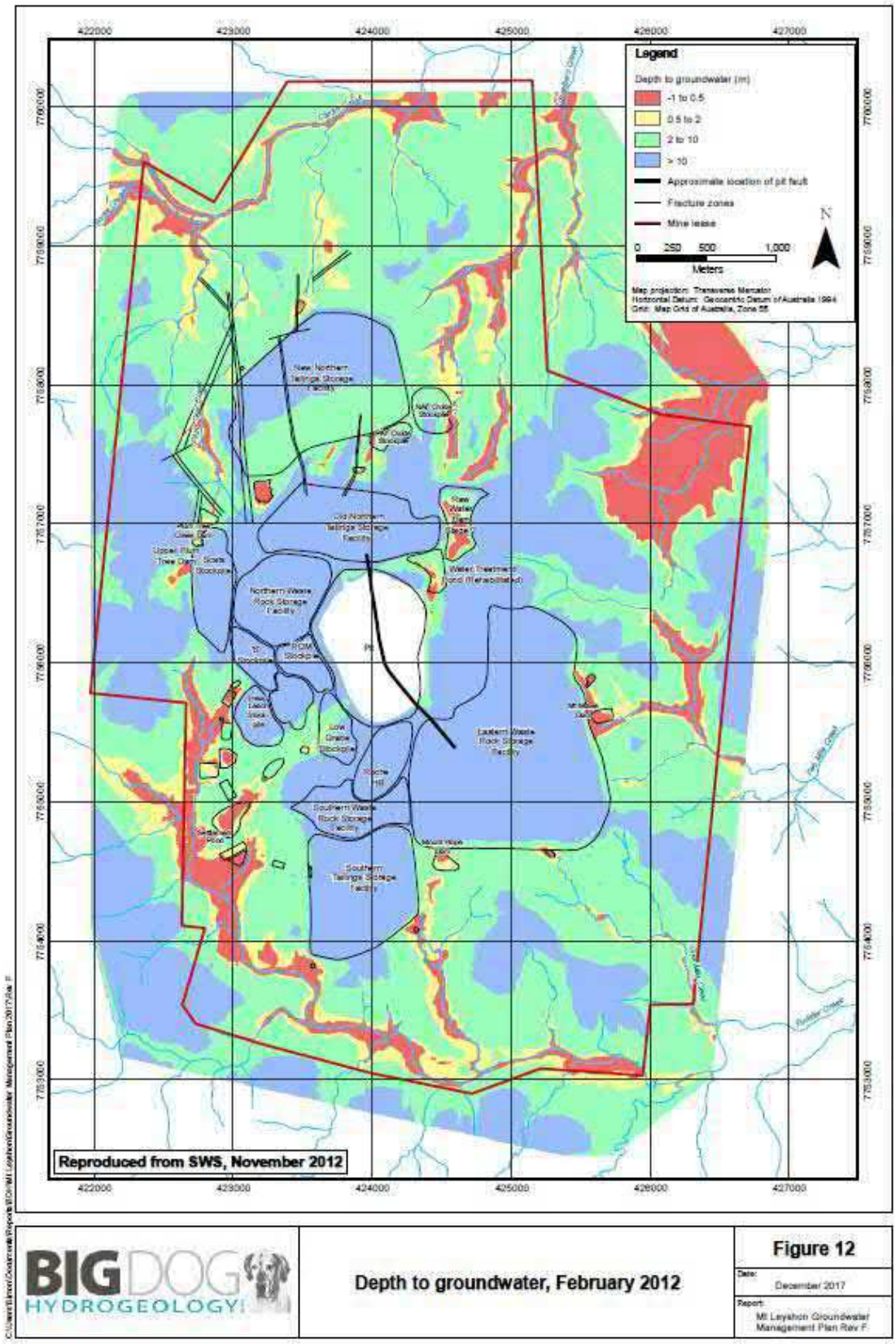


Figure 1.28: Depth to Groundwater (Source: BDH, 2017a)

Groundwater Quality

The deep groundwater system contains Total Dissolved Solids (TDS) concentrations up to 5,000 mg/L and sulphate concentrations up to 3,000 mg/L, as it is associated with naturally occurring mineralised zones near the open pit.

The interpretation of groundwater chemistry in the shallow groundwater system presented in the Groundwater Management Plan (BDH, 2017a) is summarised as follows:

- The bores which are not located downgradient of mine facilities confirm that background sulphate concentrations and metals concentrations are low, pH is in the range 7.7 to 8.2, total alkalinity is around 500 mg/L as $CaCO_3$ and EC reaches 1,700 µS/cm due to the naturally elevated alkalinity.
- Groundwater pH is comparable with background in all downgradient locations and remains unaffected by seepage influences.
- Sulphate concentrations continue to be elevated in many locations downgradient of all of the mine facilities and are the dominant change in groundwater chemistry associated with facility seepage. The highest sulphate concentration in April 2022 (19,000 mg/L) was measured at NMLMB16 immediately downgradient of the EWRSF and the Mt Mawe Dam. The Mt Mawe Dam collects seepage which typically contains around 30,000 mg/L sulphate.
- Filterable Co concentrations are consistently and regionally elevated in groundwater downgradient of the NNTSF, ONTSF and STSF, but are low downgradient of the EWRSF.
- Filterable As may be elevated in discrete locations very close to mine facilities, including at MLM28 and NMLMB6 below the EWRSF, and at MLM44 below the STSF, but is not consistently regionally elevated and is indicated not to be mobile in the receiving environment.
- Filterable U may be elevated in discrete locations very close to mine facilities, including at MLM28 and NMLMB6 below the EWRSF, but is not consistently regionally elevated and in most locations the U concentrations are consistent with the background influence of the granites hosting the shallow groundwater system.
- Other filterable metals concentrations are generally low, consistent with the alkaline groundwater pH.
- Cyanide concentrations are at or below the detection limit in all monitoring bores.

Current Extent of Sulphate in Shallow Groundwater System

The Groundwater Management Plan (BDH, 2017a) presented contours defining the extent of groundwater containing more than 500 mg/L and 1,000 mg/L sulphate in the shallow groundwater system (the ANZECC Water Quality Guidelines trigger value for sulphate for adverse health effects for livestock drinking water is 1,000 mg/L). These contours were interpreted from a site wide groundwater sampling snapshot conducted in 2012. Similar site wide groundwater sampling undertaken in June 2017 and in April 2022 have been interpreted in the same manner to generate updated contours. Figure 1.29 and Figure 1.30 illustrate that between 2012 and 2022, there have been only minor changes in the extent of sulphate in groundwater, consistent with previous groundwater model predictions that sulphate concentrations in most locations are approaching equilibrium (BDH, 2017a). At NMLMB26 to the north of the NNTSF, sulphate concentrations decreased in 2017 and increased in 2022 compared to 2012, which results from the influences of recharge pulses and seepage pulses originating in the operating period. Locations where the extent of sulphate has increased by a small amount from 2012 to 2022 are:

- To the north of the New North Tailings Storage Facility (NNTSF) near Clarke Creek. This change reflects recovery of the groundwater system from a large recharge event in 2008, which resulted in the 2012 sulphate concentrations being relatively low.
- To the northeast of the NNTSF along Schreibers Creek. Sulphate concentrations have increased at NMLMB9 and NMLMB28 and sulphate extends further in this part of the groundwater system in 2022 compared to 2012 and 2017. This response is consistent with the previous groundwater model predictions that sulphate would continue to increase during the initial closure period at NMLMB28 and NMLMB9.
- To the southeast of the EWRSF along One Mile Creek, where sulphate concentrations have increased at NMLMB37 and NMLMB5. This is consistent with the previous groundwater model predictions that sulphate would continue to increase at these bores in the initial closure period.

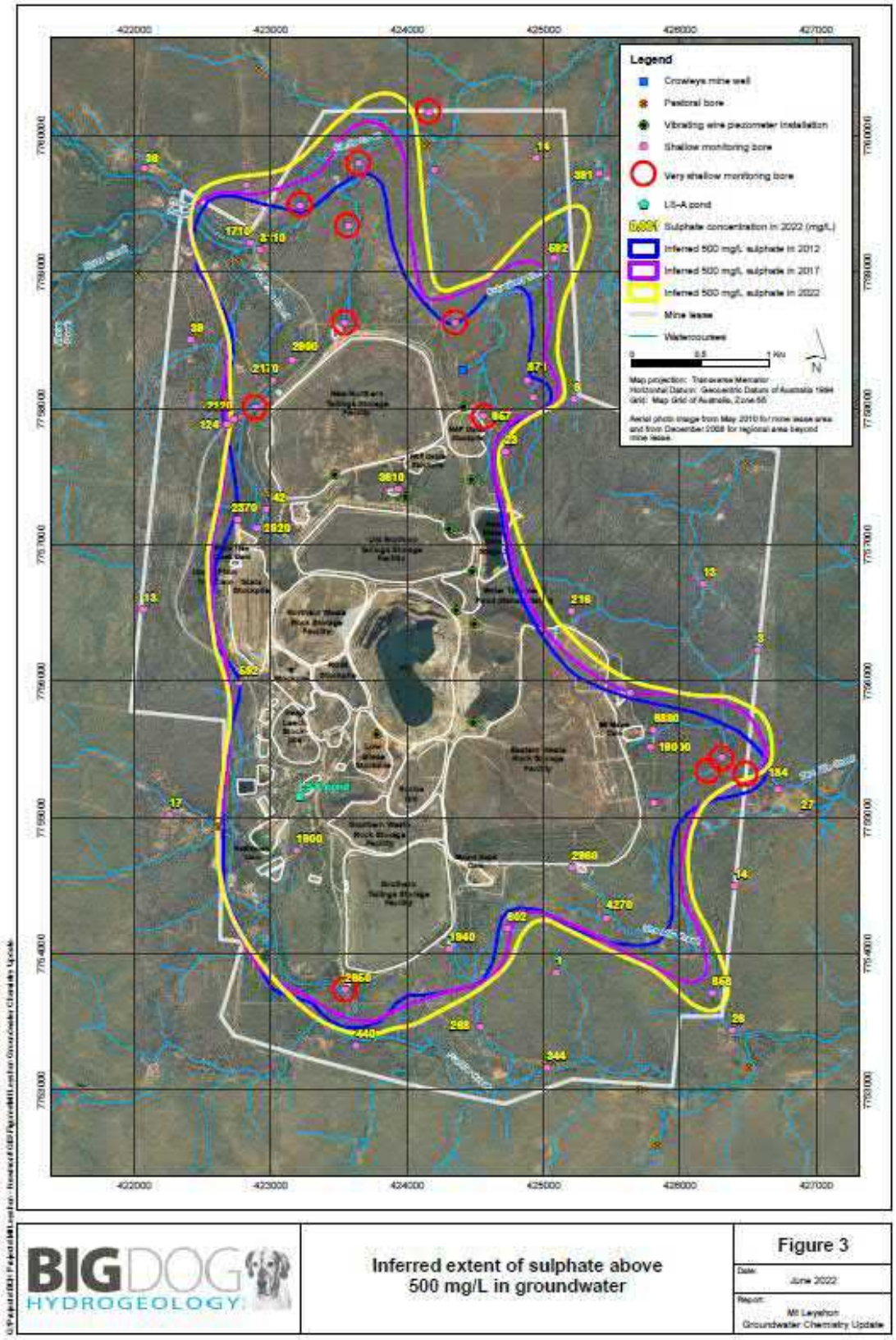


Figure 1.29: Inferred Extent of Sulphate Above 500 mg/L in Groundwater

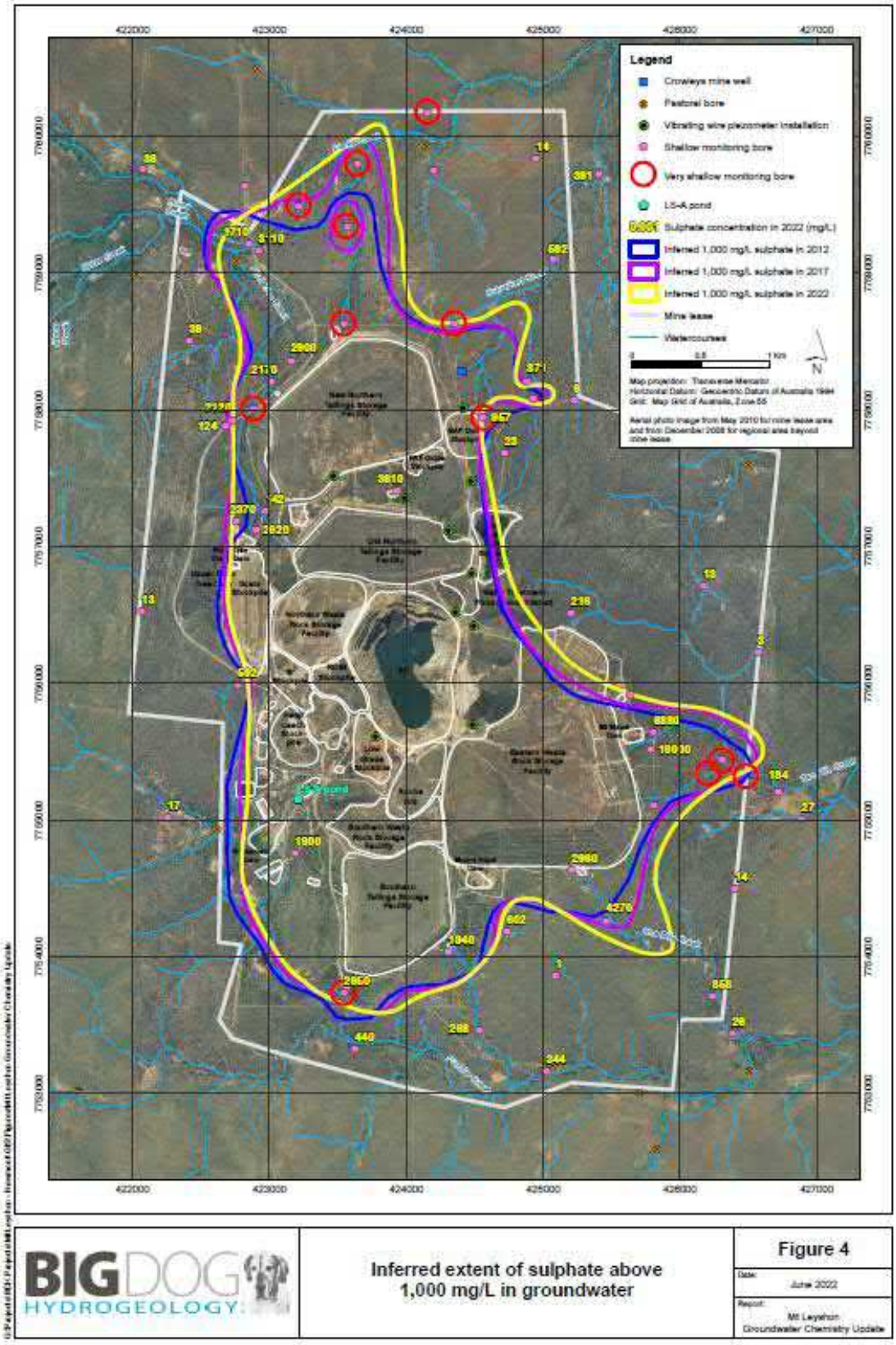


Figure 1.30: Inferred Extent of Sulphate Above 1,000 mg/L in Groundwater

Current and Future Uses of Groundwater

There are no current or future uses or environmental values associated with the deep groundwater system in the vicinity of the Mt Leyshon Mine (i.e., about 1 km to 2 km from the final void). The deep groundwater system does not occur outside the Mt Leyshon Mine.

For the shallow groundwater system current and future local environmental values have been defined to be:

1. Use of groundwater for stock watering on pastoral properties owned by Newmont. Within or near the mine leases this currently occurs at bores Bellevue House, Plants, Bellevue Yard, Black Tank, Monahans, and Scrubby located as marked in Figure 1.24. The use of the shallow groundwater system for stock watering on Newmont owned pastoral properties will be limited to locations where Sulphate concentrations are below the ANZECC Water Quality Guidelines trigger value for sulphate for adverse health effects for livestock drinking water (1,000 mg/L).
2. Support of aquatic ecosystems if groundwater discharge should be a significant input to remnant pools in the surface water systems which develop aquatic ecosystems following the wet season.
3. Support of phreatophytic vegetation in locations where root systems extend below the local water table.

On a regional basis groundwater flow within the shallow groundwater systems is from the mine leases to the northeast, eventually reaching the Burdekin River 30 km distant. There are three registered bores (Qld Government, 2021), refer Figure 1.31 intersecting the shallow groundwater system along potential flowpaths between the mine and the Burdekin River, located between 5 km and 25 km from the mine. These bores have not been investigated, but the likely use of groundwater in the region is for stock watering.

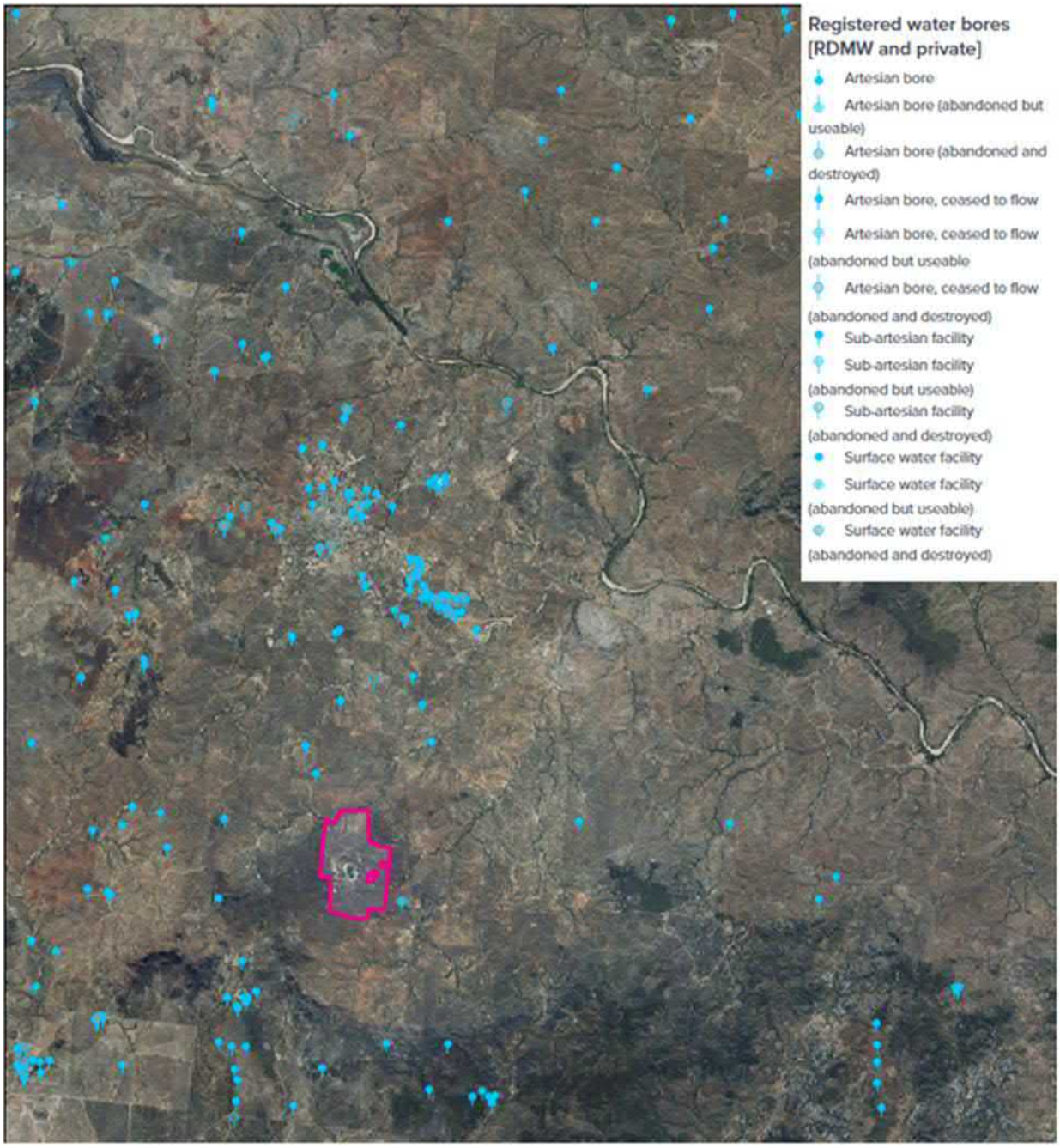


Figure 1.31: Registered Water Bores (Source: Queensland Globe)

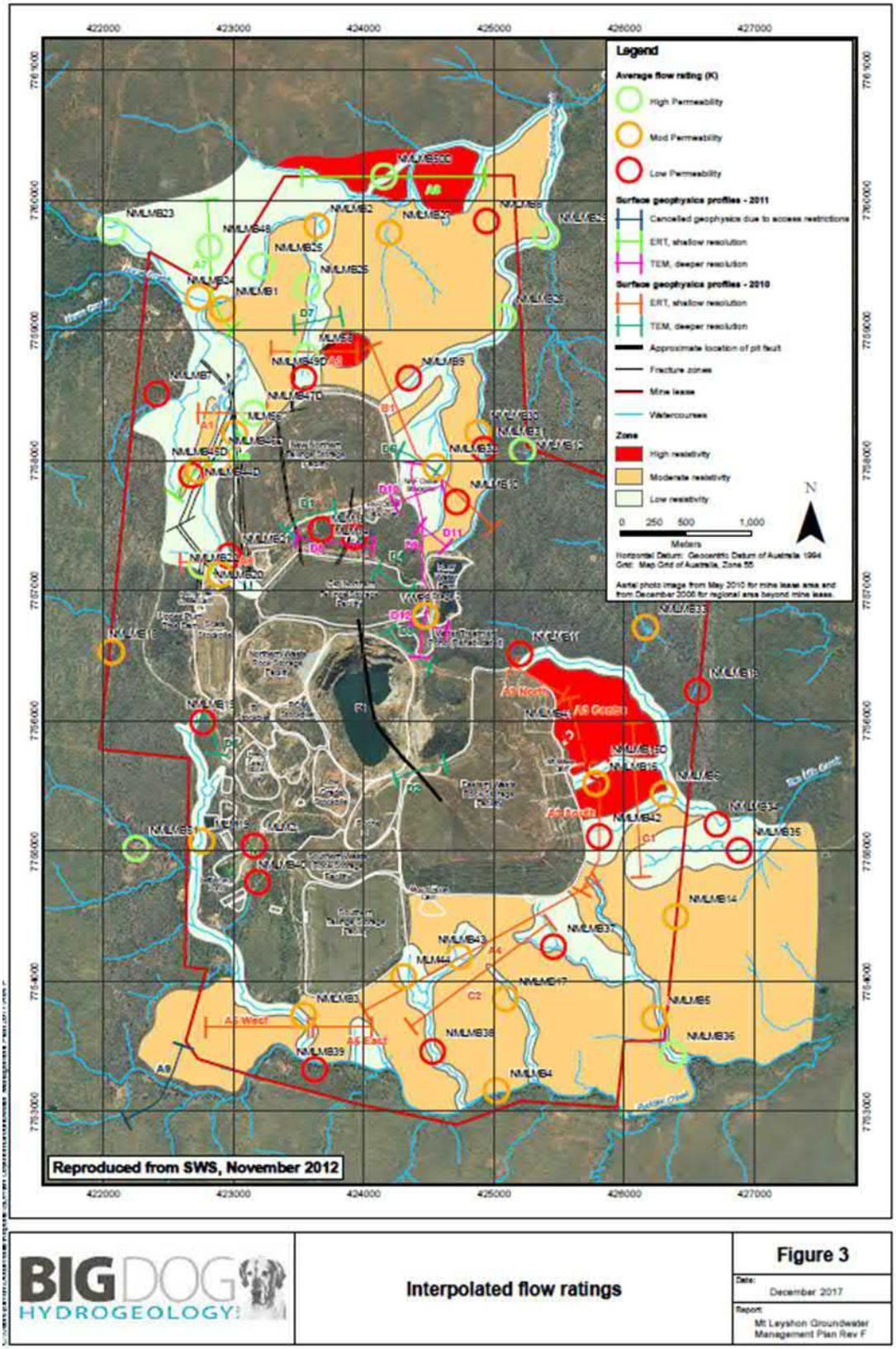
Hydraulic Conductivity, Groundwater Flow Directions, Potentiometric Mapping and Hydrogeological Sections

The hydraulic characteristics of the shallow groundwater system have been assessed based on a significant number of tests at groundwater monitoring bores screened in this system. These tests were:

- Groundwater airlift rates from open holes during drilling.
- Groundwater airlift rates from cased holes during development.
- The specific capacity of the bores, calculated from test pumping.
- Results of constant head and recovery tests.

Airlift flow rates measured in the open hole while drilling ranged from 0 to 7 L/s, but were typically in the range 0.1 to 1 L/s. Values of hydraulic conductivity interpreted from test pumping of the completed monitoring bores ranged over two orders of magnitude but were typically in the range 0.1 to 2 m/day. The airlifting and test pumping data were integrated in a qualitative manner and combined to provide an estimate of the characteristic average hydraulic conductivity for the shallow groundwater system at the location of each monitoring bore. These average hydraulic conductivity estimates were subsequently classified into low, moderate and high descriptions for each location, corresponding approximately to an indicated hydraulic conductivity of “moderate” for values from 0.1 to 0.5 m/day, “low” for values below this range, and “high” for values above this range.

In order to develop a regional interpretation for the variation in groundwater flow characteristics for the shallow groundwater system across the Mt Leyshon mine, the individual bore classifications were subsequently interpolated using the results of the ERT profiles running past each of the bores. The resulting generalised interpretation of potential groundwater flow zones is presented in Figure 1.32. The interpretation suggests that higher groundwater transmission zones are mostly restricted to the current surface water drainages in the south and east of the site but become more extensive close to Clarke Creek in the north of the site.



BIG DOG HYDROGEOLOGY

Interpolated flow ratings

Figure 3

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F

Figure 1.32: Interpolated Flow Rating (BDH, 2017a)

Groundwater elevations measured in the shallow groundwater system in February 2012 are contoured in Figure 1.25. Contour plots generated at other dates demonstrate similar patterns, although the absolute elevations vary by around 2 m between wet season and dry season conditions. The shallow groundwater system is largely absent at the open pit due to bedrock reaching surface, and if present would be dewatered by the open pit. Groundwater flow is identified to be radially away from the elevated topography near the open pit, and to be generally parallel to the surface water drainage directions, as illustrated by the arrows in Figure 1.25.

A schematic hydrogeological section is provided in Figure 1.33 which has been constructed along line AC as marked in Figure 1.24. This identifies that:

1. The open pit acts as a groundwater sink for both the shallow groundwater system and the deep groundwater system. This is because evaporation from the lake surface holds the lake elevation below the local groundwater elevations. Locally, flow is from the groundwater system into the pit lake. The pit lake will be managed in perpetuity by maintaining the inputs to be less than evaporative losses to ensure this remains the case.
2. Groundwater flow in the shallow groundwater system is radially away from the open pit, driven by natural infiltration and facility seepage in the elevated portions of the site.
3. Groundwater elevations approach surface at Clarke Creek and at Puddler Creek, and groundwater discharge into the surface water system may occur in some conditions.
4. The primary influence of the rehabilitated mine facilities on shallow groundwater conditions is identified to be changes in hydrochemistry associated with remnant seepage which occurred in the operating period, and ongoing seepage driven by reduced rates of infiltration through the facility covers, and potential influences on the receiving groundwater and surface water environments.

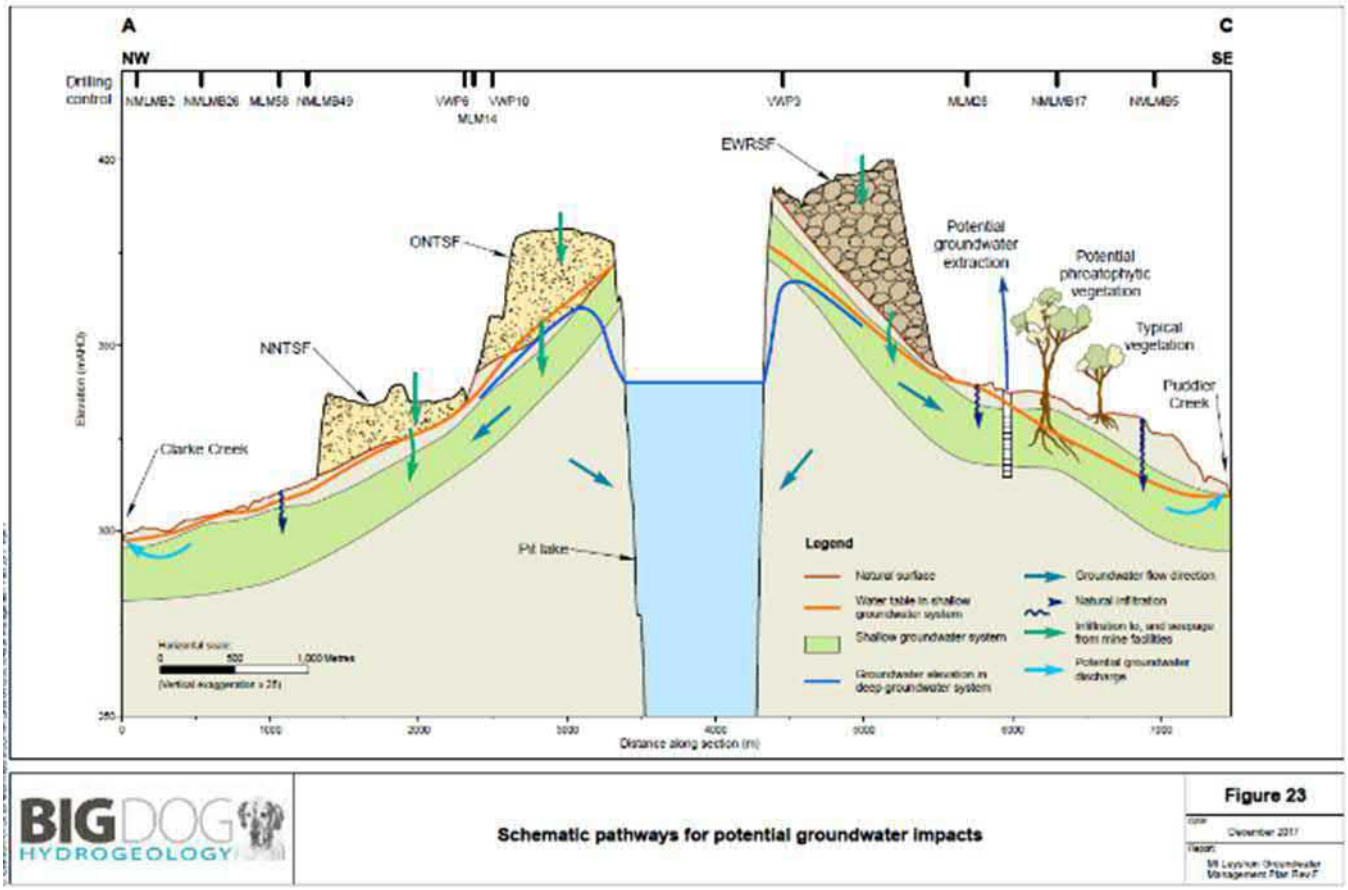


Figure 1.33: Schematic Pathways for Potential Groundwater Impacts (BDH, 2017a)

Modelling of Future Contaminant Transport within Groundwater

A numerical groundwater model of the shallow groundwater system was constructed using the code FEFLOW in 2013 (Schlumberger Water Services, 2012) and was based on data collected to 2012. The properties assigned to the model were initially derived from the extensive field investigations and were subsequently refined during calibration of the model to the observed data. The model was calibrated to observations of groundwater elevations and groundwater sulphate concentrations made during operations (1989 to 2002) and during closure (2002 to 2012).

The primary objective of the modelling was to define the maximum future extent of sulphate in groundwater in the receiving groundwater environment, and in particular to confirm that the extent would remain within land controlled by Newmont under all possible future conditions. Consistent with this primary objective, model construction and calibration were focussed on observed responses in the receiving environment, with less detail applied in the locations of the mine facilities. Key aspects of the model during the construction and calibration process were:

- Due to the progressive nature of cover installation, and taking account of the modelling objectives, an average uniform infiltration rate was applied to each of the mine facilities. A single average infiltration rate was applied in the model for each facility, which represents the average of conditions in the early 1990s (wholly uncovered), the late 1990s (partially covered), and the closure period (fully covered with vegetation progressively increasing from 2002 to 2012).
- In order to match the observed changes in groundwater elevations and groundwater chemistry during operations and closure, the calibrated average seepage rates from the facilities in the period 1990 to 2012 were 1.7% of precipitation at the NNTSF and the ONTSF, and 0.7% of precipitation at the EWRSF and the STSF. The concentration of sulphate in seepage was calibrated to be 3,500 mg/L at the STSF, 20,000 mg/L at the Scats Stockpile and 5,000 mg/L at all other facilities.
- These calibrated values do not reflect infiltration through the cover and the groundwater model cannot be used to quantify the current rates of infiltration through the covers. Infiltration through the covers may:

1. reach the base of the facility by vertical flow and flow horizontally into the downgradient containment dam as seepage to subsequently be pumped to the lake in the open pit.
2. infiltrate through the original ground surface below the facility, enter the saturated zone within the groundwater system and flow into the receiving groundwater environment; or
3. follow other pathways into the receiving environment.

- The model calibrated values discussed above reflect an average for component 2) of cover infiltration over the operating, closure and post closure periods.
- These calibration parameters resulted in a good fit to the average groundwater elevations and sulphate concentrations in the receiving groundwater system from 1989 to 2012. A key outcome from the model predictions was that if the facility covers continued to perform at the same average level assumed in the model, under average rainfall conditions the maximum future extent of sulphate concentration was unlikely to change a great deal from the extent observed in 2012 (refer Figure 1.34). In two areas (to the north-east and south-east) continued migration away from the facilities was predicted, resulting in an additional extent of around 1 km to 2 km in the very long term (200 year timeframe) in these locations (refer Figure 1.34). The maximum extent of sulphate in groundwater was concluded to be within Newmont controlled land.

The prediction of limited future expansion of the zone of elevated sulphate in groundwater under average conditions in the model resulted from a combination of hydrogeological factors, including:

- As the area of influence increases, the total volume of groundwater in the system to accommodate the fixed sulphate load increases rapidly.
- As the area of influence increases, the proportion of the area which is exposed to good quality natural groundwater recharge significantly increases.
- The more the area of influence extends, the more creek systems it covers, which provides more potential locations for the model to remove sulphate from the groundwater system by discharging it to surface water on a seasonal basis.

- The extent of the sulphate influenced zone in 2012 reflected higher than average rainfall conditions over preceding years. The base case predictive model assumed a return to average rainfall conditions, and so there was an immediate recession in groundwater elevations and sulphate concentrations in the early part of the predictive period.

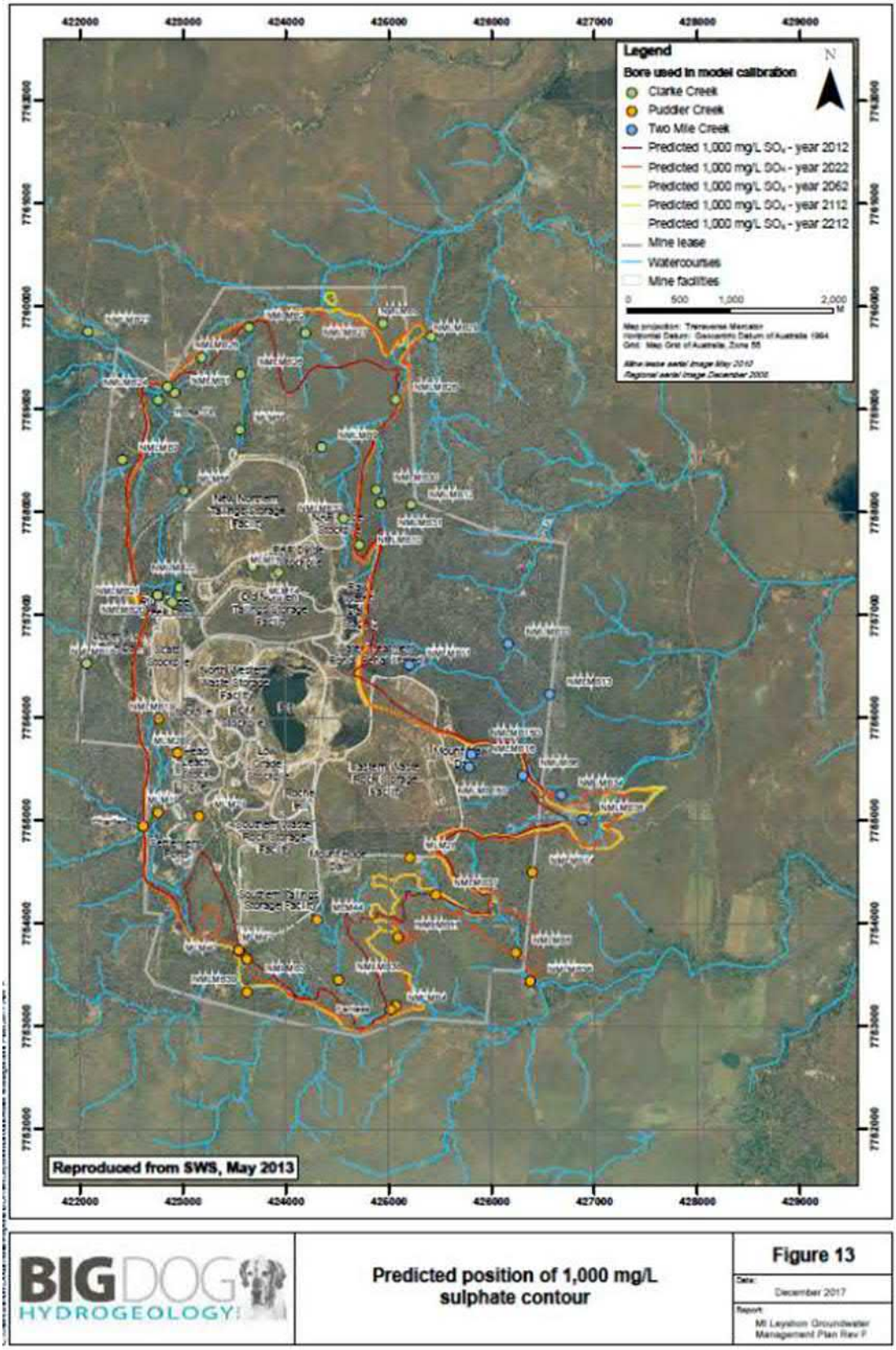


Figure 1.34: Predicted Future Position of 1,000mg/L Sulphate Contour (BDH, 2017a)

Review of Groundwater Model Predictions

The numerical groundwater model provided predictions of future groundwater chemistry under a range of scenarios, including different precipitation conditions. Scenario 1 corresponded to the facility covers continuing to perform at the same level, the sulphate concentration of seepage from the facilities remaining constant at 5,000 mg/L, and average precipitation conditions (658 mm/year). Scenario 5 adopted the same facility assumptions under wet conditions (1,200 mm/year), while Scenario 6 adopted the same facility assumptions under dry conditions (277 mm/year). Figure 1.35illustrates precipitation conditions at Mt Leyshon Mine since 2012 as measured at the Automated Weather Station (AWS) located in the middle of the mine. In the period 2013 to 2022, actual precipitation has been between the values assumed in Scenarios 1 and 6 and has clearly been closest to the average conditions in Scenario 1.

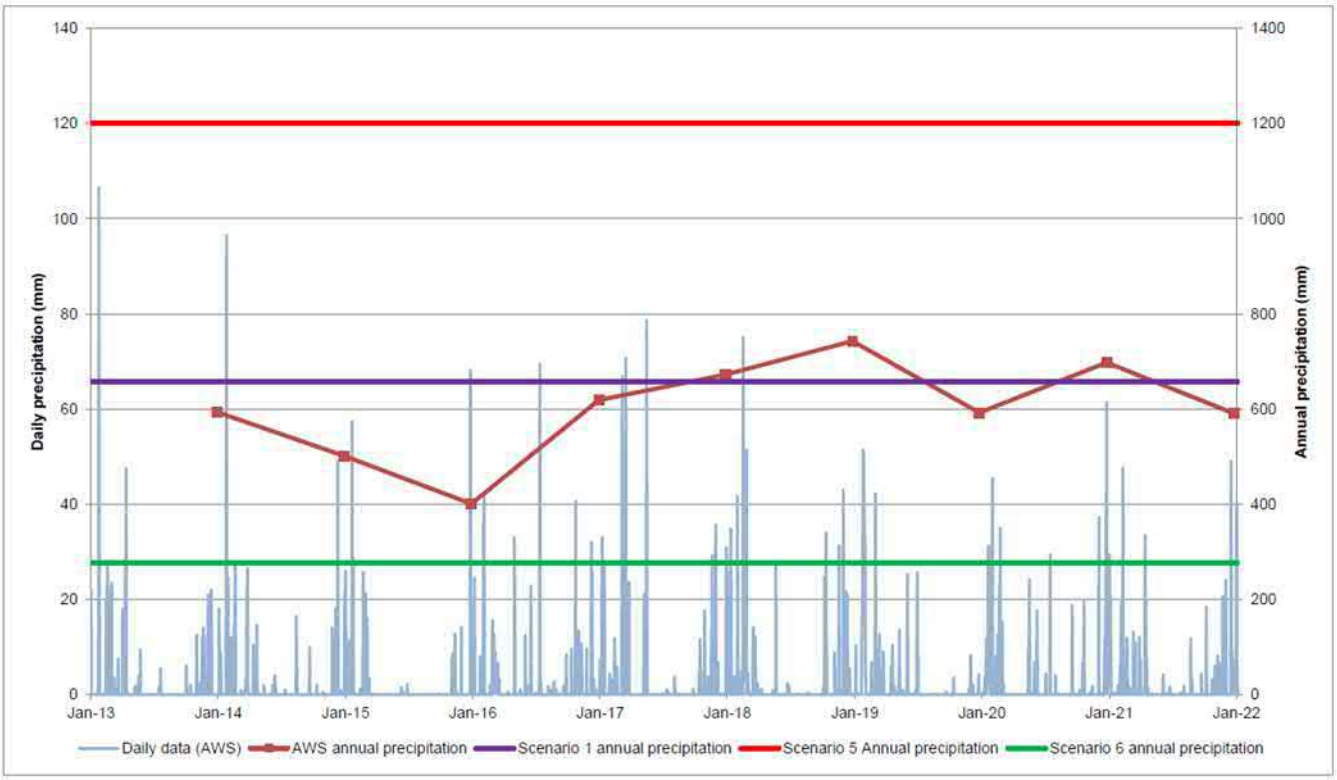


Figure 1.35: Precipitation Conditions at Mt Leyshon Mine since 2012 (BDH, 2022)

Big Dog Hydrogeology (2022) compared the groundwater sulphate concentrations predicted by both Scenario 1 and Scenario 6 against monitoring data collected since 2012 (refer Appendix C of BDH, 2022 provided in Appendix O). Every monitoring bore screened in the shallow groundwater system which could be accessed for the April 2022 sampling is included in the plots. For each bore the observed sulphate concentrations measured from 1989 to 2012 that were used for model calibration are also presented for reference. The model was calibrated to regional sulphate trends and average conditions. As a result, during the calibration period at some bores there may be observed changes in sulphate concentration due to localised influences which were not attempted to be replicated in the model results during model construction and calibration.

On a regional basis, the monitoring data collected since 2012 provide a good fit to the model predictions, with trends observed since 2012 generally being between those predicted for Scenarios 1 and 6 (refer Figures 6 to 8 of Appendix A of BDH, 2022 provided in Appendix O). In areas where the sulphate concentration was predicted by the model to stabilise or reduce after 2012, these responses are consistently validated by the sampling in June 2017 and April 2022. Figure 1.36 provides examples of locations where the rising sulphate trends in the calibration period are confirmed to have stabilised by the subsequent monitoring data.

Locations where the April 2022 data indicate long term rising trends are present in sulphate concentrations are:

- NMLMB3, NMLMB38 and NMLMB39 located downgradient of the STSF (see Figures C10 and C13 of BDH, 2022 provided in Appendix O). These rising trends result from the migration of sulphate entering the groundwater system in the operating period, and remain consistent with the model predictions, which indicate that stabilisation of sulphate concentrations will occur in the near future.
- NMLMB28 and NMLMB29 downgradient of the NNTSF (see Figure C9 of BDH, 2022 provided in Appendix O). These rising trends result from the migration of sulphate entering the groundwater system in the operating period, and remain consistent with the model predictions, which indicate that stabilisation of sulphate concentrations will occur in the near future.
- NMLMB5 located southeast of the EWRSF (see Figure C15 of BDH, 2022 provided in Appendix O). This rising trend results from a combination of recovery from a recharge event in 2008, and the migration of sulphate entering the groundwater system in the operating period. The observed trends are consistent with the model representation of average concentrations in this location, which predicts stabilisation of concentrations in the near future.
- NMLMB40 located to the west of the SWRSF (Figure C14 of BDH, 2022 provided in Appendix O). The rising trend is consistent with the model predictions which reflect the delayed migration of seepage due to relatively lower hydraulic conductivity conditions assumed in this location. The base case model predicts stabilisation of sulphate conditions in this location will be achieved by around 2030.

As with the calibration model results, the model predictions are based on regional average conditions, and there will be locations or periods where localised effects cause the actual sulphate trends to depart from those modelled. Figure 1.37 provides examples of locations where sulphate concentrations have been significantly higher than predicted by the model. MLM28 is located at the toe of the EWRSF. Following a very large precipitation event on 15 January 2008, groundwater sulphate concentrations in this location rose from 1,500 mg/L to 15,000 mg/L over a seven month period. The groundwater chemistry changes are interpreted to reflect a localised pulse of seepage emanating from the EWRSF. The updated monitoring data illustrate that this pulse decayed from 2012 to 2017 with groundwater sulphate concentrations returning to close to the modelled value. These responses at MLM28 illustrate that the model correctly reflects the long term average conditions but may not replicate localised or short term trends resulting from local effects.

The other locations where observed sulphate concentrations depart most significantly from the model predictions are at NMLMB15D and NMLMB16 plotted in Figure 1.37. These bores are located downgradient of the EWRSF and are in locations similar to MLM28. The increasing sulphate concentrations at these locations likely reflect the same seepage pulse from the EWRSF which occurred in 2008. As a result of the bores being 100 m to 200 m from the EWRSF, and due to the low sulphate migration velocity within the shallow groundwater system, it has taken several years for the sulphate concentrations to rise, but as demonstrated at MLM28, in the long term the concentrations are expected to reduce, and the observed values will return to the modelled average trends.

Figure 1.38 illustrates two bores where sulphate concentrations have been significantly lower than predicted by the model. NMLMB2 is located close to Clarke Creek while NMLMB4 is located close to Puddler Creek. Following the large precipitation event in 2008, both these bores showed a significant decrease in sulphate concentrations, which lasted for several years before concentrations started to recover towards the model predicted values. In each case this response is attributed to localised high rates of natural recharge associated with flooding in the precipitation event. While the model does not replicate the specific effects of this individual event at these bores, the long term average trends in the observed data provide a good match to the model indicating the average recharge rate applied in the model is appropriate.

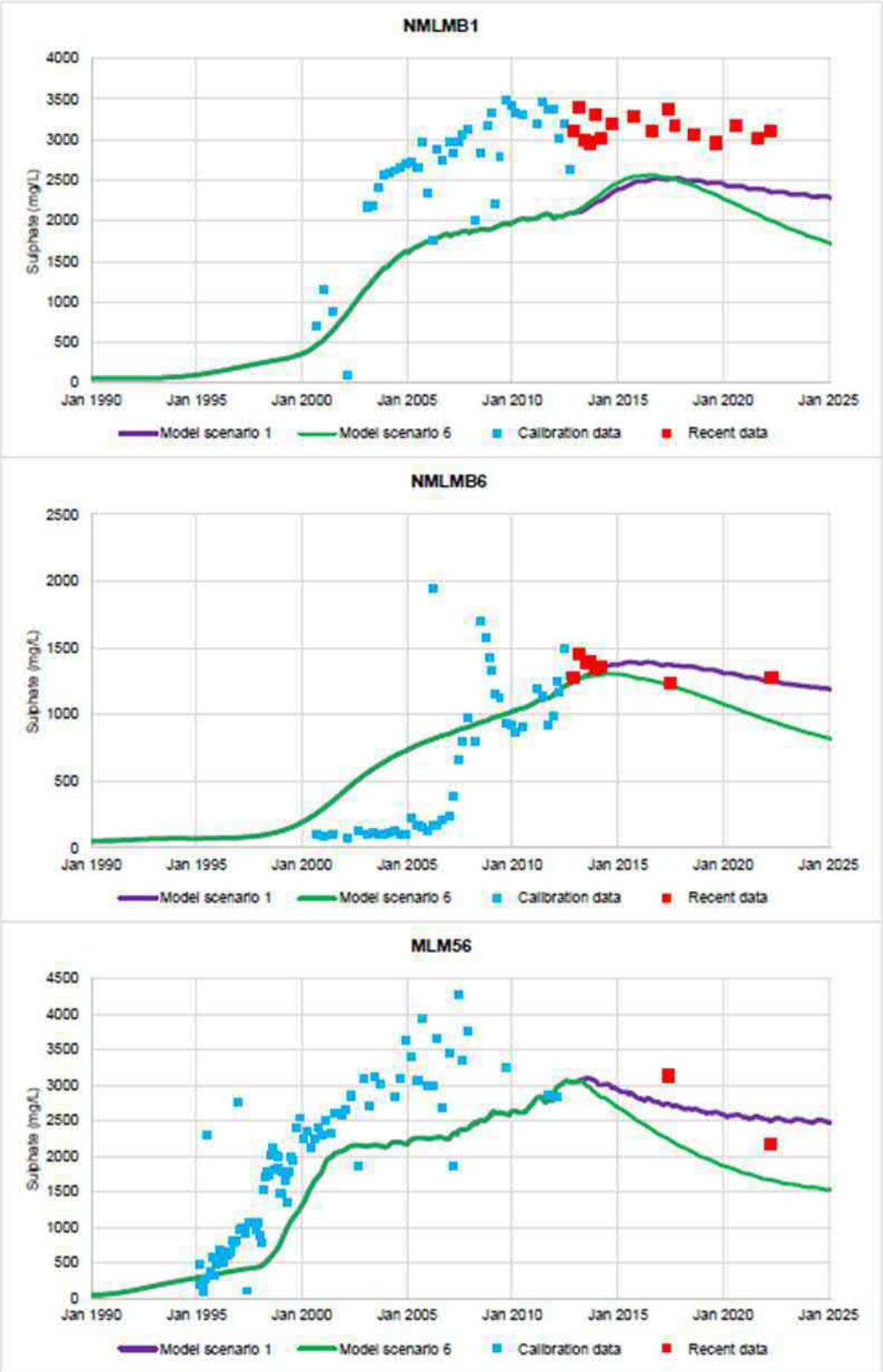


Figure 1.36: Locations of Sulphate Stabilisation Responses after 2012 (BDH, 2022)

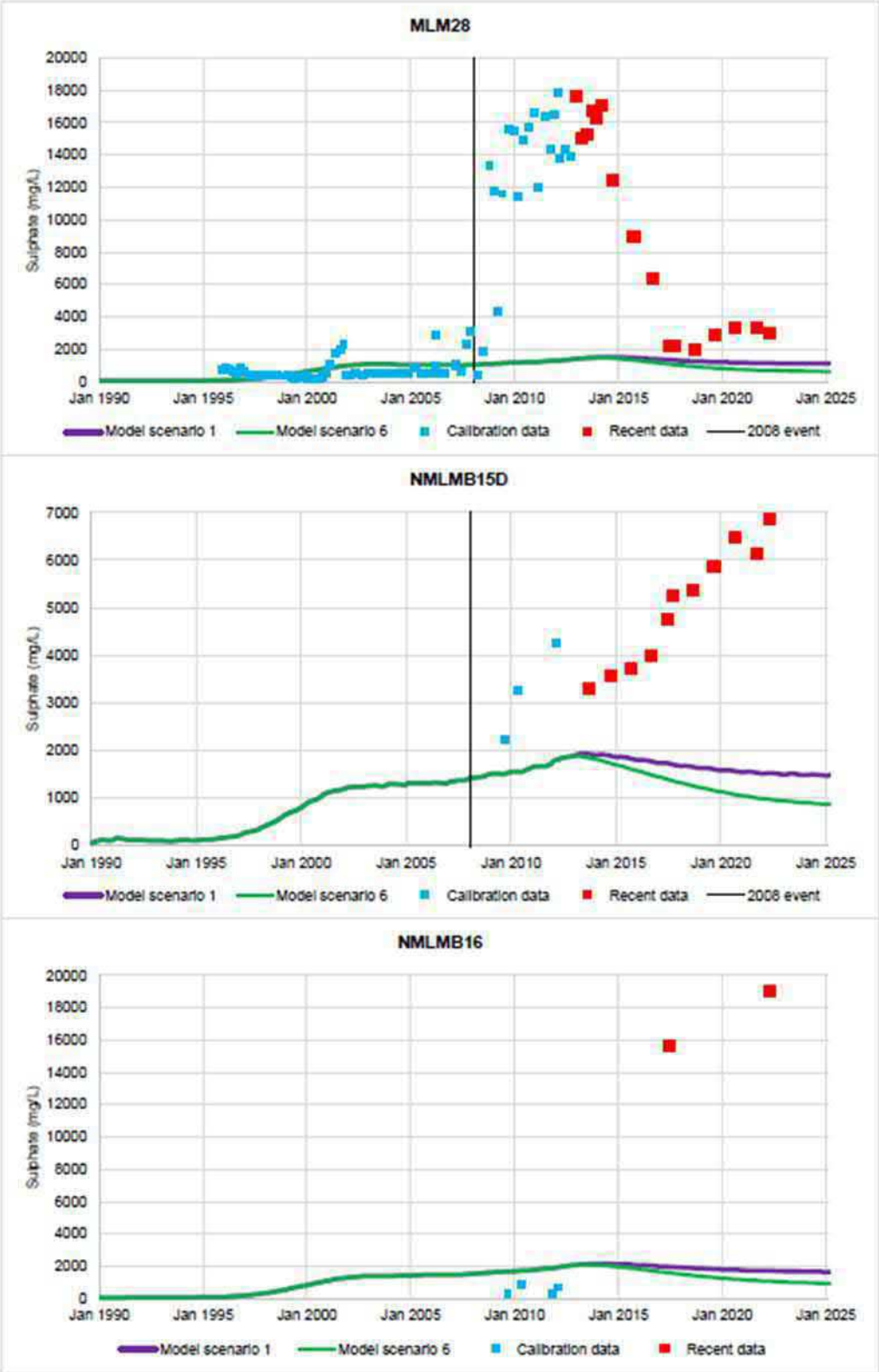


Figure 1.37: Locations of Seepage Pulse Responses after 2012 (BDH, 2022)

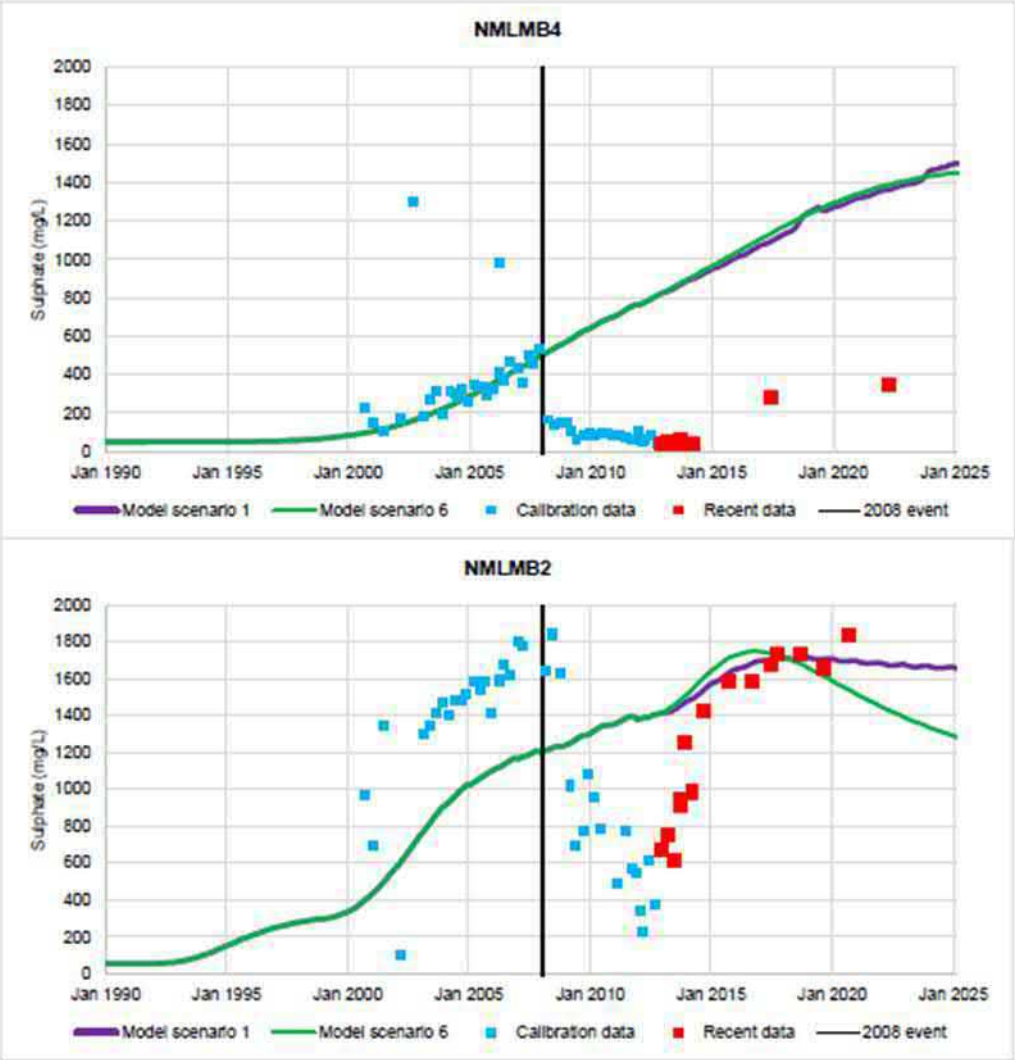


Figure 1.38: Locations of Recharge Responses after 2012 (BDH, 2022)

The Groundwater Management Plan (BDH, 2017a) presented contours for the model predicted position of the 1,000 mg/L sulphate contour for prediction year 2022. Figure 1.39 compares the actual sulphate extent in 2022 with the model predicted extent in 2022 under the base case model assumptions. The observed data confirm that the general shapes and locations of the model contours are consistent with the actual distributions, and also that the model is highly conservative, in that to the north-east and south-east, the model predicts significantly more sulphate migration in 2022 than has been observed. The over prediction of the current sulphate extent may result from the model assumed seepage infiltration rates reflecting both operating and covered conditions, while the observed responses are now more driven by the closed conditions.

The results of the recent groundwater model validation indicate that the predicted future extent of sulphate migration away from the closed mine facilities is likely to be less than originally predicted in the two areas where the greatest future migration was predicted (i.e., to the north-east and south-east). This further confirms the previous conclusions from the groundwater modelling that the maximum future extent of sulphate concentration is unlikely to change a great deal from the extent currently observed.

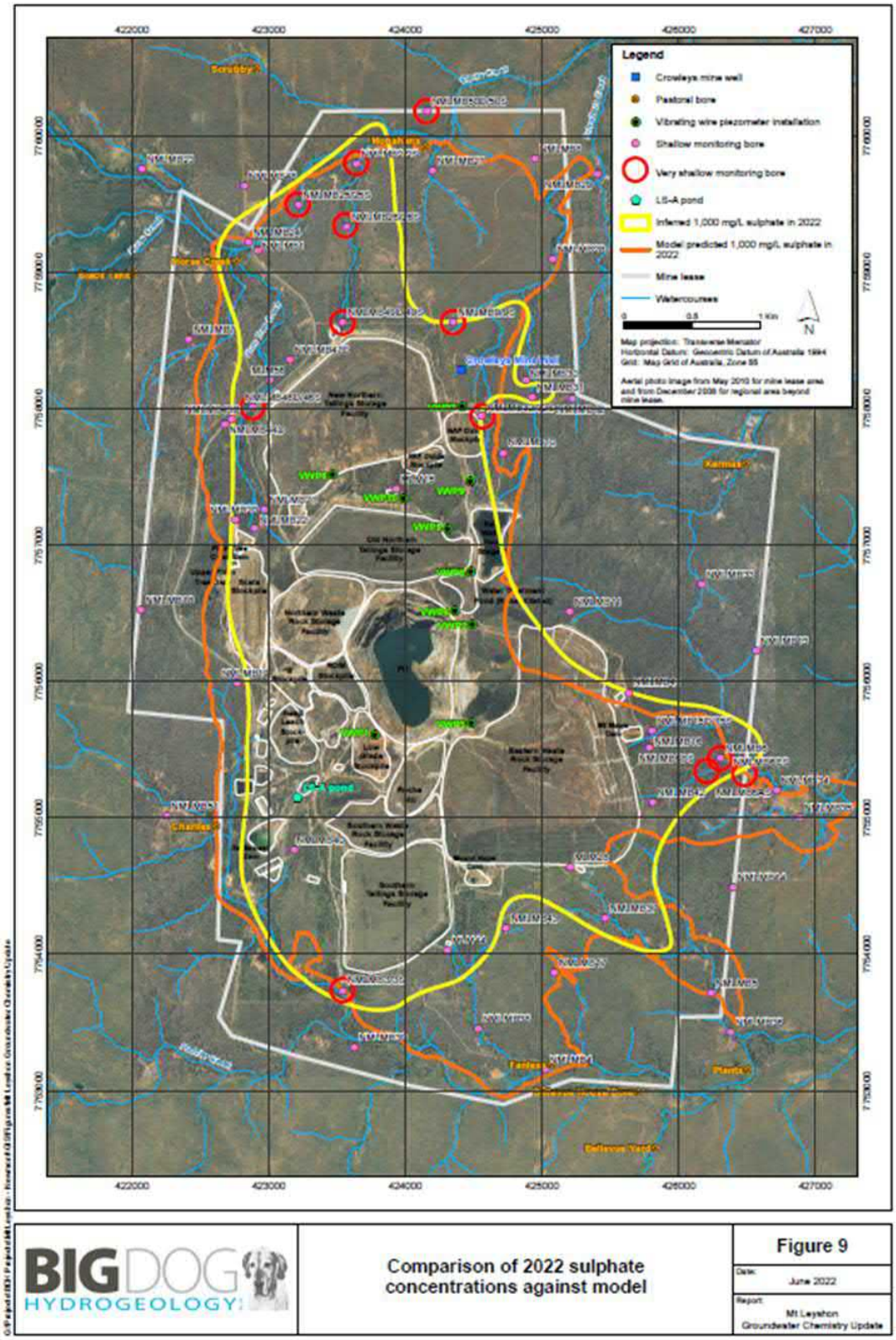


Figure 1.39: Comparison of Actual 2022 1,000 mg/L Sulphate Extent Against Groundwater Model Prediction (BDH, 2022)

Newmont is planning to improve the resolution and accuracy of the groundwater model through a more comprehensive calibration process which may involve:

- Increased spatial resolution/variation of landform infiltration rates and seepage sulphate concentrations.
- Increased temporal variation of landform infiltration rates to better reflect the different infiltration conditions that have occurred during the operations and closure phases of the mine.
- Extended calibration period to include the additional 10 year period of groundwater level and quality data collected since the original development and calibration of the groundwater model in 2013.
- Increased focus on model calibration against groundwater monitoring data in closer proximity to the mine landforms to better estimate the infiltration responses for individual landforms and seasonal or event-based rainfall conditions.

It is intended that the improved groundwater model will be able to be used for a range of closure planning purposes including:

- To provide more accurate forecasts of the expected long-term future sulphate migration extents for the mine (expected to be reduced extents compared to previous model predictions).
- To provide a better understanding of cover performance for individual landforms.
- As a predictive tool to be used periodically in conjunction with rehabilitation monitoring data to trigger the need to make modifications to the planned future rehabilitation works contained in the PRC Plan Schedule to increase the confidence of achieving the completion criteria for the rehabilitation milestones.

Flooding

The Mt Leyshon Mine is located on the topographic divide between the Clarke Creek (north) and Puddler Creek (south) drainage systems (refer Figure 1.40)Clarke Creek is a 4th order drainage system that flows in an easterly direction along the northern boundary of the mining lease, with the headwaters of the catchment originating approximately 9 km to the west of the mining lease. Puddler Creek is a 3rd order drainage system that flows in an easterly direction along the southern boundary of the mining lease, with the headwaters of the catchment originating approximately 4 km to the west of the mining lease.

All other surface drainage features within the mining lease area are smaller 1st or 2nd order drainage systems with catchments that generally originate within the mining lease area.

At their nearest locations to the mine landforms, Clarke Creek is 850 m away from the NNTSF, while Puddler Creek is 400 m away from the STSF, although a tributary arm of Puddler Creek (also a 3rd order drainage system) comes as close as 100 m to the south-western corner of the STSF.

Figure 1.40: Topography and Surface Drainage Features in Vicinity of Mt Leyshon Mine (Source: Queensland Globe)

No site-specific flood modelling studies have been undertaken to determine the floodplain extents of the surface drainage systems within the Mt Leyshon Mine mining leases. This is primarily because the mining activities occurred in areas with low flood risk and there was no requirement to consider creek flooding during either the operational or rehabilitation planning/design phases of the project. The low flood risk of the mining activities is a result of:

- The majority of the drainage features having small catchment areas (originating within the mining lease area).
- The larger creek systems (Clarke Creek and Puddler Creek) being located on the edges of the mining lease at reasonable distances from the mining activities.

There have been no recorded interactions between the mining activities and flood inundation from either Clarke Creek or Puddler Creek during the 35 year period since the Mt Leyshon Mine commenced operations. A large rainfall event occurred in January 2008 which resulted in approximately 170 mm of rain falling at the Mt Leyshon Mine over a period of 8 hours. This rainfall event was classified as larger than a 1% Annual Exceedance Probability (1 in 100 year) event and resulted in significant flooding in Clarke Creek and Puddler Creek; however, no interactions between the flooding in these creeks and the mine landforms was reported during this event.

Broad-scale (low accuracy) flood mapping of the Burdekin River basin (Basin Level Flood Modelling) was performed during Phase 3 of the Queensland Flood Mapping Program (QFMP). The modelled 1% AEP flood extents (https://floodcheck.information.qld.gov.au) in the vicinity of the Mt Leyshon Mine are shown in Figure 1.41 and demonstrate that the Mt Leyshon Mine landforms are not susceptible to creek flooding. In particular, the edges of the pit void (which is in the footprint of the former Mt Leyshon prior to mining) are more than 2 km from either Clarke Creek or Puddler Creek and well outside of the floodplain areas of these two creeks.

Figure 1.41: 1% AEP Basin Level Flood Modelling in Vicinity of Mt Leyshon Mine (Source: FloodCheck Queensland)

Soil and Capping Material Assessment

During the operational and closure period, a materials balance was maintained at the Mt Leyshon Mine to track the amount of stockpiled oxide heap leach, NAF oxide waste rock, porphyry waste rock and topsoil available on site. This materials balance was regularly compared against estimated requirements for closure, allowing cover designs to be refined to accommodate the availability of materials. The material in greatest demand was porphyry waste rock classified by site testing to be NAF, as this was a cover material which had been successfully applied to sloped surfaces. As a result of the materials balance, porphyry waste rock was reserved for capping the waste rock facilities, and the capping strategy for the tailings facilities was developed using compacted oxide heap leach in preference to porphyry. The resultant material balance and material required for minor rehabilitation works is not considered to carry an unacceptable level of risk due to proximity to existing material, the minor nature of works, and available borrow materials, etc.

The previous rehabilitation works have utilised the available growth and capping material stockpiles that were available prior to closure. In 2017 Newmont undertook rehabilitation rectification works to address erosion / scour issues in an area of the mine known as Roche Hill. The works occurred over an area of approximately 45 ha. Capping and growth media for these works was sourced from borrow pits located in the northern part of ML 10144, which have also since been rehabilitated. Subsequent annual rehabilitation monitoring of Roche Hill has shown this approach to be successful.

Topsoil and rock required for all future rehabilitation works at the site will be sourced from the future Northern Borrow Pit and Quarry (refer to Figure 1.42 and Figure 1.43), or from external suppliers (i.e. BGM liner for the Scats Stockpile rehabilitation). Table 1.15 presents the volumes of topsoil, general fill and rock estimated to be available from the Northern Borrow Pit and Quarry. The volumes presented are based on experience with sourcing material from borrow pits as part of the 2017 works to rehabilitate Roche Hill.

The Northern Borrow Pit and Quarry are recognised as Rehabilitation Areas (RAs) in the PRC plan schedule. The Northern Borrow Pit and Quarry (after completion of the future rehabilitation works) will be worked in a manner to leave them as landforms that are consistent with the surrounding terrain and will be ripped, ameliorated and shaped to form a free draining landform and seeded with grass species to match the adjoining lands for the approved PMLU.

Table 1.15: Estimated Quantities of Material Available on Site for Future Rehabilitation Works

Material Location	Surface Area (ha)	Maximum Excavation Depth	Topsoil (m^3)	General Fill (m^3)	Rock (m^3)	Total (m^3)
Northern Borrow Pit	40.1	2.60 m	55,800	987,690	0	**1,043,490**
Quarry	3.3	To be excavated to the elevation of the adjacent access road, maintaining an outer slope <30º.	0	0	154,800	**154,800**
TOTAL	**43.4**	**-**	**55,800**	**987,690**	**154,800**	**1,198,290**

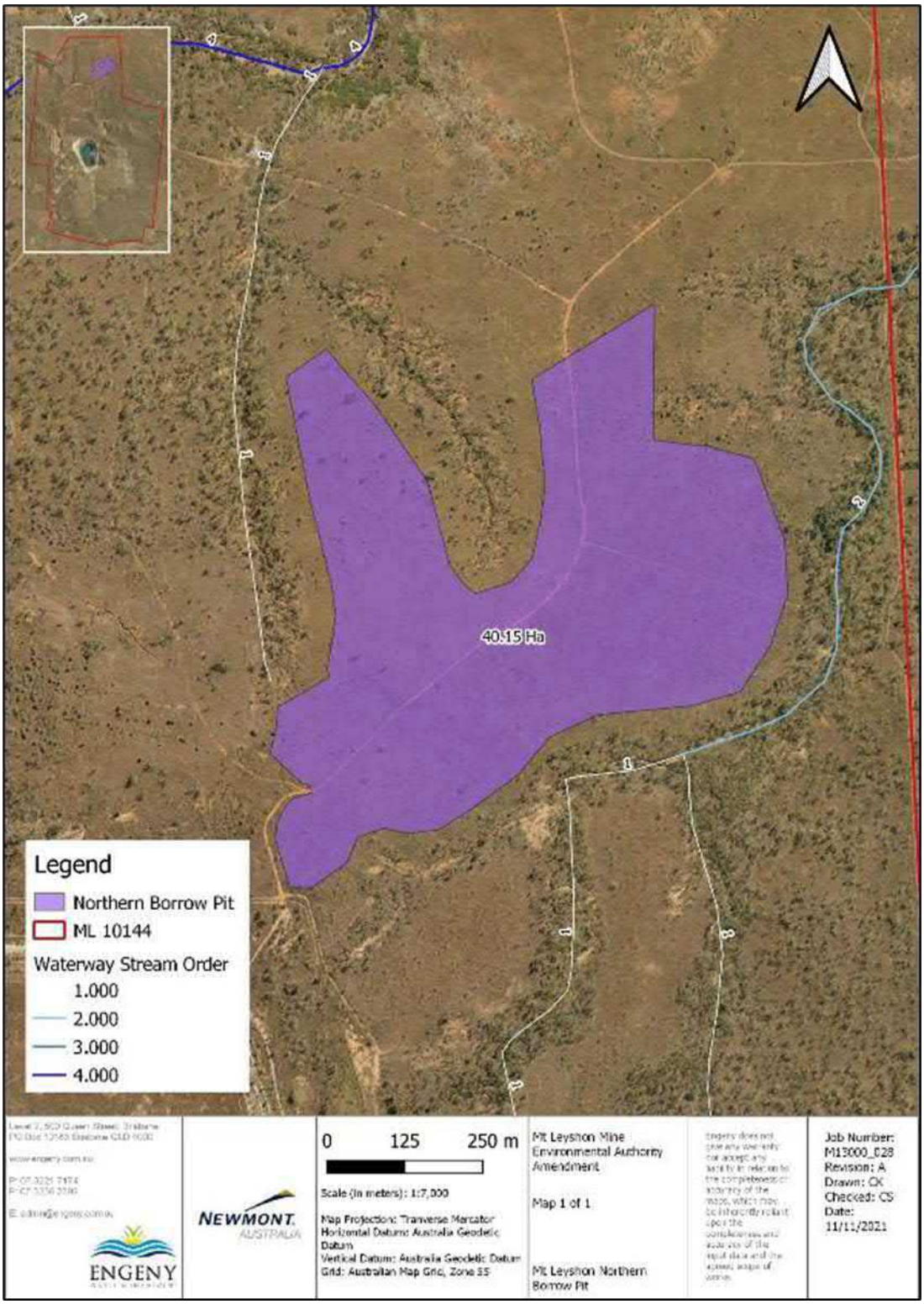


Figure 1.42: Location of the Northern Borrow Pit

Figure 1.43: Location of the Quarry

Table 1.16 presents the estimated volume of topsoil and rock estimated to be required to complete the rehabilitation of the mine site.

Table 1.16: Estimated Quantities of Material Required for Future Rehabilitation Works

Location	RA Footprint Area (ha)	Estimate of RA Footprint Requiring Rehabilitation works (%)	Estimated volume of topsoil required (m^3)[1]	Estimated volume of capping required (m^3)	Estimated volume of rock armour required (m^3)[2]
RA 1 – Eastern Waste Rock Storage Facilities	6.95	3.5	20,850	0	0
RA 2 – Northern Waste Rock Storage Facility	14.98	100	44,985	0	0
RA 3 – Southern Waste Rock Storage Facility	12.55	31	11,736	0	0
RA 4 – New Northern Tailings Storage Facility	13.32	64	25,580	0	0
RA 5 – Old Northern Tailings Storage Facility	5.19	44	6,805	0	3,293
RA 6 – Southern Tailings Storage Facility	0.69	27	571	0	1,560
RA 7 – Stockpiles	11.36	100	35,987	0	0
RA 8 – Dams and Sumps	33.69	100	119,034	0	0
RA 9 – Road and Mine Infrastructure	4.07	100	2,654	0	0
RA 10 – Northern Borrow Pits	40.15	100	60,230	0	0
RA 11 – Quarry	3.3	100	5,987	0	0
RA 12 – Scats Stockpile	29.47	100	153,910	N/A – Liner	0
Total	**202.39**	**-**	**488,329**	**0**	**4,853**
Quantity of topsoil + general fill available	-	-	1,043,490	-	-
Quantity of rock available	-	-	-	-	154,800

[1] Assumes a topsoil thickness of 0.3m, except for on the Stockpiles (0.45 m), Scats Stockpile (0.5 m), Mine Infrastructure (0.1 m) and Northern Borrow Pit and Quarry (0.15 m)

[2] Assumes a rock armour thickness of 0.5m

Given the minor nature of the maintenance / rectification works to address areas of poorly performing rehabilitation, Newmont has estimated the area and volumes of material required to complete the rehabilitation works. It is recognised that the rehabilitation of these discrete areas will utilise existing materials potentially including those immediately adjacent to the

rehabilitation areas which are able to be tied in without compromising the surrounding area. The volumes of materials required will be refined as part detailed planning. However, this is not expected to lead to material deficit given the surplus volume of material available onsite.

Testing of growth media will be undertaken prior to placement and / or seeding, as relevant. This will identify if any ameliorants (type and application rate) are required to support vegetation growth for the nominated seed mix, primarily pasture species that are known to succeed in the region. Newmont has had recent success with revegetation of the Roche Hill rehabilitation works that were completed in 2017.

Material Testing

Material testing has been undertaken on the Northern Borrow Pit and Quarry to confirm the suitability of the underlying material for the identified future rehabilitation works at the site.

Northern Borrow Pit

TropWATER was engaged by Newmont in 2022 to collect and coordinate testing of soil samples from the Northern Borrow Pit area. Eleven samples were collected from the seven test pits in Figure 1.44 and Table 1.17.

The soil samples were tested for:

- Wet bulk density.
- Bulk density.
- Organic matter.
- Wettability.
- pH.
- Electrical conductivity.
- Phosphate Phosphorous.
- Permeability.
- Texture.
- Particle size.
- Water repellence.
- Emerson Class.
- Total Organic Carbon.
- Exchangeable cations (Ca, Mg, Na, K, Al).
- Effective Cation Exchange Capacity.
- Exchangeable sodium percentage.
- Exchangeable Aluminium.
- Calcium/Magnesium Ratio.
- Chloride.
- Extractable Sulfur.
- Slaking; and
- Clouding.

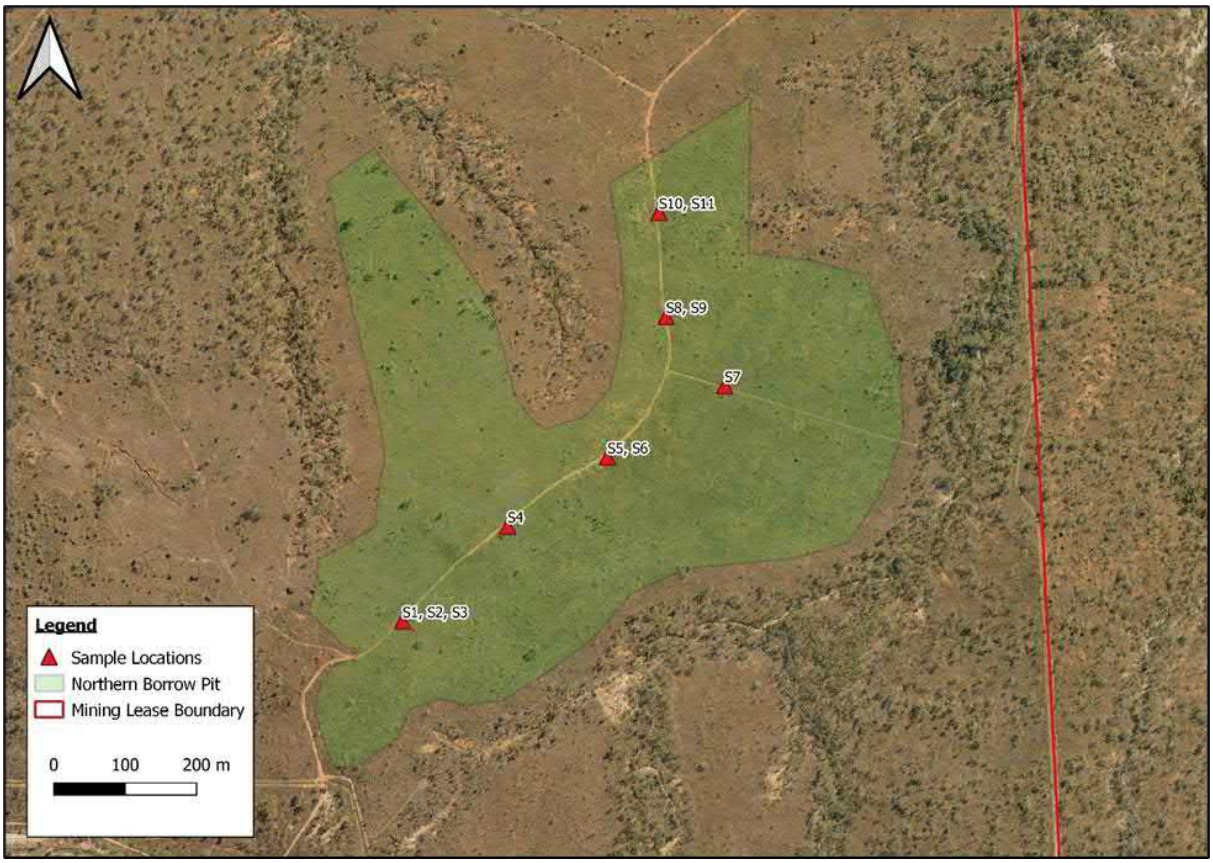


Figure 1.44: Material Testing Locations – Northern Borrow Pit

Table 1.17: Summary of Test Pit Locations

Test Pit Number	Sample Number	Sample Depth (mm)	Brief Field Description of Soil
1	S1	200-250	Reddish clayey material
1	S2	300-350	Light grey clayey fines
1	S3	2300	Decomposed granite
2	S4	1000	250-300 mm topsoil over decomposed granite and clayey fines
3	S5	0-150	0-750mm of red clay ochre
3	S6	1100-1300	Highly decomposed reddish granite
5	S7	2200-2400	Reddish decomposed granite with clayey sand
6	S8	0-200	Red ochre layer
6	S9	1200-1400	Pinkish red decomposed granite
7	S10	500-1100	Pinkish red decomposed granite
7	S11	1200-2500	Greyish material with white/black decomposed granite

The soil testing results are provided in full in Appendix M. The results were interpreted by Engeny (Engeny, 2022), who concluded that:

- The pH of 3 of the samples fall within the acceptable range of 6.0 to 8.0, whilst the remaining three samples can be modified with amelioration to reduce to below pH 8.0.
- The phosphate levels in all samples are low and need to be increased with a slow-release phosphate fertiliser such as DAP.
- The permeability and texture are acceptable within all 11 samples.
- The Emerson classes are acceptable within 7 samples and require amelioration with gypsum for the remaining samples.
- The organic carbon is moderate to low in all samples and requires the addition of a composted manure/ compost, microbial stimulant, hydromulch or seaweed extract to improve the water holding capacity, nutrient retention and nutrient release.
- The Calcium/Magnesium ratio exceeds 2:1 in all cases conforming with topsoil requirements.
- The exchangeable Aluminium levels are beneath the levels considered to retard plant growth.
- The exchangeable Sodium levels are well below the 6% set at the Australian Standard for Sodicity and therefore suitable for use as topsoil.
- The Chloride levels are significantly below the Australian Standard for Salinity.

Based on analysis of the results, all samples are suitable for use as a growth medium with the recommended amelioration (Figure 1.45 to support a sustainable grazing post-mining land use.

The preferred technique for applying the Gypsum and Organic Matter (composted feedlot manure or alternative) is via a mechanical spreader to the surface of the material prior to stripping (after vegetation removal). Mixing will occur as the material is excavated and relocated to either stockpiling or direct to the Rehabilitation area.

The preferred technique for applying the various fertilisers is by mechanical spinner to the final rehabilitated surface prior to seed application (if dry spun) or included into the hydromulch blend if using hydromulch to stabilise the final surface. If the various soils are mixed during extraction and relocation, then the fertiliser application would be simplified to a combination blend.

	Product	Rate/Ha	1	2	3	4	5	6	7	8	9	10	11
Amelioration	Gypsum	tonne/ha	5	5	5	5	0	5	5	5	5	0	0
Fertiliser	DAP	kg/ha	150	150	150	150	150	150	150	150	150	150	150
	Zinc Sulfate	kg/ha	10	10	10	10	5	10	10	10	10	5	5
Organic Matter		Tonne/ha	20	40	40	20	20	40	40	40	40	40	40

Figure 1.45: Amelioration and Nutrient Requirements for Perennial Pasture

Quarry

Nine separate sets of rock chip samples were collected from the Quarry on 28th October 2020, from the locations indicated in Figure 1.46. The rock samples were subsequently tested for:

- Acid Sulphate Rock Testing – Net Producing Potential (NAPP), NAG pH and Net Acid Generation (NAG) (single addition peroxide acidity), Acid Neutralising Capacity (ANC-BT) and Reduced Inorganic Sulphur (S-CR) (combined in NAPP equation).

Basic Metals Scan – Total Acid Extractable (ICPMS) including Aluminium, Arsenic, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Mercury, Nickel, Selenium, Silver and Zinc.

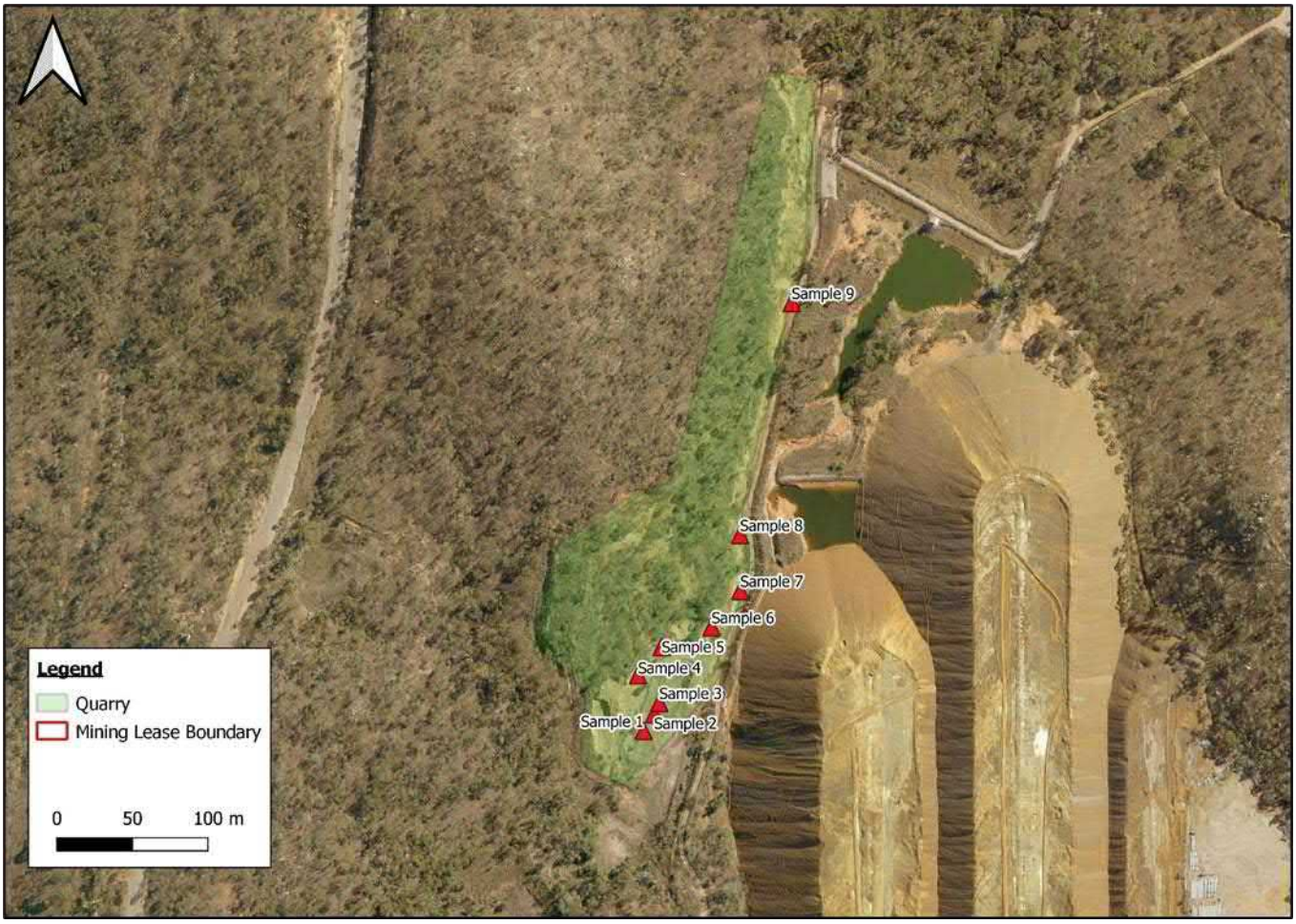


Figure 1.46: Material Testing Locations – Quarry

The rock testing results are provided in full in Appendix M. The results were interpreted by TropWATER (Templeman, 2021), who concluded that:

- None of the rock samples exhibited any acid forming potential.
- Two rock samples had measurable Chromium Reducible Sulphur, with both samples considered to potentially have acid consuming potential.
- All rock samples ha a level of acid neutralising capacity, with % $CaCO_3$ ranging from 0.08% to 10.04%.
- All rock samples had silver, cadmium, selenium, mercury and beryllium concentrations at or below the respective reporting limits (i.e., limit of detection of the testing procedure), however two rock samples had arsenic concentrations just above the respective reporting limit.
- All rock samples had chromium, lead, nickel and zinc concentrations below the (ANZG, 2018) sediment quality guideline values (low SQG-L), however two rock samples had copper concentrations just above the guideline value.
- All rock samples had manganese, iron and aluminium concentrations that are consistent with the mineralogy/geology of the area (Aspandiar, Taylor, & Eggleton, 2003; Morrison , 2007).

It is important to note that these analyses were conducted as strong acid extraction on ground samples and, as such, are very conservative measures of the potential for contaminants to be transferred into the receiving environment. Therefore, there is little risk of rock from the Quarry posing a contamination risk to the receiving environment if used for future rehabilitation works at the site (Templeman, 2021).

Waste Characterisation

There have been a large number of materials characterisation and behaviour assessments completed during the life of the operation as well as during the closure and reclamation phase. No original data and few conclusions are available from the geochemical characterisation of waste rock and tailings which was undertaken during operations and used to design the storage facilities due to the transfer of ownership of the mine. Data that is available from studies completed to inform the closure works include a geo-environmental assessment (WMC, 2009) which reports on:

- Monitoring, management and classification of porphyry waste rock prior to it being used as a seal layer during capping of various facilities.
- Geochemical assessments of the tailings stored in the Old Northern Tailings Storage Facility.
- Materials characterisation of the material remaining in the rehabilitated heap leach pad.
- Assessment of the scats stockpile and potential disposal options.

A detailed review and summary of the available data and reports was completed during closure (WMC, 2009).

Static and Kinetic Testing and Results

At an early stage in mining at Mt Leyshon it was recognised that the primary (unoxidised) waste rock contains varying levels of sulphides, mainly in the form of pyrite. Such materials, on exposure to atmospheric conditions, have the potential to produce acid rock drainage (ARD) and release contaminant metals to the hydrosphere. Studies undertaken during the mining and closure periods identified that (WMC, 2009):

- Porphyry cover materials are generally likely to be Non-Acid Forming (NAF), as indicated by Acid Base Accounting (ABA) and Net Acid Generation (NAG) testwork.
- Waste rock, not including NAF cover materials, is generally classified as Potentially Acid Forming (PAF), with Net Acid Production Potential (NAPP) values > 20 kg H_2SO_4/t and Acid Neutralisation Capacity / Acidification Potential (ANC/AP) values < 1.
- Spent oxide heap leach material ranges from NAF to PAF, with a greater number of samples classifying as the latter, with NAPP values > 20 kg H_2SO_4/t and ANC/AP values < 1.
- Tailings material generally classifies as PAF, with the majority of samples having NAPP values > 20 kg H_2SO_4/t and ANC/AP values < 1.
- Scats also classify as PAF, with all samples tested having NAG pH values < pH 3, NAPP values > 20 kg H_2SO_4/t and ANC/AP values < 1.
- A combination of ABA and NAG testwork indicates that scats have the greatest potential for acid generation, followed by tailings (in the long term).
- Leach testwork to investigate the release of metals under weathering conditions indicated that both scats and tailings have the capacity to generate low pH conditions with elevated concentrations of SO_4, Cd, Cu and Zn.

Block Models, Materials Handling and Cover Selections

During the mining period waste rock was classified for ARD potential and selectively handled accordingly. Reportedly this involved developing site specific relationships between total sulphur content and ARD characterisation, which allowed the mining block models to include ARD potential for all waste blocks mined. The Environmental Management Overview Strategy (EMOS) in 1993 stated that all materials with a sulphur content greater than 0.5% would be considered to be PAF. The EMOS refers to two studies completed by AGC Woodward Clyde in January and September 1992 which characterised the main pit lithologies with respect to metals and sulphur content and net acid production potential (NAPP). Although details of these studies are not available, it is assumed that the 0.5% sulphur cutoff originated in this research.

The mine studies concluded that porphyry waste rocks and some oxide waste rocks were NAF, while all other waste rock was PAF. Selected oxide and porphyry waste rock was therefore utilised for the final surfaces of the waste rock storages, and the cover designs for all of the waste rock storage facilities and tailings storage facilities were predicated on the stored material being PAF, which required the ingress of oxygen and water to be minimised by the cover designs.

Long Term Closure Observed Leaching Results

The water management system at the Mt Leyshon mine includes the operation of dams immediately downgradient of WRSFs and sumps downgradient of TSFs. These facilities were in place through the operating and closure periods, with contained flows being pumped into the open pit during the closure period. The dams have collected runoff and seepage from a number of sources. As a result of ongoing selective routing of runoff and seepage, the dams have collected primarily seepage flows since around 2008. The groundwater interception sumps are excavated into the water table and collect a mixture of groundwater and facility seepage which is migrating away from the mine facilities.

Dams and sumps which reflect the hydrochemistry of seepage are discussed as follows:

- EWRSF: The Mt Mawe Dam collects seepage emanating from the toe of this facility.
- STSF: The STDSW sump is located immediately downgradient and collects a mixture of groundwater and TSF seepage.
- SWRSF: There are no dams immediately downgradient of this facility. Seepage is expected to report to the Settlement Dam, however there are also other runoff and seepage sources reporting to this dam.
- Scats Stockpiles: Upper Plum Tree Creek Dam collects seepage emerging from the toe of the stockpile.
- ONTSF: The ONTD N sump is located immediately downgradient and collects a mixture of groundwater and seepage.
- NNTSF The NNTD NW sump is located immediately downgradient and collects a mixture of groundwater and seepage.

Figure 1.47 to Figure 1.52 below present the hydrochemistry of the selected dams and sumps since 2008.

It is noted that there are no dams or sumps located immediately downgradient of the NWRSF which can be used to characterise the quantity and quality of seepage from the NWRSF. However, groundwater flow directions in the vicinity of the NWRSF are well defined (Big Dog Hydrogeology, 2021). The seepage pathway from the NWRSF to the environment would be to the north-west, past the Scats Stockpile and into Plum Tree Creek (refer Figure 1.53). The closest groundwater monitoring bores to the NWRSF and Plum Tree Creek are NMLMB19, NMLMB20, NMLMB22. No mounding of groundwater has been observed at these bores (refer to Figure 1.54) as would be the case if there was a significant inflow to groundwater from seepage originating from either the NWRSF or the Scats Stockpile. Furthermore, sulphate concentrations (primary contaminant of concern) at NMLMB22, which would capture the influence of any seepage from the NWRSF or the Scats Stockpile are stable (refer to Figure 1.55) and do not show any indication of sulphate contributions from the NWRSF or the Scats Stockpile. It is concluded that rainfall infiltration through the cover system of the NWRSF is not contributing any significant quantity of seepage to groundwater.

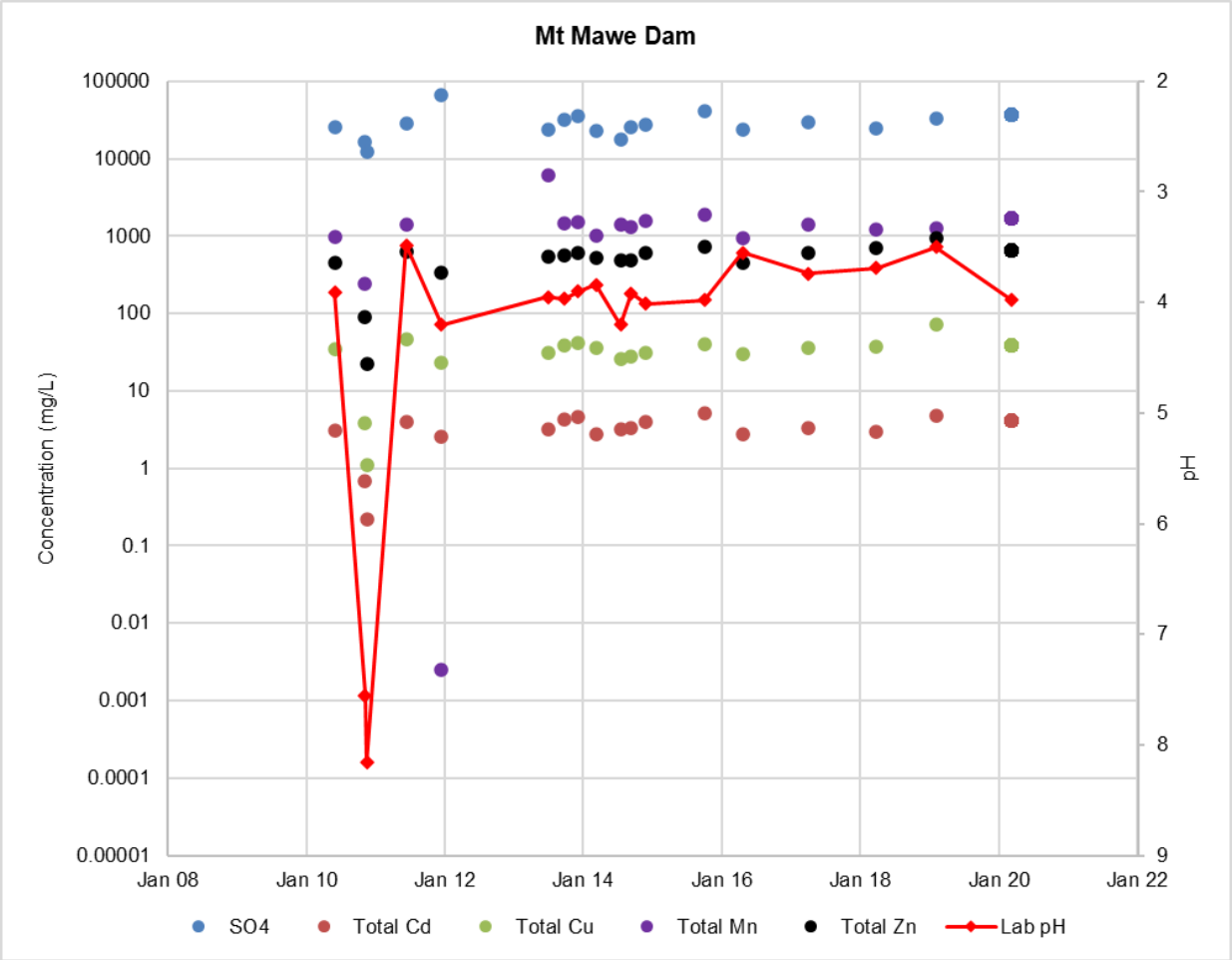


Figure 1.47: Mt Mawe Dam Hydrochemistry

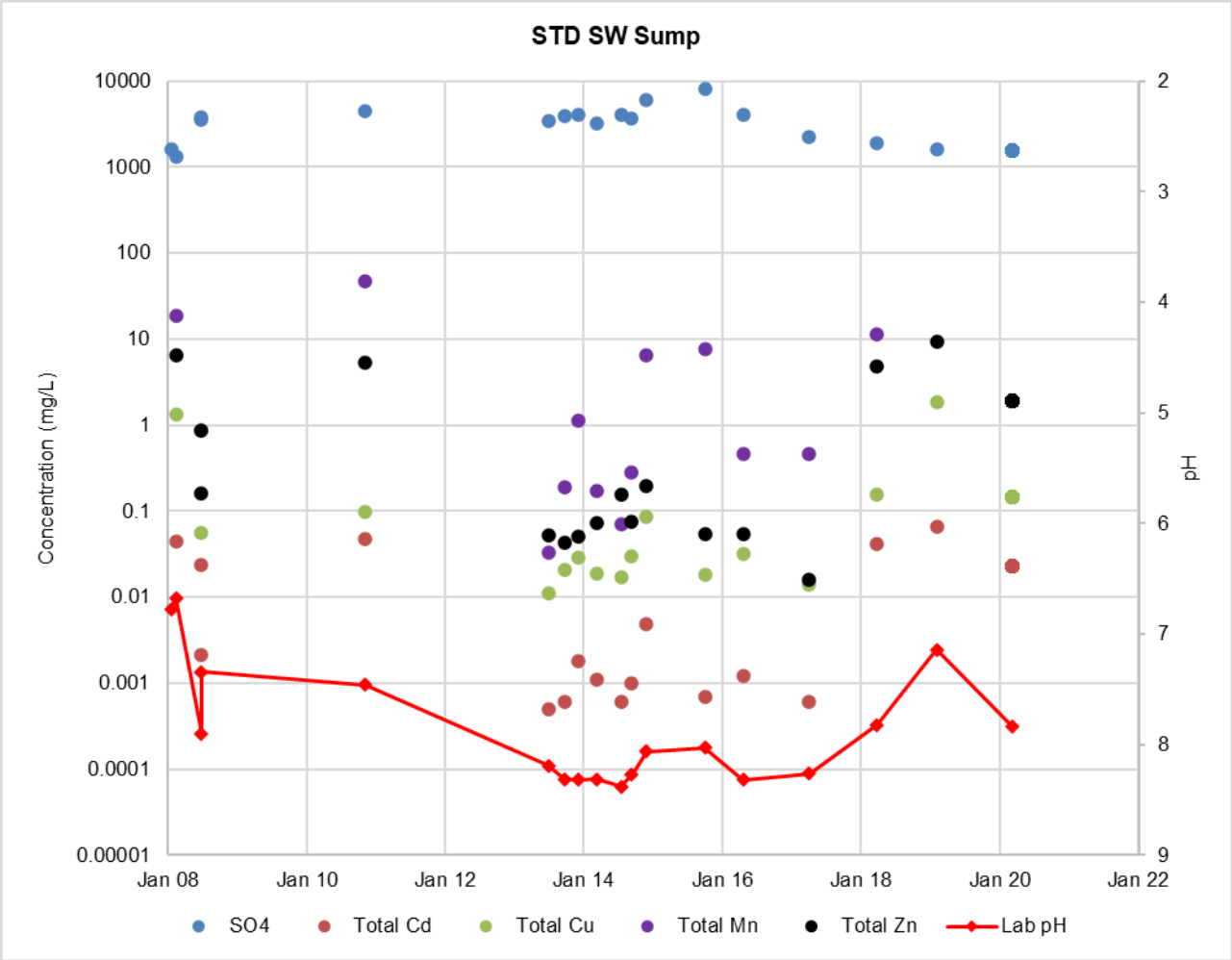


Figure 1.48: STDSW Sump Hydrochemistry

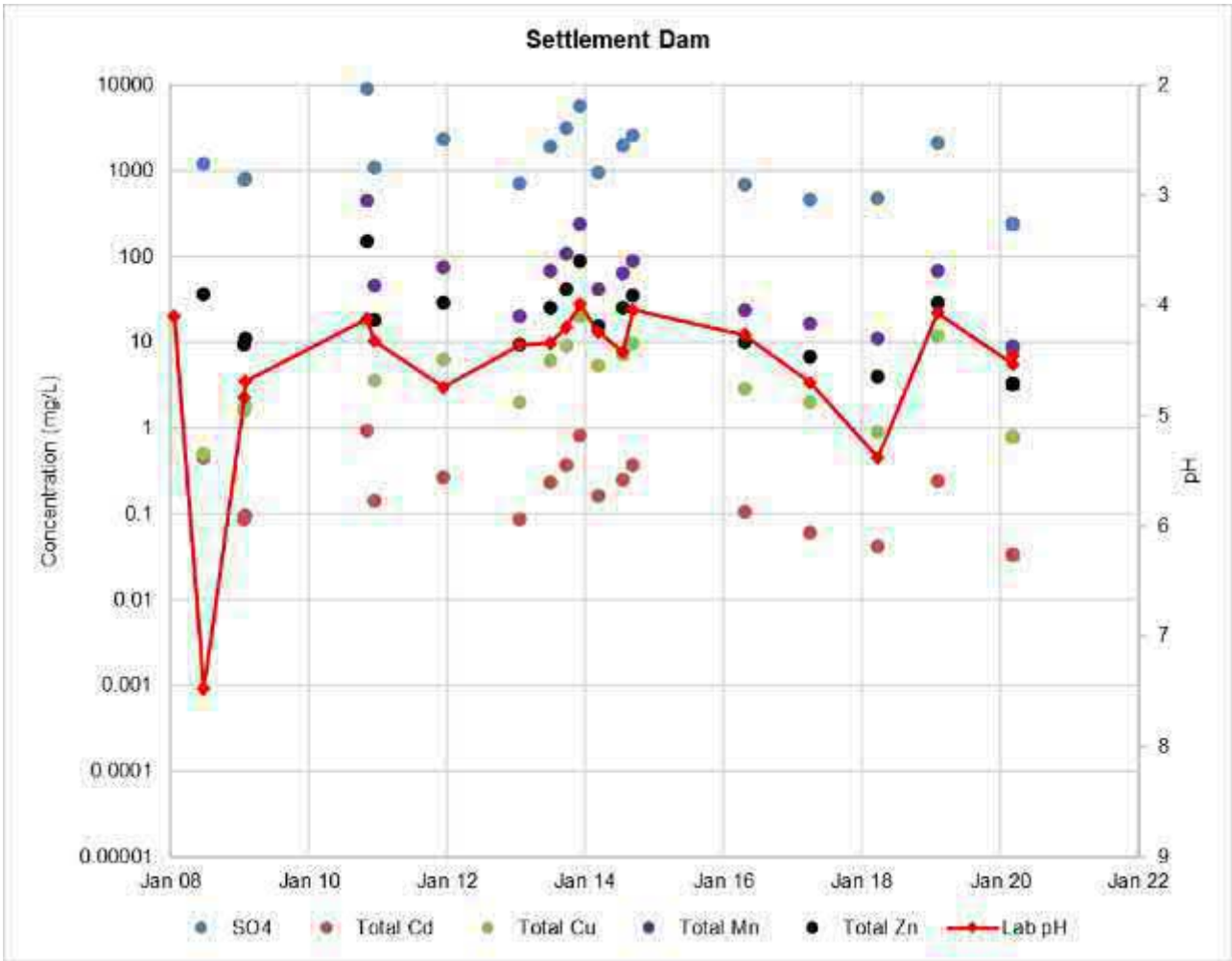


Figure 1.49: Settlement Dam Hydrochemistry

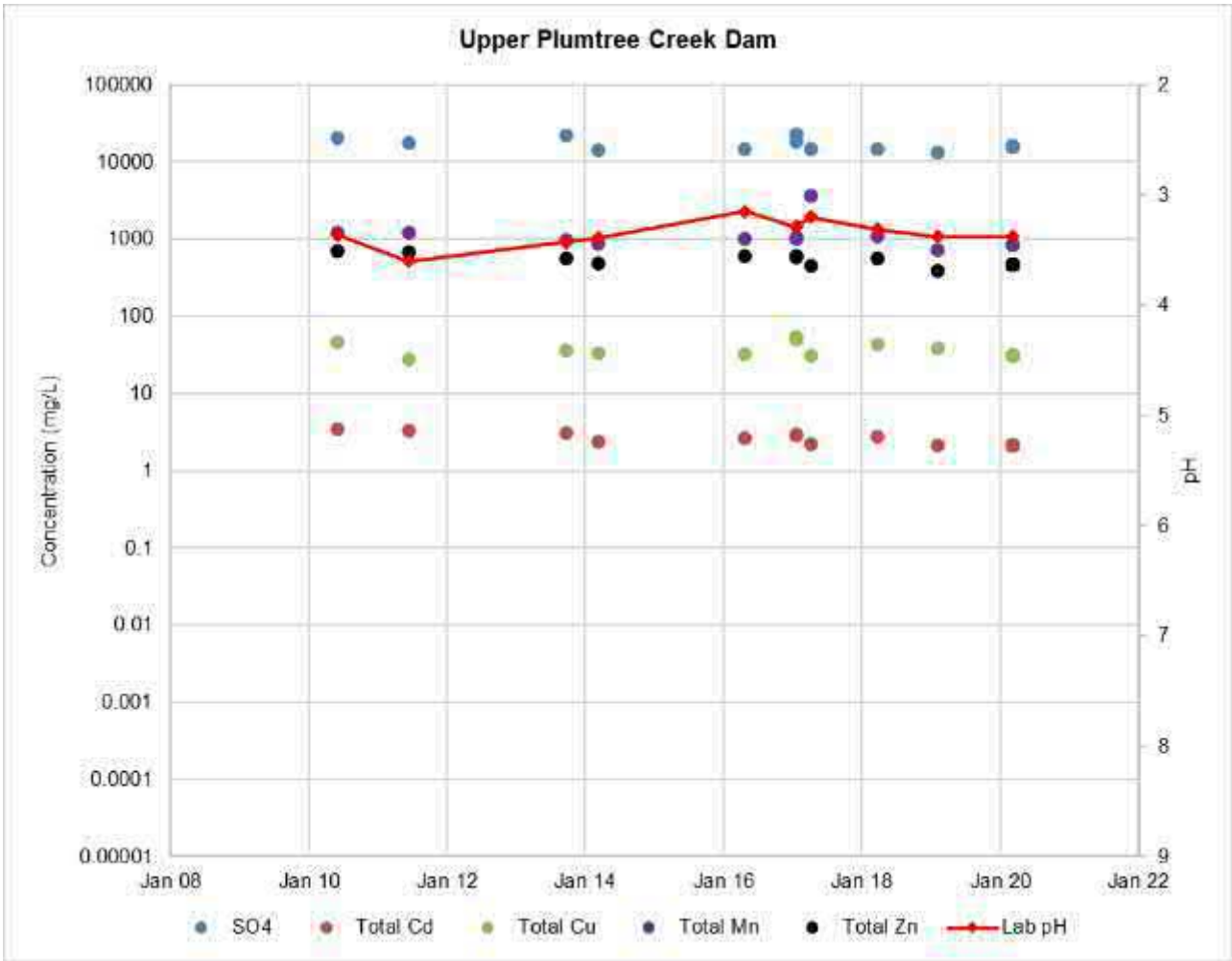


Figure 1.50: Upper Plum Tree Creek Dam Hydrochemistry

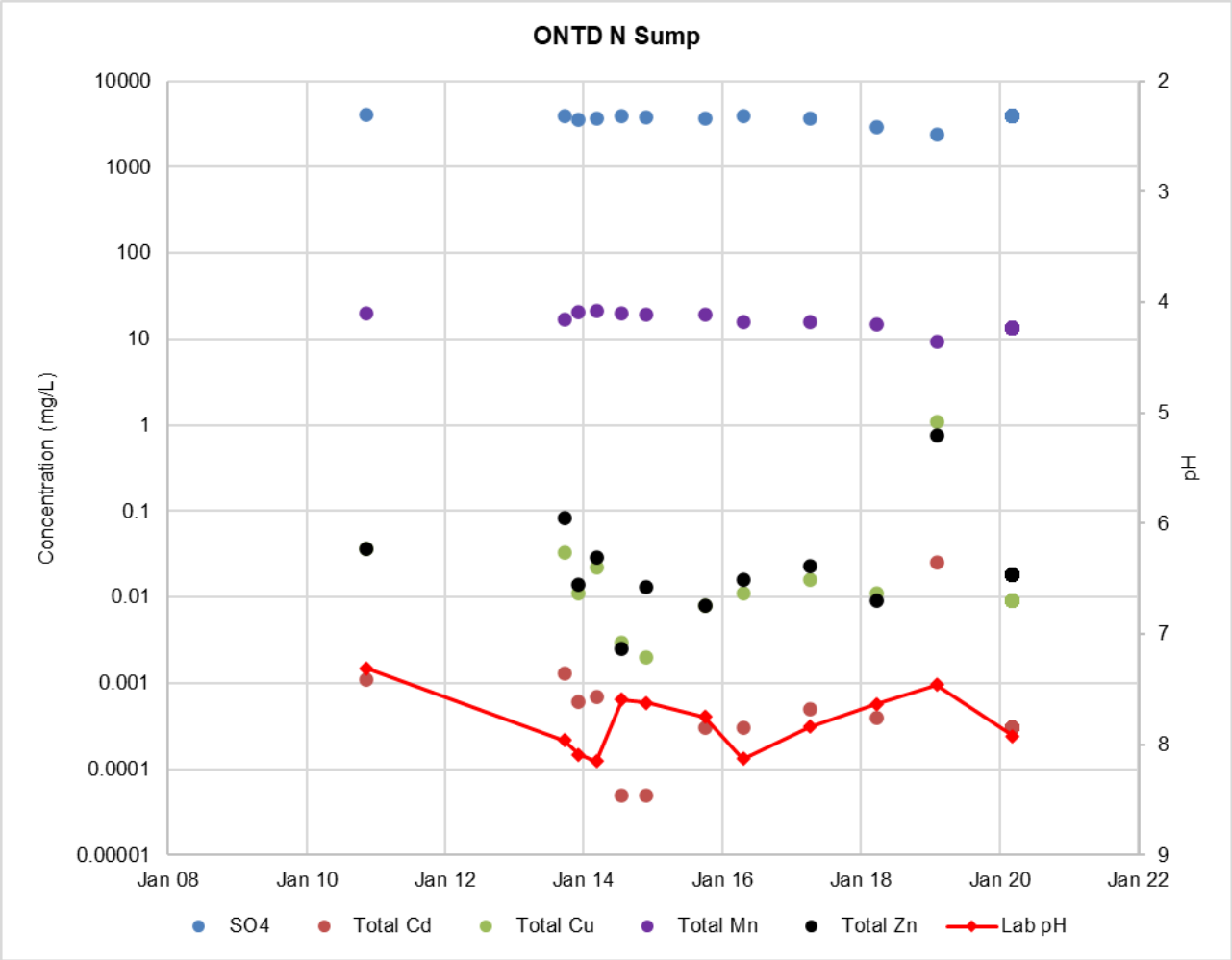


Figure 1.51: ONTD N Sump Hydrochemistry

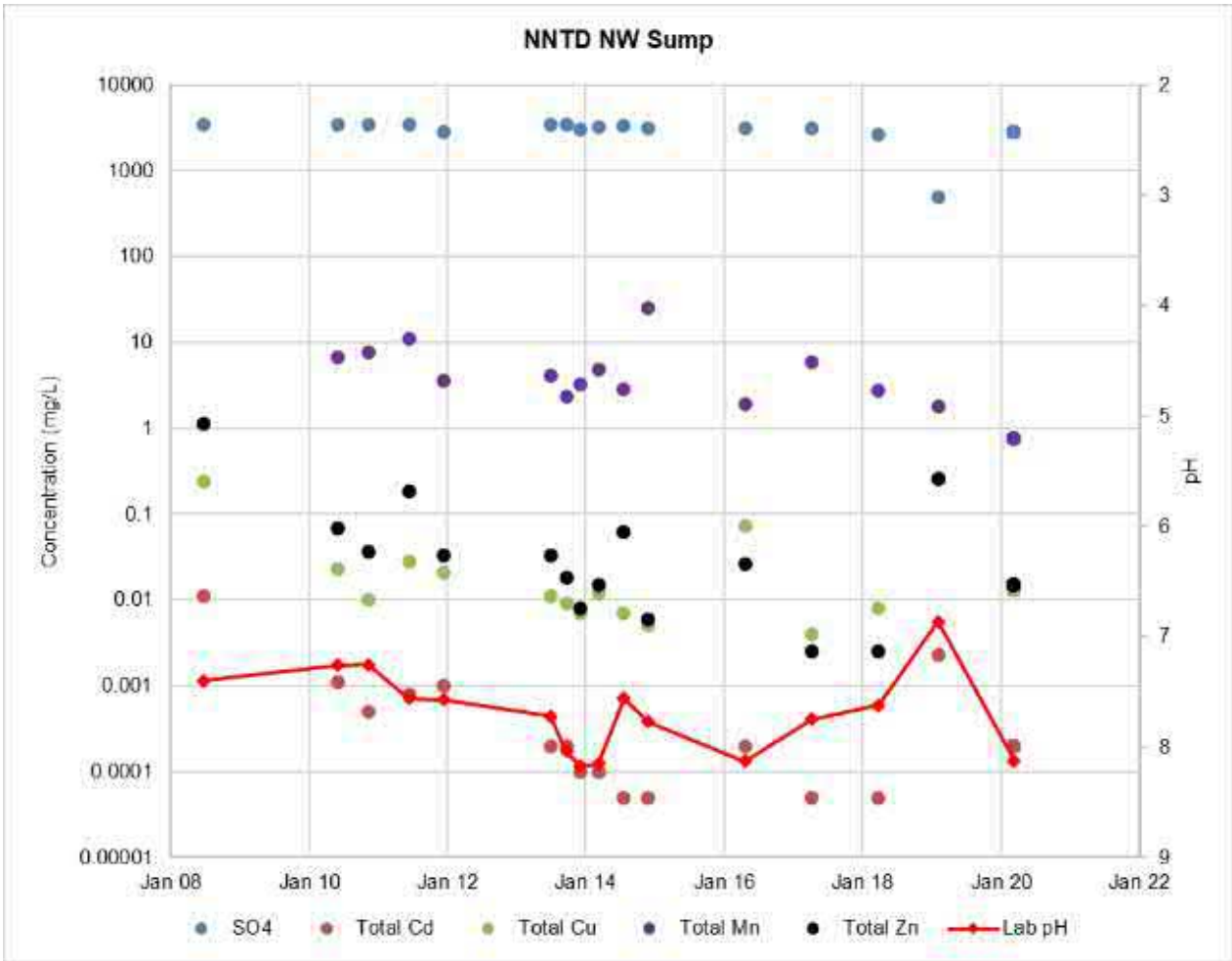


Figure 1.52: NNTD NW Sump Hydrochemistry

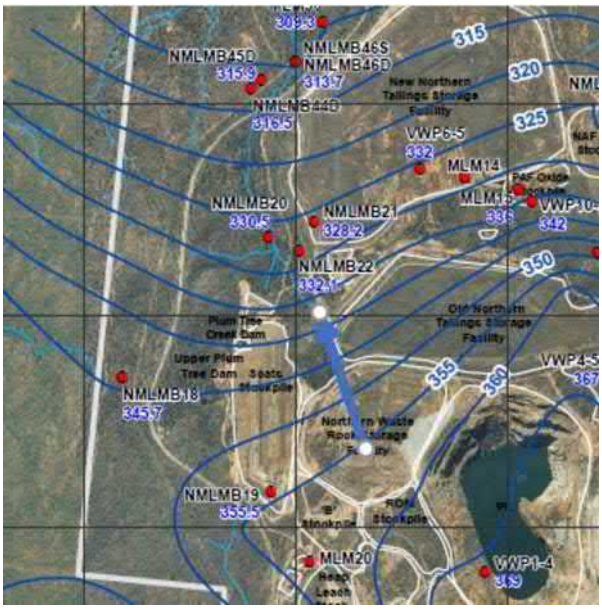


Figure 1.53: Groundwater Elevations and Flow Directions in Vicinity of NWRSF (Big Dog Hydrogeology, 2021)

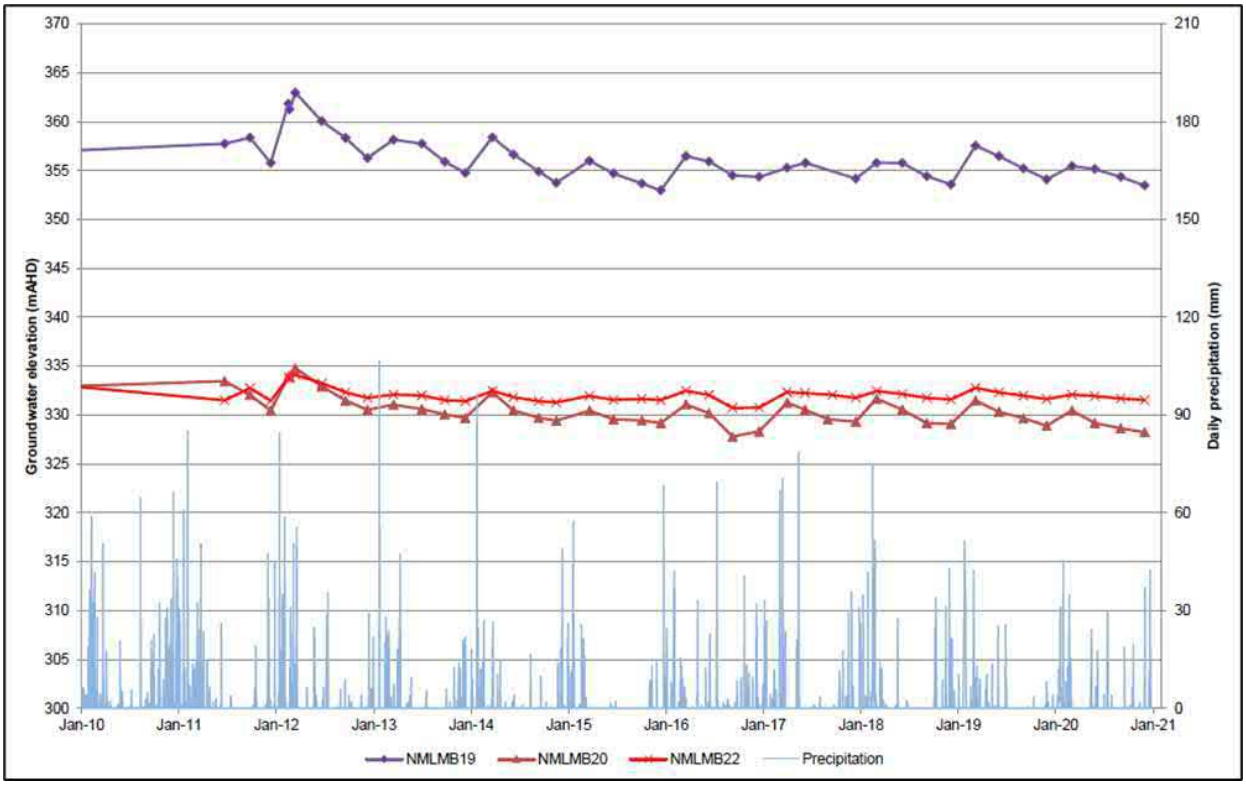


Figure 1.54: Groundwater Elevations at NMLMB19, NMLMB20 and NMLMB22 (Big Dog Hydrogeology, 2021)

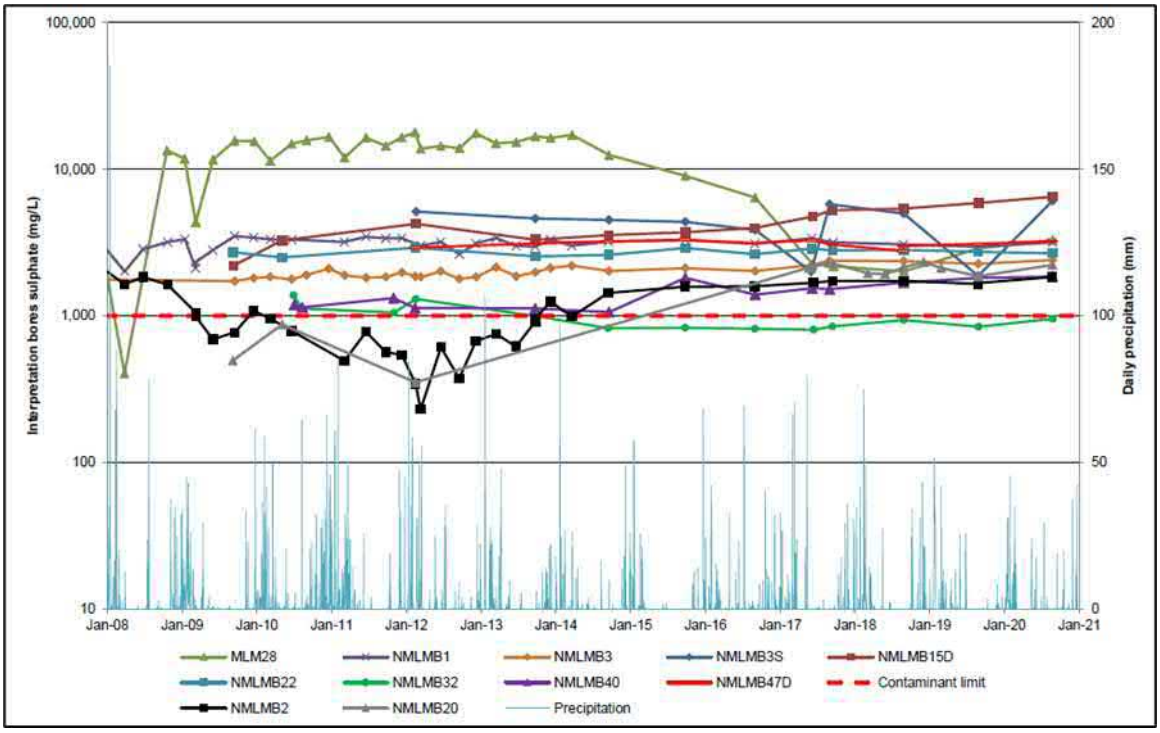


Figure 1.55: Groundwater Sulphate Concentrations at Groundwater Interpretation Bores (Big Dog Hydrogeology, 2021)

Table 1.18 presents average water quality values in (calculated from 2008) in the water containment dams and seepage sumps that are downgradient of the mine landforms. In combination, these identify that:

- Seepage hydrochemistry appears to have reached equilibrium, there is no consistent long term improvement or worsening of hydrochemistry.
- Metals concentrations correlate strongly with and are controlled by small changes in pH.
- The metals which were predicted from the static and kinetic testing to be released are confirmed to be present in seepage.
- Seepage from the EWRSF and the scats stockpile has similar chemistry, and reflects ARD generation, including a pH around 3.5, sulphate concentrations in excess of 10,000 mg/L, and elevated concentrations of metals.
- Water collected from the TSF sumps retains a neutral pH, due to the natural alkalinity of groundwater, but has elevated concentrations of sulphate (around 3,000 mg/L) due to TSF seepage.

These conclusions warrant continuation of the post closure water management system to continue to better understand long term trends, and potential adaptive management. It is determined that the water management system carries an acceptable level of risk proportionate to reduce the likelihood of potential environmental harm.

Conceptualisation of the potential interactions of mining activities on local systems is presented in the Hydrogeology section of this report and in the Groundwater Management Plan attached as Appendix A.

Table 1.18: Water Chemistry in Water Containment Dams and Seepage Sumps Downgradient of Mine Landforms

Facility		EWRSF	STSF	SWRSF	Scats	ONTD	NNTD
Dam/Sump		Mt Mawe Dam	STD SW Sump	Settlement Dam	Upper Plum Tree Creek Dam	ONTD N Sump	NNTD NW Sump
Averages	Units						
Laboratory pH		4.3	7.9	4.6	3.3	7.8	7.7
Sulphate	mg/L	29172	3483	1918	17073	3634	3006
Total Cd	mg/L	3.263	0.015	0.252	2.706	0.003	0.001
Total Co	mg/L	8.4	0.3	0.5	4.8	0.9	0.1
Total Cu	mg/L	33.21	0.28	5.81	38.55	0.11	0.05
Total Mn	mg/L	1497	8	84	1243	17	6
Total Ni	mg/L	4.14	0.03	0.23	3.90	0.02	0.01
Total Zn	mg/L	523.4	1.8	28.9	551.1	0.1	0.1

Landform Design

General

Construction of the final landform and rehabilitation was undertaken progressively during the operational phase of the mine (e.g., rehabilitation of portions of the waste rock storage facilities commenced in 1992) and detailed in the project planning section of this document, with aerial imagery and topographic survey displaying the as constructed nature of the designed landforms. Most of the final closure designs for the overall site were developed approximately 20 years ago (Klohn Crippen Consultants, 1999; SRK Consulting, 2000, Normandy Mt Leyshon Ltd, 2000). Implementation of these closure designs at most of the facilities remaining at the end of open pit mining was completed in 2002.

Most of the materials generated during mining at Mt Leyshon were defined at the time or are now known to be Potentially Acid Forming (PAF). This aspect was addressed in the landform closure design by creating a free draining final landform (i.e., constructing a domed surface over the tailings and waste rock storage facilities) and installing a cover layer to minimise both oxygen and water ingress, while making maximum use of the inventory of available materials. A comprehensive surface water drainage network has also been installed across the finished surface to maximise runoff from these facilities and minimise infiltration and erosion.

The general characteristics of each of the rehabilitated mining features is summarised in Table 1.19.

Table 1.19: Characteristics of the Primary Rehabilitated Mining Features

Mining Feature	Plan Area (ha)	Capping layer installed	Maximum height (m)	Top Slope (degrees)	Batter Slope (degrees)
Northern Waste Rock Storage Facility	38.48	Yes	53	2.98	12

Mining Feature	Plan Area (ha)	Capping layer installed	Maximum height (m)	Top Slope (degrees)	Batter Slope (degrees)
Southern Waste Rock Storage Facility	41.41	Yes	41	1.2	11
Eastern Waste Rock Storage Facility	197.67	Yes	61	0.9	13
Old Northern Tailings Storage Facility	65.3	Yes	43	0.5	15
Southern Tailings Storage Facility	68.19	Yes	36	0.3	14
New Northern Tailings Storage Facility	116.68	Yes	23	0.4	16

Figure shows the as constructed final landform of the Mt Leyshon Mine (excluding the scats stockpiles which are yet to be rehabilitated – refer section on Scats Stockpile Rehabilitation below). The final landform generally consists of domed top waste rock storage facility and tailings storage facilities and battered sides and is intersected by surface water drainage lines. This configuration is generally consistent with the surrounding landform of the region.

Designs for the original closure of the mine facilities were generated using investigation and modelling studies which reflected industry best practice at that time.

Final landform designs for the external faces of the waste rock storage facilities and tailings storage facilities at the Mt Leyshon Mine were developed taking account of the objectives of the closure planning which included:

- To ensure erosional stability of the cover and near surface materials by considering slope angles, slope lengths between benches, and longitudinal gradients for drainage features.
- To prevent the risk of deep seated, multiple bench failure of facility outslopes, by considering the geotechnical properties of the stored materials and the overall height and average slope angle for the outslopes.
- To ensure stability under seismic loading, especially for the tailings facilities prior to dewatering, taking account of the potential for liquefaction.

The only large scale mining feature that has not been rehabilitated that will result in a change to the final landform is the Scats Stockpile. The rehabilitation of the Scats Stockpile is earmarked for the later part of the PRCP schedule. This timing is due to the current controls being effective in maintaining an acceptable level of risk with respect to potential environmental harm (e.g., water interception system), stability of the landform, accessibility, and potential for future resource recovery (the Scats Stockpile has potential economic value subject to processing technology and commodity prices). A final landform design has been prepared for the Scats Stockpile and involves re-shaping of the stockpiles to a free-draining landform without the ridges and valleys of the individual stockpile fingers that are present in the current landform. The Scats Stockpile final landform design has considered landform erosion and geotechnical stability, water management and re-vegetation requirements. The final landform designs for the Scats Stockpile are summarised in reports prepared by DumpSolver (2021) and Engeny (2022) which are provided in Appendix N.

The rehabilitation of the remaining infrastructure areas and the maintenance / rectification works to address areas of poorly performing rehabilitation will be in accordance with as-constructed landforms and will therefore not result in any material change to the current landform. This includes the eastern face of the Northern Waste Rock Storage Facility which has an established cover and drainage system, but no revegetation works. The planned revegetation works for this area will follow the existing landform profile.

Newmont considered reprofiling the western face of Mt Mawe to replace the current benched arrangement with a more natural geometry. However, this option was not progressed as:

- Significant earthworks would be required to reprofile the geometry to a 14-degree slope that may result in instability as planes of weakness are exposed to weathering, and potentially increase in load bearing.
- Additional vegetation disturbance impacts would occur with the reprofiling earthworks.
- The current geometry is stable (as has been observed during the last 30 years) and a reprofiled geometry could resulted in a less stable final landform.
- The existing geometry is generally consistent with the steeper natural landforms within the mining lease (e.g., original Mt Leyshon and Wallaby Tail Hill) as shown in Figure 1.56 and Figure 1.57.

As the water quality from the rehabilitated areas improves over time the dams/sumps will be decommissioned once monitoring indicates that the water is suitable to allow release off site. These structures are generally located along natural drainage lines and decommissioning will involve relatively minor earthworks to reinstate a free draining system.

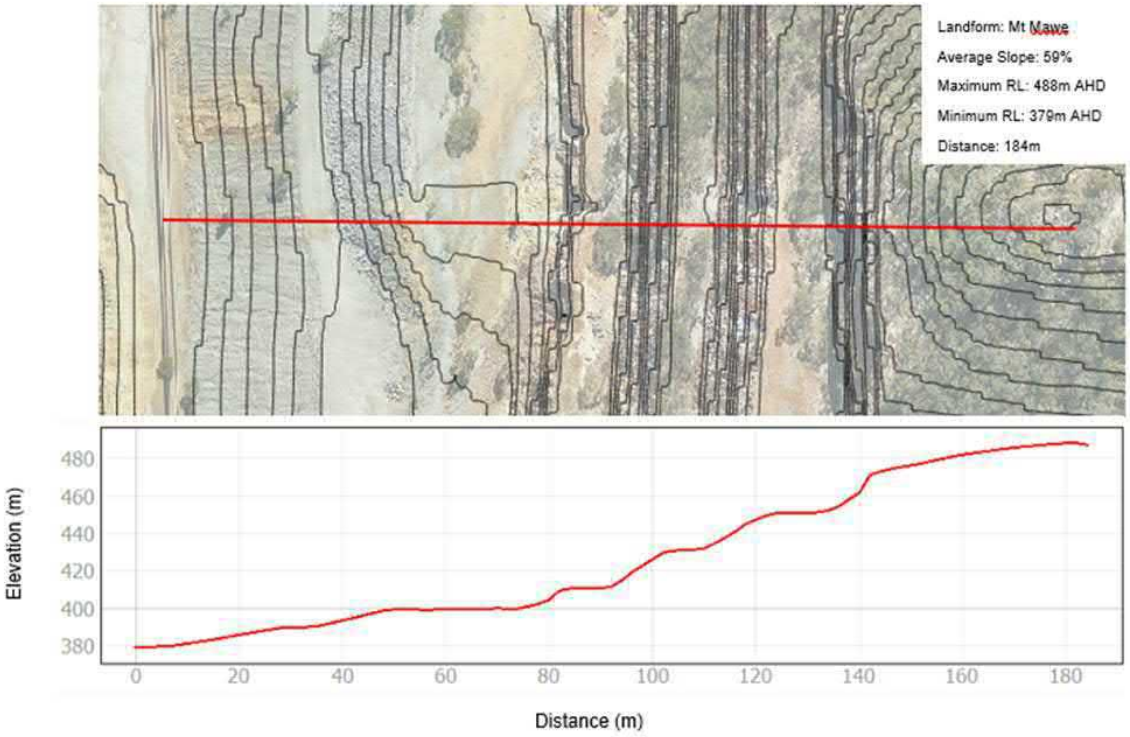


Figure 1.56: Western Face of Mt Mawe Elevation Profile

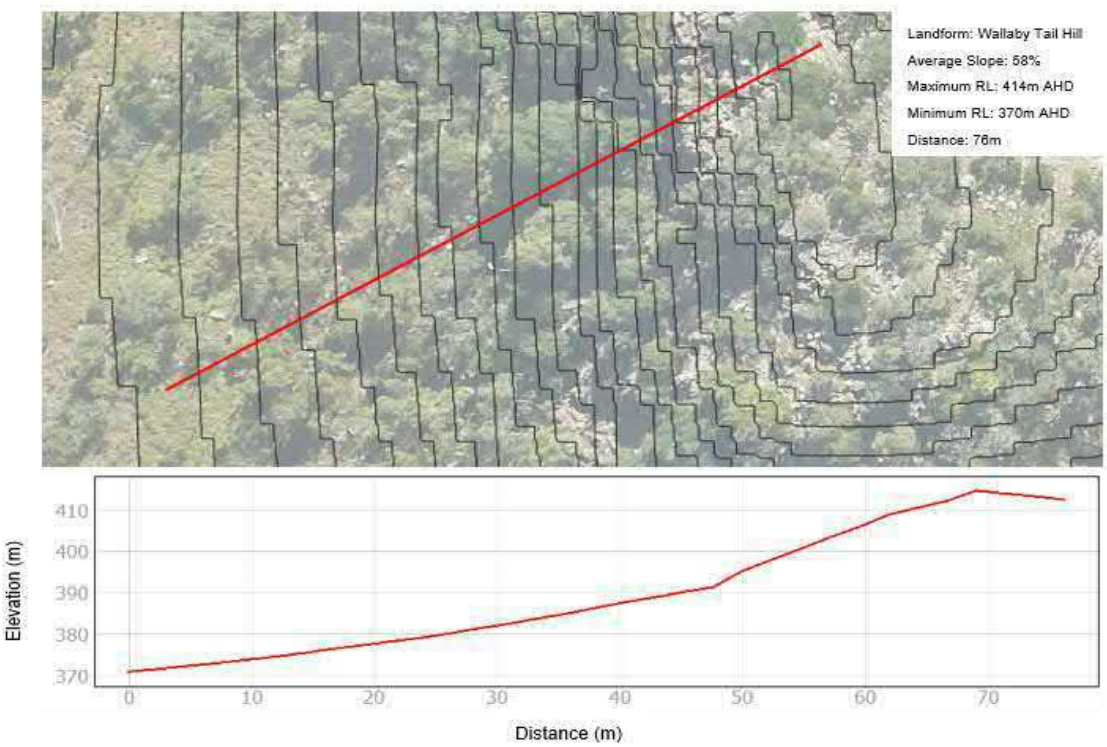


Figure 1.57: Wallaby Tail Hill Elevation Profile

Method of Construction

The waste rock storage facilities were dumped in stages / lifts, creating a stepped surface which was re-profiled, with the objective of reducing the overall slope angle of the external faces to 14 degrees. The tailings storage facilities were intended to be constructed at an average embankment slope of 11 degrees (as noted in Table 20 in the 2000 Closure Plan (Normandy Mt Leyshon Ltd, 2000) and as specified in the Environmental Management Overview Strategy).

The majority of the final landform has been constructed and rehabilitated with high density of grass coverage present (See Figure 2 of the Plan of Operations [Newmont 2019] which is contained in Appendix G. The catchments and flowpaths for the as constructed final landform are shown on Figure 1.8 on the Water Management Plan (Engeny 2020) which can be found in Appendix B. These figures show that the as constructed landform has been constructed to shed water.

A construction methodology for the proposed Scats Stockpile rehabilitation area is provided in the landform design reports included in Appendix N.

Long Term Stability

Geotechnical modelling of the stability of the tailings storage facilities identified they would be geotechnically stable under seismic loading associated with a maximum credible earthquake of magnitude 6.4 occurring on a fault at 40 km distance with focus at 10 km depth causing a maximum ground acceleration of 0.06g (URS, 2000).

Annual rehabilitation monitoring of the as-constructed final landform shows that the previous rehabilitation areas are generally stable. This stability is attributed to widespread, high grass cover and a high degree of rock incorporation into the surface. However, localised areas of erosion are present and are typically located on the batters of the waste rock storage facilities. Most of the erosion sites were not actively expanding based on visual comparison between the annual monitoring assessments (Stantec, 2020). All erosion areas will continue to be monitored and rectification works undertaken as required. A copy of the most recent (2021) rehabilitation monitoring report can be found in Appendix D.

An assessment of the long-term erosional stability of the proposed Scats Stockpile final landform has been undertaken and is included in the Engeny (2022) design Memorandum that is provided in Appendix N.

Settling and Subsidence

Minor settlement of the final landform was expected and considered in the design of the tailings and waste rock storage facilities by the inclusion of a domed profile. As these facilities were constructed more than 20 years ago, any settlement is expected to have already occurred. Settlement is therefore not expected to impact on the availability of rehabilitation areas.

Underground mining was not undertaken at Mt Leyshon and therefore subsidence will not impact the availability of rehabilitation areas. The pit north wall slip failure caused some localised subsidence of the southern edge of the ONTSF. A small additional area now drains to the pit void (included in NUMA extent).

Hydrological and Hydrogeological Assessments

The majority of the land within the mining leases will remain undisturbed. The original topography at the Mt Leyshon Mine site prior to mining was dominated by rocky outcrop hills including Mt Leyshon and Mt Mawe. These hills formed a regional topographic high and coincided with several catchment boundaries, with natural surface water drainage being generally away from the site to the north, south and east. The original topography at the Mt Leyshon Mine has been altered by the mining activities. The open pit removed much of the original Mt Leyshon, and the waste rock and tailings storage facilities are significant landforms which were constructed within the original catchments draining the site.

Stormwater runoff from the mine disturbance area is generally directed outwards from the rim of the pit in the centre of the mine lease area. Stormwater runoff flows are conveyed from the top of the mine landforms to the edge of the mine disturbance area via a network of drop structures and open drainage channels. Impacted surface water and seepage flows are intercepted by water containment dams located around the perimeter of the mine disturbance area and pumped into the pit. Stormwater runoff from natural and successfully rehabilitated areas is discharged at the edge of the mine disturbance area and flows to the receiving waterways and mine lease boundary in natural ephemeral drainage gullies and creeks.

Since the completion of mining operations Newmont has continued to assess the efficacy of the rehabilitation works (i.e., landform design, cover design and revegetation works). This assessment has included ongoing groundwater and surface monitoring which combined with hydrological and hydrogeological modelling continues to refine the understanding that the landform design, cover design and revegetation works has on the surface water and groundwater systems.

In accordance with the EA, a Receiving Environment Monitoring Program (REMP) has been developed and implemented to monitor and record the effects of the release of contaminants on the receiving environment with the aim of identifying and describing the extent of any adverse impacts on local environmental values and to monitor any changes in the receiving water (including groundwater). The REMP is required to include reference sampling locations upstream of sites potentially impacted by the mining activity and determine water quality objectives and to derive specific reference values in accordance with the *Queensland Water Quality Guidelines.* The REMP achieves this by including reference sites that meet the following criteria:

- Be from the same bio-geographic and climatic region.
- Have similar geology, soil types, and topography.
- Contain a range of habitats similar to those at the potentially impacted sites.
- Have a similar flow regime; and
- Not be so close to the potentially impacted sites that any disturbance at the potentially impacted sites also results in a change at the reference site.

Annual surface and groundwater assessments have been undertaken and communicated to the EA Administering Authority and both are well understood. The assessments are to continue and will inform any adaptive management required to incorporate into the PRCP schedule, and milestones.

Hydrological and hydrogeological risks associated with the Mt Leyshon Mine landforms have therefore been evaluated as low and are unlikely to impact on the final landform. Further information on assessments undertaken to determine the potential for

environmental harm caused by the discharge of surface water and seepage from the rehabilitated mine landforms to the receiving environment is provided in the Water Management section below.

Waste Placement Strategy

Waste rock and tailings from the mining operation have been placed in engineered facilities and capped to minimise the generation of and risks associated with any leachate. Since the mine is closed, no further placement of mining waste materials will occur that warrants consideration in this PRC Plan.

Specific Landform Requirements

There are no specific landform requirements that require special consideration in this PRC Plan other than the Scats Stockpile which are addressed in other sections of this Plan.

Monitoring of Control Measures

Newmont utilises the following direct and indirect management measures for monitoring the efficacy of the landform design and control measures:

- Survey control is implemented during the construction of the final landform to ensure that it is consistent with recommendations from the engineer's designs.
- Annual monitoring of rehabilitation areas and analogue (reference) sites using a defined methodology and numerical scoring system for a range of parameters relating to landform and soil surface characteristics, vegetation condition and structure, declared weeds and erosion.
- Monitoring of deep groundwater system:

– Continuous monitoring of the deep groundwater level at 46 bores.

- Monitoring of shallow groundwater system:

– Annual sampling at two bores up gradient (hydraulically) of the mine to define groundwater chemistry
– Annual sampling at 11 bores close to the mine facilities and within the known zone of impacted groundwater for interpretation purposes. Sampling of these bores is used to define any changes in the influence of seepage from the mine facilities.
– Annual sampling of seven bores which are located immediately outside the zone of impacted groundwater for compliance purposes. These bores are used to identify any future migration of the impacted groundwater and confirm that the predictions from the numerical groundwater model are valid.
– Six monthly measurements of the groundwater level at 69 bores. This monitoring is used to identify any localised increase in groundwater elevations near the mine facilities and provides and early warning of when regional groundwater elevations are higher in response to seasonal conditions, which increases the risk of groundwater discharge to the surface water environment.
– Periodic (nominally 5 yearly) site-wide groundwater sampling to define the spatial extent of the stock watering exclusion zone within the Mt Leyshon mining leases and surrounding Newmont-owned pastoral properties. The stock water exclusion zone includes areas where sulphate concentrations in the shallow groundwater system exceed 1000 mg/L (ANZECC water quality guidelines trigger value for adverse health effects for livestock drinking water) and groundwater is not extracted for stock watering purposes.

- Surface water monitoring; being:

– Daily contaminant release water quality and quantity monitoring at 22 locations during release events.
– Continuous stream flow monitoring at three locations downstream of the release point.
– Daily high flow bypass water quality monitoring at two locations during release events.
– Annual onsite water quality monitoring at 17 water storage locations.
– Event based sampling of release or flow events of receiving waters at 13 locations.

- Flow metering of on-site pumped transfers of water intercepted within the water containment dams and seepage sumps (intercepted water is pumped to the pit void lake). This flow metering data provides a measure of the volume of seepage water intercepted around the perimeter of the rehabilitated mine landforms which can be used to assess cover performance of the landforms in terms of net percolation of rainfall infiltration through the landform cover systems.

- Stream sediment quality monitoring at nine locations.
- Receiving Environment Monitoring Program which includes:
  - Aquatic Ecology: monitoring of macroinvertebrates for abundance, taxonomic richness, and diversity, and the SIGNAL (Stream Invertebrate Grade Number Average Level) index. These metrics are used to assess the status of the invertebrate communities at each sampling site. The number of sites sampled is dependent on water availability.
  - Australian River Assessment Scheme (AUSRIVAS) modelling. AUSRIVAS is a tool to assess the health of inland riverine environments using the resident macroinvertebrate community. The model predicts the aquatic macroinvertebrate fauna expected to occur at a site in the absence of environmental stressors, such as pollution or habitat degradation, and compares that prediction to the actual macroinvertebrate fauna collected at a particular reference site based on habitat attributes to gauge ecological health. The output from AUSRIVAS modelling is a 'band' score identifying the degree of impairment from expected reference condition.
  - Visual fish and crustacean surveys at all sites containing sufficient water to support aquatic fauna.
  - Terrestrial vegetation condition monitoring: Leaves from up to five specimen trees from the two dominant species (E. crebra and C. erythrophloia) are sampled at each site to measure concentrations of macro- and micro-nutrients and selected metals in the leaf tissue. The aim was to determine whether any elemental signature consistent with mine-impacted groundwater could be detected.
  - Riparian vegetation surveys are also undertaken. These surveys cover a 200 m length of stream bank at each site, with a nominal 25 m^2 point census undertaken at 20 m intervals. The metrics recorded are based on a range of ecosystem attributes for assessing natural variability in ecosystem health. The key metrics relate to the general composition of the riparian zone, including overstorey, understorey, and ground cover vegetation, as well as ground surface composition, and the extent of shading as an indication of combined canopy cover.

Newmont is also planning to improve the resolution and accuracy of the numerical groundwater model through a more comprehensive calibration process which may involve:

- Increased spatial resolution/variation of landform infiltration rates and seepage sulphate concentrations.
- Increased temporal variation of landform infiltration rates to better reflect the different infiltration conditions that have occurred during the operations and closure phases of the mine.
- Extended calibration period to include the additional 10 year period of groundwater level and quality data collected since the original development and calibration of the groundwater model in 2013.
- Increased focus on model calibration against groundwater monitoring data in closer proximity to the mine landforms to better estimate the infiltration responses for individual landforms and seasonal or event-based rainfall conditions.

It is intended that the improved groundwater model will be able to be used in combination with the monitoring activities described above to inform rehabilitation monitoring and adaptive management strategies including:

- To provide more accurate forecasts of the expected long-term future sulphate migration extents for the mine (expected to be reduced extents compared to previous model predictions).
- To provide a better understanding of cover performance for individual landforms.
- As a predictive tool to be used periodically in conjunction with rehabilitation monitoring data to trigger the need to make modifications to the planned future rehabilitation works contained in the PRC Plan Schedule to increase the confidence of achieving the completion criteria for the rehabilitation milestones.

Quality Assurance / Quality Control

Quality assurance and quality control "hold points" will be included in the project execution plan for future rehabilitation works. Hold points will consist of conducting a review of control effectiveness under the project execution risk assessment (which will

have clear linkage to risks and controls in milestone criteria and Land Outcome Documents). Only areas that satisfy the milestone criteria can progress to the next rehabilitation milestone. Hold points will include for example, Inspection and Test Plans (ITP) which are documents that describe the plan for managing the quality control and assurance of a particular element of the construction works providing information on the requirements, an overview of the method(s) to be used, responsibilities of relevant parties, and documentary evidence to be provided to verify compliance.

An example of a hold point and ITP for the planned Scats Stockpile rehabilitation works is to suspend works following the installation of each roll of bituminous geomembrane liner to allow an ITP activity to be completed that records conformance to manufacturer's specifications for laying, coverage, surface deformities, and anchoring. In this example, works would not proceed until responsible parties record compliance to specifications, and a proponent's representative also records their agreement. In the instance that works do not meet the specified requirements of the ITP, works remain at the hold point status until rectified.

Trial Methodology

Rehabilitation of the tailings storage facilities at the Mt Leyshon Mine commenced with the Old Northern Tailings Storage Facility (ONTSF) in 1997. The ONTSF was used as a trial and model for the other storage facilities and a range of investigations and tests were undertaken to refine the cover design.

Compaction trials were undertaken on the mounded surface using locally sourced materials to investigate the seals which could be achieved, and these field verified results were used in modelling of potential infiltration (EGI, 2000). The seal methods trialled were:

- 600 mm oxide heap leach, 4 passes impact roller.
- 300 mm clay, 4 passes impact roller.
- 600 mm NAF oxide waste rock, 4 passes impact roller.
- 600 mm NAF oxide waste rock, 10 passes impact roller.
- In situ waste rock capping material, 10 passes impact roller.

The resulting cover design for tailings storage facilities comprised:

- 1.5 to 3 m of run of mine waste rock capping, also acting as a capillary break.
- A minimum of 600 mm of compacted oxide heap leach seal. Material to be placed at a degree of saturation of more than 90% and compacted to a dry density of 97% in order to achieve a hydraulic conductivity less than 1x 10^{-7} m/s. Placed by scraper and compacted via scraper traffic.
- 300 mm of topsoil growth medium.

Ongoing monitoring of the rehabilitated areas over the last 20 years indicates that generally rehabilitation works are performing well. Similarly, monitoring of the rehabilitation rectification works undertaken by Newmont in 2017 in the Roche Hill area indicate that these recent rehabilitation works are also performing well.

Roche Hill was part of an area previously used as a low grade ore stockpile, subject to material movements throughout operations and also hosted waste materials that were PAF. The original rehabilitation of Roche Hill at closure involved capping with oxidised heap leach material and constructing berms to manage surface water. Following several high intensity rainfall events and possibly poor construction methods, erosion became evident on the western section (see Figure 1.58). Poor water quality resulted from rainfall runoff and seepage that contacted parts of Roche Hill and revegetation success was limited.

The 2017 rehabilitation rectification works (45 ha total rehabilitation area) divided Roche Hill into five treatment areas which included treatments such as filling of erosion gullies, establishment of crossfall and planned drainage features, roughening some surfaces, covering bare areas with fill/rock mulch, growth media and hydromulch, rock armouring of concentrated flow channels, managing catchment areas, and providing vehicle access. Rock was sourced from the existing quarry in the western parts of the mining lease while growth media was sourced from borrow pits in the northern part of ML 101144. The rehabilitation works were performed by a local civil contractor (revegetation/hydro mulching works were undertaken by a

specialist vegetation subcontractor) and supervised by Newmont. The rehabilitation woks were completed in 2017 and photos of the completed works are shown in Figure 1.59.

The 2017 rehabilitation repair works for Roche Hill are the last large-scale rehabilitation works that were undertaken at the Mt Leyshon Mine. The success of this recent rehabilitation project provides confidence that the future rehabilitation works proposed in this PRC Plan can be successfully executed by Newmont.

Figure 1.58: Western Section of Roche Hill prior to Rehabilitation Repair Works in 2017

Figure 1.59: Roche Hill after 2017 Rehabilitation Works

Cover Design

Designs for closure of the mine facilities were generated using investigation and modelling studies which reflected industry best practice at that time. Cover designs for the facilities were developed to minimise both oxygen and water ingress, while making maximum use of the inventory of available materials. Drainage designs were intended to maximise runoff from the facilities and minimise infiltration (i.e., water shedding). With clean water from non-disturbed and successfully rehabilitated areas discharged to surrounding receiving water bodies. Mine affected water was and is currently intercepted in dams and seepage sumps and pumped to the pit.

The waste rock storage facilities and tailings storage facilities at Mt Leyshon Mine are a potential source of acid rock drainage. To address this risk, the closure and rehabilitation of these areas involved installing a compacted waste rock capping layer and a layer of growth media to support vegetation growth which also mitigates the erosion risk to the finished landform. Further details of the as constructed capping layers for the waste rock storage facilities and tailings storage facilities is provided below.

The proposed cover system for the Scats Stockpile rehabilitation is described in Appendix N and comprises a bituminous geotextile membrane (BGM) liner installed on the re-profiled scats and a 0.5 m thick layer of growth media installed over the BGM liner. A capillary break layer is not expected to be required as the likelihood of the Scats Stockpile being able to support any capillary action would be very low due to the very coarse nature and uniform particle size of the scats (particle size of ~20 – 30 mm with a very low fine content).

Waste Rock Storage Facilities

The waste rock storage facilities at Mt Leyshon Mine were progressively rehabilitated during the operational phase of the mine, with cover placement commencing in 1992. The cover placed early in the mining period comprised 300 mm of compacted oxide heap leach, overlain by up to 300 mm of topsoil, in accordance with the original Environmental Management Overview Strategy.

A revised cover design was implemented from around 1995, which involved:

- Geochemical testing to confirm that the porphyry waste rock has a net acid generation type 1 (NAF) as defined for the site specific conditions.
- A porphyry waste rock capping layer with a minimum thickness of 800 mm.
- Compaction of the porphyry waste rock with a minimum compaction >98% over four adjacent test points.
- A topsoil layer with a minimum thickness of 250 mm on top of the compacted porphyry waste rock capping layer.

As a result of the changes in cover designs during the mine life and the progressive rehabilitation that was undertaken:

- The Northern Waste Rock Storage Facility (NWRSF) cover is predominantly compacted heap leach, but also includes compacted porphyry, including on the un-vegetated eastern slopes above the open pit.
- The cover on the Southern Waste Rock Storage Facility (SWRSF) is entirely compacted heap leach to a depth of 300 mm.
- The cover on the Eastern Waste Rock Storage Facility (EWRSF) comprises between 1 and 3 m of compacted porphyry, with compaction testing undertaken and geochemical testing undertaken, and zones found to be PAF removed and replaced.
- Rehabilitation of the eastern slopes of the NWRSF is incomplete due to the proximity to the pit; a compacted porphyry cover has been installed, but application of growth media and revegetation has not been completed. Final cover of this small area of the facility was not contemplated due to concerns over safe construction access. Re-vegetation works for this section of the NWRSF is included in the PRC Plan schedule.

Tailings Storage Facilities

The closure and capping strategy implemented across the tailing storage facilities has been designed to minimise the potential for water ingress and the generation of acid mine drainage and involved:

- Creating a domed surface on the facility to ensure that it would be water shedding once the mine is closed. The domed surface was constructed using a combination of tailings deposition and placement of waste rock.

- Installing a cover over the entire facility surface, designed to minimise the ingress of oxygen and water to the stored tailings.
- Vegetating the cover to prevent erosion and remove shallow infiltration by evapotranspiration.
- Constructing engineered drainage channels on the cover surface to minimise infiltration and direct surface runoff to water management structures.
- Continuing to operate the seepage interception trenches and sumps, with the intercepted impacted flows pumped into the pit void.

Implementation of the cover design at each TSF is summarised from the as-built data as follows:

- Old Northern Tailings Storage Facility (ONTSF):

– The ONTSF was in operation between 1988 and 1999 and was fully rehabilitated during the closure process.
– The ONTSF has been capped with topsoil (average thickness of 278 mm) and a heap leach seal (average thickness 755 mm with a minimum compaction of 97.1%).

- Southern Tailings Storage Facility (STSF):

– The STSF was in operation between 1995 and 2000 and was fully rehabilitated during the closure process.
– The STSF has been capped with topsoil (average thickness of 297 mm) and a heap leach seal (average thickness 615 mm with a minimum compaction of 97.1%).

- New Northern Tailings Storage Facility (NNTSF):

– The NNTSF was in operation between 1998 and 2001 and was fully rehabilitated during the closure process. The cover design for the NNTSF was modified to include an additional oxide waste rock seal layer above the heap leach seal.
– The NNTSF has been capped with topsoil (average thickness of 300 mm), an oxide seal (average thickness 1,330 mm with a minimum compaction of 95.5%) and a heap leach seal (average thickness 550 mm with a minimum compaction of 97.5%).

Water Management

Water Management Strategies

The management of surface water and groundwater management during the post-closure maintenance and monitoring period is described in detail in the Mt Leyshon Mine Water Management Plan (provided in Appendix B) and the Mt Leyshon Mine Groundwater Management Plan (provided in Appendix A).

The mine has been in the post-closure maintenance and monitoring period for almost 20 years and the water management system has undergone progressive modification and improvement in response to the surveillance and monitoring of the rehabilitated landforms and the occurrence of a wide range of climatic conditions.

Currently, the strategy for disposal of the impacted water contained within the water management system is to pump it to the lake which has formed in the pit void. Information on the pit void hydrology and water balance is provided in Section 1.5.3.

The following water management strategies are employed as components of the water management system:

- Engineered covers installed on the tailings storage facilities and waste rock dumps to minimise contact of water with waste material.
- Interception of impacted surface runoff and shallow seepage flows via a network of drains routed to water containment dams located around the perimeter of the disturbed footprint of the mine.
- Interception of seepage flows which may discharge through the containment dam embankments via seepage sumps located downstream of the water containment dams.
- Interception of shallow seepage flows caused by rainfall infiltration through the covers of the tailings storage facilities using a network of seepage sumps and trenches at the toe of these facilities.

- Disposal of impacted water intercepted by the water containment dams and seepage sumps to the residual mine void via pumping systems. Water levels in the sumps and dams are maintained at low levels using the pumping facilities to minimise seepage losses from these storages.
- Use of high flow bypass facilities to maximise the storage volumes available within the water containment dams for containment of impacted surface runoff and seepage flows. This system has been implemented at two dam sites and aims to capture the poorest quality inflows to the dams (typically seepage flows and small surface runoff flows) while allowing larger surface runoff flows (improved water quality) to bypass around the dams to the receiving environment.
- Installation of pressure sensors on the main water containment dam electric duty pumps to detect pipeline bursts/leaks and automatically switch off the pumps if this occurs. This is only required on pumped transfers where the pipeline is within a catchment that drains off-lease, and the leakage will not be captured by a containment dam or sump.
- Re-routing of water containment dam and seepage sump pipelines to within contained areas such that pipe bursts will discharge into containment storages.
- Diversion of surface runoff from rehabilitated and/or successfully covered catchment areas directly to receiving waterways.
- Drainage works to ensure that stormwater runoff from external un-impacted catchment areas outside of the mine disturbance footprint do not overflow into the water containment dams and seepage sumps.
- Use of constructed drainage channels with suitable scour protection to convey surface runoff flows from the top of the site landforms to the water containment dams and receiving waterways without causing erosion.
- Continuation of rehabilitation works to improve the cover and drainage systems on the closed mine facilities to minimise infiltration and improve surface water quality (e.g., rehabilitation of Roche Hill in 2017).
- Control of access to surface water in the mine lease and in the down-gradient properties. Newmont has purchased all pastoral holdings adjacent to the Mt Leyshon Mine.
- Control of access to groundwater in the mine lease and in the down-gradient properties and ensuring that any future changes in land use maintain these restrictions. Newmont has purchased all pastoral holdings adjacent to the Mt Leyshon Mine.
- Monitoring of water levels, flows and water quality in receiving waterways, groundwater systems and at key locations within the mine site to detect the discharge of impacted water from the mine lease area, assess the effectiveness of the water management strategies, refine and improve the design of the water management system and provide an increased understanding of the hydrological and water chemistry characteristics of the mine site and how they vary with both location and season.
- Implementation of a Receiving Environment Monitoring Program to identify any impacts from the mine on the receiving environment.
- Emergency response procedures including notifying down-gradient landholders in the event of a containment dam overtop.
- Studies to determine site specific guidelines for surface water and groundwater quality, which will allow the potential impacts associated with surface water discharge to be better understood.

Contaminants That Pose a Risk to Environmental Values

Surface water runoff and seepage flows from mine landforms and disturbed areas contain a variety of contaminants that pose a risk to environmental values including sediment, heavy metals and soluble salts. There are a number of landforms at Mt Leyshon Mine with similar characteristics in terms of geology, interaction with surface water and groundwater and original function during operations. These potential contaminant sources include:

- Tailings storage facilities.
- Waste storage facilities.
- Dams and sumps.
- Stockpile areas.
- Pit void.
- Water containment dams and seepage sumps.

A comprehensive review of the Mt Leyshon Mine surface water chemistry database for dams and sumps was used as an indicator to identify the contaminant characteristics and associated sources. A summary of the contaminant sources, flow paths and destinations are summarised in Table 1.20.

Table 1.20: Contaminant Sources and Destinations

Source	Transport Mechanisms	Potential Destinations	Key Contaminants
Tailings Storage Facilities	Seepage via infiltration through covers Surface runoff	Groundwater Final void (via seepage sumps and water containment dams) Water containment dams and seepage sumps Clarke Ck and Puddler Ck	Sulphate, Cadmium, Manganese, Copper, Zinc, Dissolved Salts, Cobalt, Uranium
Waste Rock Storage Facilities	Seepage via infiltration through covers Surface runoff	Groundwater Final void (via seepage sumps and water containment dams) Water containment dams and seepage sumps Clarke Ck, Puddler Ck, and Two Mile Creek	Low pH Sulphate, Cadmium, Manganese, Copper, Zinc, Dissolved Salts
Stockpile Areas	Seepage via infiltration Surface runoff	Groundwater Final void (via water containment dams) Water containment dams Puddler Ck	Low pH Sulphate, Cadmium, Manganese, Copper, Zinc
Scats Stockpile	Seepage via infiltration	Groundwater Final void (via Plum Tree Creek Dam) Plum Tree Creek Dam Clarke Creek	Low pH Sulphate, Copper, Cadmium, Dissolved Salts, Copper, Uranium, Zinc
Pit Void	Pumped water from water containment dams and seepage sumps Seepage from waste rock storage facilities	None (currently groundwater flow is into void)	Low pH Sulphate, Cadmium, Manganese, Copper, Zinc, Dissolved Salts, Cobalt, Uranium
Seepage Sumps	Seepage through floor of sumps Pumping to water containments dams and final void Overflows during heavy rainfall	Groundwater Final void and water containment dams Clarke Ck, Puddler Ck and Two Mile Ck	Low pH Sulphate, Cadmium, Manganese, Copper, Zinc, Dissolved Salts, Cobalt, Uranium
Water Containment Dams	Seepage through floor of dams Pumping to water final void Overflows during heavy rainfall	Groundwater Final void Clarke Ck, Puddler Ck and Two Mile Ck	Low pH Sulphate, Cadmium, Manganese, Copper, Zinc, Dissolved Salts, Cobalt, Uranium

Infiltration and Seepage Intervention and Collection Controls

Seepage collection sumps and water containment dams are located throughout the Mt Leyshon mining leases, downgradient of facilities where seepage flows occur, including:

- Tailings storage facilities.
- Waste rock storage facilities.
- Stockpile areas; and
- Water containment dams.

Pumping infrastructure is located at the seepage sumps and water containment dams and water collected in these storages is pumped to the pit void lake, either directly or via other seepage sumps and water containment dams.

Table 1.21 below outlines the infiltration and seepage intervention and collection controls for the various landforms at the Mt Leyshon Mine (the location of the infiltration and seepage collection facilities are shown on Figure 1.9). It is possible that some infiltration and seepage flows from the landforms immediately adjacent to the pit also drain directly to the pit void.

Table 1.21: Infiltration and Seepage Intervention and Collection Controls

Landform – Source of Infiltration/Seepage Flows	Infiltration/Seepage Collection Storage	Pumping Destination
Old Northern Tailings Storage Facility	Old Northern Tailings Dam West Sump	Plum Tree Creek Dam
	Old Northern Tailings Dam North Sump	Pit
	Old Northern Tailings Dam East Sump	Old Northern Tailings Dam North Sump
New Northern Tailings Storage Facility	New Northern Tailings Dam West Sump	Plum Tree Creek Dam
	New Northern Tailings Dam North Sump	Plum Tree Creek Dam
Southern Tailings Storage Facility	Southern Tailings Dam South-West Sump	Pit
	Southern Tailings Dam South-East Sump	Southern Tailings Dam South-West Sump
Eastern Waste Rock Storage Facility	Mt Hope Dam	Pit
	Mt Hope Extension Dam	Pit
	Mt Mawe Dam	Pit
Southern Waste Rock Storage Facility	Settlement Dam	Pit
	Mt Hope Dam	Pit
Stockpile Area	Settlement Dam	Pit
	Supergene Dam	Pit
Scats Stockpiles	Plum Tree Creek Dam	Pit
	Upper Plum Tree Creek Dam	Plum Tree Creek Dam (gravity flow, not pumped)
	Western Scats Sump	Upper Plum Tree Creek Dam
Settlement Dam	Settlement Dam Seepage Sump	Settlement Dam

Landform – Source of Infiltration/Seepage Flows	Infiltration/Seepage Collection Storage	Pumping Destination
Supergene Dam	Supergene Dam Seepage Sump	Supergene Dam
Mt Mawe Dam	Mt Mawe Dam Sump	Mt Mawe Dam
Plum Tree Creek Dam	Plum Tree Creek Dam Seepage Sump	Plum Tree Creek Dam
Raw Water Dam	Raw Water Dam Seepage Sump	Pit

Flow meters are installed on the pumping systems that pump to the pit void. A summary of the annual volumes of water (seepage and surface runoff) pumped to the pit dating back to the 2009/10 water year is provided in Table 1.20. Further details of the pumping systems installed at the mine are contained in the Water Management Plan (Appendix B).

Table 1.22 shows that the volumes of water pumped to the pit have been significantly smaller in the last 8 years which is partly a consequence of below average rainfall conditions, but is also attributed to other factors relating to the improved performance of the rehabilitated mine landforms including:

- Reduced seepage flows from the tailings storage facilities as a result of the drainage of pore water from the tailings during the first decade of closure.
- Improved cover performance on the rehabilitated landforms resulting in reduced infiltration of rainfall through the landform covers and seepage flows into the down-gradient seepage sumps and water containment dams.

The observed reduction in the volume of impacted water required to be pumped to the pit void is consistent with the observed filling history for the pit void lake since closure, which shows a fast rate of filling in the first decade after closure (generally characterised by above-average rainfall conditions), followed by a significant reduction in the pit lake filling rate in the second decade after closure (generally characterised by below-average rainfall conditions). Further information on the pit lake filling history and water balance is provided in Section 1.5.3.

Table 1.22: Annual Water Volumes (ML) Pumped to the Pit from Water Containment Dams and Seepage Sumps

Storage Name	1/06/2020 – 31/05/2021	1/06/2019 – 31/05/2020[4]	1/06/2018 – 31/05/2019[4]	1/06/2017 – 31/05/2018[1]	1/06/2016 – 31/05/2017[4]	1/06/2015 – 31/05/2016[1]	1/05/2014 – 30/04/2015[1]	1/05/2013- 30/04/2014[1]	1/05/2012- 30/04/2013[1]	1/05/2011- 30/04/2012[1]	1/05/2010- 30/04/2011[1]	9/04/2009- 9/04/2010[2]
Settlement Dam	10	0.6	61[1]	8	0	0	0	14	32	161	192	102
Supergene Dam	4	0	1	3	4	N/A	6	7	20	50	76	29
Mt Hope Dam	8	0	62[1]	7	7	5	0	30	54	175	159	64[3]
Mt Mawe Dam	35	91[3]	91[1]	38	26	20	19	50	100	116	169	66
Plum Tree Creek Dam	45	70[1]	90[1]	49	38	46	89	134	281	378	443	194[3]
Raw Water Dam Sump	3.5	11	14	27	24[1]	24	34	45	61	60	N/A	N/A
STD SW Sump	0.3	2	2	0	0[5]	0	10	19	61	83	N/A	0
ONTD N	9.4	23	21	35	22[5]	22	30	34	0	0	0	0
Site Total (ML)	**115**	**198**	**342**	**166**	**122**	**117**	**188**	**333**	**609**	**1,023**	**1,039**	**455[3]**
Rainfall (mm)[5]	718	499	755	673	832	498	468	621	640	816	1,256	719

[1] *Estimated total pumping*

[2] *Metered pumping only*

[3] *Metered pumping significantly lower than actual pumping*

[4] *Significant unmetered pumping occurred during this period*

[5] *AWS recorded rainfall*

Surface Water Diversions and Long-Term Management Requirements

The open cut pit is located within the footprint of the former Mt Leyshon, which was located on the topographic divide between the Clarke Creek and Puddler Creek catchments. No watercourse diversions were required to facilitate the development of the open cut pit or the waste rock storage facilities or tailings storage facilities.

The original drainage features within the footprint of the mine disturbance areas were all 1st or 2nd order drainage features that originated within the mining leases. These drainage features have been replaced with constructed drainage channels that convey water off the rehabilitated landforms and either into the water containment dams for water that is not yet suitable for release to the receiving waterways, or into the natural drainage features downgradient of the mine landforms for water that is suitable for release to the receiving waterways. There are also a number of diversion drains to convey runoff from undisturbed areas around the mine disturbance areas (e.g., clean water diversion drains from Wallaby Tail and to the west of the Scats Stockpiles).

Further information of the constructed drainage channels at the Mt Leyshon Mine are provided in Section 6.1 of the Water Management Plan (refer Appendix B). The constructed drainage channels were designed to be suitable for the final landform and have required minimal maintenance in the 20 year period since mine closure.

High flow bypass facilities are located upstream of the Settlement Dam and Mt Hope Dam. These bypass facilities allow small inflows (typically poor-quality seepage flows and small runoff events) to enter the dams, while larger catchment runoff flows (typically improved water quality) are diverted around the dams. Monitoring instrumentation is installed at these facilities to detect the quantity and quality of bypass flows. Discharges from the high flow bypass facilities are authorised in the Environmental Authority (subject to water quality criteria).

Further information of the high flow bypass facilities at the Mt Leyshon Mine are provided in Section 6.2 of the Water Management Plan (refer Appendix B). The high flow bypass structures will be removed prior to relinquishment (subject to confirmation of acceptable water quality through water quality monitoring), with the upstream flows allowed to drain through the rehabilitated dam footprints.

Dewatering Requirements

The mine has been closed since ~2002 with rehabilitation works performed on the majority of the disturbance areas. There is no requirement for dewatering to facilitate the planned future rehabilitation activities, with the exception of the water containment dams and seepage sumps which may require dewatering prior to the decommissioning and rehabilitation of these facilities. These water storages are maintained at low water levels and only minor dewatering activities are likely to be required to rehabilitate these facilities. On-going dewatering of the impacted water intercepted in these facilities to the pit void lake will still be required for a significant period of time following completion of the planned future rehabilitation works (as has occurred during the 20 year period since the mine closed).

On-Going Water Management

The mine has been closed since ~2002 and the on-going water management activities in the short to medium term will be similar to those that have been in place during the post-closure monitoring and maintenance period to date and that are described in the sections above and in more detail in the Water Management Plan (refer Appendix B). Impacted surface water runoff and shallow seepage flows will continue to be intercepted by the water containment dams and seepage sumps and pumped to the pit. Site water monitoring data indicates that the volume of impacted water required to be intercepted and pumped to the pit has been significantly smaller in the second decade after closure compared to the first decade, which is partly a result of drier weather conditions in the second decade, but also a result of the drain-down of tailings pore water in the tailings storage facilities and improved cover performance for the rehabilitated landforms.

The planned future rehabilitation works specified in the PRCP schedule are targeting reduced infiltration and seepage flows and improved water quality outcomes which are expected to progressively reduce the volume of impacted water required to be intercepted and pumped to the pit. In particular, the planned rehabilitation of the Scats Stockpile will eliminate the largest pumping contribution to the pit lake. The ultimate objective of the previous and future rehabilitation works (prior to

relinquishment) is to achieve water quality outcomes that no longer require interception and pumping of poor quality water to the pit void; however, it is expected that a long period of time will be required before these conditions can be achieved.

During the remaining period until relinquishment, water will continue to be managed in accordance with the requirements of the Environmental Authority, including monitoring activities to minimise the risk of environmental harm being caused and to assess the performance of the rehabilitation works in terms of achieving the completion criteria and stable land outcomes.

Potential for Environmental Harm to be Caused by Water Management

Big Dog Hydrogeology (2022) performed an assessment of the current and potential future impacts of surface runoff and seepage from the rehabilitated mine waste facilities at the Mt Leyshon Mine on the receiving environment (this assessment is provided in Appendix P). The key findings are summarised as follows:

- Discharge of impacted surface runoff into receiving waterways:
  - Current:
    - All of the available surface water monitoring data and Receiving Environmental Monitoring Program (REMP) assessments indicate that contaminant concentrations in receiving waterways are low during high streamflow conditions, when surface runoff is the primary contributor to streamflow. Therefore, surface runoff from the rehabilitated mine waste facilities is not currently causing environmental harm.
  - Future:
    - The covers on the rehabilitated mine waste facilities are routinely inspected, and erosion repairs and revegetation are undertaken as required. It has been concluded that surface runoff from the rehabilitated mine waste facilities is not currently causing environmental harm and there is no reason for this condition to change in the future.
- Elevated concentrations of sulphate or Cobalt in groundwater used for stock watering or cropping:
  - Current:
    - All of the properties where groundwater currently contains more than 500 mg/L of sulphate (the default sulphate limit for stock watering is 1,000 mg/L) are owned by Newmont.
    - Similarly, all of the properties where groundwater currently contains more than 0.01 mg/L of Cobalt (the default Cobalt limit for cropping is 0.05 mg/L) are owned by Newmont.
    - Newmont lease out these properties for agistment, and the agistment agreements all contain clauses which preclude the use of groundwater from within the properties. Therefore, there is currently no potential for environmental harm to occur due to stock watering or cropping.
  - Future:
    - All of the properties where groundwater is predicted to contain more than 500 mg/L of sulphate by the year 2212 (based on the base case predictions) are owned by Newmont.
    - It is not possible to accurately predict the future extent of Cobalt in groundwater as Cobalt is subject to geochemical attenuation during groundwater flow. However, it is known that there has been very little change in the extent of Cobalt in groundwater between 2012 and 2022, and it can be confidently assumed that the extent of Cobalt in groundwater will always be less than the extent of sulphate in groundwater. Therefore, all of the properties where groundwater is likely to contain more than 0.01 mg/L of sulphate by the year 2212 are owned by Newmont.
    - In the future, Newmont will continue to lease out these properties for agistment and future agistment agreements will all contain clauses which preclude the use of groundwater from within the properties. Therefore, there is no potential for environmental harm to occur due to stock watering or cropping in the future.
- Discharge of impacted groundwater into receiving waterways:

- Current:
  - The discharge of groundwater into the receiving surface water environment is a natural process currently occurring in portions of Plum Tree Creek, Clarke Creek, Schreibers Creek, Two Mile Creek and Puddler Creek. It has the potential to cause elevated sulphate concentrations in surface water.
  - Newmont engaged TropWATER (2022) to complete a detailed assessment of the potential impacts of current sulphate concentrations in surface water on aquatic ecology in the receiving environment. The assessment is provided in full in Appendix Q, while the key findings are summarised as follows:
    - Between 2010 and 2021, median sulphate concentrations during periods of low streamflow (where groundwater is the primary contributor to streamflow) in Clarke Creek, Two Mile Creek and Puddler Creek downstream of the rehabilitated mine waste facilities were in the range 217 mg/L to 646 mg/L.
    - This time period (2010 to 2022) encompasses a broad range of climatic conditions. Consequently, a broad range of groundwater discharge rates into the receiving surface water environment were experienced over this period.
    - Based on comparisons between major ion concentrations in surface water, site-specific quantitative measures of receiving environment health (SIGNAL, taxa richness, diversity, etc.) and published data on sulphate toxicity, sulphate in surface water at concentrations up to the range 545 mg/L to 1,186 mg/L would not be expected to adversely impact on aquatic ecology in the receiving surface water environment at the Mt Leyshon Mine. This is supported by site-specific AUSRIVAS band scores measured between 2013 and 2021 which show no indication of adverse impacts on the macroinvertebrate community at the Mt Leyshon Mine at sulphate conditions ranging from 7 mg/L to 1,900 mg/L.
    - Therefore, the discharge of groundwater into the receiving surface water environment is not currently causing environmental harm.
- Future:
  - Long-term future sulphate concentrations in surface water due to the discharge of groundwater into the receiving surface water environment are expected to remain within the range currently observed. Therefore, the long-term future discharge of groundwater into the receiving surface water environment is not expected to cause any environmental harm.

- Elevated concentrations of sulphate in groundwater in locations where phreatophytic vegetation is present:

- Current:
  - Phreatophytic vegetation species such as Red-Barked Bloodwood (*Corymbia erythrophloia*) and Narrow-leaved Ironbark (*Eucalyptus crebra*) trees are present in the riparian environment, in locations where groundwater sulphate concentrations exceed 500 mg/L.
  - The health of riparian vegetation is monitored as part of the REMP, and also inferred from leaf tissue and soil geochemistry tests performed each dry season.
  - The REMP monitoring and geochemistry tests have identified that fluctuating groundwater levels is the primary cause of riparian vegetation stress. The health of riparian vegetation where sulphate concentrations exceed 500 mg/L sulphate contour is not significantly different to the health of riparian vegetation where sulphate concentrations are less than 500 mg/L. Therefore, the current elevated concentrations of sulphate in groundwater due to seepage from the rehabilitated mine waste facilities is not causing harm to phreatophytic vegetation.
- Future:
  - In the future, the numerical groundwater model for the Mt Leyshon Mine predicts that peak sulphate concentrations in groundwater will be largely consistent with the currently observed sulphate concentrations.
  - Given that REMP monitoring and geochemistry tests conducted to have not identified any harm to phreatophytic vegetation as a result of current concentrations of sulphate in groundwater, no harm to phreatophytic vegetation associated with elevated sulphate concentrations in groundwater is expected to occur in the future.

It is therefore concluded that surface runoff and seepage from the rehabilitated mine waste facilities at the Mt Leyshon Mine is not currently causing any environmental harm and is not expected to cause environmental harm in the long-term future.

Revegetation

The EA condition F2-1 requires all areas disturbed by mining activities to be rehabilitated to a stable landform with a self-sustaining vegetation cover that are similar to adjoining undisturbed areas.

The majority of the mine has been rehabilitated to a grazing PMLU, with the rehabilitation ranging in age from 19 to 29 years. Comparison of the analogue sites to the rehabilitation areas in general shows that the rehabilitation areas had substantially more grass cover and substantially less shrub cover and more bare areas than the analogue sites. The composition of grass and shrubs in the rehabilitation areas is expected to trend towards the analogue sites through natural recruitment. While the higher proportion of bare areas in the rehabilitation areas will be addressed by the planned rehabilitation works as outlined in the PRCP schedule.

Revegetation Species and Seed Mixes for a Grazing PMLU

There are no requirements listed in the EA for inclusion of any key flora species, species of conservation significance or fauna habitat and/or use of analogue sites for the purpose of a PMLU of grazing.

The EA does, however, require the rehabilitated landform to have a vegetation cover and species that are similar to the adjoining undisturbed areas.

Annual monitoring of the rehabilitated areas (Stantec, 2021) is undertaken across 31 sub-domains on 11 landforms. In addition, three analogue areas are assessed for comparison to rehabilitation areas. The average of the analogue scores calculated for all the analogue sites represent a benchmark for the rehabilitation areas.

The analogue sites have been used to inform the defining characteristics (i.e., the rehabilitation objectives and rehabilitation completion criteria) for final land use domains. The analogue sites that have been selected are areas that represent the values and characteristics of the final land use.

The rehabilitation monitoring undertaken in 2020 shows that overall, most rehabilitation areas at Mt Leyshon Mine were in good condition and were supporting mature ecosystems (Stantec, 2021). A copy of the rehabilitation monitoring report can be found in Appendix D.

The surface of most rehabilitated areas at Mt Leyshon Mine was stable. This is attributed to widespread high grass cover and a high degree of rock incorporation into the surface. The majority of rehabilitation areas were covered in introduced and native grasses, with the most abundant being *Cenchrus ciliaris* (Buffel Grass). Overall, improved pasture grasses were the dominant vegetation type, with sparse woody shrubs also present across the landforms. The introduced herbaceous nitrogen-fixing legume, *Stylosanthes sp*. (e.g., Pencilflower), was the most common non-grass species and was present on the majority of landforms. Woody shrubs and trees were present on most landforms with Acacia and Eucalyptus as the dominant genera (Stantec, 2021). *Cenchrus ciliaris* (Buffel Grass) and the nitrogen-fixing legume *Stylosanthes spp*. (Seca), are also present in the analogue areas.

Buffel Grass is widespread and valued as fodder for grazing stock in Northern Queensland and across Australia. Similarly, *Stylosanthes* spp are considered valuable fodder for grazing agriculture practices. The dominance of these grass species within the rehabilitated landform is consistent with the grazing PMLU.

Erosion was not a major issue at most sites, with minimal gullies present in 2019. Most gullies were not actively expanding based on visual comparison between the 2018 and 2019 assessments (Stantec, 2021). Newmont will continue to monitor erosion areas and implement management measures and repairs, as needed.

Given the general revegetation success of the existing rehabilitation areas and consistency with surrounding land use and topographical features, Newmont is not proposing to change the rehabilitation approach or PMLU. As such, the pre-approved PMLU of grazing is expected to be achieved on all future rehabilitation areas.

The revegetation approach applied during the operating period at the Mt Leyshon Mine was:

- Topsoil placed to a minimum depth of 250 mm.
- Seed applied at a rate of 5 to 8 kg/ha of pasture grasses.
- Prior to 1999, application of fertiliser at a rate of 400 kg/ha.
- From 1999 onwards, application of fertiliser at a rate of 200 kg/ha.

Current revegetation methods involve:

- Topsoil placed to a minimum depth of 250 mm.
- Seed applied at a rate of 5 to 8 kg/ha of grasses (Seca, Rhodes, Cooch, Wynn-Cassia, Buffel). The seed mix varies depending on seed type and terrain. In general:
  - Seca is added to all mixes as it is a legume (Nitrogen fixation).
  - Buffel is applied on flat areas.
  - Wynn–Cassia is applied mainly to dryer areas and on slopes.
  - Rhodes and Cooch grasses are applied to the wetter areas.
  - Topsoil which has been stockpiled for lengthy times is seeded with Triticale (a hybrid of wheat and rye) initially to add organics and improve soil condition. Normal application and seeding of the soil is then undertaken the following season.
- Fertiliser is applied at a rate of 80 kg/ha. The seed is mixed with the fertilizer in a 12 Volt, 40 litre spreader mounted on the back of a Gator all-terrain vehicle.

Revegetation works (i.e., seeding) is preferentially undertaken during the dry season.

1.8.2 Tailings Storage Facilities

Open pit mining and ore processing operations (using a carbon in pulp plant) at the Mt Leyshon Mine resulted in the generation of tailings containing cyanide which were deposited into TSFs between 1989 and 2002.

Mt Leyshon Mine has three 20+ year old rehabilitated tailings storage facilities (TSFs) which are recognised and managed as rehabilitated landforms rather than tailings dams. The Progressive Rehabilitation and Closure Plan Guideline calls for technical specifications of the tailings characteristics, which is relevant for ensuring rehabilitation of operating TSFs is viable and will not result in failure. Due to the TSFs not being in operation for more than 20 years, and the complicated ownership history, full details of the tailings characteristics at the Mt Leyshon Mine are not available. This information is not relevant to the rehabilitation of these TSFs as they have already been rehabilitated and shown to be trending towards the PMLU objectives of safe, non-polluting, stable and self-sustaining.

Due to the complicated history of Mt Leyshon Mine there is limited information available on the original design of the TSFs, however the success and stability of the facilities since closure demonstrates that the facilities are performing adequately and do not pose an unacceptable level of risk where specific information requirements of the PRCP guideline are not able to be met. Summary details of the TSFs at the Mt Leyshon Mine are provided in Table 1.23 below.

Table 1.23: Mt Leyshon Mine TSFs Summary Details

TSF	Original Referable Dam License No.	Years of Operation	Estimated Tailings Volume Contained (ML)	Number of Construction Stages	Dam Crest Length (m)	Maximum Landform Height (m)	Landform Surface Area (ha)	TSF Design Plans
ONTSF	55012A	1988 to 1999	11,400	7	1,200	43	65	Coffey Partners International and BHP Engineering
NNTSF	57218A	1998 to 2001	14,000	4	2,700	23	109	Coffey Partners International

TSF	Original Referable Dam License No.	Years of Operation	Estimated Tailings Volume Contained (ML)	Number of Construction Stages	Dam Crest Length (m)	Maximum Landform Height (m)	Landform Surface Area (ha)	TSF Design Plans
STSF	54965AA	1995 to 2000	6,600	7	2,800	36	62	Coffey Partners International and BHP Engineering

Old Northern Tailings Storage Facility (ONTSF)

The ONTSF was constructed as a conventional on-land unlined impoundment. Natural terrain below the ONTSF predominantly slopes north-west towards Plum Tree Creek and the highest embankment was constructed along the north-west boundary, with a total slope height of around 40m. The ONTSF was constructed using an initial 21 m embankment comprising a zoned earth and rockfill structure with a core of spent heap leach material. Subsequent lifts of the embankment were 2 to 5 m in height and were constructed by a combination of downstream and upstream raises utilising heap leach and rockfill material (Engeny Water Management, 2021).

The ONTSF was operated from 1988 to 1999 and has been rehabilitated as a free draining landform (Engeny Water Management, 2021). Future rehabilitation improvement works planned for the ONTSF (refer PRC plan schedule) comprise:

- Drainage works to divert surface runoff from the eastern side of the top surface of the ONTSF to Schreibers Creek (i.e., bypassing the Raw Water Dam which is the current drainage destination).
- Revegetation works on the embankment batters of the ONTSF.

New Northern Tailings Storage Facility (NNTSF)

The NNTSF was constructed to the north of the ONTSF as an on-land unlined impoundment utilising the same natural topography as the ONTSF. The resulting embankment was highest on the northern margins, reaching a total slope height of approximately 25m. The starter embankment was an engineered earth and rockfill structure, with subsequent smaller upstream lifts being completed using locally sourced materials such as compacted heap leach and waste rock fill (Engeny Water Management, 2021).

The NTSF was operated from 1998 to 2001 and has been rehabilitated as a free draining landform (Engeny Water Management, 2021). Future rehabilitation improvement works planned for the NNTSF (refer PRC plan schedule) comprise:

- Revegetation works on the top surface and embankment batters of the NNTSF.

Southern Tailings Storage Facility (STSF)

The STSF was constructed as a conventional on-land unlined impoundment, using the naturally sloping topography to the south of the Southern Waste Rock Storage Facility. The highest embankment occurs on the southern margin of the facility with an overall slope height of approximately 35m in this location. The starter embankment was an engineered structure and subsequent smaller lifts were constructed using upstream raise methods (Engeny Water Management, 2021).

The STSF operated from 1995 to 2000 and has been rehabilitated as a free draining landform (Engeny Water Management, 2021). Future rehabilitation improvement works planned for the STSF (refer PRC plan schedule) comprise:

- Drainage works to divert surface runoff from the eastern side of the top surface of the STSF to the receiving environment (i.e., bypassing the Mt Hope Dam which is the current drainage destination).
- Revegetation works on the embankment batters at the north-western corner of the STSF.

Seepage Sumps

Seepage interception trenches were installed along the downgradient perimeters of the ONTSF and NNTSF between 1989 and 1995. Coarse rock was used to backfill the trenches and were covered to reduce the amount of surface water ingress. The seepage and groundwater which reported to the trenches is directed to sumps with pumps installed to transfer the impacted water back to the operational mine water management system and ultimately to the pit void lake. Seepage interception sumps were also installed down-gradient of the STSF (Newmont Australia, 2017).

Further information can be found in Appendix H.

Tailings Characterization

Tailings at the Mt Leyshon Mine were ground relatively fine (140 µm) and were known to contain sulphides. The risk of Acid Rock Drainage (ARD) generation was identified in the mine design and operating phases. In 1999, EGI reported results from tailings characterisation carried out on samples collected in 1997 from the ONTSF and STSF. Two bulk samples from each tailings storage facility were assessed along with 11 samples from a transect across the ONTSF. From the transect, the coarser fractions from the pond perimeter (beach) had the highest total sulphur (average 6.6%), the highest net acid production potential (NAPP of 180 kg H_2SO_4/t), and the highest net acid generation potential (NAG of 31 kg H_2SO_4/t). In contrast, the fine tailings from the decant pond area had the lowest sulphur (average 1.8%), the lowest NAPP (3 kg H_2SO_4/t), and a NAG of zero (0 kg H_2SO_4/t). The static test work presented (EGI, 1999) indicated that the bulk of the tailings material would be likely to be ARD generating.

Static test work determines the net balance between the components present which may potentially produce acid and the components present which may neutralise acid. The actual behaviour of the tailings in practice will be a function of how accessible each of these components are to oxidation and leaching, and whether all potential reactions extend to completion. The actual elements which would be released to the environment are not identified from static testwork.

Kinetic laboratory testwork simulates accelerated leaching of the materials, by exposing them to sequential oxidising and flushing cycles. The leachate generated during kinetic testwork is indicative of the amount of acid production which is likely to be observed in practice, and the elements which are likely to be present at elevated concentrations.

Two tailings samples were selected for use in column tests (kinetic testwork), one classified from the static testwork as Non-Acid Forming (NAF) and the other as Potentially Acid Forming (PAF). The NAF sample test continued for 140 weeks, and the pH remained around or above pH 7 for the duration of the test. The test estimated that Acid Neutralising Capacity (ANC) in the material would be consumed by around week 250, following which there was uncertainty as to whether acid conditions would develop. The leachate sulphate concentration in week 140 was 1,848 mg/L. In the final week where a range of trace metals were analysed (week 60), concentrations of 0.03 mg/L Cd, 1.16 mg/L Cu, 0.6 mg/L Fe, 6.4 mg/L Mn and 8.4 mg/L Zn were recorded, along with 1,558 mg/L sulphate. The PAF tailings column was operated for 80 weeks, and the final leachate was pH 2.6. Multi-element data for leachate are available up to week 60, at which time the leachate was pH 3.4 with 2,576 mg/L sulphate, 22 mg/L Al, 0.9 mg/L Cd, 25 mg/L Cu, 10 mg/L Fe, 130 mg/L Mn and 220 mg/L Zn.

In combination, the static and kinetic testwork indicated that the tailings would produce acid, along with elevated concentrations of sulphate, Cd, Cu, Mn and Zn, if exposed to ongoing oxidation and flushing, although the testwork indicated that there would be a lag period prior to the onset of acid generation, which was estimated to be at least 6 months and possibly more than 3-5 years, assuming exposure to surficial oxidation. A key component of the closure strategy for the tailings facilities was therefore to minimise oxidation and flushing of the stored tailings.

Further information can be found in Appendix H.

Tailings Condition Assessment

In response to recent international tailings dam failures and the extended period of time since the rehabilitated above-ground TSF landforms were inspected by a geotechnical engineer, Newmont commissioned a geotechnical audit of the rehabilitated TSF landforms at the Mt Leyshon Mine in 2019.

The geotechnical audit of the TSFs was performed by Engeny Water Management (2019) and comprised:

- Desktop identification of areas of the TSF landforms with potential landform erosion / stability or poor surface water drainage issues.
- Visual inspection of the TSF landforms (including photographs).
- Condition assessment.
- Review of piezometer monitoring data.
- Recommended actions to address identified issues including a framework for ongoing surveillance inspections of the TSF landforms.

The visual inspection of the TSF landforms was focussed on dam safety aspects critical to the retention function (integrity) of the facilities. The inspections included visual inspections of the condition of the following components:

- Dam crest.
- Downstream embankment slopes.
- Downstream embankment toes.
- Abutments.
- Drainage channels adjacent to the crest, abutments and along downstream embankment toe.
- Downstream seepage sumps.

The rehabilitated above-ground TSF landforms were observed to be generally in good condition at the time of the inspections. There were no observable signs of embankment instability. The identified embankment defects consisted of localised erosion only which is consistent with what would be expected for facilities rehabilitated approximately 15 to 20 years ago with relatively steep batter slopes.

The audit included a visual inspection of the previous slope failure (fault zone) of the northern pit wall which occurred in January 2009 and has extended into the southern end of the ONTSF impoundment. An assessment undertaken at the completion of mining determined that failure of the northern pit wall (West Mine Fault) was inevitable, but it was predicted that failure would not encroach further than 70 m from the pit rim. The existing extent of the slope failure surface is similar to what was predicted.

No exposed tailings were observed as a result of the slope failure and associated surface settlement. Cracking was observed on the capped TSF surface as far north as the existing overhead powerline alignment across the southern side of the ONTSF.

The 2019 TSF audit recommended monitoring and/or repairs to erosion and drainage problem areas which were all assigned as low priority actions due to the generally minor and localised nature of these defects. These actions are consistent with rehabilitation scheduling as part of the PRCP. The audit also recommended the following actions for the northern pit wall slope failure (which have since been implemented by Newmont):

- Installation of an array of survey monuments (deep star pickets or similar) on the rehabilitated ONTSF impoundment surface to allow for monitoring of any movement of the slip surface. Commence annual monitoring of the installed survey monuments.
- Install a hard barrier (e.g., bund) to prevent vehicle access to the pit slope failure area. Newmont has decided to install a fence as a temporary measure to exclude access to the pit slope failure area. An earth fill exclusion bund will ultimately be installed around the northern pit wall slope failure area, and this is included as a planned improvement measure for the pit void NUMA in the PRCP plan schedule.

Further information can be found in Appendix H.

Closure Spillways

The decommissioned TSFs have a domed, free-draining top surface that drains via rock-lined open drainage channels to water management structures (closure spillways) that convey the stormwater flows from the top surface of the TSF to natural ground level at the base of the TSFs. The closure spillways on the TSFs are as follows:

- ONTSF: Excavated channel on the southern edge of the ONTSF where the top surface of the TSF intersects with the natural ground surface. This channel spillway drains the entire top surface of the TSF.
- NNTSF:
  - Rock chute down embankment batter slope on western side of NNTSF (drains western half of top surface of TSF).
  - Rock chute down embankment batter slope on eastern side of NNTSF (drains eastern half of top surface of TSF).
- STSF:
  - Rock chute down embankment batter slope at north-western corner of STSF (drains western half of top surface of TSF).
  - Rock chute down embankment batter slope at north-eastern corner of STSF (drains eastern half of top surface of TSF).

The design basis for the closure spillways at the downstream ends of the drainage channels on the top surfaces of the TSFs is not known.

A hydraulic assessment of the flow capacity of these spillway structures was undertaken using a two-dimensional hydraulic modelling approach. The hydraulic assessment was performed using the TUFLOW software (Direct Rainfall modelling approach) and simulated the generation and conveyance of stormwater flows from large rainfall events falling on the top surface of the TSFs. The 1:1,000 Annual Exceedance Probability (AEP) design rainfall event was adopted for the hydraulic assessment of the spillway capacities in line with the ANCOLD Guidelines on Tailings Dams (ANCOLD, 2012) which recommends 1,000 years as a notional design life for a closed TSF.

The hydraulic modelling of the 1:1,000 AEP design flood event for the TSFs used the latest ARR19 design rainfall intensities obtained from the Bureau of Meteorology. Design storm durations from 30 minutes to 3 hours were simulated which is expected to cover the range of critical storm durations for the top surface catchment area of the TSFs. Conservatively low rainfall losses of 0 mm initial loss and 1 mm/hr continuing loss were adopted for the flood models.

The modelled maximum flood extents (i.e., maximum of all storm durations simulated) for the 1:1,000 AEP flood event are shown in the following figures:

- Figure 1.60 and Figure 1.61: ONTSF and ONSTSF spillway.
- Figure 1.62 to Figure 1.64: NNTSF and NNTSF spillways.
- Figure 1.65 to Figure 1.67: STSF and STSF spillways.

The flood modelling results indicate that all TSF closure spillways are adequately sized to convey the 1:1,000 AEP peak flood discharges from the top surfaces of the TSFs.

Figure 1.60: 1:1,000 AEP Peak Flood Extent for ONTSF

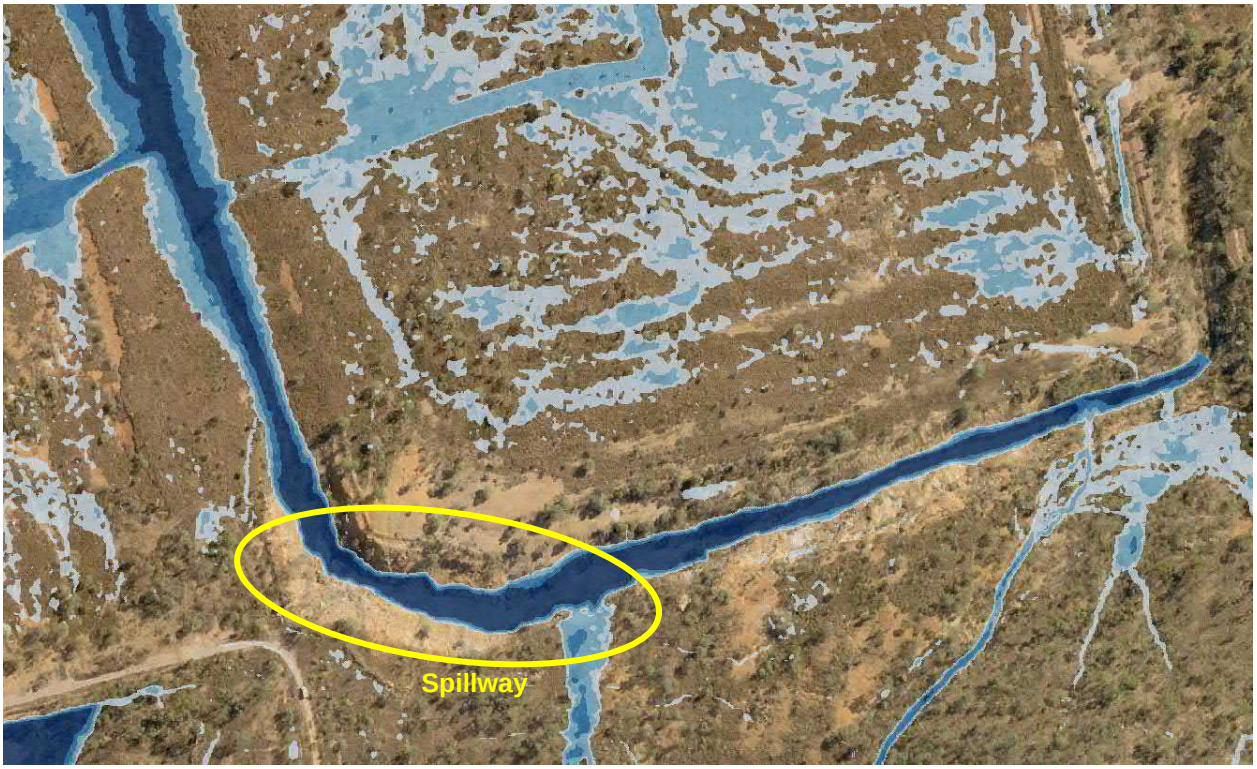


Figure 1.61: 1:1,000 AEP Peak Flood Extent for ONTSF Spillway Channel

Figure 1.62: 1:1,000 AEP Peak Flood Extent for NNTSF

Figure 1.63: 1:1,000 AEP Peak Flood Extent for Spillway at Western Side of NNTSF

Figure 1.64: 1:1,000 AEP Peak Flood Extent for Spillway at Eastern Side of NNTSF

Figure 1.65: 1:1,000 AEP Peak Flood Extent for STSF

Figure 1.66: 1:1,000 AEP Peak Flood Extent for Spillway at North-Western Corner of STSF

Figure 1.67: 1:1,000 AEP Peak Flood Extent for Spillway at North-Eastern Corner of STSF

The closure spillways have been in place since 2002 and have been stable during the 20 year period since closure. This period included a large rainfall event in January 2008 resulting from an extensive low pressure system associated with ex-Tropical Cyclone Helen. Approximately 160 mm of rainfall occurred in a 6 hour period during the January 2008 rainfall event which exceeded the 1:100 AEP design rainfall total for this rainfall duration. The adequacy of the TSF closure spillways was demonstrated by their ability to convey the flood flows from the large January 2008 rainfall event (greater than 1:100 AEP rainfall event) without any significant erosional damage to the spillways. Photos of the current configuration and condition of the TSF closure spillways are provided in Figure 1.68 (ONTSF Western Spillway), Figure 1.69 (ONTSF Eastern Spillway), Figure 1.70 (NNTSF Southern Spillway), Figure 1.71 (STSF North-Western Spillway) and Figure 1.72 (STSF North-Eastern Spillway).

Figure 1.68: ONTSF Closure Spillway – Western Side of Landform

Figure 1.69: ONTSF Closure Spillway – Eastern Side of Landform

Figure 1.70: NNTSF Closure Spillway – Southern Side of Landform

Figure 1.71: STSF Closure Spillway – North-Western Corner of Landform

Figure 1.72: STSF Closure Spillway – North-Eastern Corner of Landform

1.8.3 Voids

Overview

The final void at the Mt Leyshon Mine has been in closure since 2002 and is described in the Final Void Decommissioning and Closure Strategy (Appendix I). Mt Leyshon's EA provides for the presence of a void (Schedule A Table 1, and Conditions F91-4). The final void limits were developed during the final years of open cut mining, between 1999 and 2001 and considered options available for minimising final void area and volume as presented in regular updates to the Final Void Decommissioning Strategy as part of Plan of Operations submissions. Monitoring data collected during the closure period has been used to update the strategy, the most recent update taking place in 2018 (Newmont, 2018).

Key aspects of the final void decommissioning and closure strategy, which are described in more detail in the subsequent sections, include:

- Tailings generated during low grade stockpile processing between early 2001 and March 2002 were deposited in the final void. Similarly, contaminated soil and residual mineralised material uncovered during rehabilitation of the surrounding waste rock storage facilities and tailings storage facilities were deposited in the final void. A range of options were considered for the long-term storage of these materials; the final void was found to be the option with the lowest risk and also contributed to minimising the final void volume.
- Currently, seepage and some runoff from the surrounding rehabilitated waste rock storage facilities, tailings storage facilities and stockpile areas is impacted by Acid Rock Drainage (ARD). ARD-impacted seepage and runoff is collected in dams and sumps down-gradient of the mine landforms and pumped into the final void for long-term storage.
- Runoff from adjacent waste rock storage facilities and tailings storage facilities which are situated up-gradient of the final void, has been diverted away from the final void in order to minimise direct inflows to the final void.
- Currently, access to the final void is restricted through a combination of:
  - Fencing around the mining lease boundary.
  - A restricted access/safety bund around the final void itself.

Design Plan and Final Dimensions of the Void

The Mt Leyshon Mine is in an 'as constructed' landform therefore a three dimensional void design is not available and is not considered to present an unacceptable level of risk in terms of meeting the PRCP Guideline's requirements. Localised instability of the pit slopes was observed during mining, with failures predominantly occurring in the wet season as a result of surface water infiltration and pore pressure build up in the slopes near structural features. The mine managed this by (Newmont, 2018):

- Designing pit slope angles in the strongest lithologies (breccia) in the range of 40 to 50 degrees.
- Reducing the slope angle to 35 degrees in the lower strength units (the north pit, the mine fault and in porphyry exposures).
- Installing horizontal drains to reduce pore pressures in the pit slopes.
- Applying shotcreting, meshing and cable bolting in some areas.

A contour plan showing the current geometry of the pit walls and tailings deposition surface in the pit floor is provided in Figure 1.73 and is based on a bathymetry survey of the pit lake that was undertaken in May 2019 and LiDAR survey of the exposed pit walls that was captured in 2010. The final dimensions of the pit void are as follows:

- Length of void: 1,175 m.
- Width of void: 810 m.
- Depth of void (to tailings surface in floor of pit): 213 m.
- Tailings surface level in pit floor: 165.5 m AHD.
- Original pit floor level (prior to in-pit tailings deposition): 30 m AHD (approximate).
- Pit rim level: 378.5 m AHD.
- Storage capacity to pit rim level: 63 GL.

The direct catchment area reporting to the pit is 88 ha (Figure 1.74) and comprises primarily the area within the pit rim (68 ha inclusive of the pit lake area which is currently 25 ha) in addition to a small external area (20 ha) that drains off the western and southern sides of Mt Mawe.

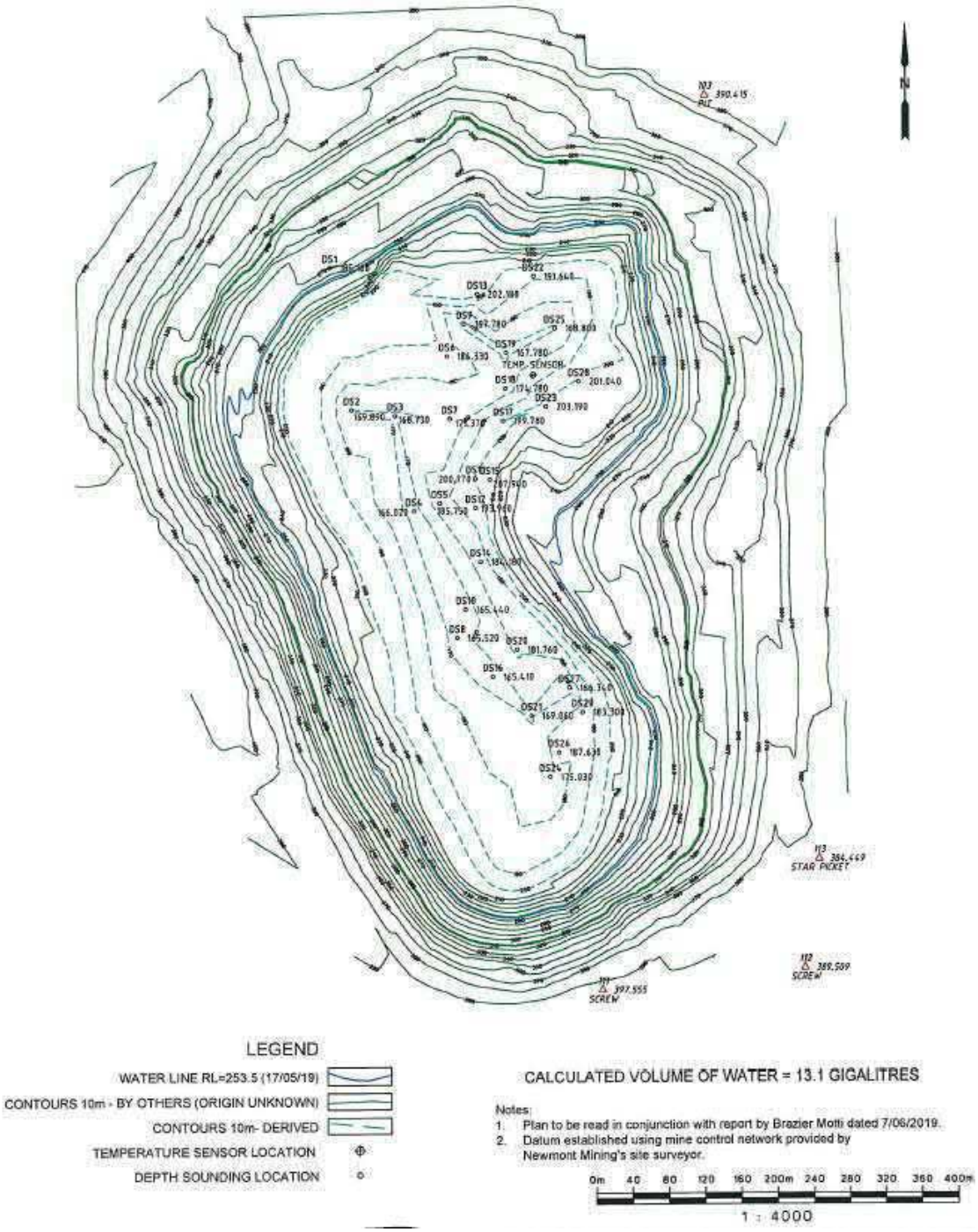


Figure 1.73: Pit Void Landform Geometry

Figure 1.74: Pit Void Catchment Area

The storage characteristics of the final void are illustrated in Figure 1.75. The storage capacity of the pit void to the pit rim level is approximately 63 GL. The current pit lake level is 253 m AHD and there is approximately 13 GL of water in the pit lake.

Limited options exist for minimising the surface area and volume of the final void, as mining has been completed and the mine has been in closure since 2002. The nominated surface area for the final void NUMA (70.4 ha, as shown in Figure 1.23) is compliant with condition Schedule A – Table 1 (Authorised Mining Activities) in the EA.

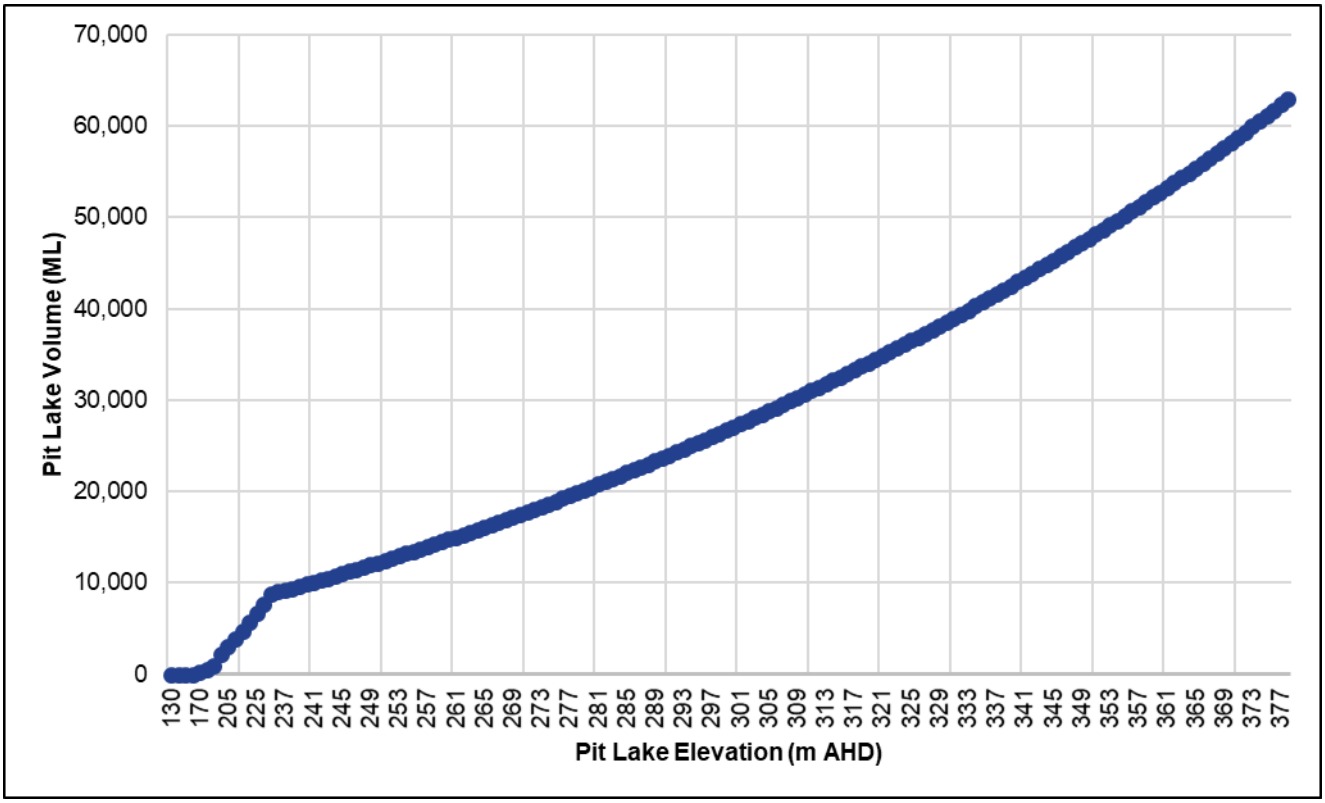


Figure 1.75: Pit Void Storage Characteristics

Geotechnical Stability

The long-term risk of failure of the final void wall was assessed at the completion of mining (Weekes, 2000). The assessment is summarised in Table 1.24. For each potential area of instability, the orientation of the controlling structural features was used to predict the maximum distance behind the pit crest that would be affected if failure were to occur. This information was then used to define the position of the restricted access/safety bund, such that the impacts of potential failures would be confined to the area within the restricted access/safety bund.

The assessment determined that the most significant risk of final void wall failure is associated with the Mine Fault in the northern wall of the final void.

Table 1.24: Assessment of the Long-Term Risk of Final Void Wall Failures (Weekes, 2000)

Potential Area of Instability	Controlling Structural Features	Predicted Mode of Failure	Likelihood of Failure
Northeast Porphyry	Wedge formed by continuous joints 67/320 and 78/224; also 56/344 and 60/230. Both sets of joints are known to form wedges in the upper porphyry benches.	Bench scale wedge failures	High
East Wall Buttress and Mt Mawe	Main structure unknown. Complex movement on a series of joints, some of which form visible wedges, at the leading edges in the northeast and southeast parts of the east wall.	Assumed to be confined failure associated with a low angle fault.	Moderate for overall failure; High for loss of pit crest at leading edges

Potential Area of Instability	Controlling Structural Features	Predicted Mode of Failure	Likelihood of Failure
Southeast Wall	Continuous joints oriented at 45/250 occur abundantly above RL180.	Plane sliding on these joints over lengths exceeding 30m will result in bench scale failures above 180 RL. These are unable to project through to the pit crest however.	High, but will not affect crest of pit.
Southwest and West Wall	Nil	Nil; Possible ravelling at crest.	N/A
Northwest Wall	Fault oriented 40/230, shears 68/089, and joints on 60/225. Also examined potential wedge formed by 46/176 and 62/118.	Topple failure on sub-vertical northeast trending shears is likely, however these will not affect the pit crest.	Inevitable failure but confined to pit
North Wall and Mine Fault	The Mine Fault (55/255) has been a dominant control on the behaviour of this wall. Other important structures include the sub vertical northeast trending shears mentioned above and shallow continuous southeast dipping joints.	Failure will occur with plane sliding on the Mine Fault footwall and circular failure of fault gouge in the hanging wall. Wedges formed by the Mine Fault and continuous joints are also possible in the upper parts of the wall.	Wall will ultimately fail: Short-term failure confined to saturated lower wall; longer term encroachment on pit crest for a distance up to 70m.

The predicted slip failure of the north pit wall along the Mine Fault occurred in January 2009 and extended into the southern side of the ONTSF impoundment (refer Figure 1.76). No tailings were exposed as a result of the slope failure and associated surface subsidence. The extent of the north wall slip failure surface is very similar to what was originally predicted.

Survey monuments have been installed on the southern edge of the ONTSF approximately 50 m away from the northern-most edge of the existing slip surface. These monuments are surveyed annually to detect any ongoing movement of the slip surface. Fencing has also been installed as a temporary measure to exclude access to the pit north wall slip failure area.

Figure 1.76: Slip Failure of Pit Void North Wall

Geochemical Stability

The slopes of the Mt Leyshon pit which are exposed above the current lake elevation at 253 mAHD comprise:

- Small amounts of PAF oxide.
- Small amounts of NAF oxide.
- Small amounts of NAF porphyry bedrock.
- Unweathered bedrock with sufficient sulphide content to be classified as PAF.
- Unweathered bedrock which does not contain sulphides and is classified as NAF.

There are no pit slope geological mapping data or block model data available to define the relative contribution of each of these units to the exposed pit slopes, and hence to predict the resulting geochemical stability. The current water management practices of transferring site water to the void are a significant influence on the void lake due to water quality and planned duration of this activity.

The influence of geochemical leaching of the pit slopes on water quality in the final void can be assessed by comparing samples of pit slope runoff with recent samples of the pit lake. In the final stages of open pit mining in 1998 and 1999, samples were collected from the sump at the base of the operating pit. As dewatering bores were operating at this time to intercept most groundwater inflow, samples collected from the pit sump in the wet season can be assumed to reflect pit slope runoff. The rocks in the pit slopes had been exposed to oxidation for up to 10 years at the time of sampling and the runoff samples therefore provide an indication of the composite leaching influences of the pit slopes.

Samples collected from the pit sump in December 1998 and November 1999 are compared against samples of the developing pit lake collected in late 2016 (table 1.25). Pit wall runoff is indicated to have a pH slightly below neutral, along with elevated concentrations of sulphate and some metals, consistent with the influence of geochemically active PAF rocks exposed in some portions of the pit slopes. However, comparison with the most recent pit lake samples collected in 2016 indicates that the lake has a much lower pH and contains metals concentrations which are higher by an order of magnitude. Samples collected in 2016 also include the influence of dumped, fine grained, mineralised Scats Stockpile material which was known to be ARD generating. This reflects that the geochemical leaching of the pit slopes which accounts for less than 10% of pit inflows is a small influence on the pit lake hydrochemistry, compared to the mine influenced water being pumped to the lake from the water containment dams and seepage sumps.

Table 1.25: Geochemical and Pit Inflow Water Quality Comparison^#

Sample	PIT - FLOOR SUMP	PIT - FLOOR SUMP	Southern drone sample (PL1)	Middle drone sample (PL2)	Northern drone sample (PL3)
Analyte (mg/L)^	15-Dec-98	25-Nov-99	16-Nov-16	22-Nov-16	16-Nov-16
pH (pH units)	6.73	6.61	4.42	4.28	4.41
EC (uS/cm)	3210	4940	9220	9370	9310
TDS	NT	NT	NT	11700	NT
OH	NT	NT	<1	<1	<1
CO_3	NT	NT	<1	<1	<1
HCO_3	NT	NT	<1	<1	<1
Total Alkalinity	NT	NT	<1	<1	<1
NTNTCl	NT	NT	102	103	104
SO_4	1480	3070	7840	7160	5960

Sample	PIT - FLOOR SUMP	PIT - FLOOR SUMP	Southern drone sample (PL1)	Middle drone sample (PL2)	Northern drone sample (PL3)
Calcium	NT	NT	347	612	528
Magnesium	134	276	NT	1310	NT
Sodium	NT	NT	NT	428	NT
Potassium	NT	NT	NT	43	NT
Calcium	347	612	NT	528	NT
Aluminium	NT	NT	55.1	53.2	53.1
Arsenic	0.001	<0.001	0.006	0.006	0.007
Barium	NT	NT	0.016	0.014	0.015
Cadmium	0.05	0.148	0.652	0.659	0.661
Chromium	NT	NT	<0.001	<0.001	<0.001
Cobalt	NT	NT	2.07	2.11	2.11
Copper	0.02	0.03	7.84	7.94	8.1
Lead	0.076	0.129	0.083	2.02	0.092
Manganese	31	55.1	370	378	382
Selenium	NT	NT	<0.01	<0.01	<0.01
Strontium	NT	NT	2.28	2.32	2.36
Uranium	NT	NT	0.075	0.072	0.073
Zinc	8.37	16.9	120	122	124
Iron	NT	NT	0.5	0.46	0.47
Mercury	<0.0005	<0.0005	NT	NT	NT

NT: Not tested

^: mg/L unless otherwise specified

#Total metals only

Groundwater

The groundwater systems present at the Mt Leyshon Mine are described in Section 1.1.2 of this document. Comprehensive groundwater assessments completed during closure (Schlumberger Water Services, 2012) have identified the following pit lake elevations at which adjacent groundwater systems may be impacted by the final void:

- RL 295 m AHD - localised deep fracture zone.
- RL 350 m AHD - deep basement groundwater system.
- RL 365 m AHD - regional shallow groundwater system.

A closure objective for the final void is that the pit lake acts as a groundwater sink to the adjacent groundwater systems. Therefore, in closure, pit lake elevation will be managed such that it remains below 340 mRL. This is above the level at which there is a potential to interact with the discrete localised deep fracture zone (contained locally), but below the level at which

interaction with the broader deep basement groundwater system and receiving environment would occur and well below the elevation at which the final void would overtop (378.5 m AHD).

A schematic hydrogeological cross section through the pit void is shown in Figure 1.26.

Void Hydrology and Water Balance

The pit lake has been filling since the mine closed in 2002 and the pit dewatering ceased. The pit lake filling history since mine closure is shown in Figure 1.77 and Table 1.26. The pit lake filling history can be characterised by:

- A fast rate of filling (net positive water balance) during the first decade after closure. This period generally corresponded to above-average rainfall conditions.
- A significantly slower rate of filling (close to neutral water balance) during the second decade after closure. This period generally corresponded to below-average rainfall conditions.

The significant decrease in the pit lake filling rate in the second decade after mine closure is a result of the lower rainfall conditions experienced during this period, but is also attributed to other factors relating to the improved performance of the rehabilitated mine landforms including:

- Reduced seepage flows from the tailings storage facilities as a result of the drainage of pore water from the tailings during the first decade of closure.
- Improved cover performance on the rehabilitated landforms resulting in reduced infiltration of rainfall through the landform covers and seepage flows into the down-gradient seepage sumps and water containment dams.

The pit void hydrology is influenced primarily by climatic conditions (rainfall and evaporation). Individual inflows and outflows for the pit void lake are as follows:

- Inflows:
  - Direct rainfall on pit lake area.
  - Surface runoff from the exposed pit walls above the pit lake level and the external catchment area above the pit rim.
  - Pumped inflows from water containment dams and seepage sumps.
  - Groundwater inflows to the pit lake.
- Outflows:
  - Evaporation from the pit lake area.

Reconciliations of the pit lake water balance, including estimation of individual inflow and outflow volumes, have been performed on an annual basis since 2011 as part of annual reviews of wet season monitoring data. The pit lake inflows and outflows have been estimated as follows:

- Direct rainfall on pit lake area: Calculated using rainfall monitoring data from the site weather station and the known storage characteristics for the pit lake.
- Surface runoff from the pit walls above the pit lake level and the external catchment area above the pit rim: Calculated using rainfall monitoring data from the site weather station and a daily rainfall runoff model for the exposed pit walls and external catchment.
- Pumped inflows from water containment dams and seepage sumps: Obtained directly from flow metering data for pumps that transfer water to the pit.
- Groundwater inflows to the pit lake: Calculated using empirical groundwater inflow relationships inferred from previous pit lake water balance reconciliations (Figure 1.78). It is noted that the groundwater inflow rates have been correlated against running 2 year duration rainfall totals, with the inferred inflows being primarily rainfall driven, suggesting an inflow pathway of seepage from the shallow groundwater system.
- Evaporation from the pit lake area: Calculated using Silo Data Drill lake evaporation data and the known storage characteristics for the pit lake.

Table 1.26: Pit Lake Filling History since Mine Closure

Date	Pit Lake Level (m AHD)	Pit Lake Volume (ML)	Rainfall During Period (mm)	Pit Lake Filling Rate	
				(m rise per 1000 mm rain)	(ML rise per 1000 mm rain)
2002 (month N/A)	165.00	0			
09 Sep 2005	197.15	1,826	1,660	19.4	
09 Jun 2007	200.00	2,267	1,139	2.5	387
14 Apr 2008	218.00	5,348	1,108	16.3	2,781
1 Mar 2009	229.00	7,518	862	12.8	2,518
19 Apr 2010	236.27	9,053	736	9.9	2,085
1 May 2011	243.77	10,727	1,258	6.0	1,331
28 June 2012	249.80	12,173	816	7.4	1,772
31 May 2013	251.68	12,638	640	2.9	726
30 April 2014	252.58	12,863	622	1.5	361
30 April 2015	252.31	12,795	468	-0.6	-144
19 June 2015	252.19	12,765	-	-	
15 June 2016	251.98	12,713	498	-0.4	-105
12 April 2017	252.00	12,718	832	0.02	6
21 June 2018	252.27	12,785	673	0.4	100
21 May 2019	253.40	13,069	755	1.5	375
03 July 2020	252.78	12,913	499	-1.2	-312
24 May 2021	252.90	12,943	718	0.2	42

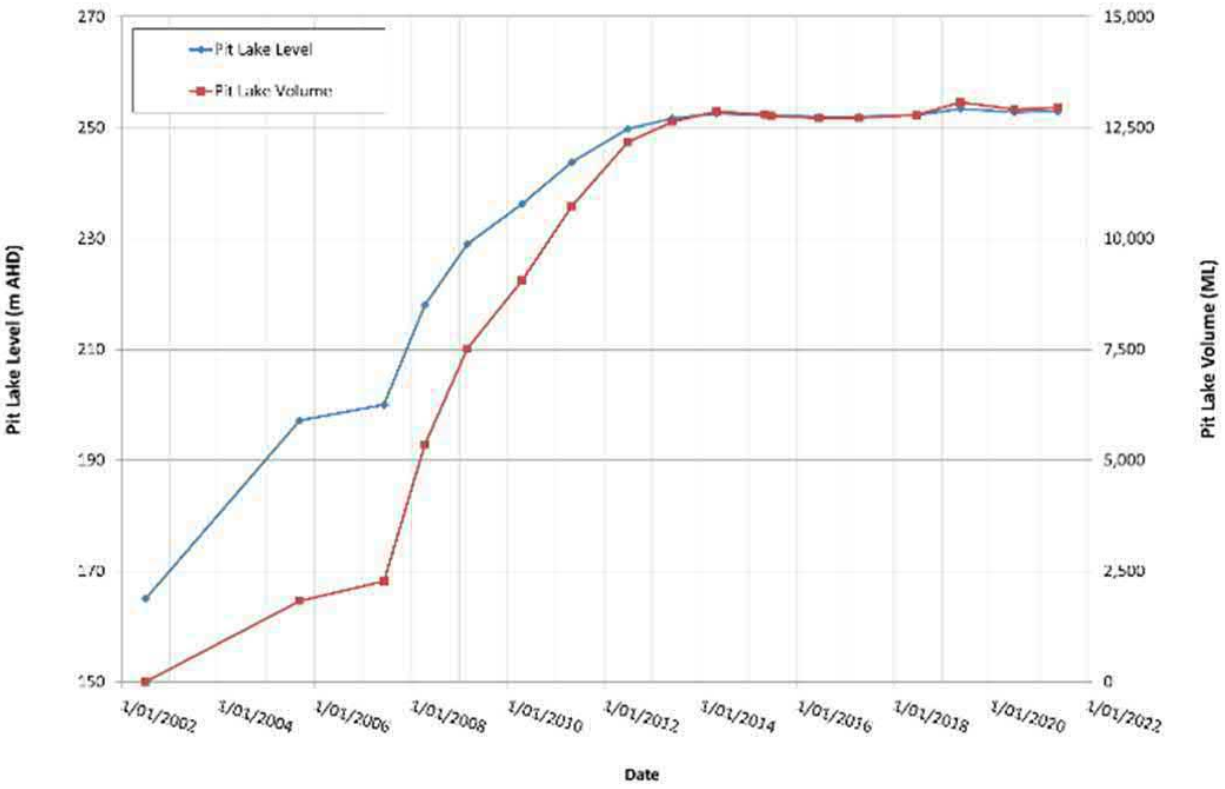


Figure 1.77: Pit Lake Rise Since Mine Closure

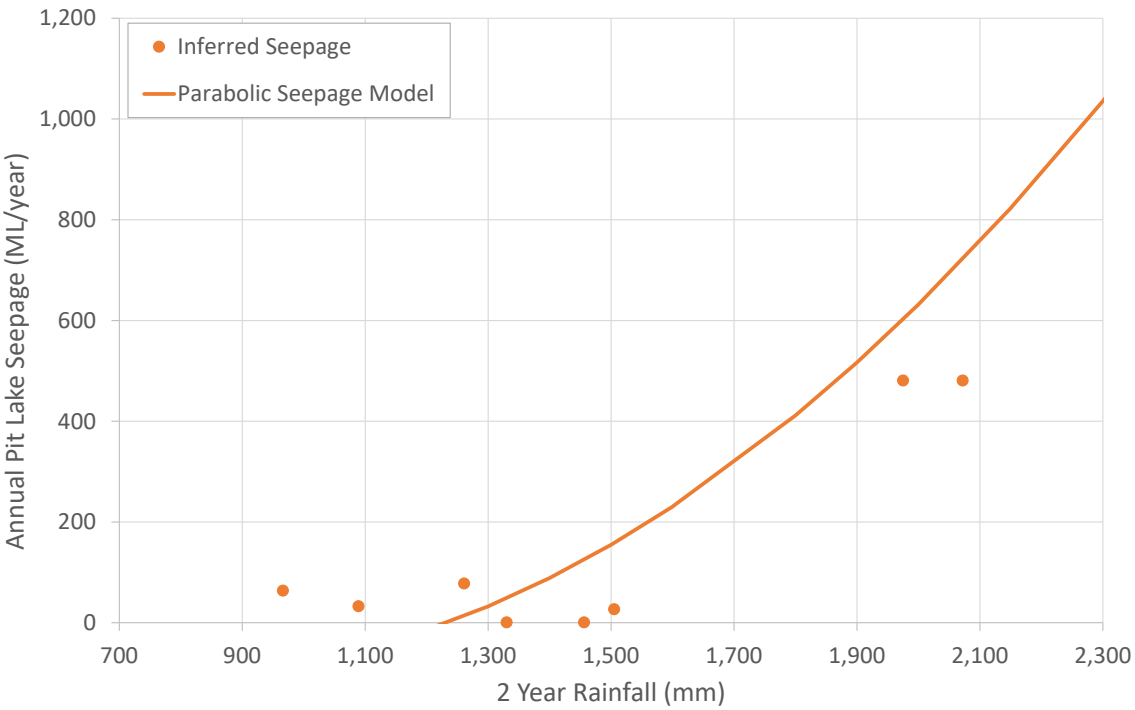


Figure 1.78: Inferred Groundwater Inflows to the Pit Lake

The annual pit lake reconciliations for a wet year in the first decade after closure and a dry year in the second decade after closure are compared in Table 1.27. This comparison demonstrates that pumped inflows to the pit (i.e. water intercepted in the dams and sumps) were by far the dominant influence on the higher pit lake filling rates during the first decade after closure (above-average rainfall), while the pumping to the pit (although still the largest inflow) was more comparable to other inflows during the second decade after closure (above-average rainfall).The annual wet season reviews and reconciliations of the pit lake water balance have highlighted that the volumes of water intercepted in the dams and sumps (primarily seepage flows) and the overall pit lake balance respond to consecutive years of either above or below average climate conditions to a greater degree than a single wet or dry year.

The large variations in pit lake filling rates experienced since closure make it difficult to forecast the future filling behaviour of the pit lake. Further monitoring of the pit lake filling behaviour (and site water management system performance) under consecutive above-average rainfall years (these conditions have not occurred for approximately 10 years) is required to understand whether the high pit lake filling rates that occurred in the first decade after closure will occur again under the same rainfall conditions.

Table 1.27: Pit Lake Water Balance Reconciliation for Wet and Dry Years

Inflow/Outflow	Wet Year (2011/12 – 816 mm Rainfall)	Dry Year (2019/20 – 499 mm Rainfall)
Direct rainfall (ML)	196	125
Catchment inflow (ML)	133	67
Pumped inflows (ML)	1,023	198
Groundwater inflows (ML)	385	54
Evaporation (ML)	-387	-475
Calculated pit lake volume increase[1] (ML)	**1,350**	**-31**
Actual pit lake volume increase[2] (ML)	**1,446**	**-156**

[1] Calculated as estimated total inflows minus total outflows.

[2] From water level monitoring data.

A water balance model of the pit lake is included in the overall site water balance model for the Mt Leyshon Mine. The water balance model for the Mt Leyshon Mine is described in the site Water Management Plan and was developed using the GoldSim software. The model operates on a daily time step and simulates the quantity and quality of water within the water containment dams and seepage sumps at the mine, the pit void lake, and receiving waterways. The water balance model is used during each annual review of wet season monitoring data to forecast the future filling behaviour of the pit lake.

The closure objective for the pit void is for the pit lake to remain below an elevation of 340 m AHD which will ensure that the pit lake remains a groundwater sink, with no potential for discharge from the pit lake into the adjacent deep basement groundwater system (pit lake levels above 350 m AHD, excluding the localised deep fracture zone immediately adjacent to the pit at 295 m AHD) or the regional shallow groundwater system (pit lake levels above 365 m AHD).

As part of the 2019/20 Wet Season Review (Engeny Water Management, 2020), the site water balance model was used to forecast the likely future rise in the pit lake level assuming:

- The current water management system at the mine remains unchanged (i.e., continued pumping to pit lake from the containment dams and seepage sumps).
- Similar site seepage flows are experienced that previously occurred and contributed to the high pit lake finning rates in the first decade after closure.

It is noted that these are very conservative assumptions and are expected to provide an unrealistically fast filling prediction for the pit lake for the following reasons:

- The pit lake filling history observed in the second decade after closure indicates that site seepage flows appear to have significantly decreased as a result of prior drainage of tailings pore water from the tailings storage facilities and overall improved performance of the cover systems installed on the rehabilitated mine landforms.
- The planned future rehabilitation works proposed in the PRCP schedule are targeting improved water management outcomes which are expected to progressively result in the need for less water to be intercepted and pumped to the pit lake, with the ultimate aim (prior to relinquishment) of no water being pumped to the pit void. In particular, the planned rehabilitation of the scats stockpiles will eliminate the largest pumping contribution to the pit lake.

The pit lake filling predictions were performed by undertaking long-term water balance model simulations for a large number (300) of rainfall scenarios with a start date selected stochastically from the long-term historical daily rainfall dataset for the mine (period 1889 to 2018) and by repeating (looping) the historical daily rainfall sequence.

The predicted range of times for the pit lake level to fill to the maximum closure level of 340 m AHD under the conservative filling assumptions is shown in Table 1.28 and ranges from approximately 70 years to 150 years, with an average value of 110 years. This indicates that with even a pessimistic forecast of the future pit lake filling rate, there is a long period of time available to implement and monitor the planned future rehabilitation works and to progressively reduce the requirement for interception and pumping of impacted water to the pit void such that the pit lake level can be maintained below the maximum closure level of 340 m AHD.

Table 1.28: Predicted Pit Lake Filling Behaviour

Pit Lake Elevation (m AHD)	Minimum Filing Time (years) – Wettest Climate Sequence	Average Filling Time (years)	Maximum Filling Time (years) – Driest Climate Sequence
340 (closure objective for maximum pit lake level)	67	110	146

Post-Closure Pit Lake Water Quality

Access into the final void has been restricted during the majority of the closure period, therefore pit lake water quality is sampled on an opportunistic basis only, with recent samples being collected using remote methods (drones). Table 1.29 contains the results of pit lake water quality sampling during the closure phase.

Table 1.29: Post-Closure Pit Lake Water Quality

Date^	6 Oct 05	6 Jun 06	6 Jun 06	14 Aug 10	16 Nov 16	22 Nov 16	16 Nov 16
Note					Southern End	Middle	Northern End
Analyte							
pH	4.55	NT	NT	4.4	4.42	4.28	4.41
EC (uS/cm)	348	NT	6,630	7,800	9220	9370	9310
TDS (mg/L)	NT	NT	9,670	9,780	NT	11700	NT
Suspended Solids (mg/L)	NT	NT	18	24			
Alkalinity (as mg/L CaCO3)							
OH	NT	NT	<1	<1	<1	<1	<1
CO_3	NT	NT	<1	<1	<1	<1	<1

Date^	6 Oct 05	6 Jun 06	6 Jun 06	14 Aug 10	16 Nov 16	22 Nov 16	16 Nov 16
Note					Southern End	Middle	Northern End
HCO_3	NT	NT	<1		<1	<1	<1
Total Alkalinity	NT	NT	<1	<1	<1	<1	<1
Dissolved Major Anions (mg/L)							
Cl	NT	NT	100	79	102	103	104
SO_4	3,670	3,680	6,170	6,360	7840	7160	5960
Dissolved Major Cations (mg/L)							
Calcium	NT	514	513	546	347	612	528
Magnesium	NT	NT	NT	887	NT	1310	NT
Sodium	NT	NT	NT	433	NT	428	NT
Potassium	NT	NT	NT	53	NT	43	NT
Total Metals (mg/L)							
Aluminium	6.51	5.85	4.89	53.7	55.1	53.2	53.1
Arsenic	<0.001	<0.001	<0.001	<0.001	0.006	0.006	0.007
Barium	0.017	0.017	0.015	<0.01	0.016	0.014	0.015
Cadmium	0.0917	0.0885	0.0832	0.652	0.652	0.659	0.661
Chromium	<0.001	0.002	<0.001	<0.01	<0.001	<0.001	<0.001
Cobalt	1.06	1.02	0.931	1.75	2.07	2.11	2.11
Copper	1.96	1.62	1.49	7.42	7.84	7.94	8.1
Lead	0.008	0.005	0.005	0.159	0.083	2.02	0.092
Manganese	43.8	48.8	47	318	370	378	382
Selenium	<0.01	<0.01	<0.01	<0.1	<0.01	<0.01	<0.01
Strontium	1.11	1.1	1.06	1.85	2.28	2.32	2.36
Uranium	0.012	0.012	0.011	0.072	0.075	0.072	0.073
Zinc	15.8	16.3	14.4	120	120	122	124

Date^	6 Oct 05	6 Jun 06	6 Jun 06	14 Aug 10	16 Nov 16	22 Nov 16	16 Nov 16
Note					Southern End	Middle	Northern End
Iron	0.09	0.98	0.91	0.56	0.5	0.46	0.47
Mercury	0.0001	<0.0001	<0.0001	<0.0001	NT	NT	NT

The pit lake water quality, in particular the low pH and elevated concentrations of salts and metals, is heavily influenced by the following factors:

- Contaminated soil and residual mineralised material that was deposited in the final void during rehabilitation of the surrounding waste rock storage facilities and tailings storage facilities, which is known to be ARD-generating.
- ARD-impacted water pumped into the pit lake from containment dams and sumps, which is the largest inflow to the pit lake.

The lack of access into the pit void since closure has made it difficult to investigate water quality variations at depth in the pit lake. A single campaign of depth profiling of the water temperature and salinity in the pit lake was undertaken in 2019 using a water quality probe attached to a drone. The water quality measurements identified the presence of slightly warmer and less saline water in the top 20 m of the pit lake water column, with a uniform temperature and salinity profile below this level. Previous observations and aerial imagery has indicated that the colour of the pit lake can fluctuate between blue and green at different times of the year or in different years. The change in the pit lake colour may be a result of turn-over events in the pit lake as a result of hydrodynamic conditions from wind, rainfall or other climatic influences leading to a break-down in the stratification in the pit lake. It is likely that a deep water body like the pit lake will develop thermal or density stratification to some degree at various times during the year.

The closure strategy for the pit void is to maintain the pit lake level below 340 m AHD such that it will remain as a groundwater sink such that the void water quality cannot cause any environmental harm.

The water quality in the final void will not be suitable for any beneficial uses such as recreation, native ecosystem, grazing, or agriculture and accordingly the final void is a non-use void (NUMA).

Improvements to NUMA

Management strategies for the final void in closure include:

- Managing the pit lake elevation such that it remains below RL 340 m AHD to avoid impacts on groundwater.
- Annual water balance modelling shows that the long-term water level in the final pit lake will remain below RL 340 m AHD.
- Ongoing improvements to previously rehabilitated mine landforms and rehabilitation of the Scats Stockpile, aimed at reducing, and ultimately eliminating, the volume of ARD-impacted seepage and runoff that must be intercepted and pumped to the final void for long-term storage.
- Modifying and improving the exclusion bund around the final void so that is suitable for relinquishment.

1.8.4 Voids in Flood Plains

In accordance with Section 3.4 of the Progressive Rehabilitation Closure Plan Guideline (ESR/2019/4964), flood plain modelling is not required for the pit void as the Environmental Authority for the Mt Leyshon Mine is a land outcome document which includes conditions that pre-approve the pit void as a NUMA with a location specified as shown below in Table 1.30.

Table 1.30: : Land Outcome Document and Voids

Land Outcome Document	Condition Pre Approving a Void	Condition Pre Approving a Void Location	Detail
EA EPML00863713	A1-1	A1-1	Schedule A – Table 1 (Authorised Mining Activities) includes the Mine Domain “Void” and includes a series of coordinates and a maximum area of

Land Outcome Document	Condition Pre Approving a Void	Condition Pre Approving a Void Location	Detail
			disturbance for it (70.4 ha).
	F2-1		Schedule F – Table 1 includes the mine feature "Pit" on ML10144.
	F9-1-4	N/A	Conditions state that residual voids must have management and decommissioning strategies (dealt with by Land Outcome Documents other than the EA, e.g., Residual Void Outcome (Appendix to Mount Leyshon Final Void Decommissioning Strategy, required by EA conditions F9-3 and 4))

Other Land Outcome Documents refer to Mount Leyshon's void and location, however in accordance with S754 (5) of the Queensland Environmental Protection Act (1994) the EA is sufficient in addressing the pre-approval for the presence and location of a void as is it appears first in the hierarchical order of Land Outcome Documents and if any inconsistency were to exist between it and other Land Outcome Documents, the EA would prevail.

Despite the fact that flood plain modelling is not required for a pre-approved NUMA with a location specified in a Land Outcome Document, the pit void would not be classified as a void in a flood plain for the following reasons:

- The location of the pit void is within the footprint of the original Mt Leyshon, which was an elevated landform located on the drainage divide between the surrounding regional drainage features.
- The only 4th order drainage feature in the vicinity of the pit void is Clarke Creek. At its' closest location to the pit void, the main flow channel of Clarke Creek is 2.6 km from the nearest edge of the void.
- Broad-scale flood mapping of the Burdekin River basin (Basin Level Flood Modelling) performed during Phase 3 of the Queensland Flood Mapping Program (QFMP) indicates that the 1% AEP flood plain area of Clarke Creek does not even extend to the mine landforms at the northern edge of the mine, which are still some distance from the pit void area.

Further information on flooding at the Mt Leyshon Mine is provided in Section 1.8.1.

1.8.5 Underground Mining

The requirements of the Progressive Rehabilitation Closure Plan Guideline (ESR/2019/4964) for underground mining do not apply to Mt Leyshon Mine as the mine operated as an open cut mine only and never conducted underground mining operations.

1.8.6 Built Infrastructure

Removed Built Infrastructure

Mining operations at Mt Leyshon Mine ceased in 2001, with processing of ore ceasing in 2002. The vast majority of infrastructure not required for rehabilitation, maintenance, or monitoring has been removed from the Mine.

The infrastructure that has already been removed from the Mine includes:

Processing Plant (including laboratory and crushing/screening area) and Ball Mills:

The plant area consisted of crushers, ball mills, conveyor systems, leach and absorption tanks, offices, laboratory, workshops (for mine plant and contractors' plant), generators and chemical and hydrocarbon storage. Decommissioning and demolition of the plant area commenced in early 2002 and completed in late 2002. Once decommissioned and relocated, 300mm of the material underlying the plant area footprint was removed and processed for gold. Sampling of contaminants of concern was undertaken to inform any rehabilitation required and subsequently 600mm and 300mm of heap leach material (compacted) and topsoil were respectively placed on the area.

The concrete substructure for the jaw crusher was not removed during the decommissioning of the processing plant.

Explosives Magazine Area – Infrastructure removed and a 300mm topsoil cover placed over area.

Dyno Area – Concrete pads removed from site and 300mm of topsoil cover placed over area.

Solid Cyanide Storage Area – Containers removed (inspection on removal showed no integrity issues), underlying soils excavated and transferred to pit.

Other Built Infrastructure:

Other ancillary infrastructure that is not required to assist management of the rehabilitation of Mt Leyshon (i.e. Jaw Crusher) may be able to be removed and rehabilitated at a time that complements the risk profile of other rehabilitation efforts at Mt Leyshon Mine. Infrastructure such as road networks are planned to remain to complement the post mine land use. It is also noted that infrastructure required to support the rehabilitation and monitoring program are required to remain until relinquishment (pumps, dams, sumps, monitoring bores, offices, workshops and electrical power distribution).

All ancillary structures were decommissioned and removed from Mt Leyshon Mine by late 2002.

Remaining Built Infrastructure:

Buildings (administration, workshops, core shed):

The administration building, workshops and core shed remain at Mount Leyshon Mine and will be decommissioned and removed following completion of the wider rehabilitation works prior to EA relinquishment.

Site Power Supply:

Power is required to facilitate rehabilitation and maintenance activities. Site power supply and infrastructure will be decommissioned and removed following completion of the wider rehabilitation works prior to the relinquishment of the EA.

Internal Site Water Supply:

No external water supply is present. Internal water use is required to facilitate rehabilitation and maintenance activities. Site water supply and infrastructure that does not complement the pre-approved PMLU will be decommissioned and removed following completion of the wider rehabilitation works prior to the relinquishment of the EA.

Contaminated Soil Assessment:

A soils contamination assessment was undertaken in 2005 following the removal of infrastructure. The assessment found that some residual hydrocarbon impacts were present in the plant area however no further remediation was required due to the low concentrations, the anticipated effects of natural attenuation, and the low potential for contaminant mobilisation. The laydown area was identified to have metals impacts that required delineation and remediation and residual contamination will be managed prior to relinquishment of the Environmental Authority by way of further assessment and subsequent).

1.9 RISK ASSESSMENT

A PRC plan risk assessment workshop was held on 22 April 2021 and updated in 2022. In accordance with section 126C(1)(f) and (j) of the EP Act, the scope of the risk assessment was to:

- Evaluate the risk of a stable condition for land described as a PMLU not being achieved and sustained, and determine how the risk will be managed and/or minimised during closure; and
- Evaluate the risk of the NUMA causing environmental harm and not being safe and structurally stable and determine how the risk will be managed and/or minimised during closure.
- The completed risk assessment is provided in Table 1.31. The risk assessment was completed in accordance with the Newmont Risk Management Standard (Newmont, 2017b) which conforms to the requirements of AS ISO 31000:2018 Risk Management – Guidelines (Standards Australia, 2018). The consequence, likelihood and risk matrices used to determine risk levels and ratings are provided in Appendices J and K.

The risk assessment process was robust in terms of inclusion of a cross section of representatives who are experts in the field of knowledge from a site, legislative, and process perspective. The risk assessment was facilitated and scribed to permit participants ability to contribute to the process. The resultant level of confidence in the process is considered appropriate. Assumptions were registered and there were no non consent matters identified from participants. Treatments were discussed from a cost benefit, practicality and resourcing perspective and are considered appropriate. Resourcing, timing and scheduling to implement treatments were considered by those responsible for approval and implementation of the plan, along with reporting and monitoring requirements. The PRCP and treatments identified in the risk assessment are approved from a Newmont perspective with agency and authority of the Manager of Legacy Sites Australia.

Table 1.31: Risk Assessment

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
Milestone	**Rehabilitation Area**	**Risk Description** (Include Activity, Product, Service description etc.)	**Potential Cause(s)**	**Impact Assumption** (Details of the credible scenario a risk rating has been assigned for)	**Controls**	Health	Safety	Environment	External Relations	Security	Legal & Other	Production	Financial	**Risk Category - Major Impacted Area**	**Consequence**	**Likelihood**	**Risk Level**	**Risk Rating**	**Risk Treatment Actions**	**Responsibility**	**Resource Requirements**	**Timing and Scheduling**
RM1: Infrastructure Decommission and Removal	**RA9**	PMLU not safe to humans, animals or the environment [processing area]	- Remaining infrastructure is a trip hazard	- Injury (minor)	- Restricted access (front gate and boundary fencing) -Infrastructure decommissioning and removal activities have been undertaken in accordance with a decommissioning strategy.		✓							Safety	2	1	**3**	**Low**	- Existing infrastructure to be removed / integrated into landscape prior to relinquishment	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings; funding for supplementary contractors, if required.	As per PRCP Schedule.
	RA9	PMLU not safe to humans, animals or the environment [ancillary infrastructure]	- Remaining infrastructure is a trip hazard - Electrical hazards	- Injury (minor)	- Restricted access (front gate and boundary fencing) -Infrastructure decommissioning and removal activities have been undertaken in accordance with a decommissioning strategy.		✓							Safety	1	1	**1**	**Low**	- Existing infrastructure to be removed / integrated into landscape prior to relinquishment	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings; funding for supplementary contractors, if required.	As per PRCP Schedule.
	RA9	PMLU not safe to humans, animals or the environment [spine drain]	- Vertical drop structures (i.e. Gabion baskets with wire mesh coverings)	Injury to personnel	- Restricted access (front gate and boundary fencing) -Infrastructure decommissioning and removal activities have been undertaken in accordance with a decommissioning strategy.		✓							Safety	1	1	**1**	**Low**	- No risk treatment proposed	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings; funding for supplementary contractors, if required.	As per PRCP Schedule.
RM2: Landform Shaping	**RA10, RA11. RA12**	PMLU not structurally stable - geotechnical stability (Pre-final landform)	- Scats stockpile is considered to be structurally stable due to its uniform aggregate size, high void ratio, and settlement to	N/A	N/A									N/A			**#N/A**	#N/A	N/A	N/A	N/A	N/A

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
		[Scats stockpile]	angle of repose																			
	RA10, RA11. RA12	PMLU not structurally stable - geotechnical stability (Post-final landform) [Scats stockpile]	- Steep batters and long slopes - Differential settling	- Batter failure	- A design for the rehabilitation of the Scat's Stockpile has been generated (including an impermeable cover system) which has a design slope of 15 degrees and is considered to be suitable to be stable for growth media and subsequent revegetation - Surface water management system - Engineered design (utilizing soil testing data) - Periodic engineering assessments - Vegetation establishment -Materials balance and characterisaiton			✓					✓	Financial	3	1	**6**	**Medium**	- No actual instances of batter failure have occurred on existing waste dump rehabilitation however slope length increased in scat stockpile design. - Geotechnical investigation and repair accordingly.	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings to execute rehabilitation and final landform design; adequate funding allocated for execution of final landform design and geotechnical investigations and repair work, where required.	As per PRCP Schedule.
	RA9	PMLU not structurally stable - geotechnical stability [spine drain]	- Wire mesh covering failure	- Movement of rock protection resulting in exposure of underlying PAF material	- Engineered design - Spine Drain is hydraulically oversized - Periodic engineering assessments		✓	✓					✓	Environment	1	4	**7**	**Medium**	- No risk treatment proposed - Eventual failure of wire in rock gabion baskets at drop structures is not expected to cause catastrophic failure of the Spine Drain. Vegetation establishment in Spine Drain will ultimately assist with channel stability	Newmont Manager Legacy Sites Australia	Funding for periodic engineering assessments.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
RM3: Cover System Install	RA4, RA5, RA6, RA7	PMLU not structurally stable - erosional stability [TSFs and NAF and PAF Stockpiles]	-poor landform design (capping depth, materials and thickness) - ineffective monitoring and inspection program	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material in dam walls (RWD only)	- Engineered design for capping stipulating capping depth, thickness and materials to be utilised (utilizing soil geochemistry) [future rehabilitation] - Conformance to design testing [future rehabilitation] - Surface water management system - Periodic engineering assessments - Vegetation establishment -Materials balance and characterisaiton			✓			✓		✓	Financial	3	4	17	High	- Repair drainage known to be causing erosion - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings to execute capping design; adequate funding allocated for execution and conformance to design testing. Funding allocated for repair work, where required/identified by monitoring.	As per PRCP Schedule.
	RA1, RA2, RA3	PMLU not structurally stable - erosional stability [Waste Rock Dumps]	-poor landform design (capping depth, materials and thickness) - ineffective monitoring and inspection program	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material	- Engineered design for capping stipulating capping depth, thickness and materials to be utilised (utilizing soil geochemistry) [future rehabilitation] - Conformance to design testing [future rehabilitation] - Surface water management system - Periodic engineering assessments - Vegetation establishment - Rehabilitation monitoring -Materials balance and characterisaiton			✓			✓		✓	Financial	3	4	17	High	- Repair drainage known to be causing erosion - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings to execute capping design; adequate funding allocated for execution and conformance to design testing. Funding allocated for repair work, where required/identified by monitoring.	As per PRCP Schedule.

	Risk Summary					Impacted Areas									Current Risk Level				Risk Treatment			
	RA10, RA11. RA12	PMLU not structurally stable - erosional stability (Post-final landform) [Scats stockpile]	-poor landform design (capping depth, materials and thickness) - ineffective monitoring and inspection program	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material	- Engineered design for capping stipulating capping depth, thickness and materials to be utilised (utilizing soil geochemistry) [future rehabilitation] - Conformance to design testing [future rehabilitation] - Surface water management system - Periodic engineering assessments - Vegetation establishment - Rehabilitation monitoring -Materials balance and characterisaiton			✓			✓		✓	Financial	3	4	**17**	**High**	- Repair drainage known to be causing erosion - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings to execute capping design; adequate funding allocated for execution and conformance to design testing. Funding allocated for repair work, where required/identified by monitoring.	As per PRCP Schedule.
RM4: Final Surface Preparation	RA4, RA5, RA6, RA7	PMLU not structurally stable - erosional stability [TSFs and NAF and PAF Stockpiles]	- Inadequate topsoil material depth and quality (i.e. lack of ameliorants used for poor quality topsoil).	- Localised erosion gullies - Sediment laden water impacts pumping infrastructure - Sediment laden migration off-site - Injury due to trip hazards - Exposure of PAF material in dam walls (RWD only)	- Surface water management system - Engineered design (utilizing soil geochemistry) - Conformance checks by suitably qualified person to verify "as constructed" complies with the design [future rehabilitation] - Vegetation establishment -Materials balance and characterisaiton			✓			✓		✓	Financial	3	4	**17**	**High**	- Repair drainage known to be causing erosion - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings to execute surface preparation plan; adequate funding allocated for execution (including appropriate equipment) and conformance to design testing by suitably qualified person for future rehabilitation. Funding allocated for repair work, where required/identified by monitoring.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
	RA1, RA2, RA3	PMLU not structurally stable - erosional stability [Waste Rock Dumps]	- Inadequate topsoil material depth and quality (i.e. lack of ameliorants used for poor quality topsoil).	- Localised erosion gullies - Sediment laden water impacts pumping infrastructure - Sediment laden migration off-site - Injury due to trip hazards - Exposure of PAF material	- Surface water management system - Engineered design (utilizing soil geochemistry) - Conformance checks by suitably qualified person to verify "as constructed" complies with the design [future rehabilitation] - Vegetation establishment -Materials balance and characterisaiton			✓			✓		✓	Financial	3	4	**17**	**High**	- Repair drainage known to be causing erosion - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings to execute surface preparation plan; adequate funding allocated for execution (including appropriate equipment) and conformance to design testing by suitably qualified person for future rehabilitation. Funding allocated for repair work, where required/identified by monitoring.	As per PRCP Schedule.
	RA10, RA11. RA12	PMLU not structurally stable - erosional stability (Post-final landform)	- Inadequate topsoil material depth and quality (i.e. lack of ameliorants used for poor quality topsoil).	- Localised erosion gullies - Sediment laden water impacts pumping infrastructure - Sediment laden migration off-site - Injury due to trip hazards - Exposure of PAF material	- A design for the rehabilitation of the Scat's Stockpile has been generated (including an impermeable cover system) which has a design slope of 15 degrees and is considered to be suitable to be stable for growth media and subsequent revegetation - Surface water management system - Engineered design - Conformance checks by suitably qualified person to verify "as constructed" complies with the design - Vegetation establishment			✓			✓		✓	Financial	3	4	**17**	**High**	- Repair drainage known to be causing erosion - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings to execute surface preparation plan (based on growth media testing); adequate funding allocated for execution (including appropriate equipment to meet required growth media depths) and conformance to design testing by suitably qualified person. Funding allocated for repair work, where required/identified by monitoring.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
					-Materials balance and characterisaiton																	
	RA9	PMLU not structurally stable - erosional stability [Processing area]	- Inadequate topsoil material depth and quality (i.e. lack of ameliorants used for poor quality topsoil).	- Localised erosion gullies - Sediment laden water impacts pumping infrastructure - Sediment laden migration off-site - Injury due to trip hazards - Exposure of PAF material	- Surface water management system - Engineered design (utilizing soil geochemistry) - Conformance checks by suitably qualified person to verify "as constructed" complies with the design - Vegetation establishment -Materials balance and characterisaiton			✓					✓	Financial	1	4	**7**	**Medium**	- Existing infrastructure to be removed / integrated into landscape prior to relinquishment - Drainage repairs - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings to execute surface preparation plan; adequate funding allocated for execution (including appropriate equipment) and conformance to design testing by suitably qualified person for future rehabilitation. Funding allocated for repair work, where required/identified by monitoring.	As per PRCP Schedule.
	RA9	PMLU not structurally stable - erosional stability [ancillary]	- Inadequate topsoil material depth and quality (i.e. lack of ameliorants used for poor quality topsoil).	- Localised erosion gullies - Sediment laden water impacts pumping infrastructure - Sediment laden migration off-site - Injury due to trip hazards - Exposure of PAF material	- Surface water management system - Engineered design (utilizing soil geochemistry) - Conformance checks by suitably qualified person to verify "as constructed" complies with the design - Vegetation establishment -Materials balance and characterisaiton			✓					✓	Financial	1	2	**2**	**Low**	- Existing infrastructure to be removed / integrated into landscape prior to relinquishment - Drainage repairs - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings to execute surface preparation plan; adequate funding allocated for execution (including appropriate equipment) and conformance to design testing by suitably qualified person for future	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
																					rehabilitation. Funding allocated for repair work, where required/identified by monitoring.	
RM5: Revegetation (Pasture Grazing)	RA4, RA5, RA6, RA7	PMLU not structurally stable - revegetation stability [TSF]	- Inadequate growth media application method (including potential impact to cover system) - Insufficient application rates applied	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material in dam walls	- Revegetation design stipulating growth media application method, rates and inspection requirements [future rehabilitation]. - Existing rehabilitation performance and monitoring. - Surface water management system			✓			✓		✓	Financial	2	4	**12**	**High**	- Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate time and budget allocated for monitoring and revegetation of areas, where required.	As per PRCP Schedule.
	RA9	PMLU not structurally stable - revegetation stability [processing]	- Poor drainage - Poor vegetation establishment on exposed areas - Erosion - Underlying heap leach material - Remaining infrastructure is a barrier to revegetation -invasive species --poor landform design (capping depth and thickness) – inadequate topsoil material depth and quality (i.e. lack of ameliorants used for poor quality topsoil).	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material	- Surface water management system - Previous rehabilitation - Ongoing repairs to previous rehabilitation -Materials balance and characterisaiton			✓					✓	Financial	1	4	**7**	**Medium**	- Existing infrastructure to be removed / integrated into landscape prior to relinquishment - Drainage repairs - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate time and budget allocated for monitoring and revegetation of areas, where required.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
	RA9	PMLU not structurally stable - revegetation stability [ancillary]	- Ancillary infrastructure areas are currently not vegetated - Remaining infrastructure is a barrier to revegetation - invasive species - poor landform design (capping depth and thickness) – inadequate topsoil material depth and quality (i.e. lack of ameliorants used for poor quality topsoil).	- Localised erosion gullies - Sediment migration off-site	- Surface water management system -Materials balance and characterisaiton			✓			✓		✓	Legal & Other	2	5	16	High	- Existing infrastructure to be removed / integrated into landscape prior to relinquishment - Drainage repairs - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings to execute revegetation plan (based on growth media testing); adequate funding allocated for execution (including appropriate equipment to meet application rates of seeds and ameliorants).	As per PRCP Schedule.
	RA10, RA11. RA12	PMLU not safe to humans, animals or the environment (Pre-final landform) [TSF]	- Falling down steep batters - Batters are uneven in some areas - Residual drill holes - Residual material in scats (e.g. steel, concrete pads, timber) poses a hazard for reprocessing - Seepage water quality would not be drinkable for humans or livestock	- Injury	- Restricted access to waste rock dumps (front gate and boundary fencing) - Residual drill holes have been covered - Regular maintenance of the surface if a hazard is observed (e.g. poor drainage, sink holes)		✓	✓	✓		✓		✓	Safety	2	2	5	Low	- No risk treatment proposed as the current risk level is considered to be commensurate with the surrounding landforms - Not aware of any injuries occurring on the scats stockpile - Not aware of an regulation requiring further action to reduce the current risk level	Newmont Manager Legacy Sites Australia	'Adequate time and budget allocated for monitoring and revegetation of areas, where required.	As per PRCP Schedule.
	RA10, RA11. RA12	PMLU not structurally stable - revegetation stability (Post-final landform) [Scats]	- invasive species -poor landform design (capping depth and thickness) – inadequate topsoil material depth and quality (i.e. lack of ameliorants used for poor quality topsoil).	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material	- A design for the rehabilitation of the Scat's Stockpile has been generated (including an impermeable cover system) which has a design slope of 15 degrees and is considered to be suitable to be stable for growth media and subsequent			✓			✓		✓	Financial	2	4	12	High	- Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings to execute revegetation plan (based on growth media testing); adequate funding allocated for execution (including appropriate	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
					revegetation - Surface water management system - Engineered design(utilizing on soil testing data) - Vegetation establishment and monitoring - capping layer interception monitoring -Materials balance and characterisaiton																equipment to meet application rates of seeds and ameliorants).	
	RA1, RA2, RA3	PMLU not structurally stable - revegetation stability [waste rock dumps]	- Poor drainage - Poor vegetation establishment on exposed areas - Erosion - Underlying heap leach material - Remaining infrastructure is a barrier to revegetation -invasive species --poor landform design (capping depth and thickness) – inadequate topsoil material depth and quality (i.e. lack of ameliorants used for poor quality topsoil).	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material	- Surface water management system - Previous rehabilitation - Ongoing repairs to previous rehabilitation -Materials balance and characterisaiton			✓					✓	Financial	1	4	7	Medium	- Existing infrastructure to be removed / integrated into landscape prior to relinquishment - Drainage repairs - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate time allocated for planning and progress meetings to execute revegetation plan (based on growth media testing); adequate funding allocated for execution (including appropriate equipment to meet application rates of seeds and ameliorants).	As per PRCP Schedule.
	RA9	PMLU not structurally stable - erosional stability [ancillary]	- Inadequate growth media application method (including potential impact to cover system) - Insufficient application rates applied	- Localised erosion gullies - Sediment migration off-site	- Revegetation design stipulating growth media application method, rates and inspection requirements [future rehabilitation]. - Existing rehabilitation performance and monitoring. - Surface water management system			✓					✓	Financial	1	2	2	Low	- Existing infrastructure to be removed / integrated into landscape prior to relinquishment - Drainage repairs - Revegetate bare areas	Newmont Manager Legacy Sites Australia	'Adequate time allocated for planning and progress meetings to execute revegetation plan (based on growth media testing); adequate funding allocated for execution (including appropriate equipment to meet	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
																					application rates of seeds and ameliorants).	
	RA1, RA2, RA3	PMLU not structurally stable - erosional stability [Waste Rock Dumps]	- Inadequate growth media application method (including potential impact to cover system) - Insufficient application rates applied	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material	- Revegetation design stipulating growth media application method, rates and inspection requirements [future rehabilitation]. - Existing rehabilitation performance and monitoring. - Surface water management system			✓			✓		✓	Financial	3	4	**17**	**High**	- Repair drainage known to be causing erosion - Revegetate bare areas	Newmont Manager Legacy Sites Australia	'Adequate time allocated for planning and progress meetings to execute revegetation plan (based on growth media testing); adequate funding allocated for execution (including appropriate equipment to meet application rates of seeds and ameliorants).	As per PRCP Schedule.
		Major rainfall event	- Cyclone	- Dam overtopping - Waste rock dump failure - TSF failure - Flooding and inundation - Rehabilitation schedule delayed	- Segregation of water quality - Spillways - High flow bypass system - TSFs are free draining - Dam levels are kept low - Backup pumps - Weather monitoring		✓	✓	✓		✓		✓	Legal & Other	4	1	**10**	**Medium**	- No risk treatment proposed		Scheduling works during dry season where possible.	As per PRCP Schedule.
RM6: Achievement of PMLU to stable condition	RA9	PMLU not structurally stable - erosional stability [Spine drain]	- Movement of rock protection - inadequate design -inadequate rock size for flows	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material	- Engineered design - Spine Drain is hydraulically oversized - Periodic engineering assessments		✓	✓					✓	Environment	1	3	**4**	**Low**	- No risk treatment proposed - Eventual failure of wire in rock gabion baskets at drop structures is not expected to cause catastrophic failure of the Spine Drain. Vegetation establishment in Spine Drain will ultimately assist with channel	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
																			stability			
	RA9	Unable to sustain PMLU [spine drain]	- Overgrazing - Failure of controls and/or failure to act on findings linked to risk event controls 7.1-7.5.	- Gradual degradation due to PMLU/grazing	- Controls identified for not achieving PMLU risk events (7.1-7.5) - Visual inspection - Undertake Rehabilitation monitoring as per Section 1.7.2 - Geotechnical inspection - Surface water monitoring as per -Water Management Plan and REMP - Groundwater monitoring as per Groundwater Management Plan		✓	✓	✓		✓		✓	Financial	3	2	**9**	**Medium**	- Development and implementation of land use management plan (LUMP) as part of rehabilitation milestone	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.
	RA9	PMLU causing environmental harm [spine drain]	- Preferential seepage through spine drain entering surface water and groundwater	- ARD discharged from site (slow leak)	- Upstream half of Spine Drain has been lined to separate runoff flows from underlying waste material. - Water quality monitoring - High flow bypass structure at end of Spine Drain (low flows enter Mt Hope Dam)		✓	✓					✓	Environment	1	4	**7**	**Medium**	- No risk treatment proposed - Eventual failure of wire in rock gabion baskets at drop structures is not expected to cause catastrophic failure of the Spine Drain. Vegetation establishment in Spine Drain will ultimately assist with channel stability - Benefit of lining the lower half of the Spine Drain does not justify the significant cost of these works (would require drop structures to be	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
																			re-constructed)			
	RA9	PMLU not structurally stable - erosional stability [ancillary]	- Poor drainage - Poor vegetation establishment on exposed areas	- Localised erosion gullies - Sediment migration off-site	- Revegetation design stipulating growth media application method, rates and inspection requirements [future rehabilitation]. - Existing rehabilitation performance and monitoring. - Surface water management system			✓					✓	Financial	1	2	2	Low	- Existing infrastructure to be removed / integrated into landscape prior to relinquishment - Drainage repairs - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required.	As per PRCP Schedule.
	RA9	PMLU causing environmental harm [ancillary]	- Contaminated land - Fuel spills	- Hydrocarbons discharged from site (single event)	- Increased pump size for fuel bay sump - Bunding -Contaminated land assessment			✓	✓		✓		✓	Financial	1	2	2	Low	- Existing infrastructure to be removed / integrated into landscape prior to relinquishment - Drainage repairs	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.
	RA9	Unable to sustain PMLU [ancillary]	- Overgrazing - Failure of controls and/or failure to act on findings linked to risk event controls 6.1-6.5.	- Gradual degradation due to PMLU/grazing	- Controls identified for not achieving PMLU risk events (6.1-6.5) - Visual inspection - Undertake Rehabilitation monitoring as per Section 1.7.2 - Geotechnical inspection - Surface water monitoring as per -Water Management Plan and REMP		✓	✓	✓		✓		✓	Financial	3	2	9	Medium	- Development and implementation of land use management plan (LUMP) as part of rehabilitation milestone	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
					- Groundwater monitoring as per Groundwater Management Plan																	
	RA9	PMLU not structurally stable - erosional stability [Processing area]	- Poor drainage - Poor vegetation establishment on exposed areas	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material	- Surface water management system - Previous rehabilitation - Ongoing repairs to previous rehabilitation -Materials balance and characterisaiton			✓					✓	Financial	1	4	**7**	**Medium**	- Existing infrastructure to be removed / integrated into landscape prior to relinquishment - Drainage repairs - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required.	As per PRCP Schedule.
	RA9	Unable to sustain PMLU [processing area]	- Overgrazing - Failure of controls and/or failure to act on findings linked to risk event controls 5.1-5.5.	- Gradual degradation due to PMLU/grazing	- Controls identified for not achieving PMLU risk events (5.1-5.5) - Visual inspection - Undertake Rehabilitation monitoring as per Section 1.7.2 - Geotechnical inspection - Surface water monitoring as per -Water Management Plan and REMP - Groundwater monitoring as per Groundwater Management Plan		✓	✓	✓		✓		✓	Financial	3	2	**9**	**Medium**	- Development and implementation of land use management plan (LUMP) as part of rehabilitation milestone	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.
	RA9	PMLU causing environmental harm [processing area]	- Contaminated land - ARD seepage bypassing Settlement Dam	- ARD discharged from site (single event)	- Investigation and monitoring of ARD seepage bypassing Settlement Dam			✓	✓		✓		✓	Environment	2	3	**8**	**Medium**	- Existing infrastructure to be removed / integrated into landscape prior to relinquishment - Drainage repairs - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
	RA8	Unable to sustain PMLU [Dams}	- Overgrazing - Failure of controls and/or failure to act on findings linked to risk event controls 1.1-1.5.	- Gradual degradation due to PMLU/grazing	- Controls identified for not achieving PMLU risk events (1.1-1.5) - Visual inspection - Undertake Rehabilitation monitoring as per Section 1.7.2 - Geotechnical inspection - Surface water monitoring as per -Water Management Plan and REMP - Groundwater monitoring as per Groundwater Management Plan		✓	✓	✓		✓		✓	Financial	3	2	9	Medium	- Development and implementation of land use management plan (LUMP) as part of rehabilitation milestone	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.
	RA8	PMLU causing environmental harm [dams]	- Overtopping - Exposure of PAF material in dam walls (RWD only)	- ARD discharged from site (could be slow leak or single event)	- Pumps (duty and standby, diesel and electric) - Regular pump testing - Seepage sumps down gradient of dams - Water quality monitoring - High flow bypass system (Settlement Dam and Mt Hope Dam) - Water is not stored in the dams at very high levels, and there is automated pumping to draw down the water level at a controlled rate		✓	✓	✓		✓		✓	Environment	3	1	6	Medium		Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.
	RA8	PMLU not structurally stable - geotechnical stability [dams]	- Embankment failure - Seepage - Undercutting	- Dam failure and release to downstream environment	- Engineered design (RWD only) - Periodic engineering inspections (all dams) - Consequence Category		✓	✓	✓		✓		✓	Environment	3	1	6	Medium		Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
					Assessments (all dams) - Plan of Operations (regulated dams) - Water is not stored in the dams at very high levels, and there is automated pumping to draw down the water level at a controlled rate - Regular dam level monitoring																	
	RA8	PMLU not structurally stable - revegetation stability [dams]	- Poor vegetation establishment on steep embankments and exposed embankment areas - Underlying soil contamination - Invasive species	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material in dam walls (RWD only)	- Vegetation monitoring during annual dam inspections		✓	✓	✓		✓		✓	Environment	2	1	**3**	**Low**	- Re-vegetation post decommissioning	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required.	As per PRCP Schedule.
		Major rainfall event	- Cyclone	- Dam overtopping - Waste rock dump failure - TSF failure - Flooding and inundation - Rehabilitation schedule delayed	- Segregation of water quality - Spillways - High flow bypass system - TSFs are free draining - Dam levels are kept low - Backup pumps - Weather monitoring		✓	✓	✓		✓		✓	Legal & Other	4	1	**10**	**Medium**	- No risk treatment proposed		Scheduling works during dry season where possible.	As per PRCP Schedule.
	RA4, RA5, RA6, RA7	PMLU not structurally stable - geotechnical stability [TSFs and NAF and PAF Stockpiles]	- Steep batters - Differential settling - Embankment failure	- Embankment failure	- Surface water management system - Vegetation establishment			✓	✓		✓		✓	Financial	4	1	**10**	**Medium**	- No risk treatment proposed as the TSFs have already been closed, the condition of tailings underneath the cover material is assumed to "improve" over time, and in line with the Failure Impact Assessment the tailings will not migrate very far downstream in	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
																			the event of an embankment failure			
	RA4, RA5, RA6, RA7	PMLU not structurally stable - revegetation stability	- Poor vegetation establishment on steep embankments and exposed embankment areas -invasive species - Poor landform design (capping depth and thickness) - Inadequate topsoil material depth and quality (i.e. lack of ameliorants used for poor quality topsoil).	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material in dam walls	- Surface water management system - Engineered design (utilizing soil geochemistry) - Periodic engineering assessments - Vegetation establishment and monitoring -Materials balance and characterisaiton			✓			✓		✓	Financial	2	4	**12**	**High**	- Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required.	As per PRCP Schedule.
	RA4, RA5, RA6, RA7	Unable to sustain PMLU [TSF}	- Overgrazing - Failure of controls and/or failure to act on findings linked to risk event controls 2.1-2.5.	- Gradual degradation due to PMLU/grazing	- Controls identified for not achieving PMLU risk events (2.1-2.5) - Visual inspection - Undertake Rehabilitation monitoring as per Section 1.7.2 - Geotechnical inspection - Surface water monitoring as per -Water Management Plan and REMP - Groundwater monitoring as per Groundwater Management Plan		✓	✓	✓		✓		✓	Financial	3	2	**9**	**Medium**	- Development and implementation of land use management plan (LUMP) as part of rehabilitation milestone	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.

		Risk Summary				Impacted Areas									Current Risk Level				Risk Treatment			
	RA4, RA5, RA6, RA7	PMLU causing environmental harm [TSF's]	- Installed covers allowing infiltration and seepage - Surface runoff from the TSFs resulting in ARD being discharged from site	- ARD discharged from site	- Pumps (duty and standby, diesel and electric) - Regular pump testing - Seepage sumps down gradient of dams - Water quality separation - Water quality monitoring - Installed covers			✓			✓		✓	Environment	2	3	**8**	**Medium**	- Undertake drainage works to minimise water ponding on the top surface of the landforms (if required - pending aerial survey acquisition) - Revegetate bare areas and erosion on the batters to improve surface runoff quality - Continue to intercept seepage flows down-gradient of landforms and pump to the pit - Divert surface runoff from top surface of landforms (where not already diverted) around mine water containment storages to prevent mixing of better quality runoff flows with poorer quality seepage flows and to minimise the volume of water required to be pumped to the pit	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.
	RA4, RA5, RA6, RA7	PMLU not safe to humans, animals or the environment [TSFs]	- Falling down steep embankments and erosion gullies - Large and exposed rock on batters/covers in some areas - Fuel load leading to fire - Tops of the TSFs being not accessible/trafficable by vehicles,	- Injury	- Restricted access to TSFs (front gate and boundary fencing) - Drainage controls (E.g. benches, drop structures) which limit the risk of erosion - Grazing as a fire management control		✓	✓			✓		✓	Safety	2	2	**5**	**Low**	- No risk treatment proposed as the current risk level is considered to be commensurate with the surrounding landforms - Not aware of any injuries occurring on any of the TSFs - Not aware of	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
			horses, etc.																any regulation requiring further action to reduce the current risk level			
	RA1, RA2, RA3	Unable to sustain PMLU [waste rock dumps]	- Overgrazing - Failure of controls and/or failure to act on findings linked to risk event controls 3.1-3.5.	- Gradual degradation due to PMLU/grazing	- Controls identified for not achieving PMLU risk events (3.1-3.5) - Visual inspection - Undertake Rehabilitation monitoring as per Section 1.7.2 - Geotechnical inspection - Surface water monitoring as per -Water Management Plan and REMP - Groundwater monitoring as per Groundwater Management Plan		✓	✓	✓		✓		✓	Financial	3	2	9	Medium	- Development and implementation of land use management plan (LUMP) as part of rehabilitation milestone	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.
	RA1, RA2, RA3	PMLU not safe to humans, animals (stock, wildlife) or the environment	- Falling down steep embankments and erosion gullies - Large and exposed rock on batters/covers in some areas - Fuel load leading to fire - Tops of the waste rock dumps being not accessible/trafficable by vehicles, horses, etc.	- Injury	- Restricted access to waste rock dumps (front gate and boundary fencing) - Drainage controls (E.g. benches, drop structures) which limit the risk of erosion - Grazing as a fire management control		✓	✓			✓		✓	Safety	2	2	5	Low	- No risk treatment proposed as the current risk level is considered to be commensurate with the surrounding landforms - Not aware of any injuries occurring on any of the waste rock dumps - Not aware of an regulation requiring further action to reduce the current risk level	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
	RA1, RA2, RA3	PMLU causing environmental harm [waste rock dumps]	- Installed covers allowing infiltration and seepage - Surface runoff from the waste rock dumps resulting in ARD and TSS being discharged from site	- ARD and TSS discharged from site	- Pumps (duty and standby, diesel and electric) - Regular pump testing - Seepage sumps down gradient of dams - Water quality separation - Water quality monitoring - Installed covers			✓			✓		✓	Environment	2	3	**8**	**Medium**	- Revegetate bare areas and erosion on the landforms to improve surface runoff quality - Continue to intercept seepage flows down-gradient of landforms and pump to the pit	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.
	RA1, RA2, RA3	PMLU not structurally stable - erosional stability [Waste Rock Dumps]	- Steep batters - Differential settling - Embankment failure - Poor drainage - Inadequate topsoil material depth and quality (i.e. lack of ameliorants used for poor quality topsoil).	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material	- Revegetation design stipulating growth media application method, rates and inspection requirements [future rehabilitation]. - Existing rehabilitation performance and monitoring. - Surface water management system			✓			✓		✓	Financial	3	4	**17**	**High**	- Repair drainage known to be causing erosion - Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required.	As per PRCP Schedule.
	RA10, RA11. RA12	PMLU not structurally stable - revegetation stability (Pre-final landform) [Scats]	- Scats stockpile currently does not sustain vegetation as there is no growth media and it is highly porous however there is no requirement for the Scat's Stockpile to host vegetation until required by the PRCP Schedule	- No/limited vegetation growth - Scats stockpile cannot sustain PMLU	- A design for the rehabilitation of the Scat's Stockpile has been generated which has a design slope of 15 degrees and is considered to be suitable to be stable for growth media and subsequent revegetation			✓			✓		✓	Legal & Other	2	4	**12**	**High**	- Rehabilitate scats stockpile to design prior to relinquishment or amend PRCP if design/availability changes	Newmont Manager Legacy Sites Australia	N/A	As per PRCP Schedule.
	RA10, RA11. RA12	PMLU not structurally stable - revegetation stability (Post-final landform) [Scats]	- invasive species -poor landform design (capping depth and thickness) – inadequate topsoil material depth and quality (i.e. lack of ameliorants used for poor quality topsoil).	- Localised erosion gullies - Sediment migration off-site - Exposure of PAF material	- A design for the rehabilitation of the Scat's Stockpile has been generated (including an impermeable cover system) which has a design slope of 15 degrees and is considered to be suitable to be			✓			✓		✓	Financial	2	4	**12**	**High**	- Revegetate bare areas	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
					stable for growth media and subsequent revegetation - Surface water management system - Engineered design(utilizing on soil testing data) - Vegetation establishment and monitoring - capping layer interception monitoring -Materials balance and characterisaiton																	
	RA10, RA11. RA12	Unable to sustain PMLU [Scats stockpile]	- Overgrazing - Failure of controls and/or failure to act on findings linked to risk event controls 4.1-4.9.	- Gradual degradation due to PMLU/grazing	- Controls identified for not achieving PMLU risk events (4.1-4.9) - Visual inspection - Undertake Rehabilitation monitoring as per Section 1.7.2 - Geotechnical inspection - Surface water monitoring as per -Water Management Plan and REMP - Groundwater monitoring as per Groundwater Management Plan		✓	✓	✓		✓		✓	Financial	3	2	9	Medium	- Development and implementation of land use management plan (LUMP) as part of rehabilitation milestone	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
	RA10, RA11. RA12	PMLU causing environmental harm (Pre-final landform) [scats stockpile]	- Major rainfall event causes seepage sump overtopping to the downstream environment (Plum Tree Ck) - Groundwater seepage - Wind transporting scats material into the air, depositing in receiving environment (limited due to coarse particulate sizing up to 45mm (Newmont, 2017), 81% of wind speeds recorded over the past 5 years (Charters Towers Airport) between 1.1-12.6km/h (BOM, 2021), 9.79% of winds <1.1km/h, and 64.31% originating from 0-90 degrees whereby the Northern WRSF (435mAHD), adjacent undisturbed area (414mAHD) and Old Northern TSF (397mAHD), exceed the elevation of the scat stockpile (393mAHD))	- Contamination of Plum Tree Ck - Groundwater contamination - Fish kills - Minor settlement of wind borne scats onto local flora and fauna (long-term gradual accumulation)	- Seepage sump downgradient of the scats stockpile - Pumps (duty and standby, diesel and electric) - Additional pumping capacity was installed after the last seepage sump overtopping event - Upstream levee diverts clean water around the scats stockpile -No observed Scats material outside of described RA extents to date			✓	✓		✓		✓	Environment	4	1	**10**	**Medium**	- Rehabilitate scats stockpile to design prior to relinquishment or amend PRCP if design/availability changes	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.
	RA10, RA11. RA12	PMLU causing environmental harm (Post-final landform) [scats stockpile]	- Installed covers allowing infiltration and seepage - Surface runoff resulting in TSS being discharged from site	- TSS discharged from site	- A design for the rehabilitation of the Scat's Stockpile has been generated (including an impermeable cover system) which has a design slope of 15 degrees and is considered to be suitable to be stable for growth			✓	✓		✓		✓	Environment	2	3	**8**	**Medium**	- Revegetate bare areas and erosion on the landforms to improve surface runoff quality - Continue to intercept seepage flows down-gradient of landforms and pump to the pit	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
					media and subsequent revegetation - Pumps (duty and standby, diesel and electric) - Regular pump testing - Seepage sumps down gradient of dams - Water quality separation - Water quality monitoring - Installed covers - Upstream levee diverts clean water around the scats stockpile.																	
	RA10, RA11. RA12	PMLU not safe to humans, animals or the environment (Post-final landform) [Scats]	- Falling down steep embankments and erosion gullies - Large and exposed rock on batters/covers in some areas - Fuel load leading to fire - Tops of landform not accessible/trafficable by vehicles, horses, etc.	- Injury	- A design for the rehabilitation of the Scat's Stockpile has been generated (including an impermeable cover system) which has a design slope of 15 degrees and is considered to be suitable to be stable for growth media and subsequent revegetation - Restricted access to waste rock dumps (front gate and boundary fencing) - Drainage controls (E.g., benches, drop structures) which limit the risk of erosion - Grazing as a fire management control		✓	✓	✓		✓		✓	Safety	2	2	**5**	**Low**	- No risk treatment proposed as the current risk level is considered to be commensurate with the surrounding landforms - Not aware of any injuries occurring on any of the waste rock dump final landforms - Not aware of an regulation requiring further action to reduce the current risk level	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
	RA10, RA11. RA12	PMLU not safe to humans, animals or the environment (Pre-final landform) [Scats]	- Falling down steep batters - Batters are uneven in some areas - Residual drill holes - Residual material in scats (e.g. steel, concrete pads, timber) poses a hazard for reprocessing - Seepage water quality would not be drinkable for humans or livestock	- Injury	- Restricted access to waste rock dumps (front gate and boundary fencing) - Residual drill holes have been covered - Regular maintenance of the surface if a hazard is observed (e.g. poor drainage, sink holes)		✓	✓	✓		✓		✓	Safety	2	2	5	Low	- No risk treatment proposed as the current risk level is considered to be commensurate with the surrounding landforms - Not aware of any injuries occurring on the scats stockpile - Not aware of an regulation requiring further action to reduce the current risk level	Newmont Manager Legacy Sites Australia	Adequate funding and resources required for monitoring execution and repair work, where required. Adequate resourcing and budget allocated for requirements under LUMP.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
Milestone	**Improvement Area**	**Risk Description** (Include Activity, Product, Service description etc.)	**Potential Cause(s)**	**Impact Assumption** (Details of the credible scenario a risk rating has been assigned for)	**Controls**	Health	Safety	Environment	External Relations	Security	Legal & Other	Production	Financial	**Risk Category - Major Impacted Area**	**Consequence**	**Likelihood**	**Risk Level**	**Risk Rating**	**Risk Treatment Actions**	**Responsibility**	**Resource requirements**	**Timing and Scheduling**
8.0 RESIDUAL VOID																						
MM1, MM3	**IA1**	NUMA causing environmental harm	Void switches from a sink to source to the groundwater aquifer	- Groundwater contamination	- Maximum pit lake fill level - Extensive groundwater modelling and monitoring - water balance model verification of water interception system to manage surface water flows into void (surface water interception system). - water balance model verification of ability to maintain level required to manage potential groundwater impacts under			✓	✓		✓		✓	Legal & Other	3	1	6	Medium	- No risk treatment proposed as current risk level is considered to be ALARP	Newmont Manager Legacy Sites Australia	Adequate resources allocated for water balance model verification.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
					1inX AEP.																	
MM2 ,MM3	IA1	NUMA not safe to humans, animals or the environment [final void]	Steep slopes Rock falls Toxic water Slope failure on northern side (fault line) Fall in pit	- Fatality	- Restricted access to the pit lake (exclusion bund and fencing) - Signs (on order) for fencing - Construction of hard control barrier (i.e. safety bund) around perimeter of NUMA - Warning signage posted around the perimeter - Certification by suitably qualified person that void is safe for humans and livestock - Certification by suitably qualified person that water quality and volume in void will not cause environmental harm.		✓							Safety	4	1	**10**	**Medium**	- Install additional bunding to minimise the exposure (humans and animals) to the pit lake	Newmont Manager Legacy Sites Australia	Fencing materials and personnel for construction and inspection. Personnel for inspections and repairs; tools and equipment for fencing. Adequate resources allocated for certification.	As per PRCP Schedule.
MM3	IA1	NUMA not structurally stable - geotechnical stability	Steep slopes Slope failure on northern side (fault line) Residual void extends beyond permitted EA domain limits --> current pit extent needs to be checked against EA coordinates	- Major wall failure - Impacts to adjacent PMLUs - Increased NUMA extent - Reduced pit lake storage volume	- Surface water management system - Diversion drains - Minimal external catchment into pit lake - External water is pumped into the pit lake - Monitoring of slip failure		✓	✓	✓		✓		✓	Legal & Other	2	2	**5**	**Low**	- If wall failure occurs, increase the extent of exclusion zone and extend the NUMA extent	Newmont Manager Legacy Sites Australia	Adequate resources allocated for inspections.	As per PRCP Schedule.

Risk Summary						Impacted Areas									Current Risk Level				Risk Treatment			
MM3	**IA1**	NUMA not structurally stable - erosional stability	Steep slopes Slope failure on northern side (fault line) Residual void extends beyond permitted EA domain limits --> current pit extent needs to be checked against EA coordinates	- Major wall failure - Impacts to adjacent PMLUs	- Surface water management system - Diversion drains - Minimal external catchment into pit lake - External water is pumped into the pit lake - Monitoring of slip failure		✓	✓	✓		✓		✓	0	1	2	**2**	**Low**	- No risk treatment proposed	Newmont Manager Legacy Sites Australia	Adequate resources allocated for inspections.	As per PRCP Schedule.

1.10 MONITORING AND MAINTENANCE

1.10.1 Rehabilitation Trials

Due to the extent and general overall success of the rehabilitation undertaken to date, no rehabilitation trials are proposed.

1.10.2 Selection of Rehabilitation Milestones and Criteria

The rehabilitation milestones are a series of discrete sequential works which align with rehabilitating the land disturbed during mining to ultimately the pre-approved PMLU of grazing. These discrete rehabilitation works are associated with:

- Removing redundant infrastructure.
- Preparing the landform (i.e., bulk earthworks, placement of capping and growth media layers).
- Revegetation.
- Demonstration of rehabilitation success against criteria, through monitoring program/s.

The overall objective of the rehabilitation works is to achieve a safe, stable and non-polluting final landform.

The PRCP Schedule identifies the rehabilitation milestones applicable to the mine. Each milestone is functionally a discrete work package required to achieve the overall PMLU of grazing. Grazing is a pre-approved PMLU for the purpose of the PRC plan because it has been identified as a PMLU in the Mt Leyshon Closure Plan (Newmont, 2019) which is a land outcome document for the Mt Leyshon Mine (required by Condition F4-1, and F10-1 and 2 of Mt Leyshon's EA). The EA and the Mt Leyshon Closure Plan (Newmont, 2019) include closure outcomes for determining whether a stable PMLU has been achieved. Determinations regarding meeting closure criteria for land were made using the CSIRO developed LFA and EFA frameworks from 2007-2011. In 2013, Newmont and Outback Ecology designed and implemented a rehabilitation monitoring program (Rapid Assessment Framework) that was based on LFA and EFA parameters and met the requirements of the EA. The Rapid Assessment Framework ultimately results in a quantitative 'score' for a rehabilitation area based on a variety of assessment measures so that rehabilitation performance can be assessed against relevant completion criteria (i.e., analogue site scores based on the same method). The Rapid Assessment technique is to be used to indicate progression of rehabilitation toward completion criteria when full LFA/EFA assessments will be undertaken to determine if completion criteria have been achieved in accordance with the Mt Leyshon Closure Plan which requires criteria to be met for three years of monitoring.

Closure outcomes have been transitioned into criteria for the applicable rehabilitation milestones (Figure 1.79). The criteria are used to measure, track and demonstrate progression of a land unit from one rehabilitation milestone to another over time. Milestone criteria are used to inform if the rehabilitation milestone has been achieved. These rehabilitation milestone and milestone criteria allow rehabilitation success to be tracked throughout the life of the mine and inform decisions regarding the progression of a land unit between milestones.

Monitoring is undertaken as part of each milestone to assess whether the works undertaken have met the milestone criteria or whether rectification works are required. Rehabilitation areas which satisfy the milestone criteria can progress to the next rehabilitation milestone (where relevant) as shown in Figure 1.79. The rehabilitation milestone criteria have been based on the Mount Leyshon Closure Plan (Newmont, 2019) and the Mount Leyshon Plan of Operations (Newmont, 2019). The basis of the criteria set to demonstrate rehabilitation success was primarily the EMOS (Newmont 1993) and were also informed by historical monitoring reports for surface water and groundwater (Big Dog Hydrogeology) and rehabilitation (Stantec/Outback Ecology Services). The criteria are based on the "SMART" approach to goal setting. The supporting monitoring methodology is repeatable and provides measurable data to track progress and trends against criteria.

For the RM6 rehabilitation milestone, the completion criteria are based around meeting acceptable standards when compared to analogue sites and are taken to nominally meet acceptable standards 20 years after reaching RM5 for areas that are not reliant on the water interception system, and nominally 100 years for those areas that are reliant on the water interception system. The duration is justified based on gathering representative data over time and the long-term stabilization of systems reliant on the interception systems.

The RM1-6 rehabilitation milestone criteria are dependent on the works complying with the design criteria. The use of analogue sites is deemed suitable from the perspective that they have not been disturbed by mining, have been subject to long term seasonal variabilities, are representative of the PMLU for Mount Leyshon Mine, and have long term monitoring data collected on them.

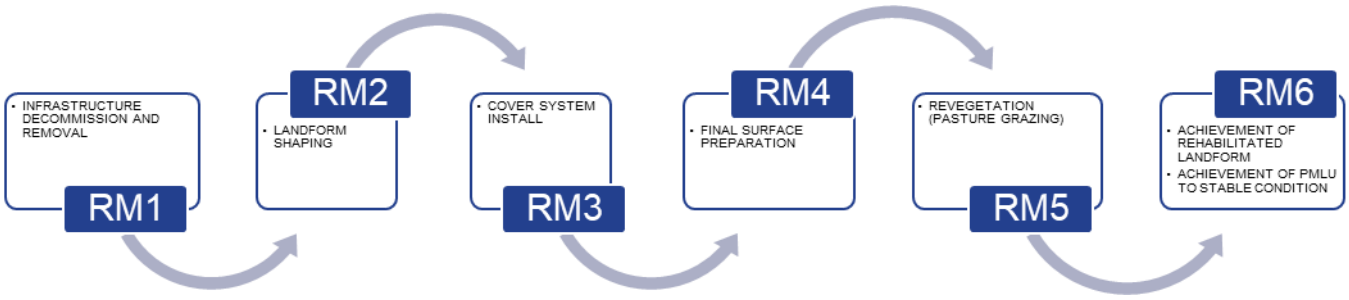


Figure 1.79: Rehabilitation Milestone Progression Phases

The milestone criteria are a mix of physical, environmental and ecological attributes e.g., infrastructure removed, landform, vegetation composition etc. The criteria have been developed taking into consideration guidelines, standards and scientific literature or other sources such as current knowledge from monitoring data and operational experience, as appropriate which were available at the time of preparing the document.

There is an element of risk attached to the development of criteria, in that it is difficult to predict all the variables that might influence the rehabilitation success of post mining rehabilitated lands. Many variables operate at catchment or regional scales, such as river flows, bushfires and pest outbreaks. Other factors that operate at continental or even global scales, such as climatic influences (including droughts or floods brought about by La Niña and El Niño events), could significantly influence the long-term sustainability of the vegetated lands encompassed by the site. To this end, the criteria have been designed to provide an appropriate benchmark or guide against which to assess rehabilitation progress and the resulting improvements.

1.10.3 Monitoring and Maintenance Program

Groundwater

Condition C13-1 of the EA requires Mt Leyshon to provide a groundwater monitoring program (Appendix A: and report annually (Condition C16-1). The program is based on EA conditions and includes monitoring locations, frequencies, and analysis requirements. The EA sets trigger levels and contaminant release limits in Schedule C – Table 13 which are incorporated into the plan. It is noted that electrical conductivity and pH do not have trigger levels and contaminant levels set in the EA, and sulphate does not have a trigger level set in the EA and are reliant on the REMP already submitted.

The EA specifies the conditions which contaminant limits are not to be exceeded, and scenarios when investigations are required. Compliance with the EA provides a monitoring regime and closure criteria until alternate criteria are agreed between DES and Mt Leyshon. In the interim, achievement of compliance with the EA conditions related to groundwater for eighteen groundwater samples over a two year period is considered sufficient to demonstrate achievement of completion criteria in accordance with the methods to establish guideline criteria (DES, 2021). The conditions which are to be used as criteria for use in milestones in the PRCP schedule for groundwater are: C15-1, C15-2, C15-3.

Table 1.32: Groundwater Quality Completion Criteria

Quality Characteristic	Contaminant Release Limit Level (mg/L unless otherwise)	Trigger Levels (µg/L unless otherwise)	Comment
Electrical Conductivity (µS/cm)	TBA	TBA	To be determined in conjunction with REMP discussions with DES.
pH (pH unit)	TBA	TBA	

Quality Characteristic	Contaminant Release Limit Level (mg/L unless otherwise)	Trigger Levels (µg/L unless otherwise)	Comment
Sulphate	1000	TBA	N/A and To be determined in conjunction with REMP discussions with DES.
Aluminium	5	55	N/A
Arsenic	0.5	13	N/A
Cadmium	0.01	0.2	N/A
Chromium	1	1	N/A
Cobalt	1	2.8	N/A
Copper	1	1.4	N/A
Lead	0.1	3.4	N/A
Nickel	1	11	N/A
Zinc	20	8	N/A
Cyanide (Free)	0.22	7	N/A

Surface Water

Condition C1-4 of the EA requires Mt Leyshon to provide annual updated monitoring data associated to trigger levels and contaminant limits in the EA. The trigger levels and contaminant release limits are specified in Schedule C – Table 2 of the EA, noting that electrical conductivity and pH do not have trigger levels and contaminant levels set in the EA, and sulphate does not have a trigger level set in the EA and are reliant on the REMP already submitted. The EA specifies the conditions under which releases are able to occur, including contaminant limits not to be exceeded under natural waterway flow regimes, and scenarios when investigations are required when trigger levels are exceeded. Compliance with the EA provides a monitoring regime and closure criteria until alternate criteria are agreed between DES and Mt Leyshon as a result of implementation of the REMP. In the interim, for moderately and highly disturbed waters, the *Guideline: Deciding aquatic ecosystem indicators and local water quality guideline values* states that the median value of preferably five or more independent samples at a monitoring site should be compared against the corresponding ecosystem water quality objectives (DES, 2022). For the purpose of achieving completion criteria, ten samples collected over a two year period (with releases occurring from direct rainfall runoff from a Mt Leyshon catchment) that are compliant with release criteria of the EA are considered sufficient to demonstrate achievement of completion criteria. The conditions which are to be used as criteria for use in milestones in the PRCP schedule for surface water are: C1-4, C2-2 to 4, C3-1 to 2, C4-1 to 3, C4-5 to 7.

EA contaminant limits and trigger levels for receiving waters are presented in Table 1.33.

Table 1.33: Surface Water Quality Completion Criteria

Analyte	Contaminant Release Limit Level (mg/L unless otherwise)	Trigger Levels (µg/L unless otherwise)	Comment
pH	TBA	TBA	To be determined in conjunction with REMP discussions with DES.
EC (µS/cm)	TBA	TBA	
Sulphate	1000	TBA	N/A and To be determined

Analyte	Contaminant Release Limit Level (mg/L unless otherwise)	Trigger Levels (µg/L unless otherwise)	Comment
			in conjunction with REMP discussions with DES.
Total Suspended Solids	50	N/A	
Aluminium (dissolved)	5	55	N/A
Arsenic	0.5	13	N/A
Cadmium	0.01	0.2	N/A
Chromium	1	1	N/A
Cobalt	1	2.8	N/A
Copper	1	1.4	N/A
Lead	0.1	3.4	N/A
Nickel	1	11	N/A
Uranium	0.2	8.0	N/A
Zinc	20	8	N/A
Cyanide (Total)	1	7	N/A

Monitoring of Landforms

In 2013 Newmont implemented a “Rapid Assessment” methodology to track the progress of the rehabilitation areas over time, which is pivotal for meeting several milestone criteria for RM6. This methodology was developed by Outback Ecology and submitted to the Administering Authority prior to implementation (Outback Ecology, 2013). The Rapid Assessment method separates each rehabilitated landform into sub-domains. Each sub-domain represents an area comprising of different ages of rehabilitation, topography, vegetation communities or aspect. In total, 31 rehabilitation sub-domains across 11 landforms were identified during the first assessment in 2013, in addition to three analogue areas that were used as reference sites.

The sub-domains are then assessed, and results quantified using scale-based scores for a range of parameters relating to landform and soil surface characteristics, vegetation condition and structures, weeds and erosion which are all based on LFA/EFA methods. Each parameter score ranges from one to five, with one representing the lowest score possible and five representing the highest score possible. An aggregate numerical score from 20 parameters (maximum possible score of 100) is assigned to each sub-domain so changes in rehabilitation condition can be detected over time. All parameters are treated equally, with no numerical weighting applied. Analogue sites are subject to the same assessment and results are compared to determine if they meet the established criteria (i.e. rehabilitated area score >70% of analogue score). Note that a perfect score of 100 is extremely unlikely to be achieved by any site, including analogues (Stantec, 2019).

In addition to the scale-based scoring, the assessment also includes:

- photo-point monitoring of existing EFA transects and installation of additional representative photograph locations.
- way-pointing (GDA94) and photographing erosion features (gullies and rills).
- way-pointing (GDA94) of restricted invasive species (such as Opuntia stricta (Prickly pear)), and observations of other environmental weeds.
- documenting other potential factors affecting condition (i.e., tree death). and,

- incidental notes relating to vegetation and landform condition including the observation of fauna or surface expression of potentially hostile materials.

Object Based Image Analysis (OBIA) was implemented during the 2020 annual monitoring program to compliment the rapid assessment. OBIA uses aerial imagery and computer software to categorise cover classes in the image. This occurs through:

- The normalised difference vegetation index (NDVI), which measures greenness and therefore condition (indicating vegetation health).
- Ground cover analysis, which highlights significant concentrations of low or high cover through classification of bare ground, grass, shrub, litter, shadow and water.

Prior to the use of the Rapid Assessment methodology, the CSIRO-developed Ecosystem Function Analysis (EFA) Framework was utilised, hence the reference to the EFA in the PMLU completion criteria. It is important to clarify that despite the change in methodology from full LFA/EFA assessments to the Rapid Assessment Framework, the basis of the change is to report on the same parameters and outcomes are tracked within RM6 criteria through the Rapid Assessment Framework and it is considered that the Rapid Assessment Framework is suitable to indicate achievement of criteria based on the LFA/EFA monitoring frameworks. Table 1.34 shows how the Rapid Assessment Framework methodology is based on LFA/EFA techniques and provides a suitable framework for tracking rehabilitated landform stability and vegetation performance toward completion criteria requirements. Once the Rapid Assessment indicates a strong likelihood of achieving full LFA/EFA method results that meet the Closure Plan (2019) completion criteria, full LFA/EFA assessments will be conducted with achievement of completion criteria occurring when criteria are met for three years (which has been adopted for RM6 as shown Table 1.34.

Table 1.34: Landform Stability and Vegetation Completion Criteria

PMLU Rehabilitation Goal (2019 Closure Plan)	PMLU Indicator (2019 Closure Plan)	PMLU Completion Criteria (2019 Closure Plan)	LFA/EFA Methodology	Rapid Assessment Framework (RAF) Methodology (Refer to Rapid Assessment Handbook , APPENDIX D)	Comment	Completion Criteria
Stable Landform	Assessment of soil stability and erosion through **Landscape Function Analysis (LFA) monitoring.**	Soil surface stability greater than or equal to the lower limit of the average regional range for three years of monitoring.	Soil stability and surface condition assessed through landscape function analysis (LFA) scoring system and supporting spreadsheet to provide indices for each zone for stability, infiltration and nutrient cycling: • Soil cover • Perennial basal cover • Litter cover • Crust condition • Erosion features • Deposited materials • Cryptogram cover • Micro-topography • Surface nature • Slake test • Texture	Soil stability assessed through scoring system and supporting spreadsheet to provide an overall 'performance score' at photo points: • Slope angle • Slope length • Topsoil • Slake test • Overall condition • Investment required • Factors affecting closure • Surface stability • Surface cover	Stability of a landform is assessed on the as constructed grade and the annual influence of the preceding seasons. Consistent measure of angles and lengths will indicate subsidence, tunnel erosion, piping, etc. Presence of topsoil will determine ability to establish and maintain vegetation to complement the PMLU and will also indicate erosive processes. Slake testing indicates the potential for structural stability. All indicators from the RAF are based on the LFA/EFA monitoring frameworks.	≥70% of analogue median score (to be verified through future monitoring) for three years of monitoring.
	Erosion monitoring conducted in conjunction with **Ecosystem Function Analysis (EFA) monitoring.**	Erosion features less than or equal to the upper limit of the average regional range for three monitoring years.	Erosion assessed through fixed-position erosion transects on upper and lower sections at right angles to the main transect. Number of rills (0.3m deep) and gullies (greater than 0.3m deep) are counted and their width and depth measured.	Erosion features assessed through scoring: • Rill frequency (numerous/severe, numerous/small, many, few, none) • Gullies (many/large, many/small, few/establishing, few/established, none) • Feature stability (active, mostly active, becoming stable, mostly stable, stable)	Erosion measured in consistent locations annually. Major types of erosion are identified during field observations and reported on annually to inform status. All indicators from the RAF are based on the LFA/EFA monitoring frameworks.	≥70% of analogue median score (to be verified through future monitoring) for three years of monitoring.
Sustainable Ecosystems	Demonstrate that vegetation establishment trends towards relevant analogue sites, or it is appropriate in terms of plant species composition, diversity, abundance, cover and function.	70% of analogue median (to be verified through future monitoring) for three years of monitoring, applicable to: • Native grass cover and diversity • Woody species cover and diversity • Perennial grass species cover and diversity	Vegetation establishment and diversity assessed through below methods: Point-Centred Quarter (PCQ): sampling points located 5m intervals along transect, area divided into quarters, width/breadth/species and distance from tape of nearest perennial plant is measured to obtain plant cover and density indices for each quarter. Wandering Quarter (WQ): calculates upper-storey value of cover and density for perennial plants >3m in height, and values for cover and density of sparsely dispersed lower-storey vegetation. Belt: quantify density of Stylosanthes spp within 2 metres either side of transect (stems/ha) Area method: used where too few plant individuals are present. All plants counted and measured within quadrat.	Vegetation establishment and diversity assessed through scoring system and supporting spreadsheet to provide an overall 'performance score' at photo points for grasses, herbs, woody species (<1.5m), upper storey (>1.5m): • Cover (none, low-%, patchy-%, moderate-%, high-%) • Species richness (none, low 1-2 , medium 3-5, high 6-10, very high >10) Scoring from rapid assessments complimented with object based image analysis (OBIA) to categorise cover classes through: • The normalised difference vegetation index (NDVI), which measures greenness and therefore condition (indicating vegetation health). • Ground cover analysis, which highlights significant concentrations of low or high cover through classification	Vegetation measured in consistent locations annually. The assessment covers the likely range of canopies and species types expected for the PMLU and includes unwanted species. All indicators from the RAF are based on the LFA/EFA monitoring frameworks.	≥70% of analogue median score (to be verified through future monitoring) for three years of monitoring.

				of bare ground, grass, shrub, litter, shadow and water. Introduced species and weeds are recognised in the assessment for completeness regarding wanted and unwanted species types.		
	Weed populations do not require specific management above that of the surrounding land.	All legal requirements are met for declared or noxious weed management (compliance with QLD weed management legislation).	Weed presence assessed through the Crown Separation Ratio method.	Weed presence along corridors and edges assessed through scoring system (species abundance and cover %) and supporting spreadsheet to provide an overall 'performance score' at photo points.	Identification of unwanted species in non-rehabilitated areas forms the basis of acceptable presence. All indicators from the RAF are based on the LFA/EFA monitoring frameworks.	No restricted invasive Category 3 plants not already present at analogue rehabilitation sites.
	Vegetation monitoring along permanent transects as part of **EFA assessment.**	The capacity to retain water and nutrient resources is equivalent to target ecosystems. **LFA** infiltration index and nutrient cycling index are at least 70% of median for target ecosystem for three years of monitoring.	Soil stability and surface condition assessed through landscape function analysis (LFA) scoring system and supporting spreadsheet to provide indices for each zone for stability, infiltration and nutrient cycling: • Soil cover (1-5) • Perennial basal cover (1-4) • Litter cover (simple 1-10, complex 1-30) • Crust condition (1-4) • Erosion features (1-4) • Deposited materials (1-4) • Cryptogram cover (1-4) • Micro-topography (1-5) • Surface nature (1-5) • Slake test (1-4) • Texture (1-4)	Soil stability assessed through scoring system and supporting spreadsheet to provide an overall 'performance score' at photo points: • Surface stability (unstable %, unstable patches %, fair %, mostly intact %, very stable %) • Surface cover (bare %, plants %, litter %)	The cover and diversity assessment provides a representative assessment of vegetation performance which relies on water and nutrients that has been influenced by seasonal conditions.	≥70% of analogue median score (to be verified through future monitoring) for three years of monitoring.

Fundamental to Newmont demonstrating the successful rehabilitation of the mine site is the comparison of annual monitoring results for the analogue with the rehabilitation sites. The analogue sites that have been selected are areas that represent the values and characteristics of the final land use. The average of the analogue RAF scores calculated for all the analogue sites relates to the rehabilitation milestone criteria. The RAF scores from the annual monitoring of the rehabilitation and analogue sites is influenced by localised and wider climatic and environmental conditions. The milestone criteria are therefore dynamic and provide a more representative snapshot and comparison between the rehabilitation and analogue sites both between and within years.

Further details on the rehabilitation monitoring methodology can be found in Appendix D.

1.10.4 Data Analysis and Reporting

Rehabilitation monitoring data will be assessed against the milestone criteria and compared to previous annual monitoring results which commenced in 2013. Data will be analysed to identify changes, trends and map the trajectory of rehabilitation to identify whether it is on track to achieve the PMLU and / or to identify areas of rehabilitation where constraints to performance may require remedial actions.

All rehabilitation monitoring reports and supporting data and documents will be stored in Newmont's data and document management system. All other rehabilitation documentation including milestone completion records and the PRCP schedule will also be stored.

1.10.5 PRCP Schedule

The PRCP Schedule is provided in Appendix R:

Table 1.35: Rehabilitation Milestone. Criteria and Monitoring

Milestone Reference	Rehabilitation Milestone	Milestone Criteria	Monitoring Methodology	Monitoring Frequency	Reporting	Contingency Strategy
MILESTONES FOR PMLUs						
RM1	INFRASTRUCTURE DECOMMISSION AND REMOVAL	• All infrastructure (i.e., mining and ancillary) removed unless relied upon for rehabilitation and water management purposes or otherwise agreed and asset transfer agreement in place for infrastructure retained.	• Visual inspection (i.e. site assessment of remaining infrastructure against agreed retained items/asset register) and review of termination documentation to demonstrate termination/removal	• Annually	• Internal • Document inspections (Update mapping and records)	• Organize disconnection • Update mapping and records as required
RM2	LANDFORM SHAPING	• Bulk earthworks have been completed to achieve final landform design batter slope requirements: **Facility** / **Batter Slope (Degrees)** Scats stockpile: 15 Northern Waste Rock Storage Facility: 12 Southern Waste Rock Storage Facility: 11 Eastern Waste Rock Storage Facility: 13 Old Northern Tailings Storage Facility: 15 Southern Tailings Storage Facility: 14 New Northern Tailings Storage Facility: 16 • Install future ESC structures as per design and certified by an appropriately qualified person. • Report provided by suitably qualified person to verify "as constructed" complies with the final landform design for any future re-shaping works.	• Visual during works • Ground survey and / or LiDAR.	• At nominated hold points as described in the inspection test program (i.e., progressively) and at the completion of the works	• Report verifies "as constructed" complies with the design	• Reprofile landform to comply with design • Update schedule or adjust work schedule (i.e. accelerate or decelerate as needed)
RM3	COVER SYSTEM INSTALL	• Bituminous Geo-Membrane transported, handled, stored, and installed to Original Equipment Manufacturers OEM specifications on Scats Stockpile. • Conformance checks verify "as constructed" complies with the design for: – slope angle (maximum 15 degrees) – sub grade preparation (i.e. uniform grades, acceptable deformities) – ultimate footprint extents – anchoring and overlap/joining of materials	• Visual during works • Ground survey and / or LiDAR and/or test pitting. • Material complies with design specification – geotechnical report • ITP for all critical installation points	• At nominated hold points as described in the inspection test program (i.e., progressively and at the completion of the works to agreed standard between contractor and principal).	• Report verifies "as constructed" complies with the design	• Reprofile landform to comply with design • Update schedule or adjust work schedule (i.e., accelerate or decelerate as needed)
RM4	FINAL SURFACE PREPARATION	• Remediation of existing erosion/ponding and conformance checks by suitably qualified person demonstrate acceptable surface preparation to design. • Application of ameliorants to growth media harvested from Northern Borrow Pit sample locations prior to placement: – Samples 1-4; Gypsum at 5t/ha – Samples 1-11 Nitrogen, Phosphorous, Sulphur fertilizer at 150kg/ha – Samples 1-4, 6-9: Zinc Sulfate at 10kg/ha and samples 5, 10 and 11 at 5kg/ha – Samples 1, 4, 5: Organic matter at 20t/ha, samples 2,3 and 6-11 at 40t/ha • Apply nominated depth of growth media, 0.3m otherwise: – Stockpiles (0.45m) – Scats Stockpile (0.5m) – Mine Infrastructure (0.1m) – Northern Borrow Pit and Quarry (0.15m) • Conformance checks by suitably qualified person verify "as constructed" complies with the design.	• Visual during works • Ground survey and / or LiDAR and /or test pitting.	• Prior to placing topsoil or seeding as appropriate.	• Document topsoil depth • Document conformance checks and reporting by suitably qualified person • Document soil ameliorants requirements	• Adjust topsoil depth as needed • Test and / or ameliorate as needed.

RM5	REVEGETATION (PASTURE GRAZING)	• Apply pasture grass seed mix (*Buffel, Seca, Couch, Wynn-Cassia, Rhodes*) at 5 to 8 kg/ha (equal portions). • Apply ameliorants at rates determined by an appropriately qualified person (see RM4). • Rip/plough/tyne growth media (preserving cover system) as per design.	• Visual inspection and document review	• After seeding has occurred	• Document seed mix, • Ameliorant application rates and areas	• Remediate areas not adequately ripped • Reseed as required • Review seeding methodology, seeding rate, seed species, seed viability, etc.
RM6	ACHIEVEMENT OF PMLU TO STABLE CONDITION	• Infrastructure decommissioning and removal activities have been undertaken in accordance with a decommissioning strategy. • Infrastructure (i.e., mining and ancillary) removed unless otherwise agreed and asset transfer agreement in place for infrastructure retained. • Site contamination investigation report for mine has been prepared by an approved auditor under the *Environmental Protection Act 1994* and any requirements for a site management plan incorporated into the Land Use Management Plan (LUMP). • Groundwater quality meets EA conditions C15-1, C15-2, C15-3 for at least 18 samples collected over a two-year period • Surface water quality with the potential to directly discharge to the environment meets EA conditions C1-4, C2-2 to 4, C3-1 to 2, C4-1 to 3, C4-5 to 7 for 10 samples collected over a two-year period • Soil stability greater than or equal to the lower limit of the average regional range for three years of monitoring using full LFA/EFA methods • Erosion features less than or equal to the upper limit of the average regional range for three monitoring years using full LFA/EFA methods • >70% of analogue median using full LFA/EFA assessments for 3 years of monitoring for native grass cover and diversity, woody species cover and diversity, and perennial grass species cover and diversity • Full LFA assessment method for infiltration index and nutrient cycling index are at least 70% of median for target ecosystem (determined at analogue sites) for three years of monitoring. • No restricted invasive Category 3 plants not already present at analogue rehabilitation sites observed at rehabilitated sites measured by using the rapid assessment method. • 10-yearly report trending water interception volumes and quality against REMP trigger limits requirements submitted to DES for RA's reliant upon water interception system.	• LFA/EFA • Geotechnical inspection • Surface water monitoring as per Water Management Plan, REMP, and EA condition C1-4 • Groundwater monitoring as per Groundwater Management Plan and Condition C16-1 of the EA	• Surface water quality and groundwater quality: Rainfall event based. • All: Annually	• LFA/EFA assessment reports • Geotechnical inspection reports including assessment regarding predicted failures and general stability • Water management plan and REMP reports • Groundwater Management Plan	• Investigate underlying cause of issues • Develop maintenance program for remediation • Carry out remediation program

MILESTONES FOR NUMAs

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
MM1	ACHIEVEMENT OF SURFACE WATER REQUIREMENTS	• After decommissioning of water interception system (pumping ceases due to water quality meeting EA release requirements) • Water balance model verification that RL340 will not be reached through inputs into void (catchment water flows, localised seepage, rainfall)
MM2	ACHIEVEMENT OF SURFACE REQUIREMENTS	• Construction of hard control barrier (around perimeter of NUMA at minimum of 1m high • Warning signage posted every 100 m of the perimeter
MM3	ACHIEVEMENT OF SUFFICIENT IMPROVEMENT	• Certification from an appropriately qualified person that the water level and quality in the void will not cause environmental harm to the surrounding environment • Certification from an appropriately qualified person that the void is safe to humans and livestock

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Appendix A:
Mt Leyshon Groundwater Management Plan

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NEWMONT MINING SERVICES PTY LTD MT LEYSHON GROUNDWATER MANAGEMENT PLAN

Report Status

Revision	Date	Signature
A (Draft)	*July 2013*	
B (Final)	*September 2013*	
C (Final)	*September 2013*	
D (Final)	*January 2015*	
E (Final)	*January 2017*	
F (Final)	*December 2017*	S Barnett

EXECUTIVE SUMMARY

The Mt Leyshon mine is an open pit gold mine located 24 km south of Charters Towers, which has been in closure since 2002. Operations at the Mt Leyshon mine are governed by Environmental Authority (EA) EPML00863713 issued to Newmont Landco Pty Ltd (Newmont). Schedule C of the EA defines operating conditions for water, including groundwater bores to be sampled (Schedule C, Table 12), and contaminant limits and trigger values for groundwater (Schedule C, Table 13). Condition C13-1 of the EA requires that a groundwater monitoring program is developed for the site, and submitted to the Department of Environment and Heritage Protection (DEHP) by 30 November, 2013, and the original version of this document (Revision C) was submitted to DEHP within the required timeframe to satisfy this condition.

The groundwater monitoring locations and frequency defined in the previous version of the EA issued in 2013 were derived from the compliance groundwater monitoring programme defined in original versions of the EA, which in turn were based on the understanding of groundwater conditions which was available at the start of the closure period.

Hydrogeological investigations undertaken at the Mt Leyshon mine during the mining and closure period include both shallow and deep electrical geophysical surveys, installation of 10 deep investigation holes to depths up to 300 m with vibrating wire piezometer (VWP) sensors installed, installation of 58 shallow monitoring bores, and investigation of 35 existing monitoring bores. In combination with monitoring data collected during the mining and closure period, these provided a detailed understanding of the groundwater transmitting systems at the site. This understanding allowed the potential pathways and mechanisms for the transmission of groundwater which could cause environmental harm to be defined. Subsequently, a recommended groundwater monitoring programme was developed, which was designed taking account of these identified pathways and mechanisms, and was described in Revision C of this document, as required under the conditions in the EA.

The deep groundwater system comprises fracture zones within the deep unweathered basement rocks. These occur predominantly close to the open pit and limited fracturing was identified in the surrounding granite and dolerite country rocks. The primary interaction for the deep groundwater system is with the lake in the open pit, and the risk of environmental harm associated with the deep groundwater system was assessed to be very low. Monitoring which was recommended for the deep groundwater system was continuous monitoring of the 46 installed VWP sensors. Responses in these sensors will identify the interactions between the pit lake and the deep basement groundwater system as the elevation of the pit lake increases.

The shallow groundwater system comprises the weathered and fractured zone at the upper basement surface, typically encountered between 5 and 25 mBGL. The main changes from background conditions which have been observed in groundwater in this system are increased groundwater elevations near the mine facilities, increased sulphate concentrations down-gradient of all facilities, and increased Co concentrations down-gradient of tailings facilities. These changes are well defined by the available data, and potential future changes in sulphate concentration have been determined using a numerical groundwater flow model. This model was recently reviewed and validated using monitoring data collected from 2012 to 2017 (BDH, 2017). The shallow groundwater system potentially interacts with groundwater abstractors and with the surface water systems. Based on an assessment of the potential pathways for migration of environmental harm, monitoring which was recommended for the shallow groundwater system was:

- Annual sampling of bores indicated to be hydraulically up-gradient of the site to define background groundwater chemistry.
- Annual sampling of bores which are close to the mine facilities and within the known zone of impacted groundwater for interpretation purposes. Sampling of these bores was intended to define any changes in the influence of seepage from the mine facilities.

- Annual sampling of bores which are located immediately outside the zone of impacted groundwater for compliance purposes. Results will identify any future migration of the impacted groundwater and confirm that the predictions from the numerical groundwater flow model remain valid.
- Measuring depth to groundwater in all 69 available monitoring bores twice per year, in order to identify any localised increase in groundwater elevations near the mine facilities, and to provide early warning of when regional groundwater elevations are higher, in response to seasonal conditions, which increases the risk of groundwater discharge to the surface water environment.

These recommendations for groundwater monitoring were subsequently used as the basis to update groundwater monitoring requirements in the version of the EA issued in June 2014. This document provides an updated version (Revision F) of the Groundwater Management Plan (GMP) which includes changes to account for the updated closure approach for the Scats Stockpile. The preferred remediation approach for the Scats Stockpile is to leave the stockpile in its current configuration (uncovered, as described in the Scats Remediation Plan [Newmont, 2017]). The primary change to the GMP is the addition of NMLMB20 as an interpretation bore, to be sampled annually in order to confirm that no significant changes in groundwater chemistry are observed immediately down-gradient of the Scats Stockpile.

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Appendices

Appendix A Completion diagrams for recommended groundwater sampling bores

1. Introduction

1.1 Background and version control

The Mt Leyshon site is an open pit gold mine located 24 km south of Charters Towers, which has been in closure since 2002. Mt Leyshon commenced operations in September 1986. It produced gold and silver, initially as a heap leach operation of oxide ore, and then via carbon in pulp processing of primary un-oxidised ore commencing in 1989. Mining ceased due to depletion of the ore body in early 2001 after which mill feed was sourced from low grade stockpiles which were processed until March 2002. Maintenance and rehabilitation of the site is being undertaken by Newmont Landco Pty Ltd (Newmont), and is ongoing.

Operations at the Mt Leyshon site are governed by Environmental Authority (EA) EPML00863713 issued to Newmont. Schedule C of the EA defines operating conditions for water, including groundwater bores to be sampled (Schedule C, Table 12), and contaminant limits and trigger values for groundwater (Schedule C, Table 13). Condition C13-1 of the EA required that a groundwater monitoring program is developed for the site, and submitted to the Department of Environment and Heritage Protection (DEHP) by 30 November, 2013. This condition was met by an earlier version (Revision C) of the current document, referred to as the Groundwater Management Plan, or GMP.

The groundwater monitoring locations and frequency defined in the previous version of the EA issued in 2013 had been derived from the compliance groundwater monitoring programme defined in original versions of the EA, which in turn were based on the understanding of groundwater conditions which was available at the start of the closure period. Between 2009 and 2013, a detailed groundwater investigation programme had been completed at the site, including three campaigns of extensive investigation drilling, which allowed the development of an improved and detailed characterisation of the groundwater systems at Mt Leyshon.

Newmont commissioned Big Dog Hydrogeology Pty Ltd (BDH) to prepare the original GMP (Revision C) in 2013, which was required to:

- Summarise the understanding of the characteristics of the groundwater transmitting systems at Mt Leyshon.
- Identify potential for harm to environmental values to occur resulting from mining related changes in the groundwater systems.
- Describe mitigation options and concurrent studies in place to quantify and minimise the risk of environmental harm.
- Define an updated monitoring plan which took account of the identified risks, was supported by the available characterisation data, and met all the requirements for a monitoring plan defined in condition C13-1 of the EA.
- Provide a convenient stand-alone summary of current and potential future groundwater conditions, which could be referenced during the generation of other plans for Mt Leyshon, including the Receiving Environment Monitoring Plan (REMP) and the Water Management Plan.

The resulting GMP was described in the version (Revision C) of this document issued in September 2013 (BDH, 2013). Subsequently, the groundwater monitoring regime described in the GMP was used to update the version of the EA issued in June 2014.

In September 2014, a review of the GMP was undertaken, which recommended minor changes to the document to reflect minor changes in the conceptual groundwater flow model derived from monitoring data collected in 2013 and 2014. Revision D of the GMP which included the recommended changes was issued in January 2015 (BDH, 2015a).

During 2016, minor further changes were made to the monitoring groundwater regime at the Mt Leyshon mine. These changes related to VWP monitoring, continuous depth monitoring, and monitoring bore decommissioning. Revision E of the GMP was issued in January 2017 to account for these changes.

In June 2017, the Scats Remediation Plan (SRP) was updated and reissued (Newmont, 2017), and described that the preferred approach for the Scats Stockpile was to retain the current configuration (without a cover). Additional groundwater sampling undertaken during preparation of the SRP identified that the influence of the Scats Stockpile on down-gradient groundwater hydrochemistry could not be discerned over the existing influences from the adjacent rehabilitated New North Tailings Storage Facility. However, the SRP noted that ongoing sampling of NMLMB20 located down-gradient of the SRP could be undertaken to confirm this remains the case.

This version (Revision F) of the GMP has been updated to include these changes in Section 4. The interpretation of monitoring data and environmental values presented in Sections 2 and 3 have not been updated, other than to confirm that the recent monitoring data continue to support the interpretations made in 2013. Table 1 summarises the revision history of the GMP.

Table 1: GMP revision history

GMP Version	Issue Date	Details
Rev C Final	September 2013	Summarised and interpreted all groundwater data available to 2013 and recommended new monitoring regime for incorporation into EA.
Rev D Final	January 2015	Updated to reflect change in status of NMLMB2 from compliance to interpretation and to match the actual conditions in the EA.
Rev E Final	January 2017	Updated to reflect the change to manual monitoring of VWP sensors and manual depth measurement at MLM28, NMLMB1, NMLMB6, and to remove monitoring bores decommissioned by grouting in 2016 (MLM14, MLM19, MLM20, MLM21, MLM58).
Rev F Final	December 2017	Updated to reflect the addition of NMLMB20 as an interpretation bore, with sampling undertaken to confirm groundwater hydrochemistry downgradient of the Scats Stockpile.

1.2 Reference documents

The foundation for development of the original GMP (Revision C, BDH 2013) comprised two key documents produced by Schlumberger Water Services (SWS), which provided a complete description of groundwater conditions at Mt Leyshon. These key documents were:

1. SWS, 2012. Mt Leyshon, 2012 Updated Assessment of Groundwater Conditions. Report 50322R4. This report compiled all available geophysical, drilling and monitoring data into an updated description of the groundwater transmitting systems at Mt Leyshon.
2. SWS, 2013. Mt Leyshon Groundwater Flow and Solute Transport Modelling. Report 50322R5. This document described the construction and calibration of a numerical model of groundwater flow and sulphate transport, which was subsequently employed to predict future groundwater conditions at the site.

The large amount of detail included in these key documents is not reproduced in this GMP. However, the important conclusions and the most illustrative figures from these documents are re-presented, to provide sufficient description of the groundwater conditions to provide an understanding of the context of the identified mitigation options and monitoring. This allows the GMP to function as a stand-alone reference document for other management plans in place at the Mt Leyshon mine.

1.3 Compliance with EA requirements

Components which are required to be included in the monitoring plan for Mt Leyshon are described in condition C13-1 of the EA. For convenience, Table 2 reproduces these requirements from the EA, and describes where each requirement is met, both within this GMP, and within the key reference documents.

Table 2: Locations where EA requirements are addressed

EA Clause	EA Requirement	Where Addressed in GMP	Where Addressed in Reference Documents
C13-1 a	Locations of monitoring bores	Section 4, Figure 26	SWS, Nov 2012, Table 1.1, Figure 1.1
C13-1 b	Justification of monitoring locations including background and contamination	Section 3, Figure 26	SWS, Nov 2012, Section 3.3.6
C13-1 c	Monitoring of deep and shallow groundwater, defining potential impacts	Section 2, Section 3	SWS, Nov 2012, Section 3
C13-1 d	Understanding of baseline groundwater quality, flow directions, flow rates	Section 2, Figures 3, 7, 8, 11	SWS, Nov 2012, Sections 3.3, 3.4
C13-1 e	Characterisation of current and future impacts	Section 3, Figures 8, 13, 24	SWS, Nov 2012, Sections 4.2, 4.3. SWS, May 2013, Section 5
C13-1 f	Confirm groundwater samples are representative of aquifers sampled	Section 2.3	SWS, Nov 2012, Section 3.3
C13-1 g	Construction details and results of geophysical surveys	Figures 2, 14. Appendix A	SWS, November 2012, Section 2.4, Appendices A, B, C, D

2. Summary of groundwater transmitting systems

2.1 Site conditions

2.1.1 Mine facilities and topography

The facilities remaining on site are illustrated in Figure 1, along with the position of the mining lease boundary, and include:

- The open pit, in which the pit lake is developing,
- Three tailings storage facilities:
  - New North Tailings Storage Facility (NNTSF),
  - Old North Tailings Storage Facility (ONTSF), and
  - Southern Tailings Storage Facility (STSF).
- Three waste rock storage facilities:
  - Northern Waste Rock Storage Facility (NWRSF),
  - Southern Waste Rock Storage Facility (SWRSF), and
  - Eastern Waste Rock Storage Facility (EWRSF).
- Remnant heap leach and stockpiled material, and
- The scats stockpile.

All of the facilities with the exception of the scats stockpile have been rehabilitated by placement of a cover, construction of drainage systems, and development of vegetation.

Prior to mining, the surface topography at the Mt Leyshon site was dominated by Mt Leyshon which formed the highest point and has now been replaced by the open pit. Natural surface topography slopes downwards in all directions from the pit, towards Clarke Creek in the north (which drains much of the northern part of the mine area and flows to the northeast), towards Puddler Creek in the south (which drains most of the southern part of the mine area and flows to the east), and towards Two Mile Creek in the east (which drains the eastern part of the mine area and flows to the east).

2.1.2 Climate

Most of the rainfall occurs at Mt Leyshon in the summer, meaning summers are humid while winters are dry and cool. The mean annual rainfall from 1989 to 2014 is 651 mm, with 65% of rainfall occurring between December and March. The minimum annual total rainfall was 277 mm in 1993 and the maximum annual total rainfall was 1,200 mm in 2010. Intense tropical lows during the summer months result in highly variable rainfall. Mean minimum and maximum temperatures range between 22 ^{0}C and 34 ^{0}C in December and between 11 ^{0}C and 25 ^{0}C in July. These climate conditions result in intermittent flows within the surface water streams draining the general mine area in the summer wet season, which reduce to isolated drying pools in the winter dry season.

2.1.3 Geology

The orebody and general geology of the site is well understood in the area of the former mine and within the lease boundary. The area within and down-gradient of the mine lease boundary is characterised by the following (in order of depth):

- A thin clayey soil cover.
- Some limited development of alluvial material related to the creeks in the area of the mine. The alluvial material becomes more significant down-gradient.

- A more significant thickness of either sandy and gravely weathered basement material or less weathered material where relict structural features remain. This presents higher permeability beneath the clayey soil cover. The weathered zone has been shown to be preferentially developed along some of the existing surface water drainages.
- A significant thickness of granite and dolerite country rock which extends to depth. The country rock originally surrounded the ore body, but this has now been all but replaced by the pit void. Unlike the weathered zone and ore body the country rock has few structures and limited faulting.

2.2 Source data

The characterisation of the groundwater systems at the Mt Leyshon mine presented in this GMP has been based largely on the interpretations and conclusions provided in the summary groundwater report (SWS, 2012). This key reference document was in turn compiled from several geophysical surveys, and the results from drilling and collecting monitoring data at over 100 groundwater monitoring locations, including 35 existing bores, and 68 new installations. The sources of data for the summary groundwater report included:

1. Geophysical surveys undertaken by Klohn Crippen in September 1998,
2. Installation of regional monitoring bores by Water Studies Pty Ltd in 2000,
3. Shallow trenching across surface water drainages undertaken by the Centre for Mined Land Rehabilitation (CMLR) in 2008,
4. A geophysical and drilling investigation program completed by SWS in 2009,
5. A drilling investigation program completed by SWS in 2010, and
6. A geophysical and drilling programme completed by SWS in 2011.

The summary groundwater report also interpreted all monitoring data collected up to mid-2012, including a comprehensive site wide survey of groundwater quality and groundwater elevations conducted in February 2012. The summary groundwater report concluded that there are two main groundwater transmitting systems at Mt Leyshon, being:

- The shallow groundwater system which represents the main zone in which groundwater is transmitted away from the site, and
- The deep groundwater system.

The description and characterisation of these groundwater systems described in the following sections has been based directly on the conclusions contained in the summary groundwater report. However, where relevant, monitoring data collected from 2012 to present have also been presented and reviewed, to confirm that the conclusions presented in the summary groundwater report remain valid, and to update these conclusions where necessary.

2.3 Shallow groundwater system

2.3.1 Geology and extent

The shallow groundwater system has been defined to comprise the upper weathered and fractured surface of the basement rocks, typically occurring between around 5 and 25 m below ground level (mBGL). It takes the form of either sandy and gravely weathered basement material or less weathered material where relict structural features remain.

The shallow groundwater system has been extensively investigated across the Mt Leyshon mine through geophysical Electrical Resistivity Tomography (ERT) profiling and a targeted drilling programme. The ERT profiling used a 5 m electrode spacing to produce definition of changes in ground resistivity with depth up to a maximum depth of around 40 m. An example of a shallow ERT profile, which has been inverted into a section presenting ground resistivity against elevation, is provided in Figure 2, where profiling across Plumtree Creek confirmed the shallow groundwater system to be preferentially developed at the current location of the surface water drainage. A total of 15 km of shallow ERT profiling has been completed across the Mt Leyshon mine, and was used to target the locations of investigation drillholes.

The investigations have provided the following characterisation data:

- The locations of saturated zones of well-developed weathering identified from the ERT as anomalously low resistivity features.
- Various logging information (i.e. chip samples collected during drilling, penetration rates, measurement of rates of airlifted flows and occurrence of fracture zones) from about 80 investigation boreholes.

The combination of these two datasets has shown that the upper weathered zone, which is indicative of the shallow groundwater system:

- Is present over the whole of the site apart from outcrop zones,
- Is preferentially developed along some but not all of the current surface water drainage systems,
- Is usually encountered between 5 and 25 mBGL, and
- Transitions into unweathered basement between 1 and 30 mBGL.

The potential for groundwater to be transmitted in the very shallow strata above the shallow groundwater system at the Mt Leyshon mine is investigated in Section 2.3.7, and this investigation concluded that the shallow groundwater system represents the primary means by which groundwater flows away from the Mt Leyshon mine.

2.3.2 Hydraulic characteristics

The hydraulic characteristics of the shallow groundwater system have been assessed based on a significant number of tests at groundwater monitoring bores screened in this system. These tests were:

- Groundwater airlift rates from open holes during drilling.
- Groundwater airlift rates from cased holes during development.
- The specific capacity of the bores, calculated from test pumping.
- Results of constant head and recovery tests.

Airlift flow rates measured in the open hole while drilling ranged from 0 to 7 L/s, but were typically in the range 0.1 to 1 L/s. Values of hydraulic conductivity interpreted from test pumping of the completed monitoring bores ranged over two orders of magnitude, but were typically in the range 0.1 to 2 m/day. The airlifting and test pumping data were integrated in a qualitative manner, and combined to provide an estimate of the characteristic average hydraulic conductivity for the shallow groundwater system at the location of each monitoring bore. These average hydraulic conductivity estimates were subsequently classified into low, moderate and high descriptions for each location, corresponding approximately to an indicated hydraulic conductivity of “moderate” for values from 0.1 to 0.5 m/day, “low” for values below this range, and “high” for values above this range.

In order to develop a regional interpretation for the variation in groundwater flow characteristics for the shallow groundwater system across the Mt Leyshon mine, the individual bore classifications were subsequently interpolated using the results of the ERT profiles running past each of the bores. The resulting generalised interpretation of potential groundwater flow zones is presented in Figure 3. The interpretation suggests that higher groundwater transmission zones are mostly restricted to the current surface water drainages in the south and east of the site, but become more extensive close to Clarke Creek in the north of the site.

2.3.3 Groundwater elevations and flow directions

Precipitation is the primary input of water to the Mt Leyshon mine, driving intermittent runoff flows in the surface water systems, and seasonal recharge to the groundwater systems. Manual measurements of groundwater elevations are available for some monitoring bores in the shallow groundwater system from 1994; while detailed monitoring data have been collected using automated pressures sensors installed in three monitoring bores since 2010 (see Figures 4 to 6).

Comparison of all of the available groundwater elevation data from the operating and closure periods against precipitation records (SWS, 2012) indicated that groundwater elevations within the shallow groundwater system are dynamic and highly variable. Groundwater elevations respond to the larger daily precipitation events, to seasonal conditions, and also to long term trends in annual precipitation totals.

The monitoring data are consistent with the occurrence of recharge to the shallow groundwater system in response to precipitation events. This is interpreted to occur via natural infiltration processes (the primary cause of rises in groundwater elevations in the bores distant from the facilities, such as NMLMB1 in Figure 5), in conjunction with facility seepage (causing larger short term rises in bores located adjacent to the facilities, such as MLM28 in Figure 4, and resulting in groundwater elevations close to the facilities being higher than the inferred pre-mining conditions). These recharge processes are observed in bores distant from surface water drainages, as well as bores close to the drainages, and the infiltration is inferred to occur on a regional basis, and is not localised to the occurrence of surface water flows. The variation in the magnitude of recharge events, and the time for them to dissipate between different bores is consistent with the interpreted wide range of hydraulic conductivities within the shallow groundwater system.

As a result of the dynamic nature of groundwater elevations in the shallow groundwater system, when comparing or contouring data collected in different bores, it is important to collect these data over a relatively short time period. Depth to groundwater was measured in all available monitoring bores in February 2012, and these depths were then converted to groundwater elevations using accurately surveyed elevations for the bore collars. Contours of the resulting groundwater elevations in the shallow groundwater system are reproduced (from SWS, 2012) in Figure 7.

Groundwater flow directions follow the general surface topography and the main water courses, being to the northeast (towards Clarke Creek), to the east (following Two Mile Creek), and to the southeast (following Puddler Creek). Very little groundwater flow occurs to the west.

Steepest hydraulic gradients (~0.05 m/m) occur near the vicinity of the pit and mine facilities, with a reduction in gradients (~0.025 m/m) towards the main water courses (Clarke Creek and Puddler Creek), confirming that the development of higher permeability along creeks systems aids drainage of the groundwater system. A minor gradient reduction along Two Mile Creek suggests limited development of permeability in this area.

Groundwater elevations in the shallow groundwater system near the pit are defined by measurements from shallow vibrating wire piezometer sensors (VWP) grouted into investigation holes within the shallow groundwater system in this area. These define the groundwater elevation near the pit to be in the range 368 mRL to 375 mRL, which is more than 100 m higher than the pit lake elevation which was surveyed to be 252.3 mRL on 30 December 2014. This suggests there is minimal depressurisation within the shallow groundwater system associated with groundwater flow towards the open pit, with most flow being radially away from the pit. The extensive dataset of groundwater elevations measured in February 2012 contours relatively smoothly, confirming that all of the bores used are consistent with intersecting the shallow groundwater system, and that despite the hydraulic conductivity of the system being locally variable, there is regional continuity of hydraulic connection within the system.

2.3.4 Baseline groundwater chemistry

As mining commenced prior to the collection and analysis of any groundwater samples at the Mt Leyshon mine, no true background chemistry data are available to define groundwater quality in the absence of any mining influences. Table 3 summarises selected monitoring bores which were installed after mining commenced, but are interpreted to be either up-gradient of the facilities, or to be far enough down-gradient not to be influenced by mining.

Table 3: Interpreted background bores

Bore	Drilled date	Location	Screen interval
NMLMB8	20-Aug-09	250m within lease boundary, NE of site	19m - 37m
NMLMB13	18-Aug-09	East of Eastern WRD, at the lease boundary	28m - 40m
NMLMB18	20-Aug-09	West of Scats Stockpile, at the lease boundary	13m - 25m
NMLMB23	10-Jun-10	300m outside of lease boundary, NW of site	6.2m - 18.2m
NMLMB33	29-Jun-10	350m within eastern lease boundary	5m - 23m
NMLMB48	5-Nov-11	250m outside of lease boundary, NW of site	5m - 30m
NMLMB51	7-Nov-11	400m outside of lease boundary, west of Settlement Pond	12m
Scrubby	Pastoralist bore	500m outside of lease boundary, NW of site	
Black tank	Pastoralist bore	200m outside of lease boundary, NW of site	
Kermas	Pastoralist bore	150m within the eastern corner of the lease boundary	

Groundwater chemistry data recorded for the bores in Table 3 are summarised in Table 4, along with trigger levels and contaminant limits defined for groundwater in the version of Schedule C Table 13 of the EA which was in force when the GMP was compiled (Revision C, BDH 2013). Most of the metals concentrations available for the bores prior to 2013 are total values determined from unfiltered samples, whereas the EA trigger values are intended to be compared against concentrations determined from filtered samples. Background groundwater is indicated to have a total dissolved solids (TDS) concentration between 650 mg/L and 2,000 mg/L, with an average around 1,000 mg/L. Correspondingly electrical conductivity (EC) is indicated to be in the range 800 to 2,500 uS/cm, which is naturally elevated over the trigger value which was included in the EA at that time. The pH is generally alkaline, having an average of 7.2, and total alkalinity averages 600 mg/L as $CaCO_3$, being composed wholly of bicarbonate. Major ions are dominated by Na, Cl and HCO_3, with minor Mg and Ca present as well. Background concentrations of sulphate are indicated to be in the range 6 mg/L to 194 mg/L with an average of 38 mg/L. Unfiltered concentrations of metals are generally low, although Cu, Co, and Zn are present at detectable concentrations in some samples.

Table 4: Summary of inferred background groundwater quality

Analyte	Unit	Min	Max	Mean	Trigger Value (filterable) (2013 EA)	Contaminant Limit (2013 EA)
Laboratory EC	µS/cm	122.7	3,260	1573	560	TBD
Laboratory pH		7.16	8.39	7.61	TBD	TBD
Temperature	^{o}C	26.5	28.9	27.6		
Total Al	mg/L	0	5.5	0.24	0.055	5
Total alkalinity as $CaCO_3$	mg/L	418	877	600		
Bicarbonate alkalinity as $CaCO_3$	mg/L	414	877	600		
Hydroxide alkalinity as $CaCO_3$	mg/L	0	0.5	0.07		
Total As	mg/L	0	0.007	0	0.013	0.5
Total Ba	mg/L	0	0.498	0.125		
Total Ca	mg/L	30	121	69.8		
Total Cd	mg/L	0	0.0025	0.0002	0.0002	0.01
Cl	mg/L	30	656	218		
Weak Acid Dissociable Cyanide	mg/L	0	0	0		
Total Co	mg/L	0	0.005	0.001		
Total Cr	mg/L	0	0.07	0	0.001	1
Total Cu	mg/L	0	0.051	0.01	0.0014	1
Total Fe	mg/L	0	8.97	0.86		
Total Hg	mg/L	0	0.00005	0		
K	mg/L	0	9	2.61		
Mg	mg/L	45	160	78		
Mn	mg/L	0	0.44	0.09		
Na	mg/L	70	547	195.75		
Total Pb	mg/L	0	0.008	0	0.0034	0.1
Total Se	mg/L	0	0.01	0		
Sulphate	mg/L	6	194	37.54		
Total Sr	mg/L	0.369	2	0.93		
Total U	mg/L	0.001	0.021	0.01		
Total Zn	mg/L	0	0.41	0.03	0.008	20
Total dissolved solids	mg/L	656	2000	1022		
Total suspended solids	mg/L	0	250	16		

2.3.5 Changes in groundwater chemistry during operations and closure

Groundwater samples were collected every three months from the nine bores defined in the version of the EA issued in 2013 as compliance locations. A comprehensive set of groundwater samples was collected from every available monitoring bore at the Mt Leyshon mine in February 2012. In combination, these data sources identify that:

- The most significant change in groundwater chemistry compared to the inferred background conditions has occurred at MLM21, where groundwater has locally exhibited a reduced pH, and elevated total metals concentrations since January 2008. The investigations have concluded these anomalous groundwater chemistry conditions to result from local facility seepage overcoming the buffering capacity of the groundwater system. MLM21 is in close proximity to the seepage source, immediately down gradient of the LS-A Pond (Figure 1), where a continuously flowing discharge channel from the pond is located only 5 m away from the bore. The LS-A pond intercepts shallow groundwater flow/seepage from up-gradient facilities and generally retains water even during dry periods. The pond receives drainage/seepage from the general Heap Leach Stockpile area and discharges via a drain into the Settlement Dam, where the flows are contained and routed to the final void. MLM21 is also located within a low permeability zone of the aquifer (Figure 3) where natural groundwater throughflow is reduced.
- In all other monitoring bores, groundwater pH has remained relatively high throughout the operating and closure periods, consistent with inferred background conditions.

- The most significant and widespread change in groundwater chemistry in the shallow groundwater system is identified in sulphate concentrations. Long-term monitoring data demonstrate "breakthrough" type events in monitoring bores located down-gradient of the mine facilities, which occurred during both the operating and closure periods. Sulphate concentrations in groundwater also vary in response to major precipitation events, consistent with the competing influences of good quality recharge to the system in the down-gradient areas, and high sulphate recharge to the system close to the mine facilities.
- TDS concentrations in groundwater have also increased during the operating and closure periods, which is attributed to the changes in sulphate concentrations.
- These changes in groundwater chemistry identified in the shallow groundwater system are consistent with the influence of Acid Rock Drainage (ARD) seepage being generated by the mine facilities during both the operating and closure periods, and entering the groundwater system.
- Sampling data from the containment sumps and dams operated as part of the mine water management system indicate that these ARD seepage sources may typically be characterised as:
    - Neutral to acid pH, with sulphate concentrations around 3,000 mg/L for seepage from closed tailings facilities, and
    - A pH around 4, and sulphate concentrations in the range 2,000 to 30,000 mg/L for seepage from waste rock facilities and the scats stockpile.
- As a result of the significant natural alkalinity of the groundwater, in most locations the ARD seepage does not change the groundwater pH significantly, and most metals which would be expected to be included in the ARD seepage are not generally mobile within the groundwater system.

Figure 8 illustrates the results of contouring sulphate concentrations in groundwater measured during the comprehensive sampling event completed in February 2012, and updated using monitoring data from 2013 and 2014.

Contouring of the data in Figure 8 has been undertaken as follows:

1. The solid yellow contour defines the boundary for the portion of the shallow groundwater system where sulphate concentrations have been above 1,000 mg/L in the period 2012 to 2014.
2. The dashed blue contour provides an estimated indication of the portion of the shallow groundwater system where sulphate concentrations have been above 500 mg/L from 2012 to 2014.
3. The dashed red contour provides an estimated indication of the portion of the shallow groundwater system which has been influenced by sulphate over the entire mining and closure period. This has been drawn by comparing data collected over the entire operating and closure period against the inferred background concentrations.

The monitoring data identify that shallow groundwater system is heterogeneous, with significant changes in sulphate concentration observed over small lateral distances, and also related to the depth of the screen (as described for NMLMB15S and NMLMB15D in Section 2.3.7), and the contours therefore necessarily represent an averaged interpretation. In general, the interpretation identifies that:

- The zone of groundwater above 1,000 mg/L sulphate is largely restricted to being within the mine lease.
- The edge of the zone of groundwater with elevated sulphate has a relatively sharp boundary in most locations, and the 1,000 mg/L contour, and the inferred 500 mg/L contour generally plot close together.
- In areas where historical monitoring data indicate there has been a more extensive influence, the boundary tends to be more diffuse (extending northeast from the NNTSF, southeast from the STSF, and southeast from the EWRSF).

- Over the mining and closure period, elevated sulphate in groundwater has had a maximum extent from the mine facilities in the north of the site (extending more than 1 km from the NNTSF) and in the southeast of the site (extending up to 2 km from the STSF and EWRSF, where Pastoralist bores Plants, Fanless and Bellevue House have displayed elevated concentrations in the past). The extent of elevated sulphate in 2014, is significantly less than the maximum extent inferred over the mining and closure period.
- There is very limited extent of sulphate in groundwater to the west of the mine facilities.
- The monitoring data confirm that the more extensive areas of elevated sulphate in the shallow groundwater system tend to be aligned with the weathering zones which follow the current surface water drainage systems.

Figure 9 illustrates the variation in TDS concentrations in groundwater based on the comprehensive sampling event undertaken in February 2012. TDS concentrations follow a similar trend to, and are controlled by the sulphate concentrations, being elevated over the inferred background levels close to the mine facilities, and extending to the north and to the southeast and east of the mine. The highest TDS concentrations measured in February 2012 were 32,000 mg/L at MLM28 adjacent to the EWRSF, 7,500 mg/L at NMLMB15D adjacent to the EWRSF, and 5,800 mg/L at NMLMB1 north of NNTSF, compared to an estimated background concentration in groundwater of around 1,000 mg/L. TDS concentrations are consistent with background in locations more than 1 to 2 km down-gradient of the facilities.

Schedule C Table 13 of the current version of the EA issued in June 2014 defines trigger levels for groundwater chemistry at the Mt Leyshon mine. These trigger levels are designed to be applied to metals concentrations measured on filtered samples. In the comprehensive sampling event undertaken in February 2012, only total (unfiltered) metals concentrations were analysed, as this is what was required under the EA at that time. Regardless, the February 2012 data, and any other available data for each bore, have been compared against the trigger values to provide a preliminary assessment of the extent of metals concentrations in groundwater as follows:

- Al concentrations in groundwater are commonly elevated compared to the trigger value of 0.055 mg/L, but as the reported results were based on unfiltered samples, this likely relates to suspended but non-dissolved material generated during sampling, and the total concentration data have not been reviewed in detail.
- Ni, Pb and Cd were mostly below detection in the February 2012 samples, consistent with the observed pH values.
- Total concentrations of Zn, Cu and Cr have been variable at individual locations, within the range of inferred background concentrations, and mostly below the trigger limits included in the EA once hardness correction is applied (at a hardness of 400 mg/L as $CaCO_3$, the limits are 0.005 mg/L for Cr, 0.01 mg/L for Cu, and 0.07 mg/L for Zn, all based on filterable concentrations).
- Figure 10 summarises total As concentrations measured in February 2012. Migration of As within the groundwater system is not widespread, and the small number of locations at which the trigger value of 0.013 mg/L (defined for filterable concentrations) is exceeded comprise individual bores generally located very close to the mine facilities.
- Total concentrations of Co in groundwater as measured in February 2012 are plotted in Figure 11. The EA trigger value (0.0028 mg/L for filtered samples) has been exceeded in inferred background bores, and so a contour value of 0.01 mg/L has been applied to total Co for the purposes of assessing the facility influences on groundwater. Figure 11 demonstrates that migration of Co within the groundwater system has occurred, and is primarily identified in the area within 1 km down-gradient of closed tailings facilities, but is not identified down gradient of waste rock facilities.

- In combination, the contoured sulphate data in Figure 8, and the contoured data for total Co in Figure 11, provide definition of the zone in which groundwater chemistry has been altered by the mine facilities, and based on the limits currently defined in the EA, result in the groundwater in this zone being described as impacted. The zone of impacted groundwater is defined to extend preferentially to the north and northeast from the NNTSF, to the east from the EWRD, and to the southeast from the STSF.

2.3.6 Recharge and discharge processes

As discussed in the preceding sections, recharge to the shallow groundwater system has been defined to result from a combination of seepage reaching the groundwater in the area of the mine facilities, and natural surface infiltration occurring around the mine facilities and in the down-gradient region, all driven by precipitation conditions in the wet season.

The assessment of groundwater elevations and hydraulic characteristics confirms that groundwater moves through the shallow groundwater system as horizontal groundwater flow, in directions mostly radially away from the mine area.

The investigations to date also indicate the groundwater likely leaves the groundwater system as surface discharge into the surface drainage systems down-gradient of the mine facilities, where structures are present which allow vertical movement of groundwater. This potential discharge mechanism has been identified from:

1. Flowing conditions observed at monitoring bore MLM42 located adjacent to the STSF until the bore was decommissioned.
2. Field mapping in the dry season in 2010 to identify damp locations along the non-flowing streams in the mine lease area which could indicate groundwater discharge.
3. Comparing accurately surveyed stream bed elevations against groundwater elevations measured in selected nearby monitoring bores. Groundwater heads above the stream were measured as far away from the mine facilities as NMLMB36, located outside the mine lease to the southeast (Figure 1).
4. Comparing the contoured groundwater elevations measured in February 2012 against surface topography defined from a digital terrain model combined with localised topographic surveys. The results of this comparison are reproduced (from SWS, 2012) in Figure 12, and indicate that following the wet season, where seepage pathways exist, groundwater discharge potentially occurs in 1) Puddler Creek below the Settlement Pond and below the STSF; 2) the stream draining below Mt Hope Dam; 3) Two Mile Creek downstream of Mt Mawe Dam; 4) Plumtree Creek below Plumtree Creek Dam; and 5) the tributaries draining to the northeast from the NNTSF.

2.3.7 Potential for very shallow groundwater transmission

Most of the field investigations at the Mt Leyshon mine have focussed on the shallow groundwater system, which typically occurs between 5 and 25 mBGL. In the 2011 field programme, the studies were expanded to investigate whether groundwater and seepage may be transmitted away from the site in the very shallow zone, which could be associated with alluvial deposits. At 12 locations, selected from geophysical and drilling data, very shallow bores were installed with maximum screen depths of 5 to 7 m, and with a cement seal at surface to prevent the ingress of surface waters. With the exceptions of the very shallow bores drilled in the general area near NMLMB6, the very shallow bores were paired with an adjacent shallow monitoring bore (Figure 1).

Table 5 compares geological, completion, hydrogeological and hydrochemical data collected from each pair of bores. Observations from the paired bores are:

- Despite targeting the very shallow installations at locations where sandy materials may be present, the shallow bores did not intersect any highly transmissive alluvial materials.
- Although all of the very shallow targets were saturated (damp), the potential for groundwater transmission was limited, based on the very low airlift flows measured during drilling, and based on the attempts to undertake test pumping of the bores after completion.
- In general, the groundwater quality measured in the very shallow monitoring bores was consistent with the adjacent shallow monitoring bores. However, at NMLMB2 and NMLMB3, the shallow bore was more influenced by seepage than the deeper bore, and suggests when the deep bores were constructed at the start of the closure period in 2001 the screen was potentially set too deep in the deep bores.
- Vertical hydraulic gradients acting between the shallow and deep bores were small and generally within the measurement error when measured in February 2012 at the end of the wet season.
- When checked in the dry season in June 2013, many of the shallow bores were dry, while all of the deep bores remained saturated.

Table 5: Comparison of very shallow and shallow monitoring bores

	Geology and Construction				Groundwater elevations		Groundwater chemistry		
Bore pair	**Drilled depth (m)**	**Screen interval (mBGL)**	**Screened formation**	**Flow info**	**Groundwater elevation Feb 2012 (mRL)**	**Vertical gradient**	**pH**	**TDS (mg/L)**	**Sulphate (mg/L)**
NMLMB50D	30	5 to 30	granite	High	295.7		7.9	780	9
NMLMB50S	5	3 to 5	silty sand	Low	295.6	Up	7.8	684	6
NMLMB49D	30	14 to 30	w granite	Low	310.0		7.5	5,510	2,860
NMLMB49S	7	3 to 7	sandy clay	Low	310.2	Down	7.4	5,380	3,030
NMLMB46D	19	7 to 13	fractured dolerite	High	317.2		7.3	3,750	1,770
NMLMB46S	5	2 to 5	silty clay	Low	316.9	Up	7.4	3,910	1,980
NMLMB2	30	28 to 30	granite	High	295.7		7.7	1,350	343
NMLMB2S	7	3 to 7	silty w granite	Low	295.6	Up	7.4	798	33
NMLMB26	25	4 to 16	dolerite	High	301.9		7.8	3,280	1,460
NMLMB26S	6	3 to 6	w granite	Low	301.8	Up	8	3,340	1,590
NMLMB25	25	11 to 17	w granite	High	297.9		7.7	1,360	283
NMLMB25S	5	3 to 5	silty sand	Low	297.9	None	NA	NA	NA
NMLMB9	25	7 to 25	w granite	Low	316.7		7.6	1,040	335
NMLMB9S	5	3 to 5	clayey w granite	Low	316.9	Down	7.5	584	97
NMLMB32	25	6 to 24	granite	Low	326.9		7.3	2,370	1,300
NMLMB32S	5	3 to 5	clayey sand	Low	326.9	None	7.4	1,940	1,090
NMLMB3	40	28 to 40	fresh rock	High	326.2		7.4	3,780	1,860
NMLMB3S	5	3 to 5	clayey dolerite	Low	326.5	Down	7.8	8,490	5,140
NMLMB15D	25	10 to 25	w granite	Low	327.6		7.4	7,500	4,240
NMLM15S	5	2 to 5	fractured granite	Low	327.8	Down	7.5	762	199

Overall, the data confirm that preferential very shallow groundwater flow paths are not present at the Mt Leyshon mine, and that the very shallow strata can be considered part of the shallow groundwater system as previously defined.

2.3.8 Modelling of future sulphate migration

A numerical groundwater flow and solute transport model of the Mt Leyshon mine has been constructed and calibrated to provide predictions of future sulphate conditions around the mine facilities (SWS, 2013). The model simulated the shallow groundwater system, and was calibrated against time variant groundwater level data at 53 separate locations and time variant sulphate concentration data at 76 separate locations. The ability of the model to reproduce these observations was assessed using hydrographs, contour plots and scatter plots. In particular the model's ability to match the observed 1,000 mg/L and inferred 500 mg/L sulphate concentrations in February 2012 was considered the highest priority, to confirm that the regional changes in sulphate concentration with time were being accurately simulated.

The calibrated model was modified and extended to allow the simulation of several predictive scenarios. These were run for 200 years into the future to provide an extremely long term forecast. The scenarios considered future sulphate conditions around the mine under similar conditions to those currently observed, under a particularly wet or dry climate, with limited up-gradient throughflow and included a preliminary assessment of the influence on sulphate conditions of altering seepage conditions in the facilities.

The results showed that with the calibrated parameters and average rainfall conditions the maximum future extent of sulphate concentration is unlikely to change a great deal from the extent observed in 2012. In two areas (to the northeast and southeast) continued migration away from the facilities is predicted, but this is limited to about an additional 1 to 2 km to the east in the year 2212 as plotted in Figure 13.

The prediction of limited future expansion of the zone of elevated sulphate in groundwater under average conditions in the model results from a combination of factors, including:

- As the area of influence increases, the total volume of groundwater in the system to accommodate the fixed sulphate load increases rapidly.
- As the area of influence increases, the proportion of the area which is exposed to good quality natural groundwater recharge significantly increases.
- The more the area of influence extends, the more creek systems it covers, which provides more potential locations for the model to remove sulphate from the groundwater system by discharging it to surface water on a seasonal basis.
- The extent of the sulphate influenced zone in 2012 reflects higher than average rainfall conditions over preceding years. The predictive model assumes a return to average rainfall conditions, and so there is an immediate recession in groundwater elevations and sulphate concentrations in the early part of the predictive period.

2.4 Deep groundwater system

2.4.1 Geology and extent

The deep groundwater system comprises fracture zones within the deep unweathered basement rocks, which include the breccias close to the open pit, and the surrounding dolerite and granite country rocks. The geometry and extent of the fracture zones has been investigated using data collected during exploration and mining of the ore body, and using geophysical surveys and drilling conducted by SWS during the closure period. Examples of the Time Domain Electromagnetic (TEM) surveys completed by SWS to identify conductive zones in the deep basement are provided in Figure 14. The identified conductive zones were investigated by drilling to depths of 200 to 300 mBGL, with each drill hole instrumented with VWP sensors, grouted in place.

These investigations identified that most of the basement rocks across the Mt Leyshon mine demonstrate relatively high resistivity, consistent with a low degree of fracturing (porosity) and limited presence of pore waters. Fracturing may be present in the basement rocks at depths of up to 200 m, but is limited to the area close to, and to the northeast of the open pit (intersected primarily in VWP2 and VWP4). This is consistent with observations during mining that the main structural feature in the area was the Mine Fault, which was primarily identified within the open pit, as marked in Figure 1. The available data indicate that there is little development of fracturing beyond about 1 to 2 km from the open pit, and the granite/dolerite country rocks in the surrounding area have limited fracturing.

2.4.2 Groundwater elevations and flow directions

Groundwater responses within the deep groundwater system have been monitored through the use of the VWP sensors. These provide an electronic signal which can be converted to groundwater head at the location of the sensor. The locations of the VWP installations are provided in Figure 1. Updated monitoring data recorded in the sensors, compared against the elevation of the pit lake, are provided in Figures 15 to 19. Observations from the monitoring data are:

- In most cases the upper sensor is grouted in the shallow groundwater system, matches shallow monitoring bore data, and confirms the groundwater elevation is in the range 368 to 375 mRL, which is significantly higher than the lake elevation in the open pit.
- At most of the installations, the deeper sensors installed into the deep groundwater system to depths of 200 to 300 mBGL indicate groundwater elevations which are comparable with or slightly lower than the shallow groundwater system (330 to 370 mRL).
- Sensors VWP4-2 (installed at 227 mRL), VWP4-3 (installed at 276 mRL), VWP2-1 (installed at 183 mRL), and VWP2-2 (installed at 231 mRL) are the only four sensors out of the 46 installed which are indicated to intersect a zone of fracturing, which is saturated, and has reduced groundwater elevations (285 to 300 mRL), consistent with hydraulic connection to the open pit, and the presence of residual drawdown associated with dewatering during mining.
- Most sensors display a smoothed response to seasonal precipitation trends, indicative of wet season recharge, which may occur as direct infiltration to exposed fractured basement rocks in the pit area, or as downward leakage from the shallow groundwater system.

Figure 20 maps the groundwater elevation measured at each of the VWP installations, for the sensors which are located closest to the elevation of 200 mRL, where the zone of fracturing is inferred to occur northeast of the open pit. These illustrate that within the deep groundwater system:

- In locations more than around a few hundred metres from the margins of the open pit, and at most depths, hydraulic gradients indicate groundwater flow directions are away from the pit. The drawdown cone within the deep groundwater system surrounding the pit is relatively steep and close to the pit, consistent with the inferred relatively low hydraulic conductivity in this system.
- A fracture zone intersected northeast of the pit in VWP2 and VWP4 at around 200 mRL contains groundwater at lower pressures. The depressurised area potentially extends up to 500 m from the pit boundary. Investigations further to the north and northeast (TEM surveys, drilling and completion of VWP5, VWP8, VWP10), which are above and below this zone identify higher groundwater elevations, and indicate little connection to the identified fracture zone.
- VWP sensors installed at depths equivalent to the base of the pit demonstrate high groundwater pressures, comparable to pressures measured at shallow depths, and consistent with groundwater flow towards the pit for the basement rocks at depth and close to the pit.

2.5 Interactions between the deep groundwater system and the shallow groundwater system

The shallow groundwater system is present in all locations at the Mt Leyshon mine, other than in the open pit, or at localised discrete locations where unweathered basement rocks may crop out at surface. The deep groundwater system is limited in occurrence to the area close to the open pit (typically within 1 to 2 km), and the greatest extent of fracturing occurs at around 200 mRL, within 500 m of and northeast of the open pit.

In locations where both the shallow groundwater system and the deep groundwater system are present (near the open pit), these two groundwater transmitting systems are separated vertically by unweathered and mostly unfractured breccia, granite and dolerite, as indicated by the schematic section presented in Figure 21, which has been drawn along section line CD as marked in Figure 1. Mechanisms which may act to provide vertical connection through these basement rocks potentially include pervasive zones of fracturing associated with major structural features, or artificial connection created by un-grouted drillholes installed near the ore body during the development and mining periods.

Based on the groundwater elevations measured in the VWP sensors, in all locations vertical groundwater gradients act downwards, with the groundwater elevation being higher in the shallow groundwater system. In any locations where vertical hydraulic connection is present, this suggests the occurrence of downward seepage from the shallow groundwater system into the deeper groundwater system. There are no locations in which the groundwater pressure in the deep system suggests that discharge could occur into the shallow system where pathways are present.

2.6 Groundwater interactions with the pit lake

At the completion of open pit mining at the Mt Leyshon mine, the pit had reached a lowest elevation of around 60 mRL. Subsequently during stockpile processing the lower part of the pit was filled with tailings to an elevation reported to be around 130 mRL. Since tailings deposition was completed, the pit has been allowed to develop as a lake from natural inflows and from water pumped from all of the containment dams and sumps on site. The total storage volume above the tailings has been estimated as 67,000 ML to the potential spillpoint at 377 mRL. The pit lake elevation has risen steadily throughout the filling period, and in recent years has risen around 2 to 10 m per year. On 30 December 2014, the pit lake elevation was surveyed as 252.3 mRL. The pit lake has been sampled intermittently during filling, and the lake waters have had a pH around 4.5, with significantly elevated concentrations of sulphate, Cd, Cu, and Zn. These observations are consistent with flows pumped from the containment dams being the dominant input to the pit lake.

The permeable zones of the deep groundwater system are expected to be in hydraulic contact with the pit lake, as they comprise fracture zones associated with structural features which daylight in the open pit.

Logging data from VWP1, VWP2, VWP3 and VWP4 which were drilled close to the open pit suggest that the shallow groundwater system was present within a few hundred metres of the pit slopes, but becomes more shallow towards the pit, consistent with outcrop of unweathered basement at the pit. It is unclear whether the shallow groundwater system pinches out close to the pit, or continues to intersect the upper pit slopes.

The schematic hydrogeological cross section presented in Figure 21 illustrates that groundwater flow conditions at the current pit lake elevation are as follows:

- Groundwater elevations in the deep basement system in most locations are more than 80 m higher than the pit lake. Within around 200 m of the pit lake, groundwater flow directions in the deep groundwater system are towards the pit lake. More distant from the pit lake, groundwater flow is away from the pit in the deep groundwater system.
- In the area to the northeast of the open pit, and at elevations around 200 mRL, groundwater elevations in the deep groundwater system are more than 40 m higher than the pit lake and groundwater flow is towards the pit, within around 500 m of the pit.
- The calibrated pit lake water balance model suggests that total groundwater flow entering the pit lake from the deep groundwater system is currently around 2 L/s on average. This is consistent with the small extent of the residual cone of depression around the pit, and is consistent with observations made during mining. These observations included operation of a dewatering bore in the deep groundwater system at 2 L/s which resulted in a drawdown of 75 m.
- In the shallow groundwater system, groundwater elevations near the pit are around 120 m higher than the lake elevation, and the shallow groundwater system may terminate against unweathered basement near the pit. Dewatering at the pit has had minimal influence, and in most locations groundwater flow is away from the pit.
- The elevation of the pit lake at the Mt Leyshon mine continues to rise, driven by natural inflows and by flows pumped from containment dams. As the area of the lake increases, the net excess of evaporation over precipitation may result in a stable lake elevation, subject to the magnitude of the other inflows.

- The summary groundwater report compiled for the Mt Leyshon mine identified that the maximum safe elevation for the pit lake was 340 mRL (SWS, 2012). Figure 22 schematically illustrates the inferred groundwater flows that would occur if the lake were allowed to reach this elevation. Even if the shallow groundwater system does daylight in the upper pit slopes, groundwater pressures would continue to be at least 28 m higher than the pit lake, and lake waters would not enter the shallow groundwater system. For most of the deep groundwater system, including the southwest part of the pit as drawn in Figure 22, groundwater heads at all elevations would continue to be higher than the pit lake, and groundwater flow close to the pit would continue to be into the pit lake from the deep groundwater system.

In the area extending a maximum of 500 m to the northeast of the open pit, and at elevations around 200 mRL, hydraulic gradients would be reversed, and pit lake waters would gradually migrate into the fracture zones in the deep groundwater system. However, as illustrated in Figure 22, the influence of the pit lake waters would be restricted to:

1. The fracture zones at around 200 mRL, and
2. The portion of the deep groundwater system within 500 m of the open pit.

3. Environmental values, potential impacts and mitigation

3.1 Environmental values for groundwater

The deep groundwater system as described in Section 2.4 exists only within the Mt Leyshon mine lease and near the open pit. This groundwater system is isolated from surface by the overlying unweathered basement rocks and by the overlying shallow groundwater system. There are no groundwater bores screened in the deep groundwater system, and no environmental values are identified for this isolated groundwater system.

The shallow groundwater system is present across all of the Mt Leyshon mine lease, except at the open pit, and is expected to continue into the receiving environment. As described in Section 2.3, groundwater flow in this system travels away from the Mt Leyshon mine facilities, predominantly to the northeast, east and southeast. Environmental values associated with the shallow groundwater system in the greater receiving environment have been assessed in the relevant concurrent studies, including the REMP. These investigations into environmental values included consultation with stakeholders to determine what use is made of groundwater resources in the region. In the area of the mine lease and the surrounding pastoral leases, environmental values associated with potential use or abstraction of groundwater from the shallow groundwater system have been identified to be:

- Any potential phreatophytic vegetation,
- Stock watering,
- General farm use, and
- Drinking use.

Indirect environmental values, associated with groundwater in the event that it should discharge to surface and enter the surface water systems, were identified to include:

- Support of aquatic ecosystems, and
- Primary recreation.

3.2 Identified mechanisms for potential groundwater impacts

Based on the detailed understanding which has been gained on groundwater flows and groundwater chemistry in the shallow groundwater system, the full list of interactions which could conceivably impact on the preliminary environmental values for the receiving environment is identified to be:

- If the zone of impacted groundwater which continues to have neutral pH but to have elevated TDS and sulphate concentrations were to reach locations where groundwater is abstracted for use, the ability to use that groundwater for stock watering or potable use may be compromised.
- If the zone of impacted groundwater which continues to have neutral pH but demonstrates total Co concentrations above 0.05 mg/L were to reach locations where groundwater is abstracted for use, the ability to use that groundwater for crop irrigation could be compromised.
- If impacted groundwater should discharge into the receiving streams down-gradient of the site, the TDS, sulphate or Co concentrations could potentially cause environmental harm to aquatic organisms in the surface water systems.
- If phreatophytic vegetation is present in the environment, which has roots in the permanently saturated zone below the water table, the migration of groundwater with elevated TDS into this zone could potentially cause stress to that vegetation.

- If the natural buffering capacity of the groundwater system were to be overcome by ARD seepage from the closed mine facilities, the pH of the groundwater could reduce, and a range of metals in addition to Co could become mobile in the groundwater, potentially causing harm if that groundwater reaches any of the groundwater receptors.
- Once the pit lake is allowed to rise to 340 mRL, if any pathways are present which allow the lake water to enter the shallow groundwater system down-gradient of the pit, this could potentially cause harm if the groundwater subsequently reaches groundwater receptors.

Figure 23 provides a schematic illustration of potential pathways for the migration of groundwater impacts, using a hydrogeological cross section constructed along line ABC as drawn in Figure 1. The section in Figure 23 illustrates that groundwater flows away from the pit area to the north, and away from the pit area to the south, driven by a combination of natural recharge and infiltration of seepage from the closed mine facilities. The section also illustrates examples of potential impacts on environmental values, including discharge into Puddler Creek, groundwater use by phreatophytic vegetation, and groundwater abstraction via bores.

Taking account of these pathways, each of the mechanisms by which environmental harm could potentially occur are discussed in the following sections, along with an assessment of the risk for potential harm to occur, existing or planned mitigation measures to reduce these risks, and a description of monitoring required to determine whether these potential impacts may be occurring in reality.

3.3 Potential impacts to groundwater abstraction

The available monitoring data confirm that potential impacts to groundwater abstraction from the shallow groundwater system have already occurred at the Mt Leyshon mine. The Horse Creek bore located to the north of NNTSF, which was originally constructed for stock watering, would now potentially provide groundwater with a sulphate concentration which exceeds stock drinking guidelines if equipped and operated. However, this bore is located on property owned by Newmont, and operation of the bore is controlled and prevented by Newmont.

The risk associated with uncontrolled groundwater abstractors being impacted by groundwater quality in the shallow groundwater system at the Mt Leyshon mine is assessed to be very low, based on the following:

- The current extent of impacted groundwater is well defined by monitoring data from a large number of bores.
- The potential pathways for future migration of this impacted groundwater are well defined by the geophysical surveys, hydraulic testing, and measurements of hydraulic gradients.
- The potential future extent of the impacted groundwater is predicted by the groundwater model, which confirms that little expansion of the area is expected. Figure 24 illustrates the modelled location of the 1,000 mg/L sulphate concentration contour in 200 years time. This modelling assumes that seepage from the facilities continues at the current rates, and that average rainfall conditions occur.
- Figure 24 also illustrates the boundaries of the properties which are owned by and controlled by Newmont. This confirms that in the locations where the extent of sulphate is predicted to expand, potential uncontrolled groundwater abstraction locations down-gradient are at least 2,000 m distant from the predicted maximum extent of sulphate in the year 2212.

Mitigation measures which are in place to manage the risks to groundwater abstractors are; 1) to continue to improve the cover and drainage systems on the closed mine facilities to minimise infiltration; 2) to continue to control access to groundwater in the mine lease and in the down-gradient properties; and 3) to ensure that any future changes in land use maintain these restrictions.

Monitoring which is proposed to confirm the assessment of the level of risk, is to undertake regular groundwater quality sampling outside of the impacted groundwater zone, to confirm the future migration of sulphate is consistent with the modelling predictions.

3.4 Potential impacts to surface water systems

The risk associated with potential discharge of impacted groundwater to surface is assessed to be high, given that:

- Detailed ground based topographic surveys have identified that groundwater elevations in the shallow groundwater system were above the stream bed in a number of streams in February 2012, and that groundwater discharge would therefore occur if migration pathways were present.
- Interpolation of groundwater and surface elevations in Figure 12 identifies a significant extent of streams where discharge may occur.
- Some of the identified discharge zones coincide with areas where sulphate and total Co concentrations are elevated in groundwater. Figure 25 provides an indication of the areas which are potentially at highest risk from discharge of groundwater at surface, by highlighting areas where 1) sulphate concentrations exceed 1,000 mg/L and/or total Co concentrations exceed 0.01 mg/L; and 2) groundwater was interpolated to be within 4 m of surface in February 2012.
- Figure 25 does not represent an assessment of actual impacts at surface. Potential impacts will be determined during the ongoing studies into the fate and implications of TDS, sulphate and Co in the surface environment. Rather Figure 25 defines the zones where the potential risk is relatively higher, and is intended to be used to prioritise the monitoring and investigation studies.

Mitigation measures which are in place to reduce the identified risk are:

- Ongoing remediation of covers on the mine facilities, and improvement of surface drainage from the facilities, to minimise potential infiltration which is the primary source of this potential impact.
- Concurrent studies to determine site specific guidelines for surface water quality, which will allow the potential impacts associated with groundwater discharge to be better understood.

Monitoring which is proposed to further define the level of risk associated with this potential impact is:

- Regular measurement of depth to groundwater across the site to identify any further mounding which may occur, and to allow comparison against surface topography to determine the potential for seasonal or long term groundwater discharge to be occurring.
- Regular sampling of groundwater chemistry outside the current area of mining influence to identify future migration of the zone of impacted groundwater.
- Surface water sampling to monitor streamflow chemistry, including down-gradient of the priority risk zones identified in Figure 25.

3.5 Potential impacts to phreatophytic vegetation

The potential risk associated with high TDS groundwater reaching the root zone of phreatophytic vegetation is not well defined, as the existence of phreatophytic vegetation has not been specifically investigated at the Mt Leyshon mine. Mitigation measures which are in place to reduce this potential risk include the ongoing remediation of covers on the mine facilities, and improvement of surface drainage from the facilities, to minimise potential infiltration which is the primary source of this potential impact.

The areas at greatest risk for this potential impact are as defined in Figure 25, where groundwater is identified to be potentially shallow, and groundwater quality has been impacted during the mining and closure period. Monitoring which is proposed to investigate the level of risk associated with this potential impact is:

- Regular sampling of groundwater chemistry outside the current area of mining influence to identify future migration of the zone of impacted groundwater.
- Investigation of vegetation health in the higher priority zones defined in Figure 25 during the ongoing environmental monitoring and maintenance operations at the site.

3.6 Changes in groundwater pH

The potential risk associated with significant reductions in groundwater pH, which would potentially occur in response to the influence of facility seepage, and subsequently cause impacts in the receiving environment is assessed to be low, given that:

- Throughout the operating and closure period, the only location at which a significant reduction in groundwater pH has occurred is at MLM21, located immediately adjacent to a significant source of ARD seepage from the mine facilities.
- Locations at which this could potentially occur in future would be immediately adjacent to the closed mine facilities.
- Groundwater migration velocities within the shallow groundwater system are relatively low, and the total alkalinity contained within down-gradient groundwater is relatively high, and in combination these would act to limit the down-gradient influence of the changes in groundwater quality. It is noted that the significant change in groundwater pH at MLM21 occurred in 2008, and this change in groundwater quality has not yet been observed at NMLMB40, located only 250 m down-gradient.

Mitigation measures which are in place to reduce this potential risk include the ongoing remediation of covers on the mine facilities, and improvement of surface drainage from the facilities, to minimise potential infiltration which is the primary source of this potential impact. Monitoring which is proposed to investigate the level of risk associated with this potential impact is:

- Groundwater sampling from within the zone of impacted groundwater, and close to the mine facilities, to identify any potential reduction in groundwater pH.

3.7 Potential impacts from pit lake waters

The potential risk associated with poor quality water in the pit lake entering the shallow groundwater system once the pit lake reaches its final elevation, and causing changes in groundwater chemistry, is assessed to be very low, given that:

- At the current time, groundwater elevations in the shallow groundwater system near the pit are much higher than the lake elevation. This confirms there is little hydraulic connection between the lake and the shallow groundwater system. If groundwater is unable to drain into the pit in the current environment, this suggests an absence of pathways for the pit lake water to act in reverse and enter the shallow groundwater system once the pit lake rises.

No mitigation actions are proposed to reduce the risks of impacts from the pit lake waters, as the risk is assessed to be very low. Monitoring which is proposed to confirm the assessment of the levels of risk of impacts is:

- Ongoing monitoring of groundwater pressures defined in the 46 VWP sensors installed between surface and 300 mBGL around the pit lake.
- Monitoring of the pit lake elevation.

4. Groundwater monitoring plan

4.1 Introduction

The version of the EA in place in 2013 for the Mt Leyshon mine identified nine bores which were required to be sampled for groundwater quality compliance, and these bores had been sampled continuously for more than a decade. Many of these bores were located immediately adjacent to the mine facilities and within the zone where groundwater is known to be impacted by the mine facilities, and in these locations the impact had been present continuously in the monitoring data.

The updated groundwater monitoring regime described in the following sections has been based on the detailed understanding of site conditions presented in this report, in conjunction with monitoring data collected since the first version of the GMP was compiled in 2013 (Revision C, BDH 2013), and the changes which were made to the monitoring regime during 2016 and 2017. The locations of bores proposed for monitoring have been selected taking account of the relative risks of potential environmental harm arising from groundwater, and the identified mechanisms and pathways by which potential harm could occur.

The frequency of sampling recommended for the identified bores is also based on an assessment of the relative risks of environmental harm, and the typical migration times for groundwater along the identified pathways.

The trigger values and contaminant limits for groundwater quality in Schedule C Table 13 of the current version of the EA have been defined by DEHP based on recommended limits for the protection of aquatic ecosystems in slightly to moderately disturbed tropical Australian lowland river environments, on recommended limits for stock watering, and on background groundwater chemistry. These limits have been designed to identify and investigate the implications of any significant change from background groundwater quality.

The basis of the monitoring regime is that bores which are within the zone of impacted groundwater, the margins of which and the potential future migration of which are well understood, are sampled for interpretation purposes, rather than as compliance bores. The change in groundwater chemistry from background conditions in this zone is well known, and the potential for environmental harm has been investigated in detail in this report and in the concurrent studies.

Monitoring bores located down-gradient of the current extent of impacted groundwater are defined as compliance bores, so that any significant change in groundwater quality from background conditions at these locations will trigger an investigation into the implications, which is consistent with the intent of the EA, and the rationale for setting limits in the EA.

The locations of monitoring bores for regular groundwater sampling are plotted in Figure 26. In order to illustrate the rationale for selecting these locations, Figure 26 also presents the 2017 extent of the 1,000 mg/L sulphate contour in groundwater.

4.2 Background groundwater quality

During the 2010 and 2011 field investigation programmes it was planned to drill regional groundwater monitoring bores intersecting the shallow groundwater system up-gradient of the Mt Leyshon site. Due to access restrictions imposed by the holders of the relevant pastoral leases at that time, these background bores could not be installed before the drilling rig was demobilised. However, two bores were installed within Newmont controlled leases and as distant as possible from the closed mine facilities, and subsequent measurement of hydraulic gradients suggests they are in fact up-gradient of the mine facilities. The bores are highlighted in Figure 26 and are discussed as follows:

- NMLMB23 is located northwest of the mine lease boundary, adjacent to Clarke Creek. Reference to the groundwater elevations contoured in Figure 7 confirms that the bore is not down-gradient of flows leaving the area of the NNTSF. Completion details for the bore are provided in Appendix A, and confirm that the bore is screened in a permeable section of the shallow groundwater system comprising weathered granite.
- NMLMB51 is located to the west of the Settlement Pond. Although the bore is relatively close to the rehabilitated stockpile areas, Figure 7 confirms the groundwater elevation is 2 m higher than that measured in bores near the stockpiles, and the bore is inferred to be up-gradient of the site. The completion diagram in Appendix A indicates the bore is screened in weathered dolerite and granite associated with the shallow groundwater system.

Regular sampling of NMLMB23 and NMLMB51 is therefore recommended, concurrent with sampling of interpretation and compliance bores, to assist with the interpretation of changes in groundwater chemistry.

4.3 Interpretation monitoring within the impacted groundwater zone

The extent of groundwater which has been impacted by the mining activities at the current time is well defined and is illustrated by the 1,000 mg/L sulphate contour presented in Figure 26. Monitoring of groundwater in this zone is proposed to confirm the current interpretation, and to provide early warning if groundwater pH were to reduce in this zone, which would result in the mobilisation of metals through the groundwater system. The recommended monitoring locations are identified in Figure 26, and construction details confirming these bores intersect the shallow groundwater system are provided in Appendix A. Note that no completion details are available for MLM28 which was drilled in the mining period. The rationale for the selection of each bore is:

- NMLMB3. Including this bore provides continuity of monitoring, as it was included in the version of the EA issued in 2013, and will identify changes in groundwater quality driven by seepage from the STSF.
- NMLMB3S. Sampling of NMLB3S in addition to NMLMB3 is recommended, as the investigations have identified the screen in NMLMB3 is potentially too deep to fully intercept STSF seepage.
- MLM28. This location, immediately down-gradient of the EWRSF provides further continuity of data, as it was included in the EA issued in 2013. At MLM28, TDS and sulphate concentrations have been most strongly impacted by seepage, and it therefore provides a potential early warning if the significant seepage inferred at this site should result in lowered pH values in groundwater.
- NMLMB15D is suitably located to provide early warning of any changes in seepage influence immediately to the east of the EWRSF.
- NMLMB32 and NMLMB47D are located along the boundary of the NNTSF, and will provide early warning of any changes in the seepage which is migrating from this facility through the groundwater system to the north and northeast.

- NMLMB1, located to the northwest of the NNTSF, provides continuity of monitoring, and will help to confirm that NMLMB23, located further to the northwest, is intercepting background groundwater.
- NMLMB2, located north of the NNTSF, and at the northern extent of the zone where sulphate concentrations exceed 1,000 mg/L provides continuity of monitoring and identifies any change in the margin of the impacted groundwater.
- NMLMB20 and NMLMB22 are inferred to be potentially down-gradient of the scats stockpile, and are included to provide early warning of any significant changes in groundwater chemistry associated with this facility, taking account that the stockpile is planned to remain uncovered.
- NMLMB40 is positioned 250 m down-gradient from MLM21, which is the only location at which a significant reduction in groundwater pH has been observed to date. Monitoring at NMLMB40 is intended to investigate potential migration of the groundwater identified at MLM21.

4.4 Compliance monitoring outside the impacted groundwater zone

Bores which are defined as compliance locations in the EA are illustrated in Figure 26. In general, they have been selected as they are immediately outside or at the margin of the current zone of impacted groundwater, and are along the inferred future flow paths for impacted groundwater. Monitoring at these locations is intended to confirm the future movement of the impacted groundwater, and to provide early warning of any changes which do not match the current model. Completion diagrams for the identified bores are provided in Appendix A, and all are screened within the shallow groundwater system. Bores which are aligned along the predicted future flow paths to the south, east and northeast are MLMB39, NMLMB38, NMLMB5, NMLMB34, and NMLMB28. Two bores which are along the western boundary of the mine lease (NMLMB7 and NMLMB18) are also included, to confirm the current model which predicts minimal changes in groundwater chemistry to the west of the site.

4.5 Frequency of groundwater quality sampling

Up to 2013, groundwater quality sampling at the Mt Leyshon mine had been undertaken at three monthly intervals, as required under the EA. While three monthly sampling would be applicable at an operating mine site, where the mine facilities are changing rapidly with the mine plan, it is not appropriate for a closed mine site, where the facilities are in their final configuration and have been rehabilitated, and the site groundwater conditions are well understood. Taking account of the objectives of the groundwater monitoring programme, which are to define changes along the migration pathways which have been defined for potential environmental harm, and considering the predicted rates of change in the groundwater system, annual groundwater sampling is considered appropriate to meet these objectives. Sampling would be undertaken at the end of the dry season each year, to ensure samples are collected at the same point in the seasonal cycle, and when the influence of natural recharge on groundwater quality is lowest.

Figures 27 and 28 present sulphate data collected from bores MLM21 and NMLMB4 at three monthly intervals. In each Figure, an alternative plot is provided using only annual concentrations recorded at the end of the dry season (predominantly September sampling events).

At MLM21, which is located below the heap leach and low grade stockpile areas and has been monitored through both the operating and closure periods, a breakthrough event occurred in 1992 in response to mine operations, when sulphate concentrations became elevated over background levels, and a reduction in sulphate concentrations occurred as a result of high rainfall in early 2004. A second breakthrough type event was observed from 2005 to 2009 in response to seepage in the area of the LS-A pond. These major changes to groundwater chemistry in the area of MLM21 are all faithfully represented in the lower graph, in which only September sampling results are plotted.

At NMLMB4, which was drilled close to Puddler Creek at the start of the closure period, sulphate concentrations rose steadily above background levels in the period 2001 to 2008 as impacted groundwater migrated from the area of the STSF. Subsequently, the very large precipitation events in January and February of 2008 generated significant recharge to the groundwater system, and concentrations of sulphate in groundwater reduced to close to background levels. These long term trends in groundwater chemistry near Puddler Creek are well defined in the lower graph, which presents only groundwater samples collected in September of each year.

The comparison plots provided in Figures 27 and 28 confirm that annual sampling of groundwater will provide sufficient data to identify and interpret any future breakthrough type events resulting from the migration of impacted groundwater, or any significant improvements in groundwater chemistry in response to natural seasonal recharge.

4.6 Groundwater elevations

The primary objectives of recording groundwater elevations in the VWP sensors and monitoring bores installed at the Mt Leyshon mine are:

1. To identify any changes in groundwater pressures and hydraulic gradients in the deep groundwater system around the pit as the pit lake elevation increases.
2. To map groundwater elevations and hydraulic gradients within the shallow groundwater system and confirm that flow directions are consistent with the current model.
3. To identify any localised increase in groundwater elevations near the mine facilities which could indicate an increase in the rate of leakage from the facility into the groundwater system.
4. To provide early warning of when regional groundwater elevations are higher, in response to seasonal conditions, which increases the risk of groundwater discharge to the surface water environment.

In order to meet these objectives, and allow regular contouring of groundwater elevations and comparison against the surface topography, recommendations for groundwater elevation monitoring are:

1. Three monthly manual measurement of groundwater elevations at NMLMB1, NMLMB6 and MLM28, where the automated continuous monitoring sensors have failed.
2. Continued automated or manual three monthly monitoring of groundwater pressures defined in the 46 VWP sensors installed around the open pit.
3. Measurement of depth to water in all available monitoring bores across the site twice per year. Monitoring would be undertaken at the end of the dry season (to define the lowest groundwater elevations over the year), and at the end of the wet season (to define the highest elevations over the year, at the time when the potential for groundwater discharge to surface is highest).

4.7 Summary of recommended monitoring plan

Table 6 summarises the locations and frequency recommended for the collection of groundwater samples for laboratory analyses. Sampling would be undertaken following the site standard procedures, and would include the miro-purge sampling method, and measurement of stable hydrochemical parameters before sampling. Analytes included for each sample would include all of the components which currently have, or will in future have a limit specified in the EA, along with major components required for strategic analyses (major ions, alkalinity and TDS).

Table 6: Recommended groundwater sampling

Monitoring Bore	Easting GDA94	Northing GDA94	Collar Elevation mRL	Sampling Frequency
Background bores				Annual, end dry season
NMLMB23	422079	7759757	309.29	
NMLMB51	422254	7755020	343.41	
Interpretation bores				Annual, end dry season
MLM28	425205	7754639	333.58	
NMLMB1	422920	7759164	302.88	
NMLMB15D	425807	7755642	330.30	
NMLMB20	422755	7757193	338.86	
NMLMB22	422897	7757125	339.47	
NMLMB3	423542	7753737	326.76	
NMLMB3S	423545	7753736	327.31	
NMLMB32	424565	7757943	329.37	
NMLMB40	423185	7754767	345.41	
NMLMB47D	423154	7758370	315.29	
NMLMB2	423644	7759803	300.18	
Compliance bores				Annual, end dry season
NMLMB5	426236	7753716	313.66	
NMLMB7	422412	7758511	315.43	
NMLMB18	422065	7756531	358.83	
NMLMB28	425070	7759097	306.70	
NMLMB34	426680	7755249	316.01	
NMLMB38	424514	7753450	322.66	
NMLMB39	423623	7753332	328.03	

Table 7 summarises the locations and frequency recommended for the monitoring of groundwater elevations at Mt Leyshon. Depth to groundwater would be measured to an accuracy of 0.01 m from the surveyed reference point at the bore collar, and for any bore that is dry at the time of measurement; this information would also be specifically recorded. Depth measurement would be recorded twice per year, at the end of the wet season, and at the end of the dry season.

Table 7: Recommended monitoring of groundwater elevations

Monitoring Bore	Easting GDA	Northing GDA	Collar Elevation mRL	Monitoring Bore	Easting AGD	Northing AGD	Collar Elevation mRL
MLM15	423,932	7,757,415	340.37	NMLMB24	422,850	7,759,222	303.21
MLM28	425,205	7,754,639	333.58	NMLMB25D	423,214	7,759,496	303.06
MLM42	423,621	7,753,650	325.33	NMLMB25S	423,186	7,759,504	303.57
MLM44	424,306	7,754,034	331.45	NMLMB26D	423,563	7,759,344	303.27
MLM56	423,010	7,758,209	313.71	NMLMB26S	423,563	7,759,344	303.70
NMLMB1	422,920	7,759,164	302.88	NMLMB27	424,192	7,759,744	297.30
NMLMB2	423,644	7,759,803	300.18	NMLMB28	425,070	7,759,097	306.70
NMLMB2S	423,645	7,759,801	300.18	NMLMB29	425,419	7,759,717	297.75
NMLMB3	423,542	7,753,737	326.76	NMLMB30	424,882	7,758,217	322.03
NMLMB3S	423,545	7,753,736	327.31	NMLMB31	424,921	7,758,086	323.45
NMLMB4	425,021	7,753,161	316.44	NMLMB32D	424,565	7,757,943	329.37
NMLMB5	426,236	7,753,716	313.66	NMLMB32S	424,566	7,757,944	330.03
NMLMB6	426,305	7,755,438	321.77	NMLMB33	426,167	7,756,718	330.01
NMLMB6AS	426,482	7,755,322	317.55	NMLMB34	426,680	7,755,249	316.01
NMLMB6BS	426,208	7,755,346	324.02	NMLMB35	426,888	7,755,007	313.30
NMLMB6CS	426,305	7,755,438	322.23	NMLMB36	426,378	7,753,438	309.41
NMLMB7	422,412	7,758,511	315.43	NMLMB37	425,460	7,754,275	324.81
NMLMB8	424,946	7,759,838	307.23	NMLMB38	424,514	7,753,450	322.66
NMLMB9D	424,349	7,758,633	320.08	NMLMB39	423,623	7,753,332	328.03
NMLMB9S	424,349	7,758,631	320.60	NMLMB40	423,185	7,754,767	345.41
NMLMB10	424,716	7,757,682	345.60	NMLMB41	425,632	7,755,922	343.41
NMLMB11	425,202	7,756,514	360.81	NMLMB42	425,808	7,755,112	334.92
NMLMB12	425,221	7,758,076	327.08	NMLMB43	424,734	7,754,188	333.75
NMLMB13	426,565	7,756,231	348.79	NMLMB44D	422,672	7,757,892	326.56
NMLMB14	426,398	7,754,496	330.19	NMLMB45D	422,719	7,757,937	325.81
NMLMB15D	425,807	7,755,642	330.30	NMLMB46D	422,880	7,758,018	320.83
NMLMB15S	425,804	7,755,643	330.42	NMLMB46S	422,881	7,758,018	320.82
NMLMB16	425,784	7,755,521	334.23	NMLMB47D	423,154	7,758,370	315.29
NMLMB17	425,091	7,753,865	335.98	NMLMB48	422,796	7,759,642	308.79
NMLMB18	422,065	7,756,531	358.83	NMLMB49D	423,546	7,758,622	312.78
NMLMB19	422,766	7,755,991	366.11	NMLMB49S	423,547	7,758,622	312.59
NMLMB20	422,755	7,757,193	338.86	NMLMB50D	424,147	7,760,174	299.61
NMLMB21	422,967	7,757,266	335.80	NMLMB50S	424,145	7,760,175	299.65
NMLMB22	422,897	7,757,125	339.47	NMLMB51	422,254	7,755,020	343.41
NMLMB23	422,079	7,759,757	309.29				

5. Summary and conclusions

Hydrogeological investigations undertaken at the Mt Leyshon mine during the mining and closure period include both shallow and deep electrical geophysical surveys, installation of 10 deep investigation holes to depths up to 300 m with VWP sensors installed, installation of 58 shallow monitoring bores, and investigation of 35 existing monitoring bores. In combination with monitoring data collected during the mining and closure period, these provide a detailed understanding of the groundwater transmitting systems at the site. This understanding has allowed the potential pathways and mechanisms for the transmission of groundwater which could cause environmental harm to be defined. Subsequently, a recommended groundwater monitoring programme has been developed, which has been designed taking account of these identified pathways and mechanisms.

The deep groundwater system comprises fracture zones within the deep unweathered basement rocks. These occur predominantly close to the open pit and limited fracturing has been identified in the surrounding granite and dolerite country rocks. The primary interaction for the deep groundwater system is with the lake in the open pit, and the risk of environmental harm associated with the deep groundwater system is assessed to be very low. Monitoring which is recommended for the deep groundwater system is continuous monitoring of the 46 installed VWP sensors. Responses in these sensors will identify the interactions between the pit lake and the deep basement groundwater system as the elevation of the pit lake increases.

The shallow groundwater system comprises the weathered and fractured zone at the upper basement surface, typically encountered between 5 and 25 mBGL. The main changes from background conditions which have been observed in groundwater in this system are increased groundwater elevations near the mine facilities, increased sulphate concentrations down-gradient of all facilities, and increased Co concentrations down-gradient of tailings facilities. These changes are well defined by the available data, and potential future changes in sulphate concentration have been determined using a numerical groundwater flow model. The shallow groundwater system potentially interacts with groundwater abstractors and with the surface water systems. Based on an assessment of the potential pathways for migration of environmental harm, monitoring which is recommended for the shallow groundwater system is:

- Annual sampling of two bores indicated to be hydraulically up-gradient of the site to define background groundwater chemistry.
- Annual sampling of eleven bores which are close to the mine facilities and within the known zone of impacted groundwater for interpretation purposes. Sampling of these bores is intended to define any changes in the influence of seepage from the mine facilities.
- Annual sampling of seven bores which are located immediately outside the zone of impacted groundwater for compliance purposes. Results will identify any future migration of the impacted groundwater and confirm that the predictions from the numerical groundwater flow model remain valid.
- Measuring depth to groundwater in all 69 available monitoring bores twice per year, in order to identify any localised increase in groundwater elevations near the mine facilities, and to provide early warning of when regional groundwater elevations are higher, in response to seasonal conditions, which increases the risk of groundwater discharge to the surface water environment.

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Certification

Certification of Groundwater Management Plan

Name of Hydrogeologist Providing Certification

Simon Ian Douglas Barrett

Address of Hydrogeologist Providing Certification

10 Grosvenor Rd, Bayswater, WA6053

Statement of Independence

I, Simon Barrett, hold the role of Principal Hydrogeologist with Big Dog Hydrogeology Pty Ltd. Big Dog Hydrogeology Pty Ltd is wholly owned by myself, and is independent of Newmont Landco Pty Ltd.

Statement of Experience

I, Simon Barrett, am suitably qualified and experienced in the field of hydrogeology to meet the requirements of the definition of a "suitably qualified and experienced person".

Certification

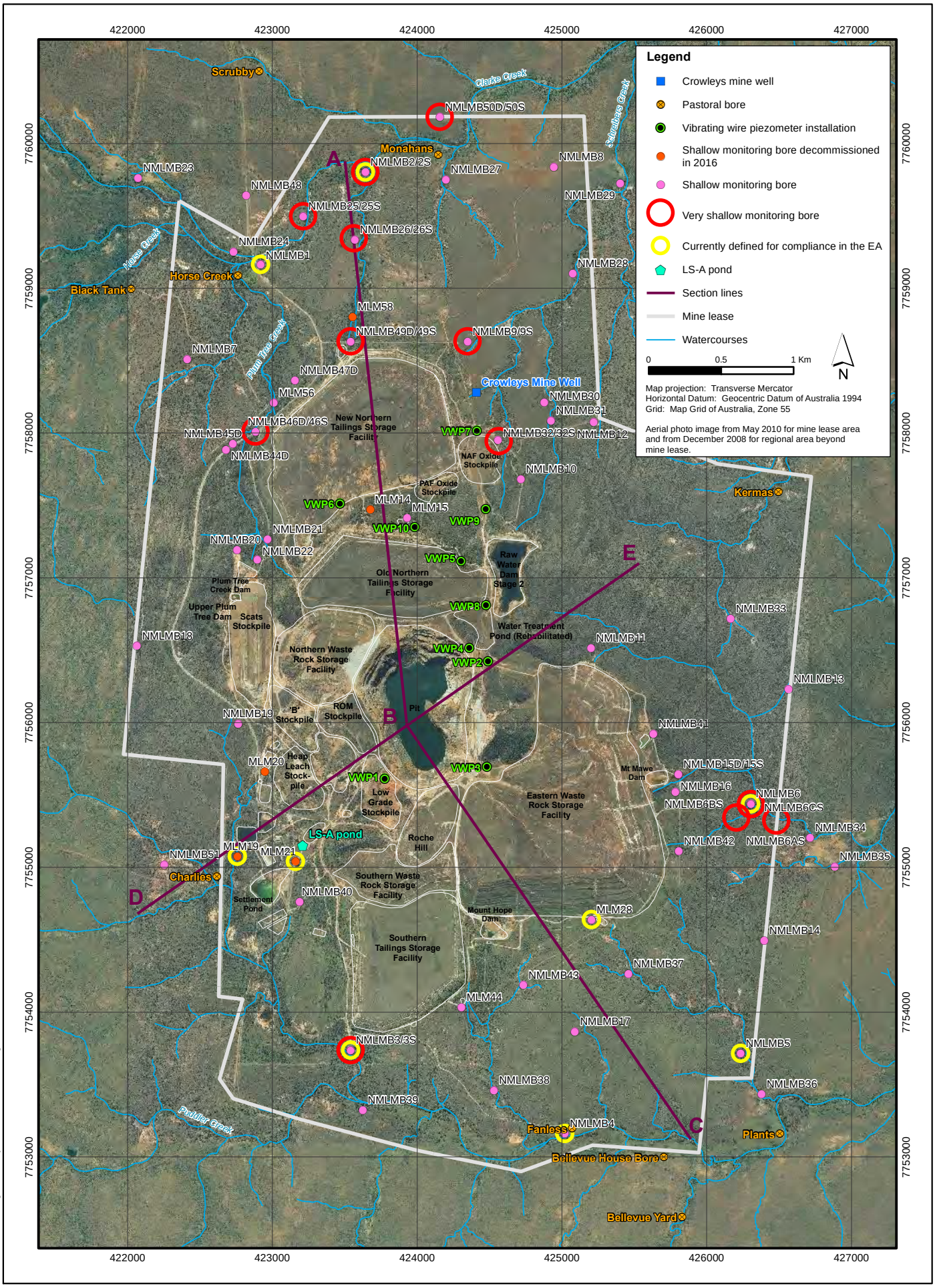
I hereby certify that the groundwater management plan titled "Newmont Mining Services Pty Ltd, Mt Leyshon Groundwater Management Plan" which has a status of "Revision F, Final", and is dated December 2017, presents and takes account of all relevant hydrogeological data, provides a management and monitoring plan which meets the requirements defined under Environmental Authority EPML00863713, and is appropriately protective of the environmental values at the site.

I, Simon Ian Douglas Barrett, declare that the information provided as part of this groundwater management plan is true to the best of my knowledge. I acknowledge that it is an offence under Section 480 of the Environmental Protection Act 1994 to give the administering authority a document containing information that I know is false, misleading or incomplete in a material particular.

Signed:

Date: 30 Dec 2017

Figures



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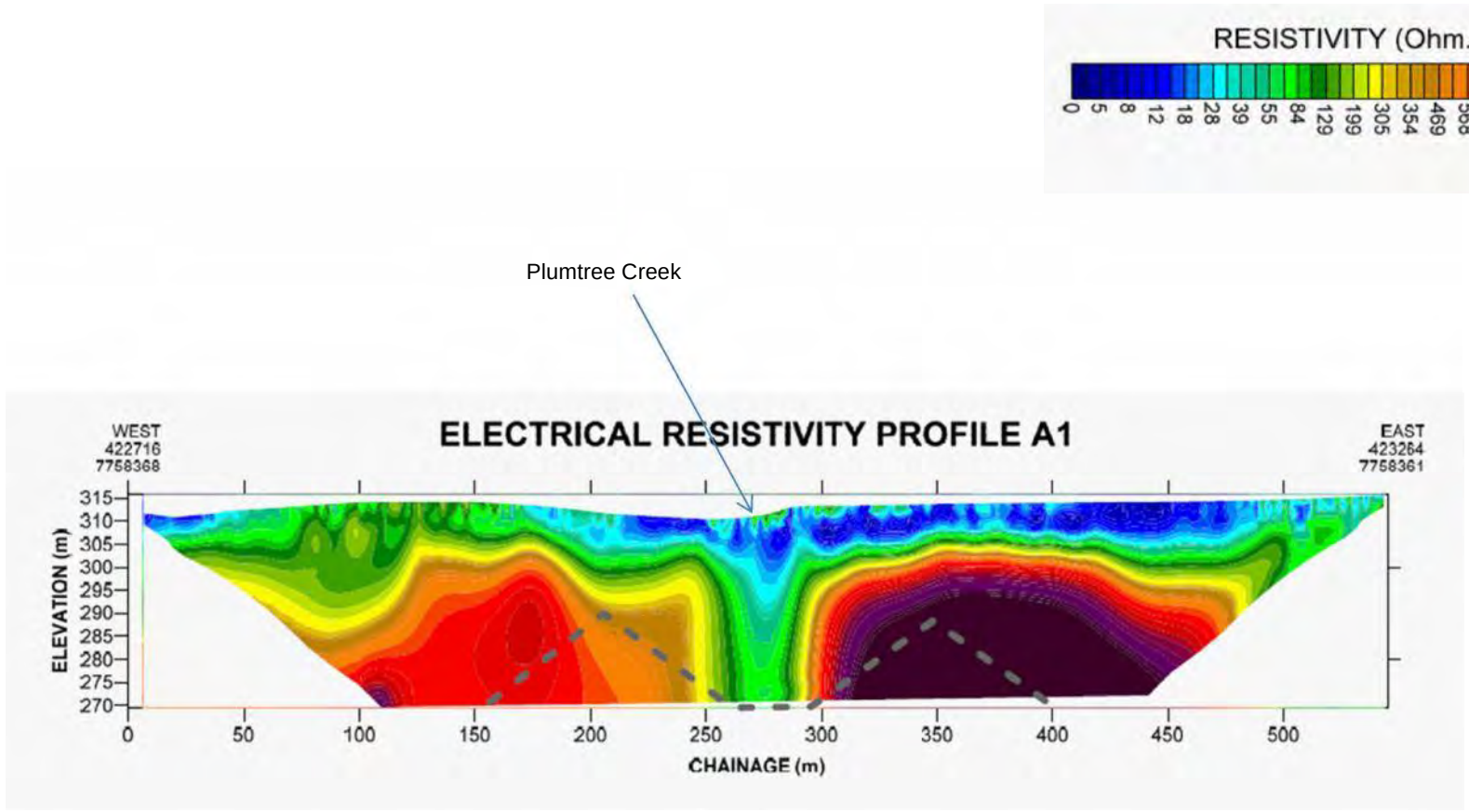
BIG DOG HYDROGEOLOGY

Active groundwater monitoring locations

Figure 1

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F



Shallow ERT profiling across Plumtree Creek, illustrating a conductive zone developed to around 30 m depth at the current location of the surface water drainage.

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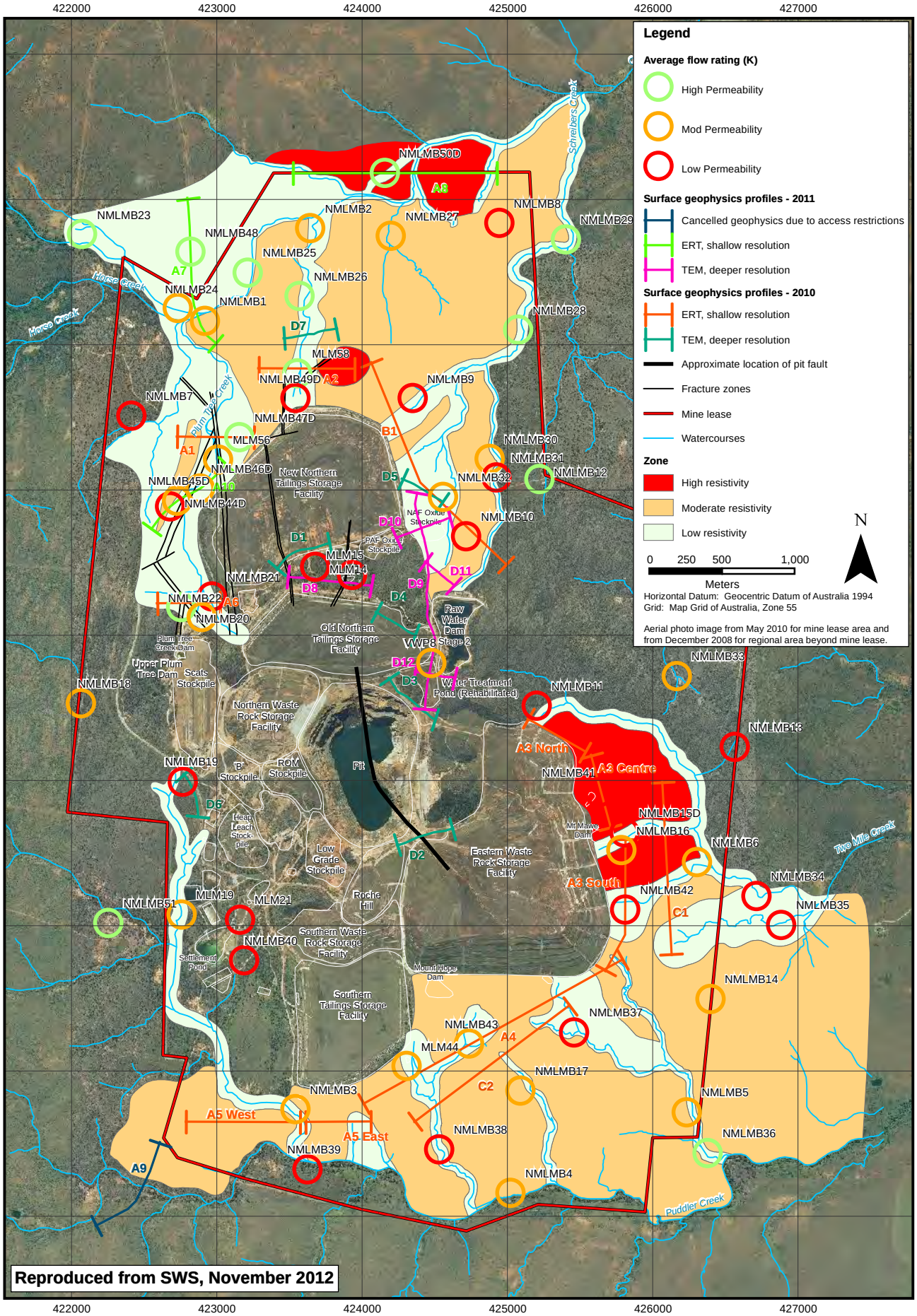
BIG DOG HYDROGEOLOGY

Example of shallow ERT profiling results

Figure 2

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F



BIG DOG HYDROGEOLOGY

Interpolated flow ratings

Figure 3

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F

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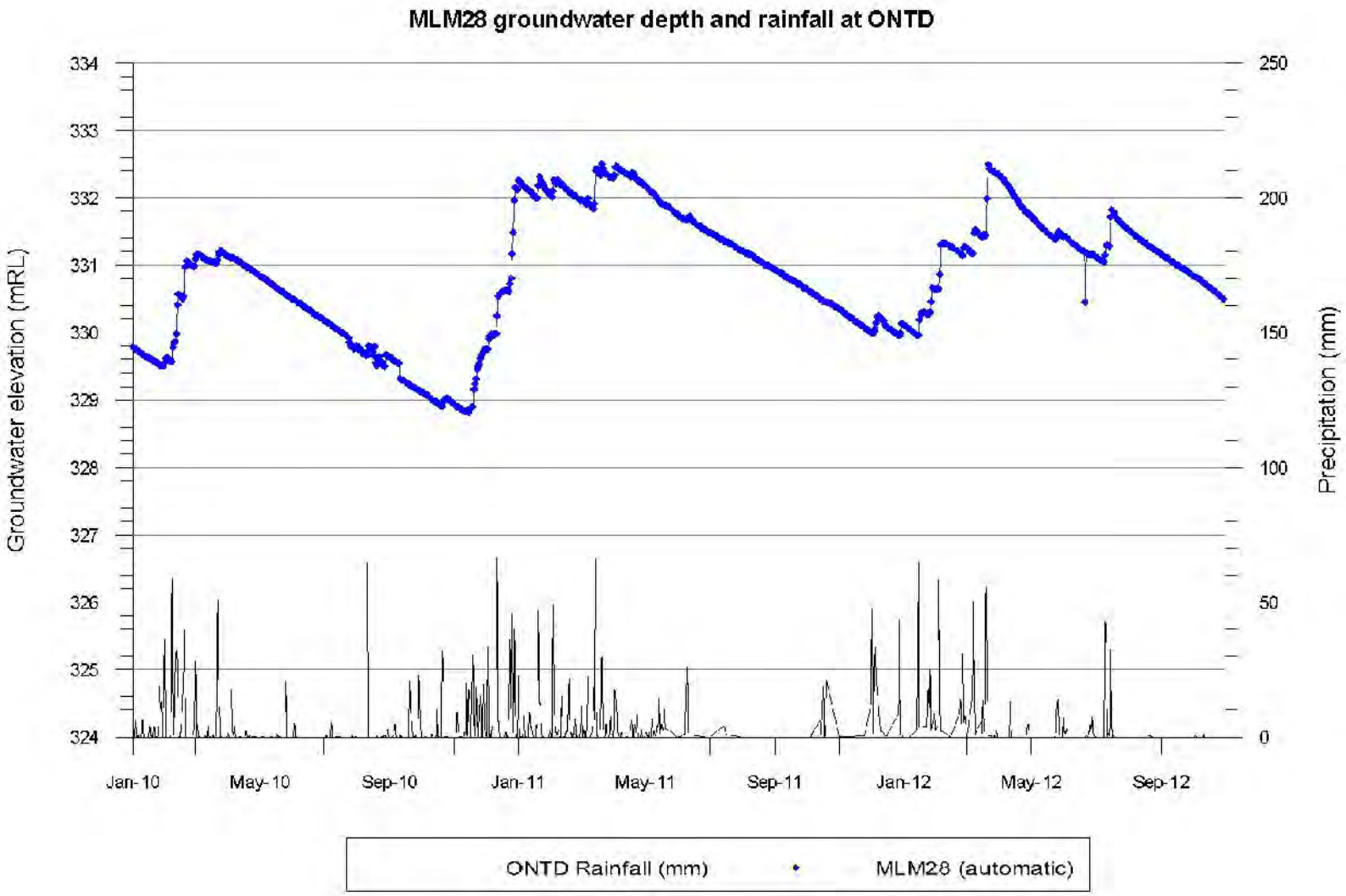

Reproduced from SWS, November 2012

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BIGDOG HYDROGEOLOGY

Automated hydrograph - MLM28

Figure 4

Date: December 2017

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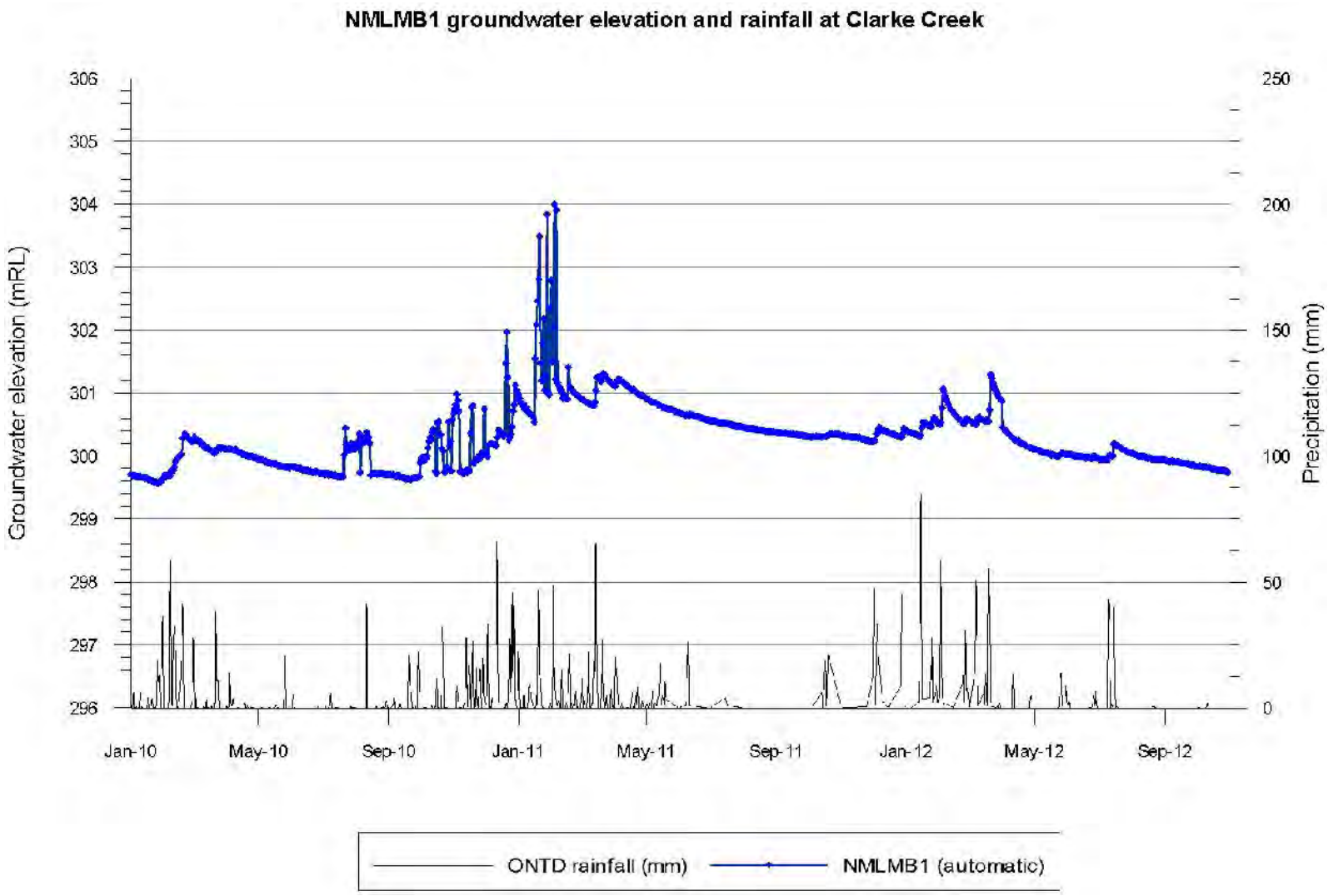

Reproduced from SWS, November 2012

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BIGDOG HYDROGEOLOGY

Automated hydrograph - NMLMB1

Figure 5

Date: December 2017

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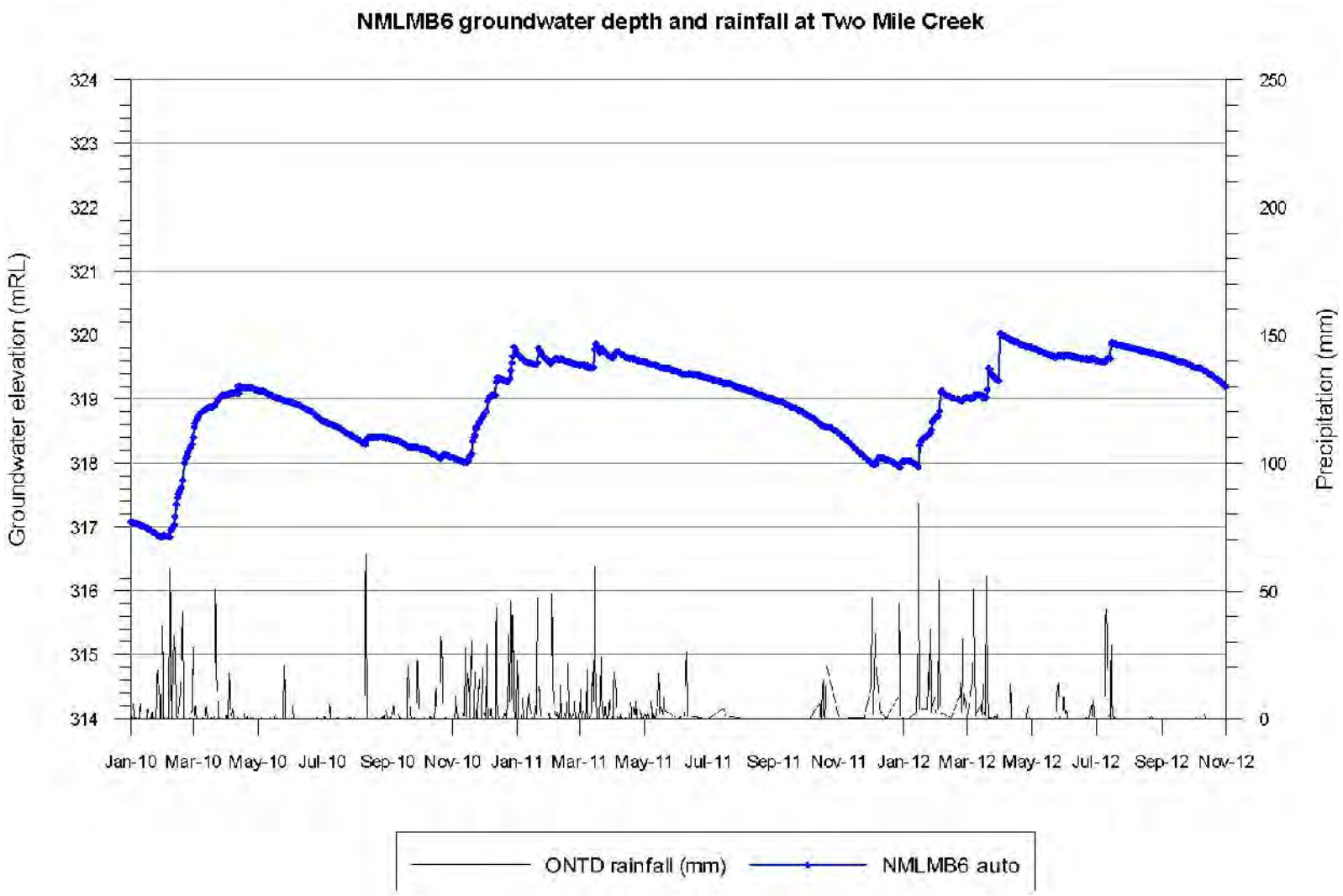

Reproduced from SWS, November 2012

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BIGDOG HYDROGEOLOGY

Automated hydrograph - NMLMB6

Figure 6

Date: December 2017

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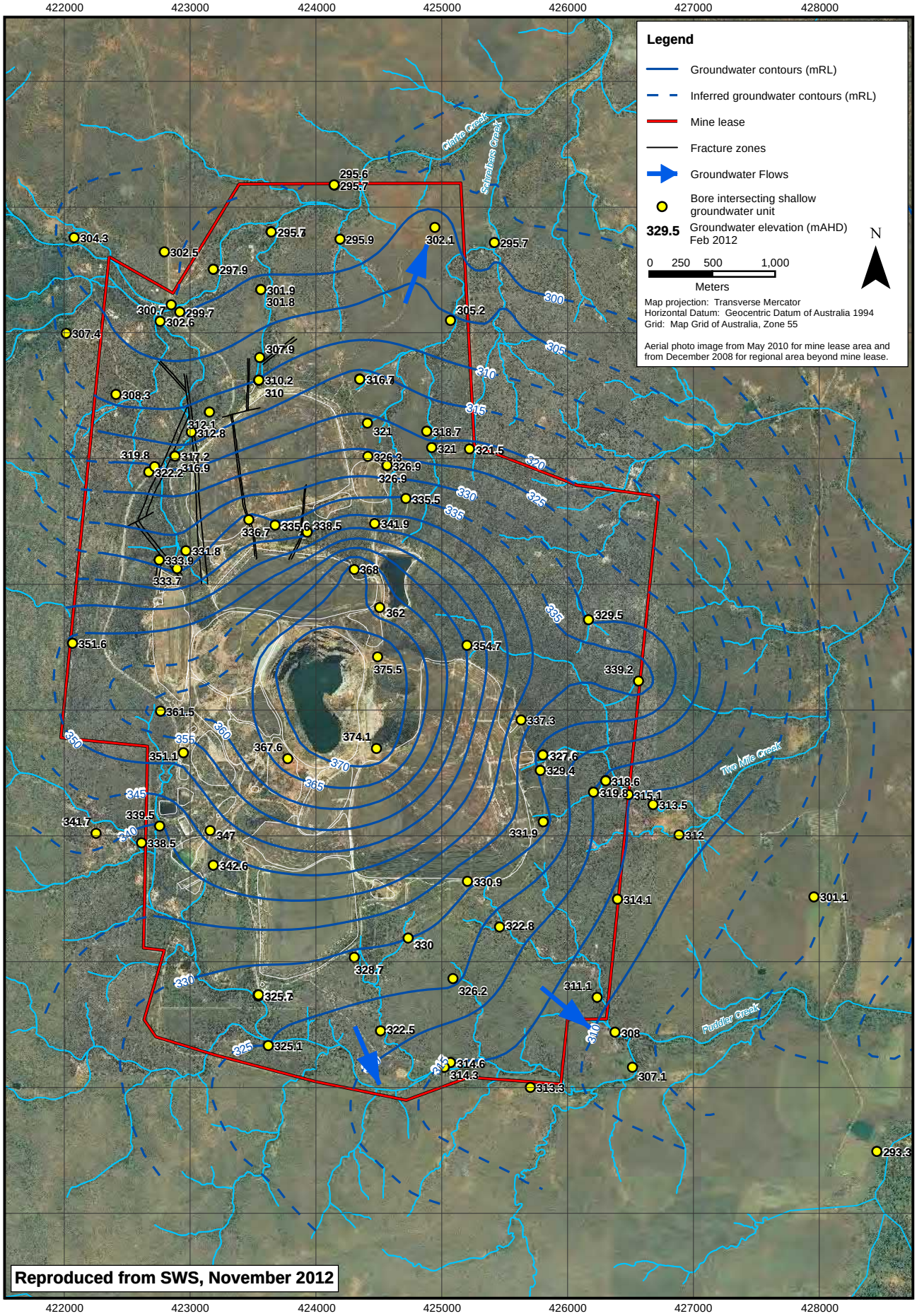

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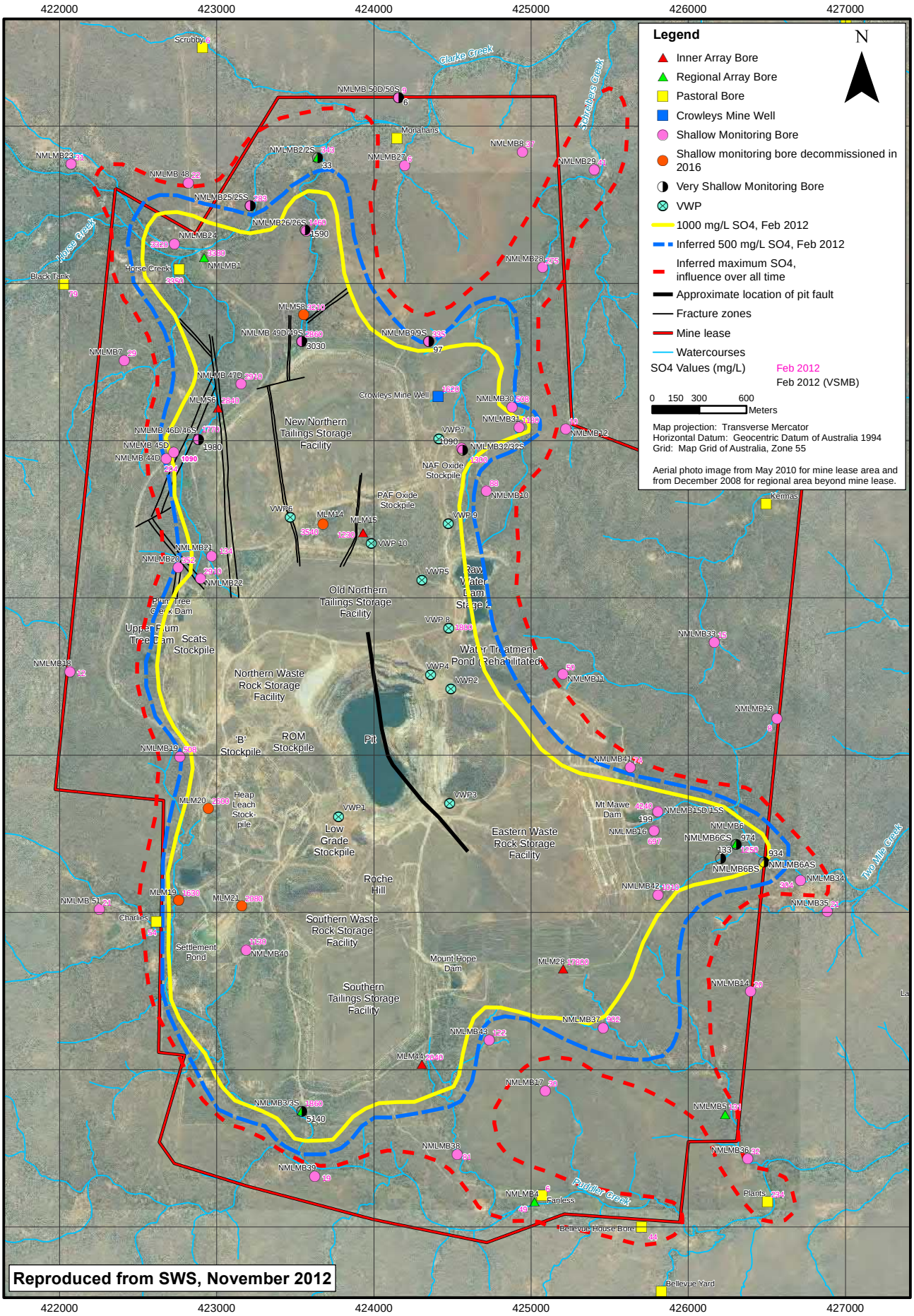
BIG DOG HYDROGEOLOGY

Groundwater elevations - February 2012

Figure 7

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F



G:\Projects\BDH Projects\Mt Leyshon - Newmont\GIS\Figures\Mt Leyshon Groundwater Management Plan Rev F

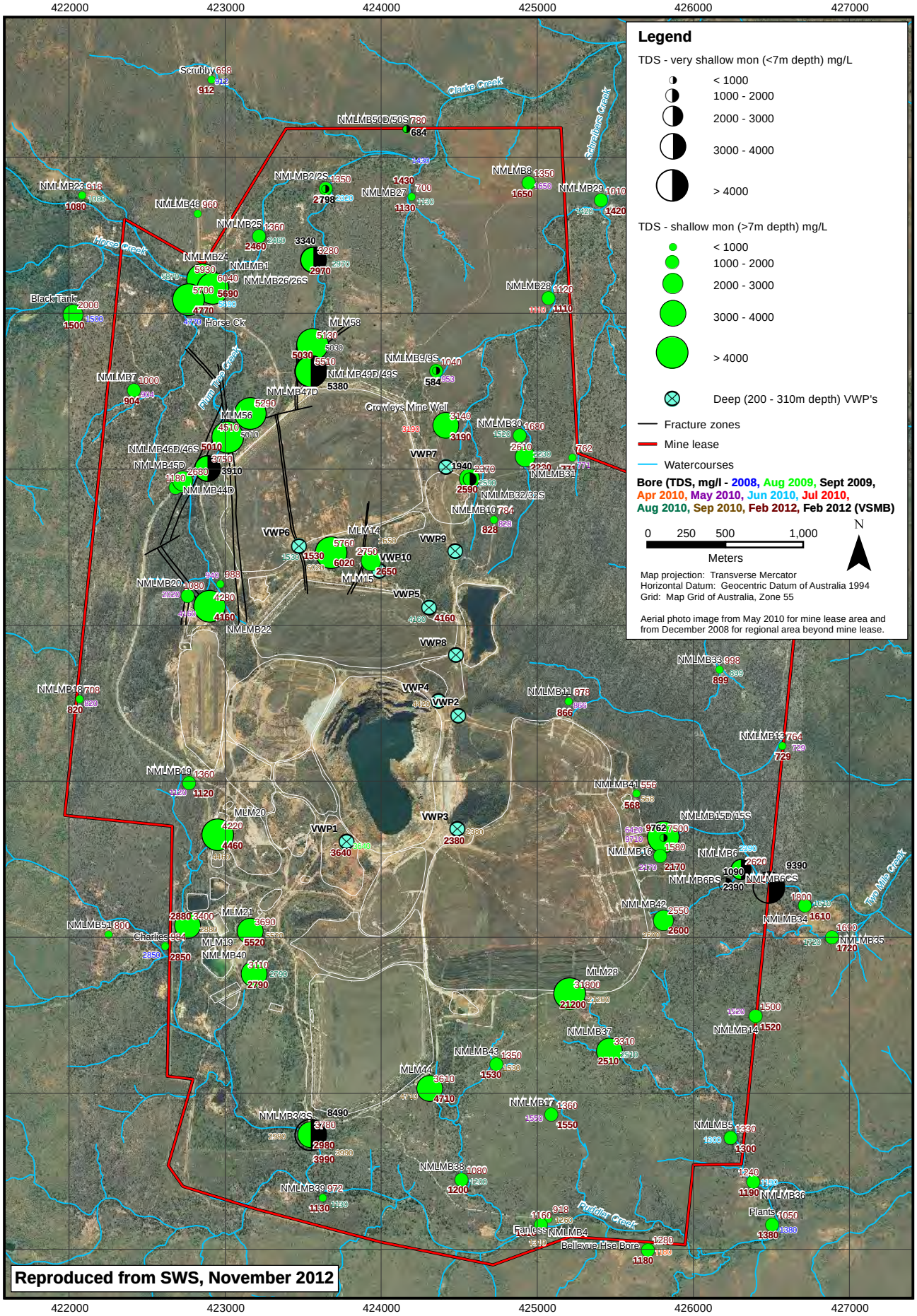
BIG DOG HYDROGEOLOGY

Extent of sulphate in groundwater

Figure 8

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F



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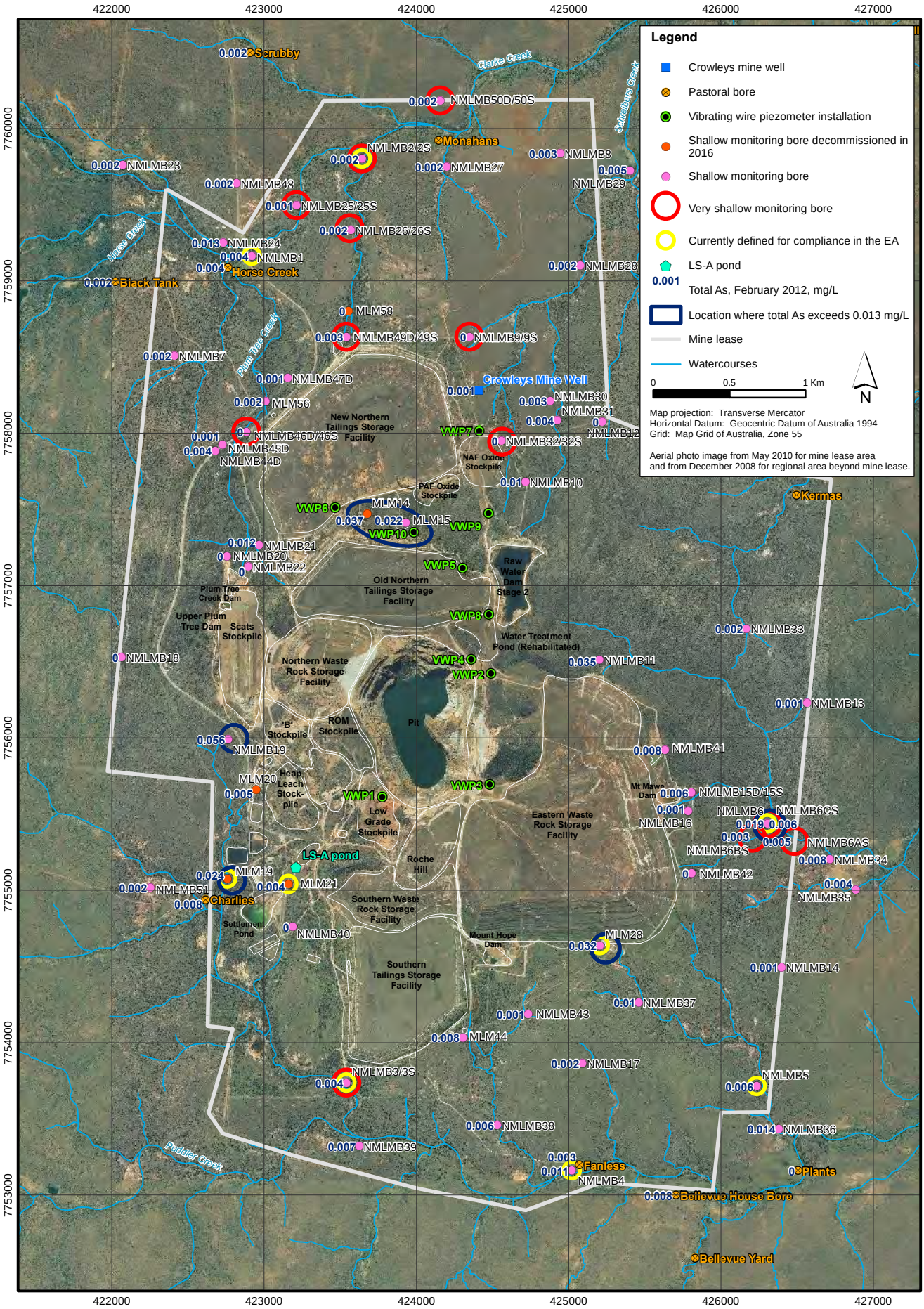
BIG DOG HYDROGEOLOGY

TDS concentrations in groundwater

Figure 9

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F



G:\Projects\BDH Projects\Mt Leyshon - Newmont\GIS\Figures\Mt Leyshon Groundwater Management Plan Rev F

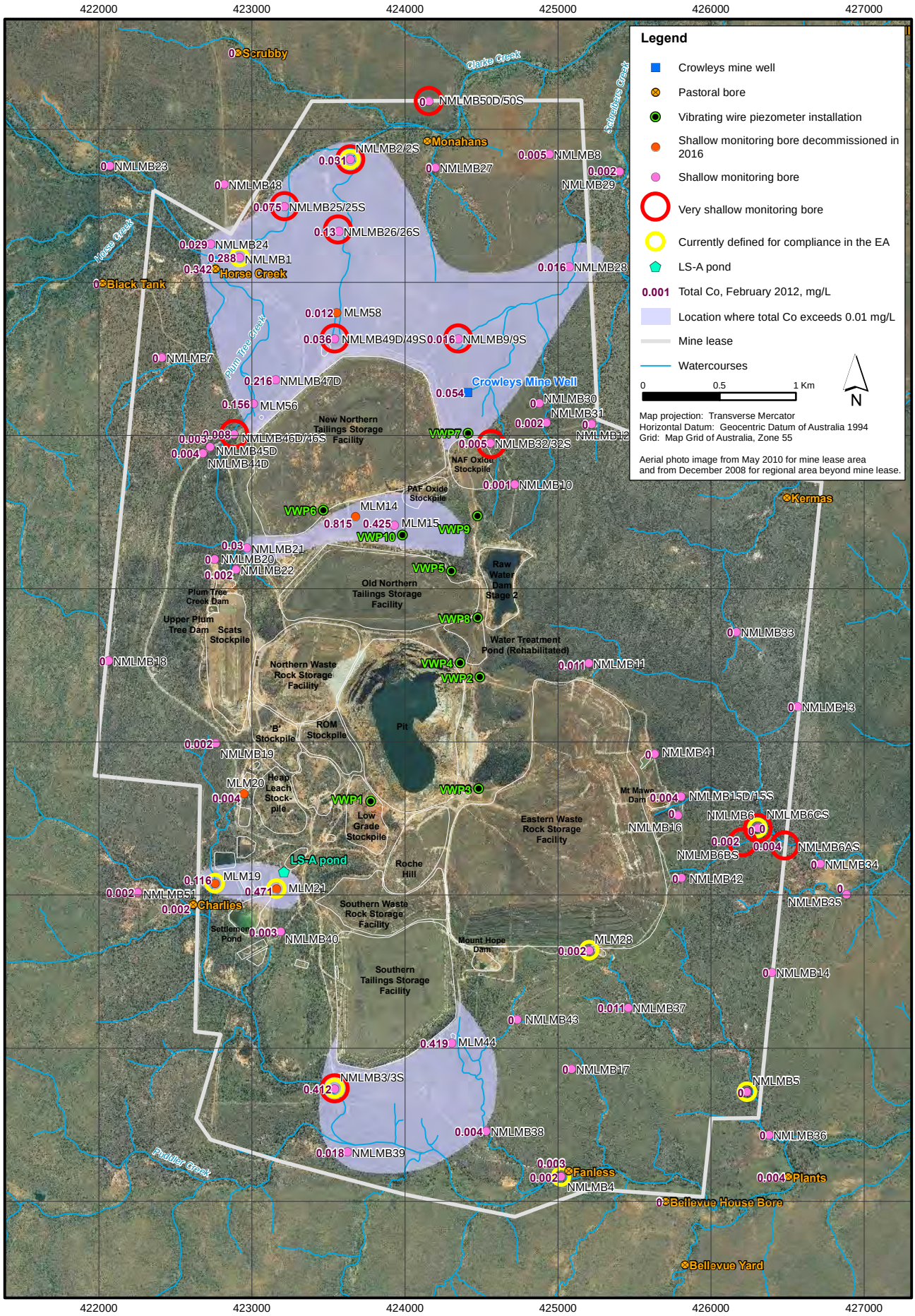
BIG DOG HYDROGEOLOGY

Total As concentrations in groundwater

Figure 10

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F



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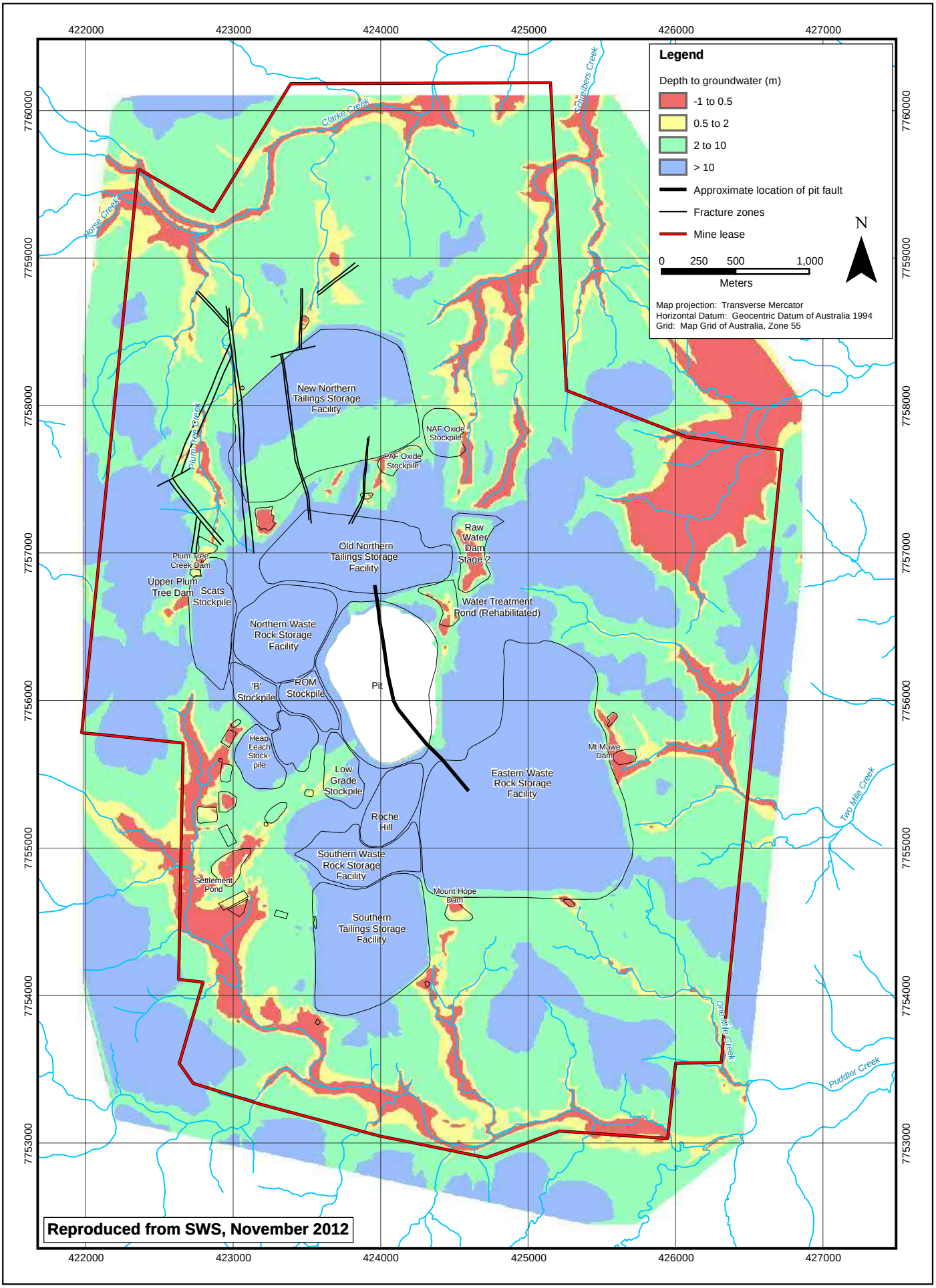
BIG DOG HYDROGEOLOGY

Total Co concentrations in groundwater

Figure 11

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F



BIG DOG HYDROGEOLOGY

Depth to groundwater, February 2012

Figure 12

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F

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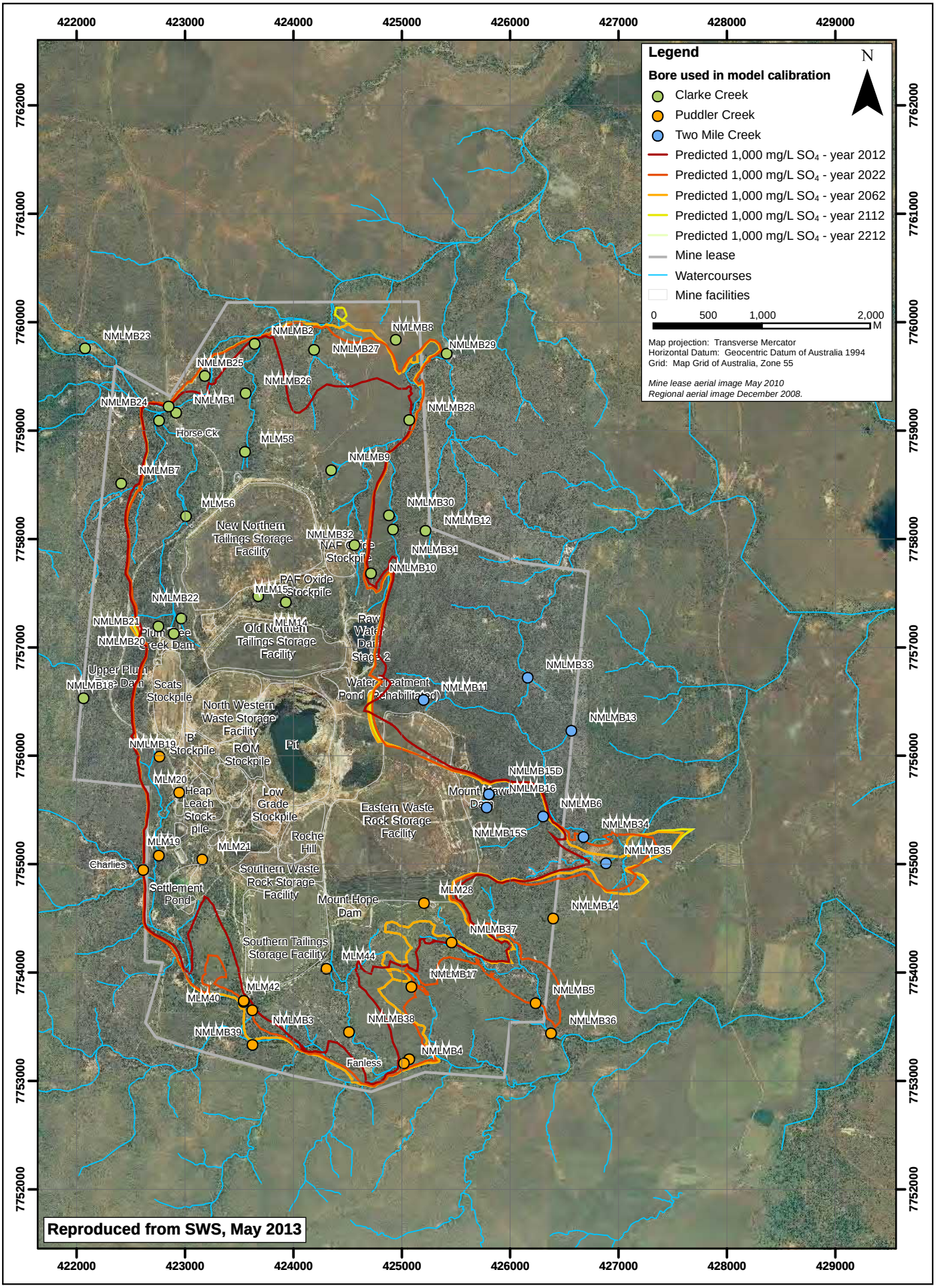

BIG DOG HYDROGEOLOGY

Predicted position of 1,000 mg/L sulphate contour

Figure 13

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F

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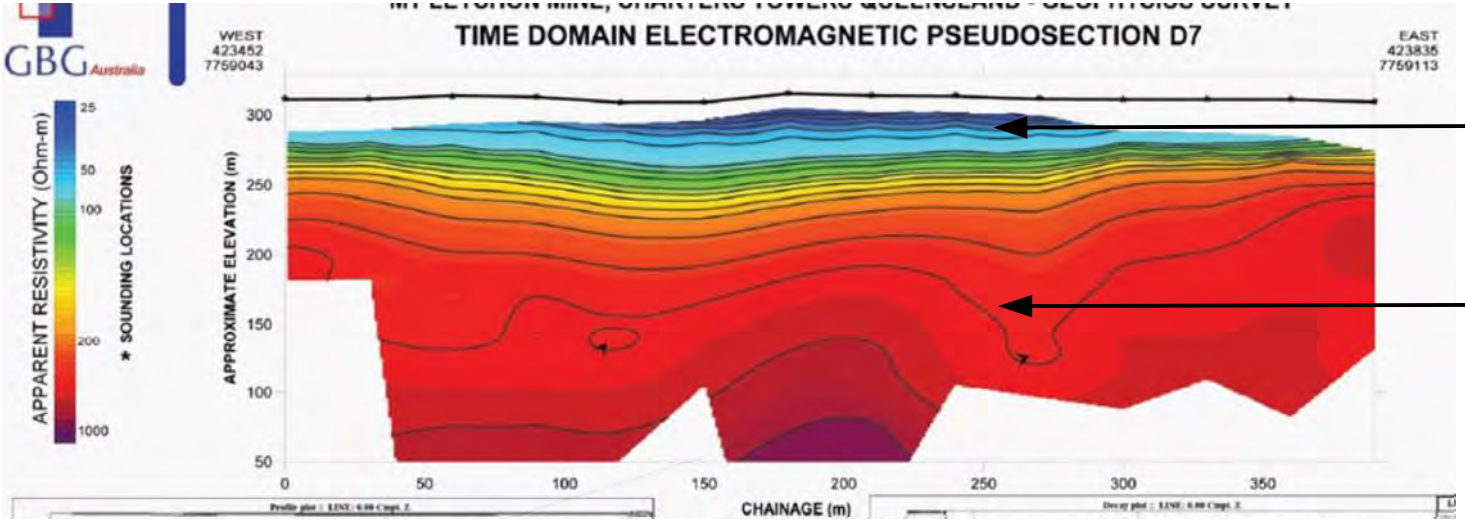
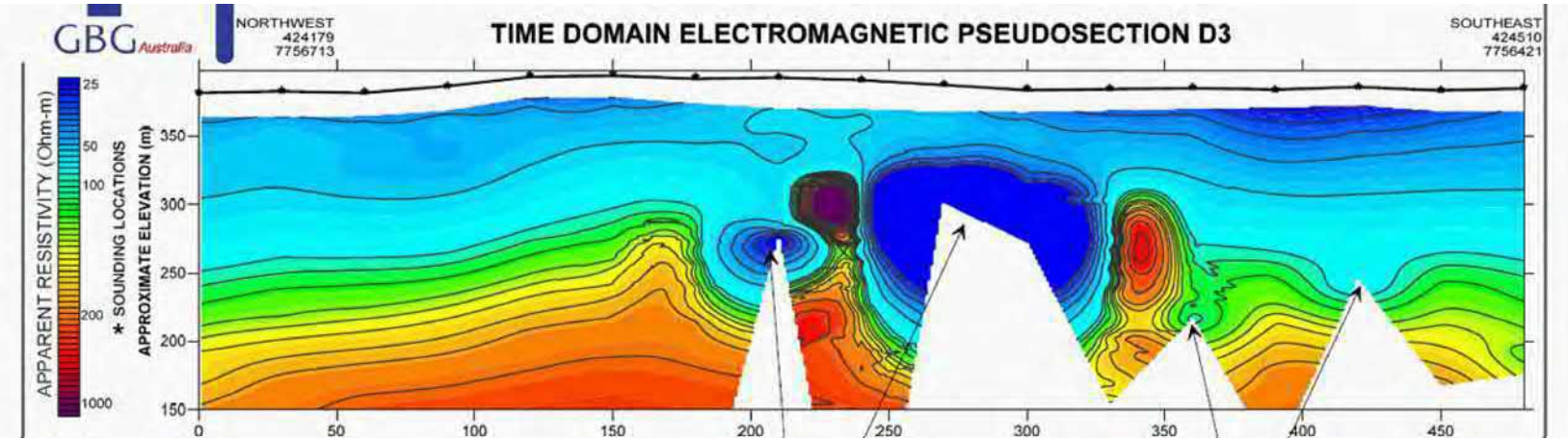


Conductive layer associated with the shallow groundwater system

Uniformly low conductivity in the deep groundwater system



Conductive features at around 100 m depth in the deep groundwater system, subsequently investigated by drilling VWP2 and VWP4

BIG DOG HYDROGEOLOGY

Example of deep TEM profiling results

Figure 14

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F

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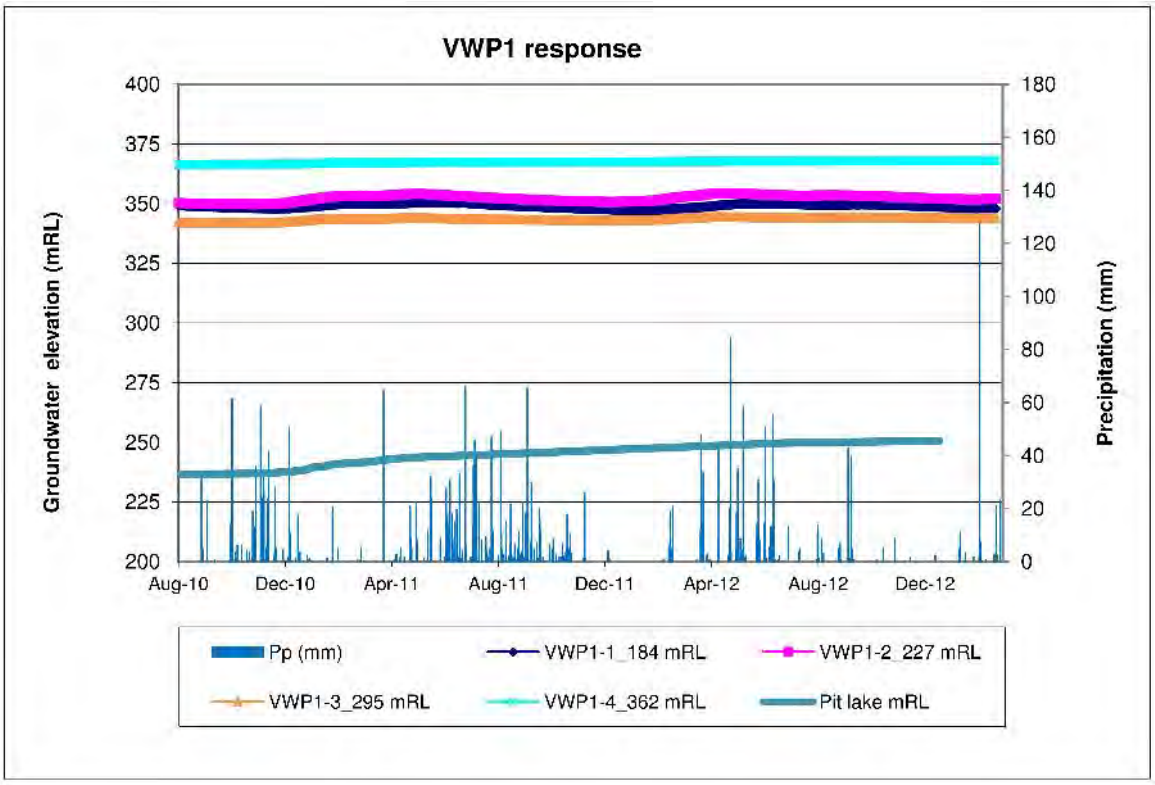

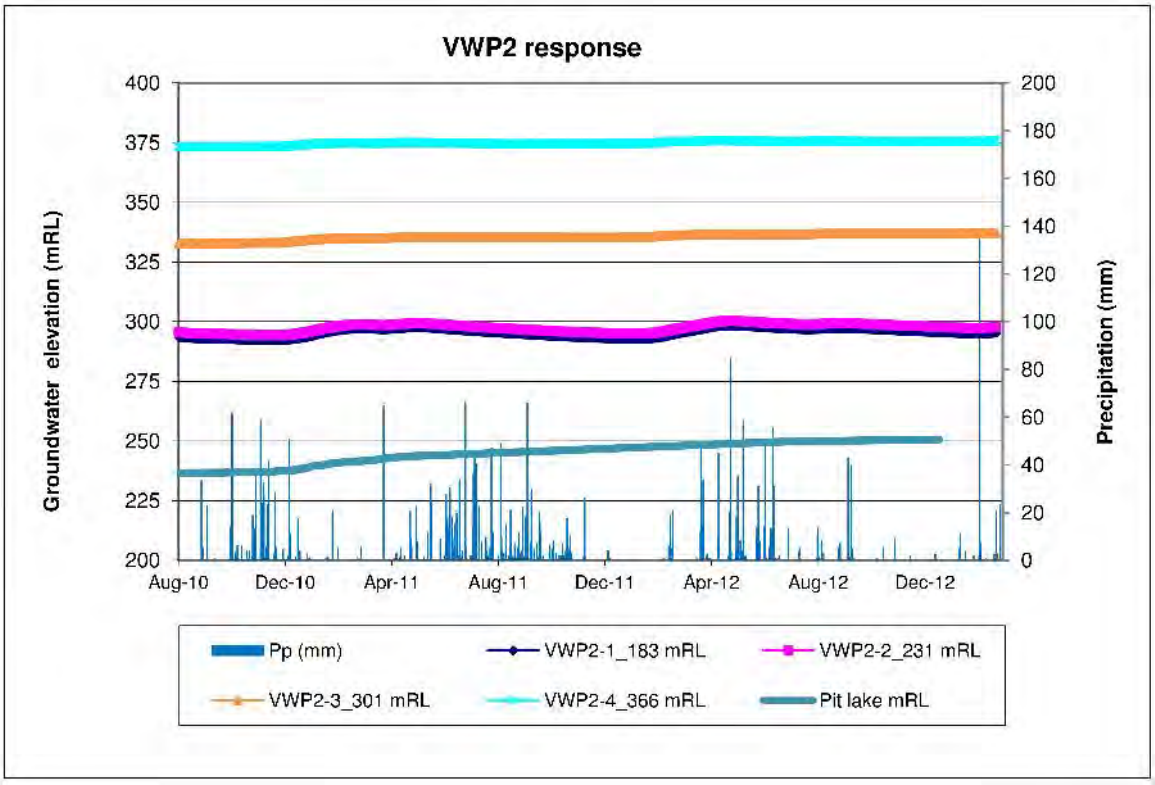

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BIG DOG HYDROGEOLOGY

Groundwater elevations, VWP1 and VWP2

Figure 15

Date: December 2017

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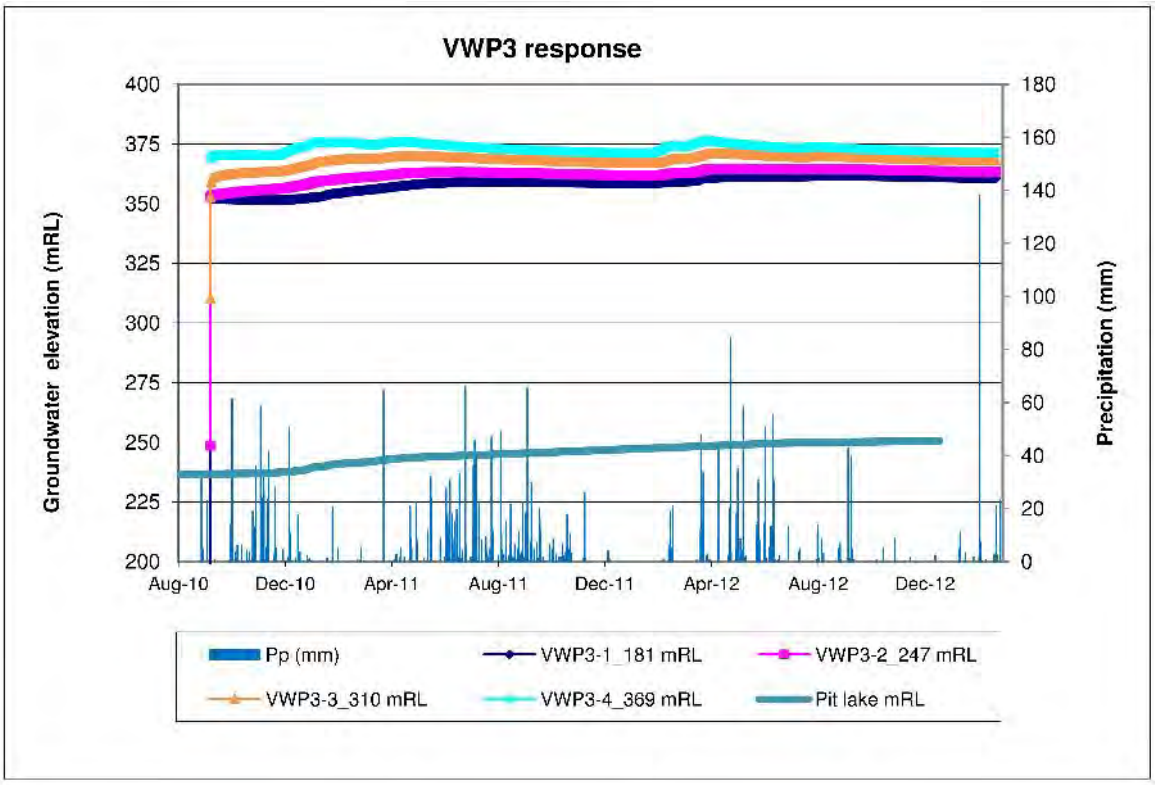

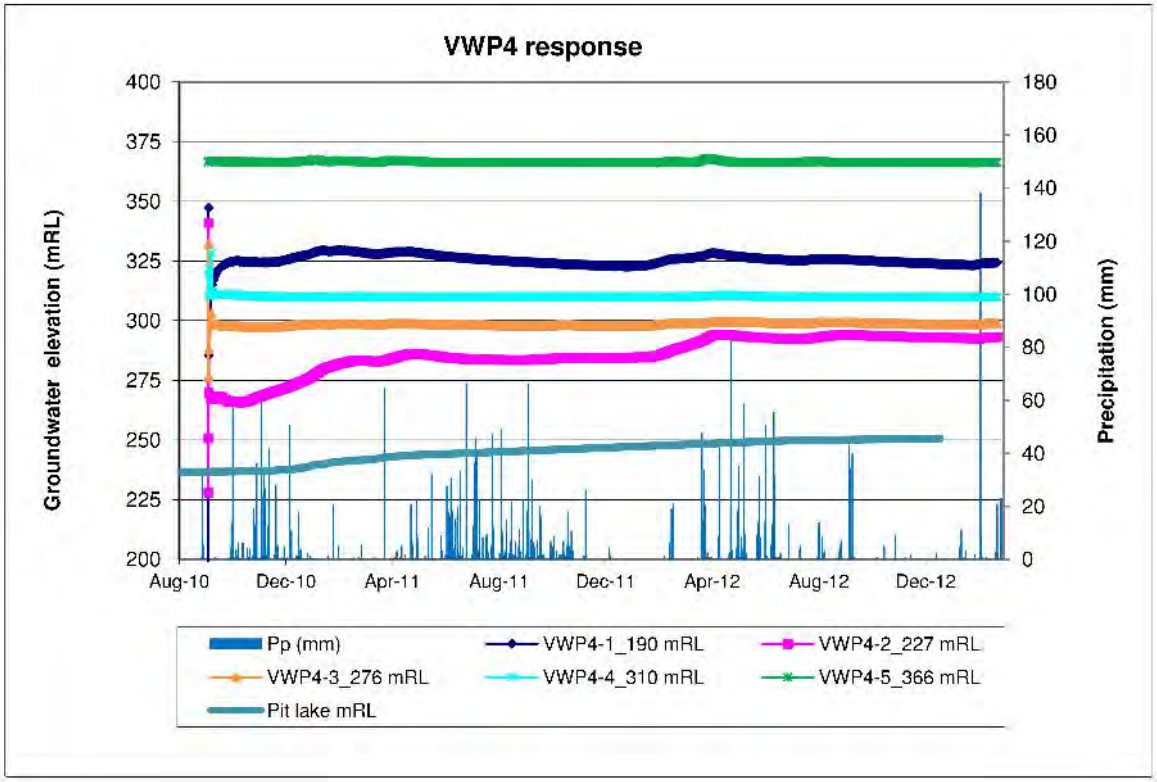

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BIG DOG HYDROGEOLOGY

Groundwater elevations, VWP3 and VWP4

Figure 16

Date: December 2017

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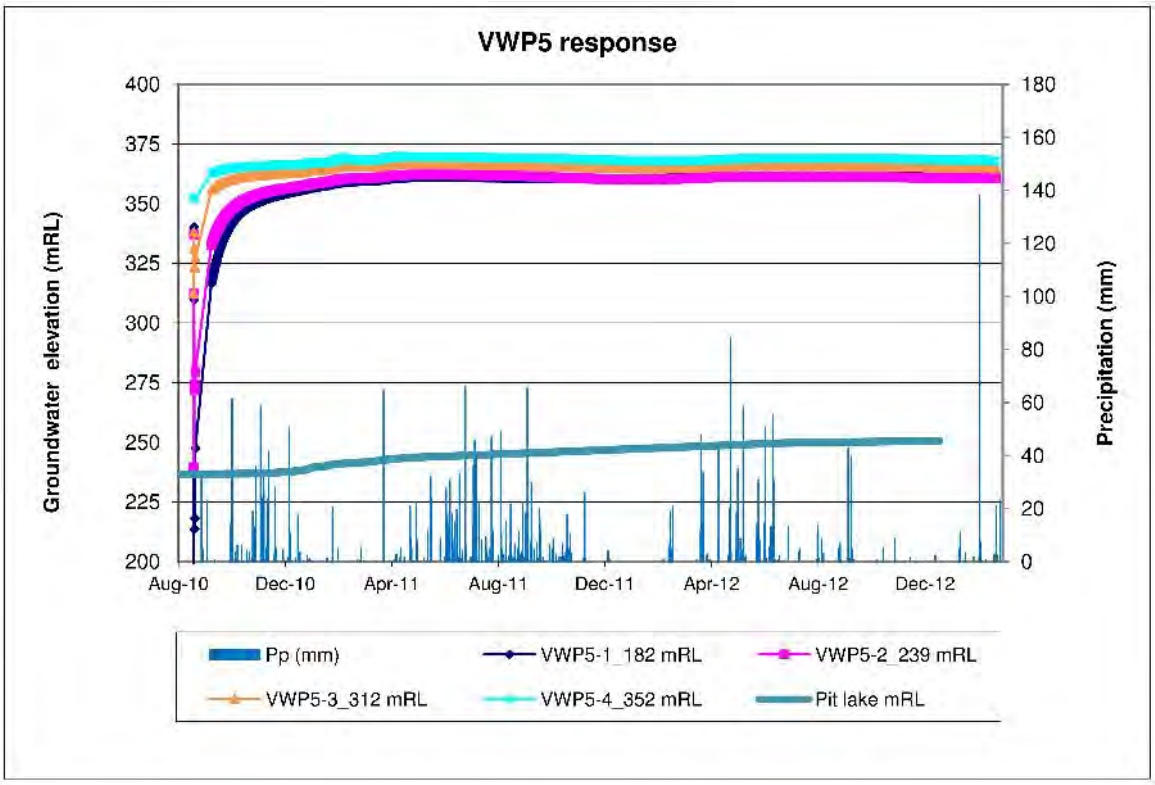

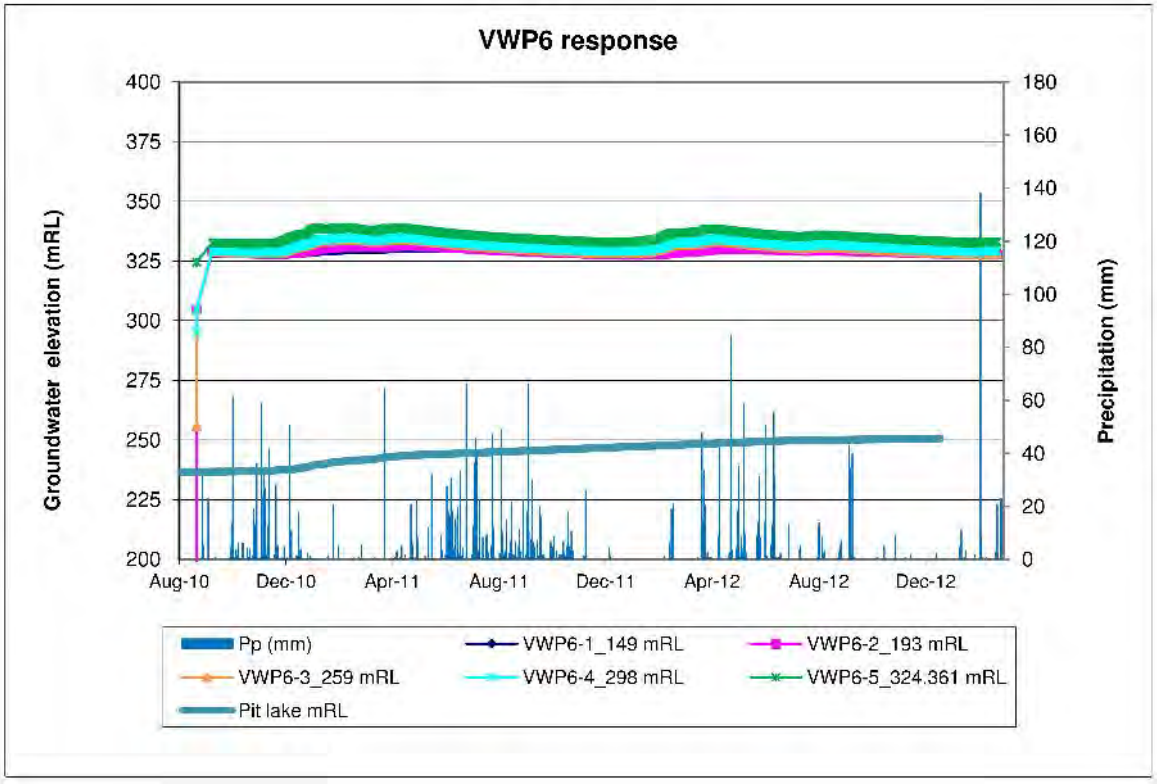

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BIG DOG HYDROGEOLOGY

Groundwater elevations, VWP5 and VWP6

Figure 17

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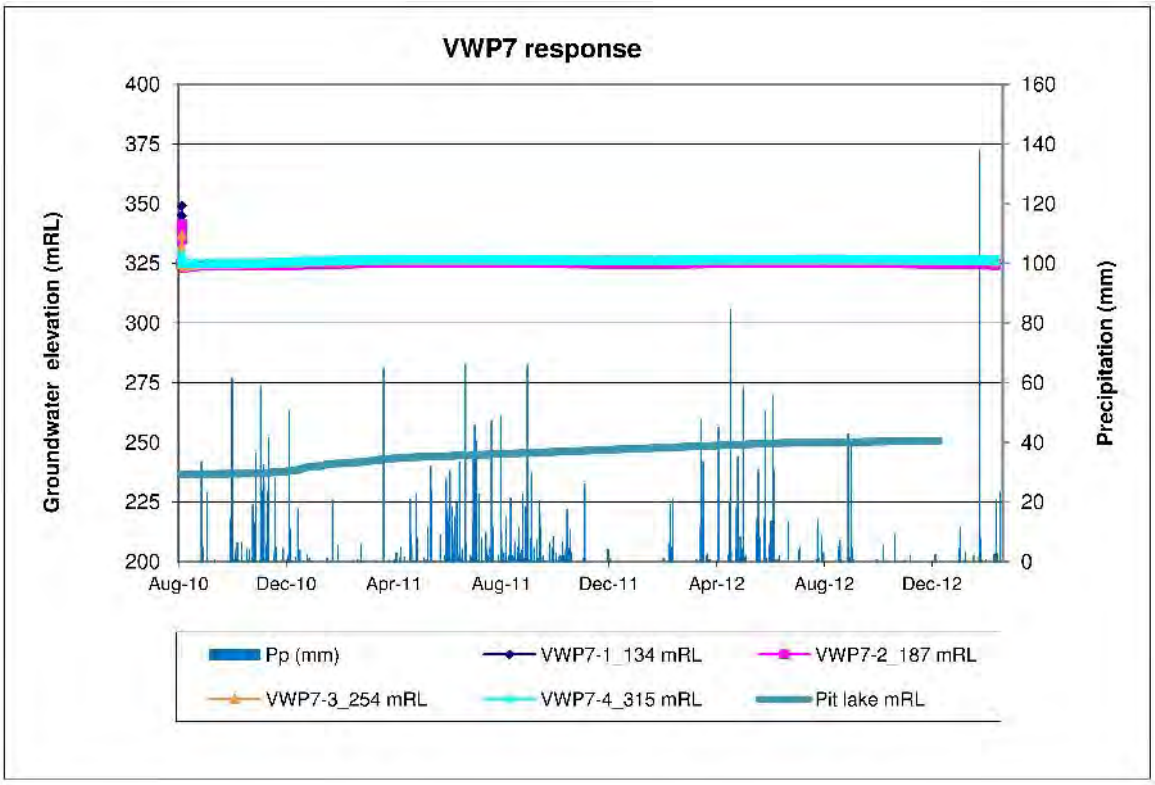

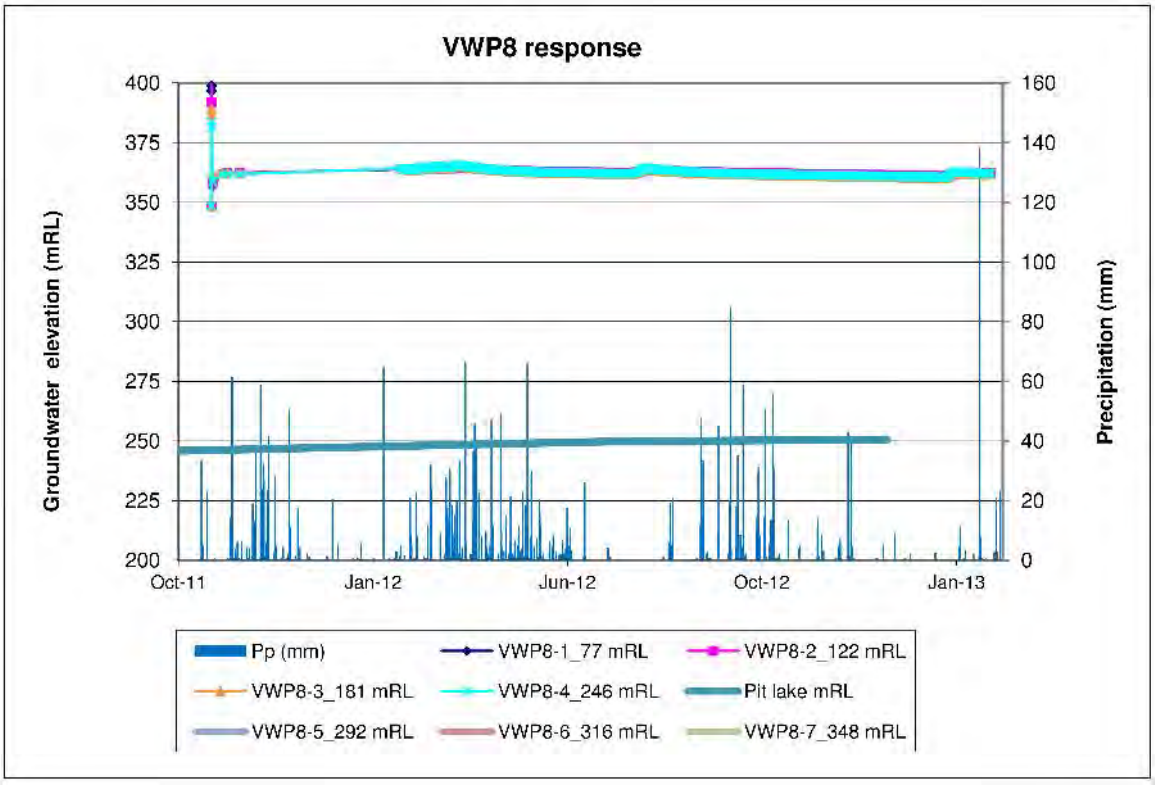

BIG DOG HYDROGEOLOGY

Groundwater elevations, VWP7 and VWP8

Figure 18

Date: December 2017

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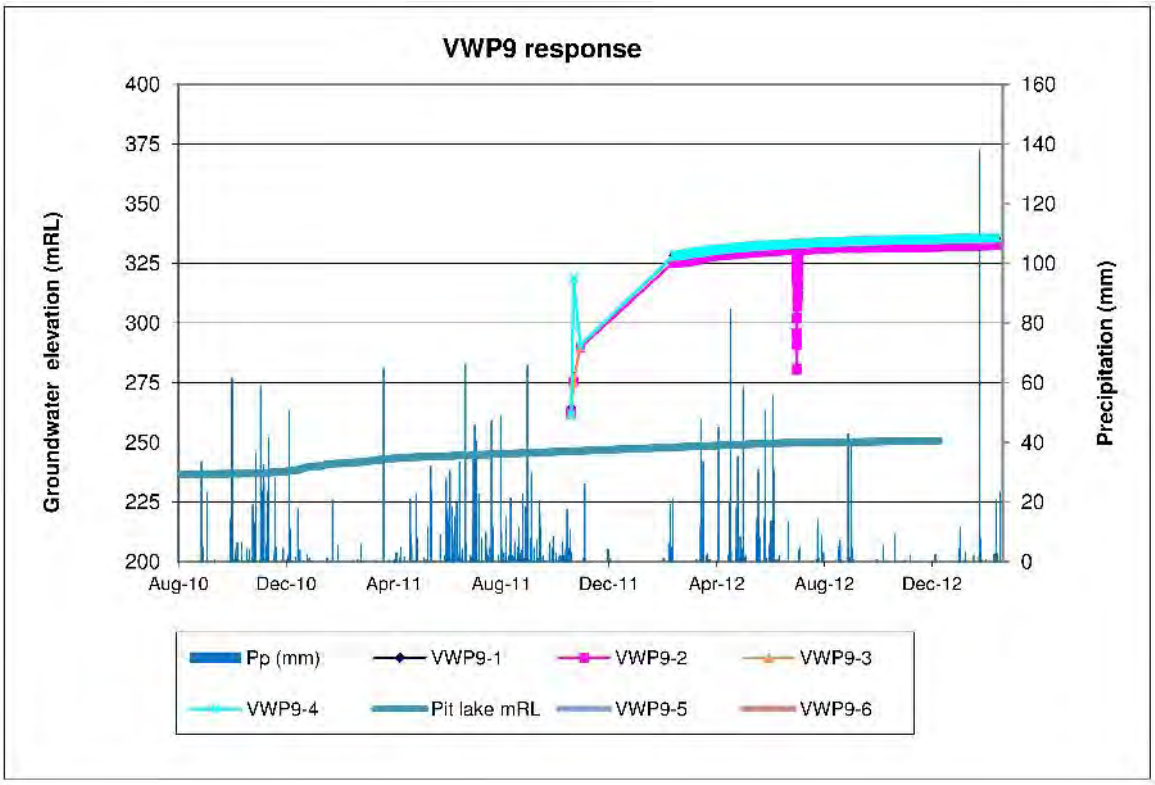

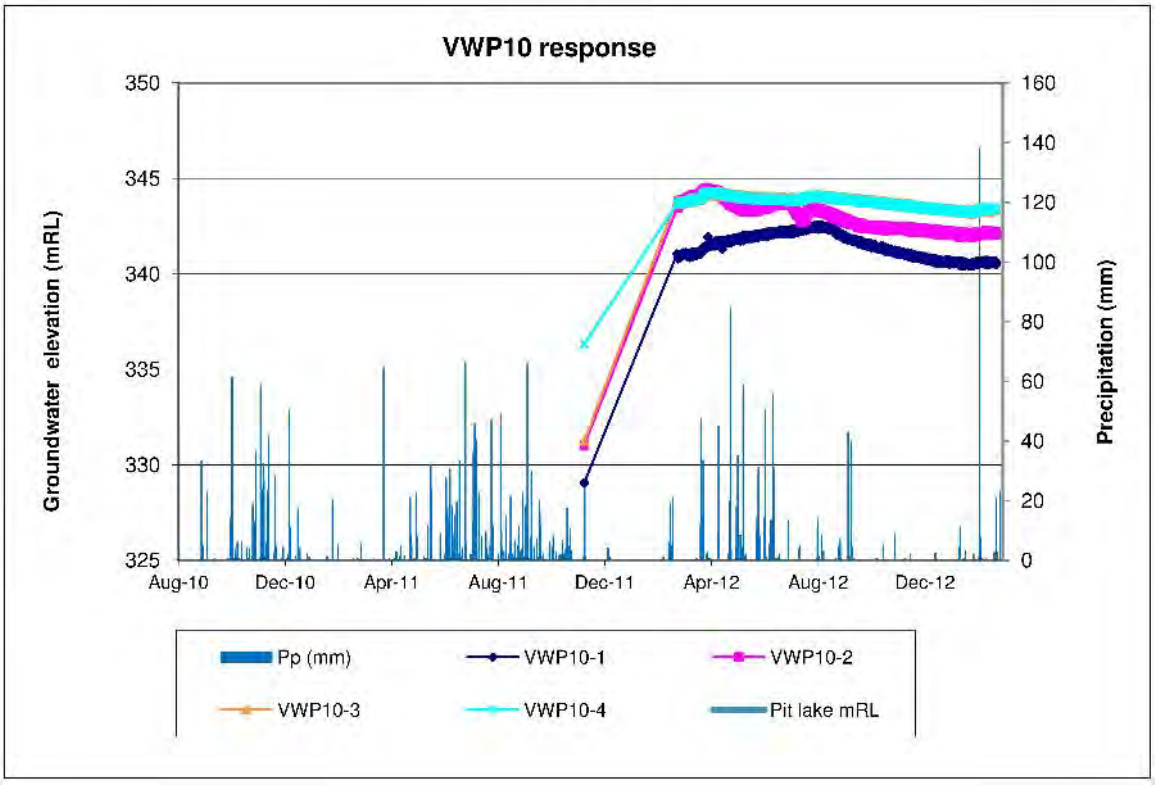

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BIG DOG HYDROGEOLOGY

Groundwater elevations, VWP9 and VWP10

Figure 19

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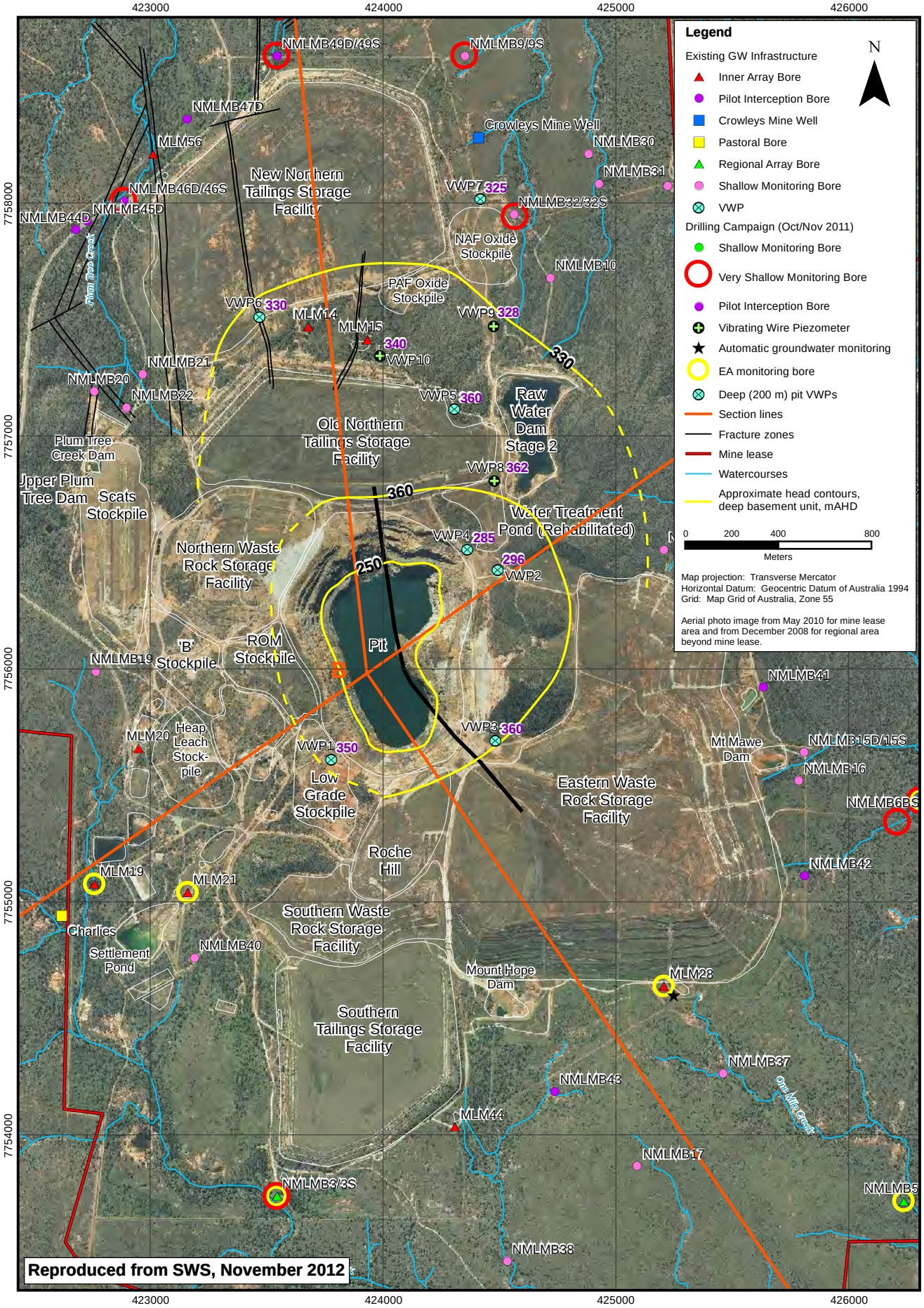

BIG DOG HYDROGEOLOGY

Groundwater elevations measured at 200 mAHD

Figure 20

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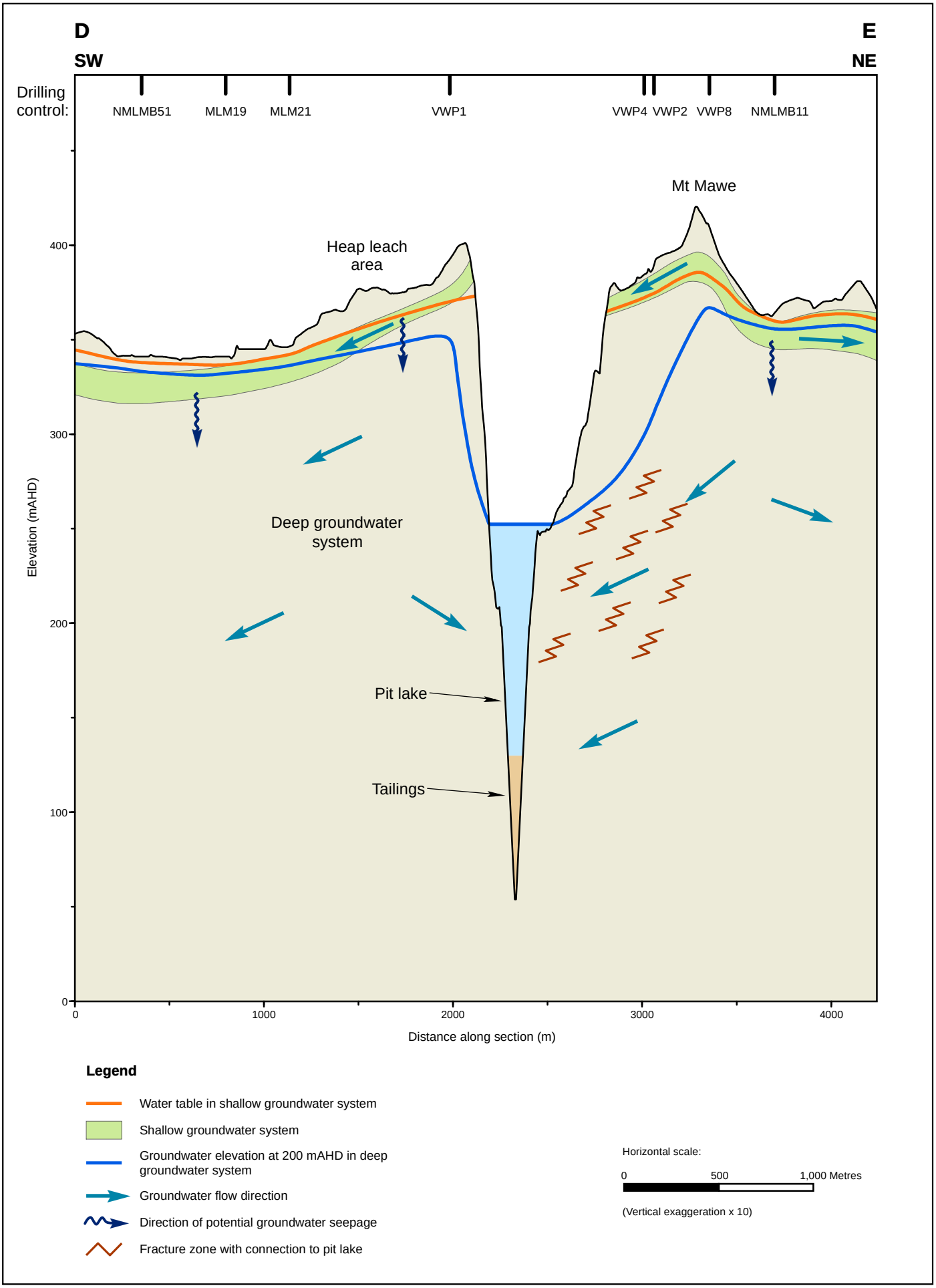

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BIG DOG HYDROGEOLOGY

Schematic hydrogeological cross section

Figure 21

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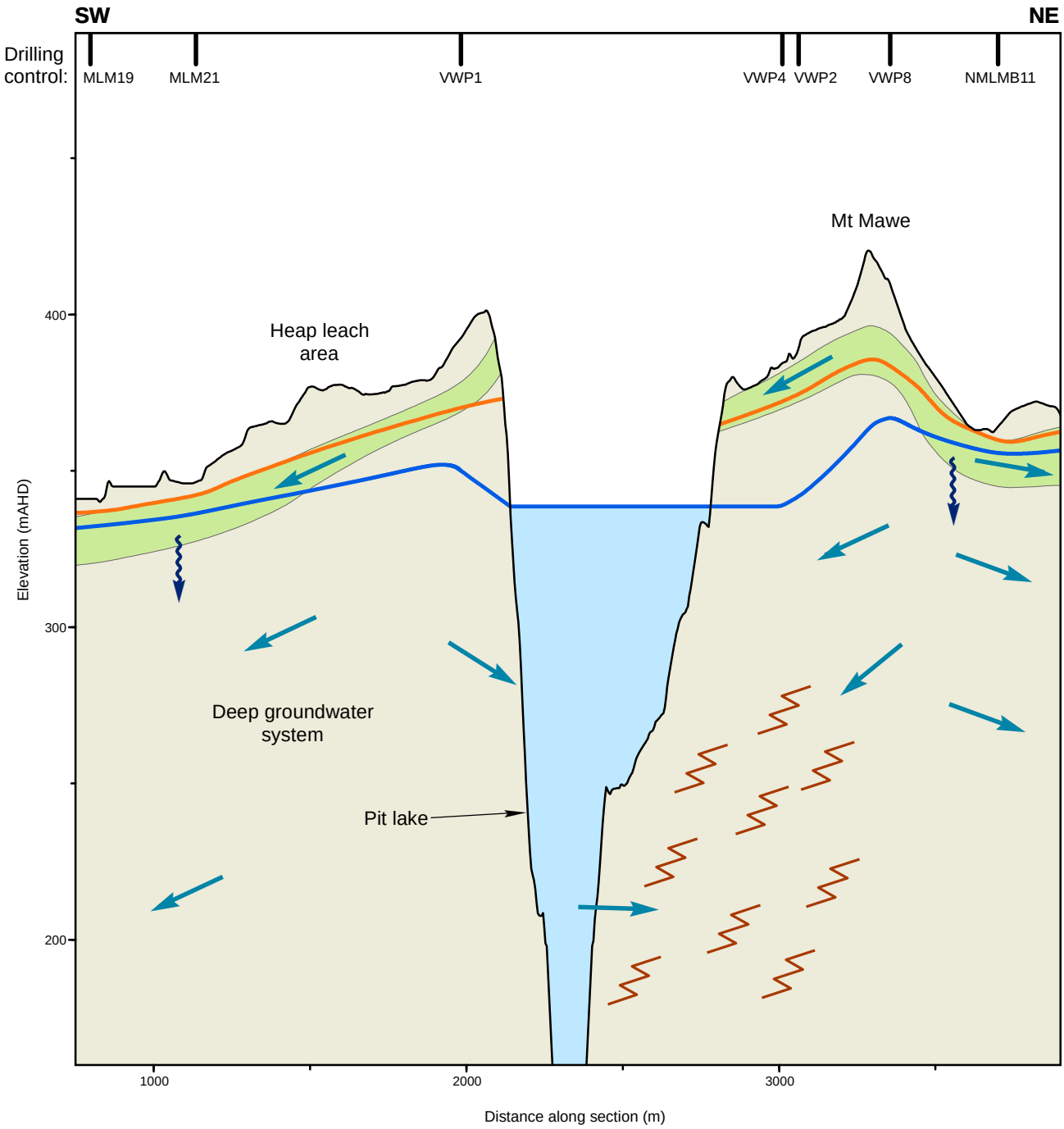

Legend

- Water table in shallow groundwater system
- Shallow groundwater system
- Groundwater elevation at 200 mAHD in deep groundwater system
- Groundwater flow direction
- Direction of potential groundwater seepage
- Fracture zone with connection to pit lake

Horizontal scale:

0 500 1,000 Metres

(Vertical exaggeration x 10)

BIG DOG HYDROGEOLOGY

Groundwater flow directions at final pit lake elevation

Figure 22

Date: December 2017

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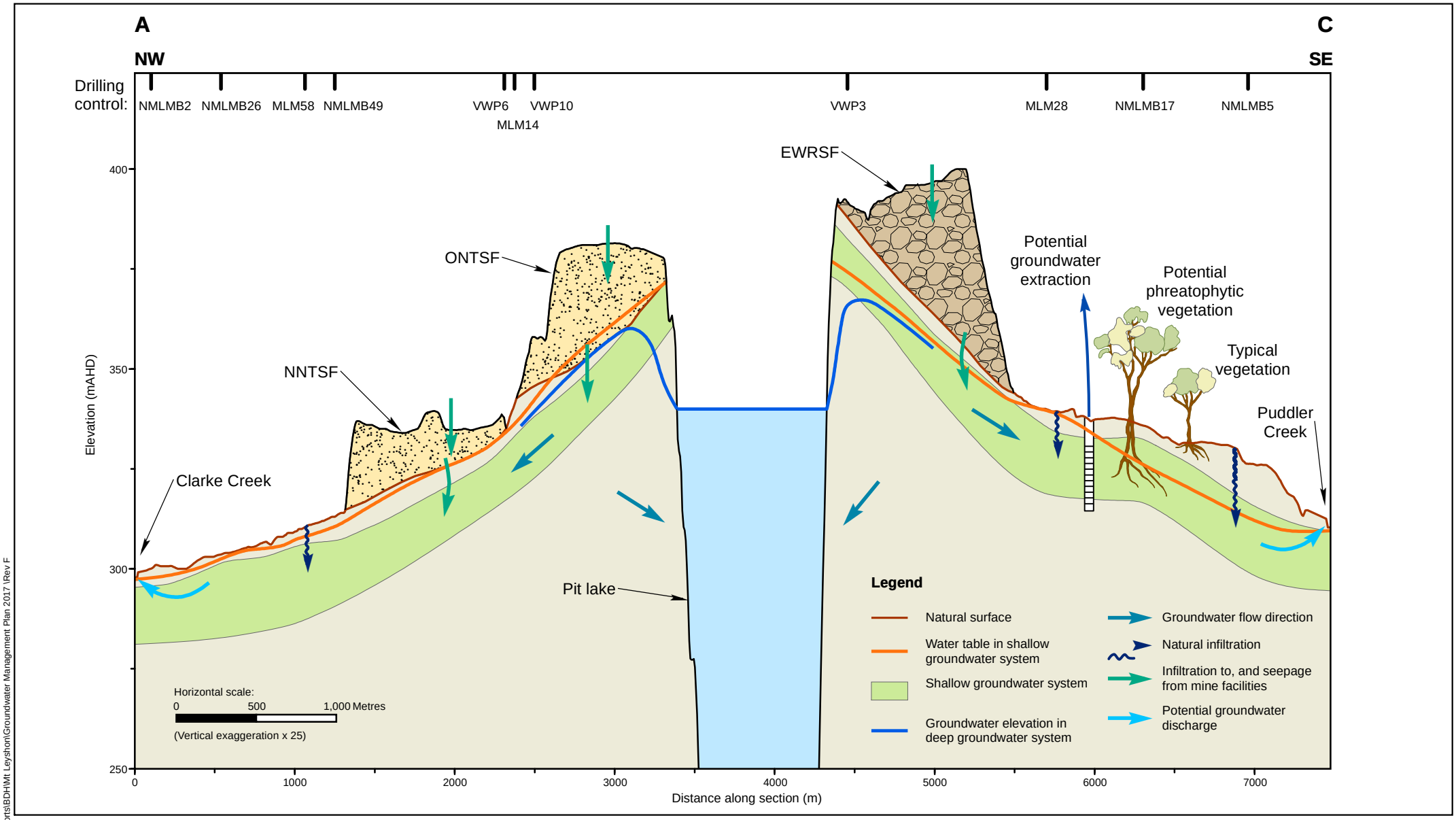

BIG DOG HYDROGEOLOGY

Schematic pathways for potential groundwater impacts

Figure 23

Date: December 2017

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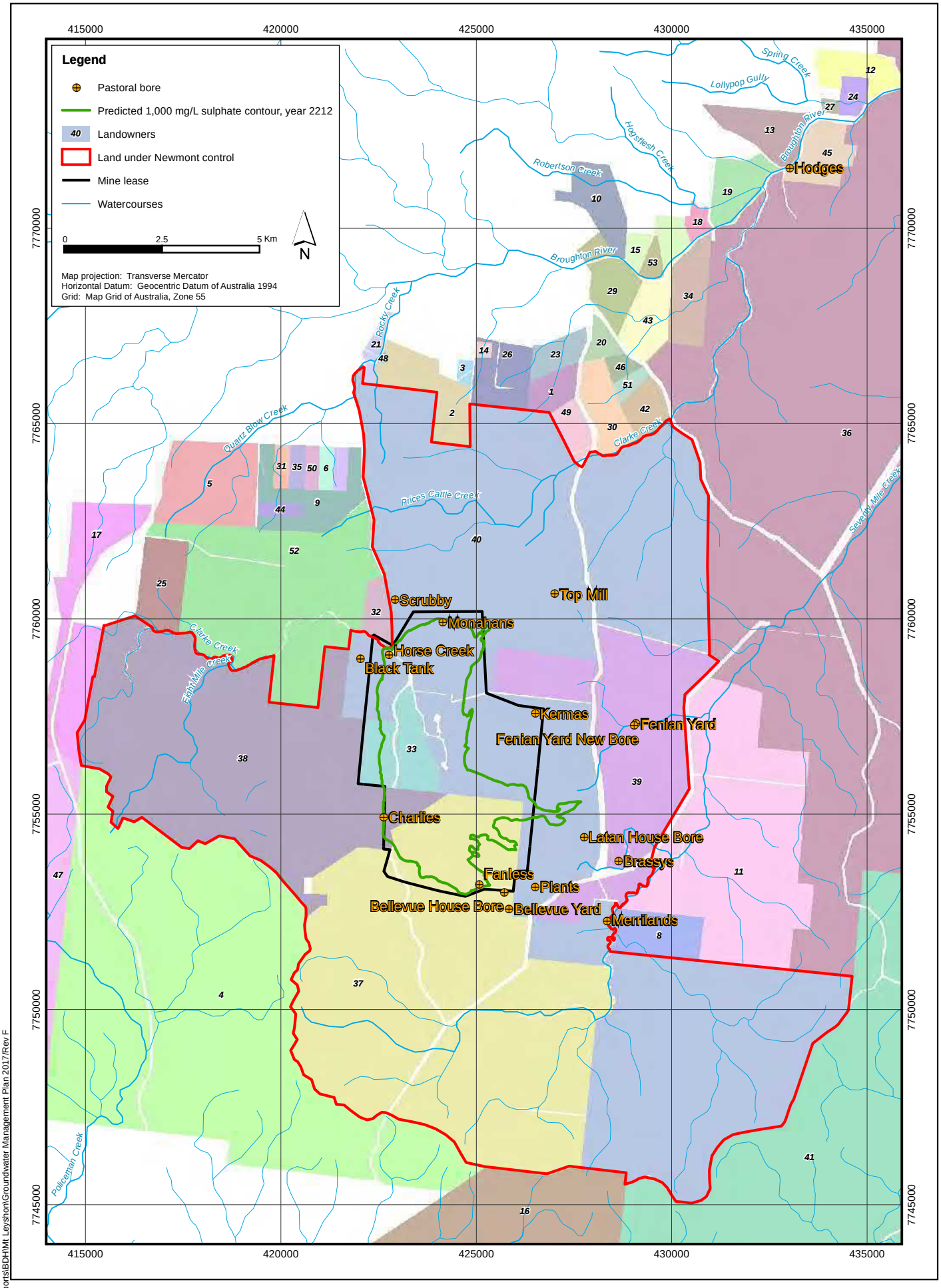

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BIG DOG HYDROGEOLOGY

Predicted extent of 1,000 mg/L sulphate in 2212

Figure 24

Date: December 2017

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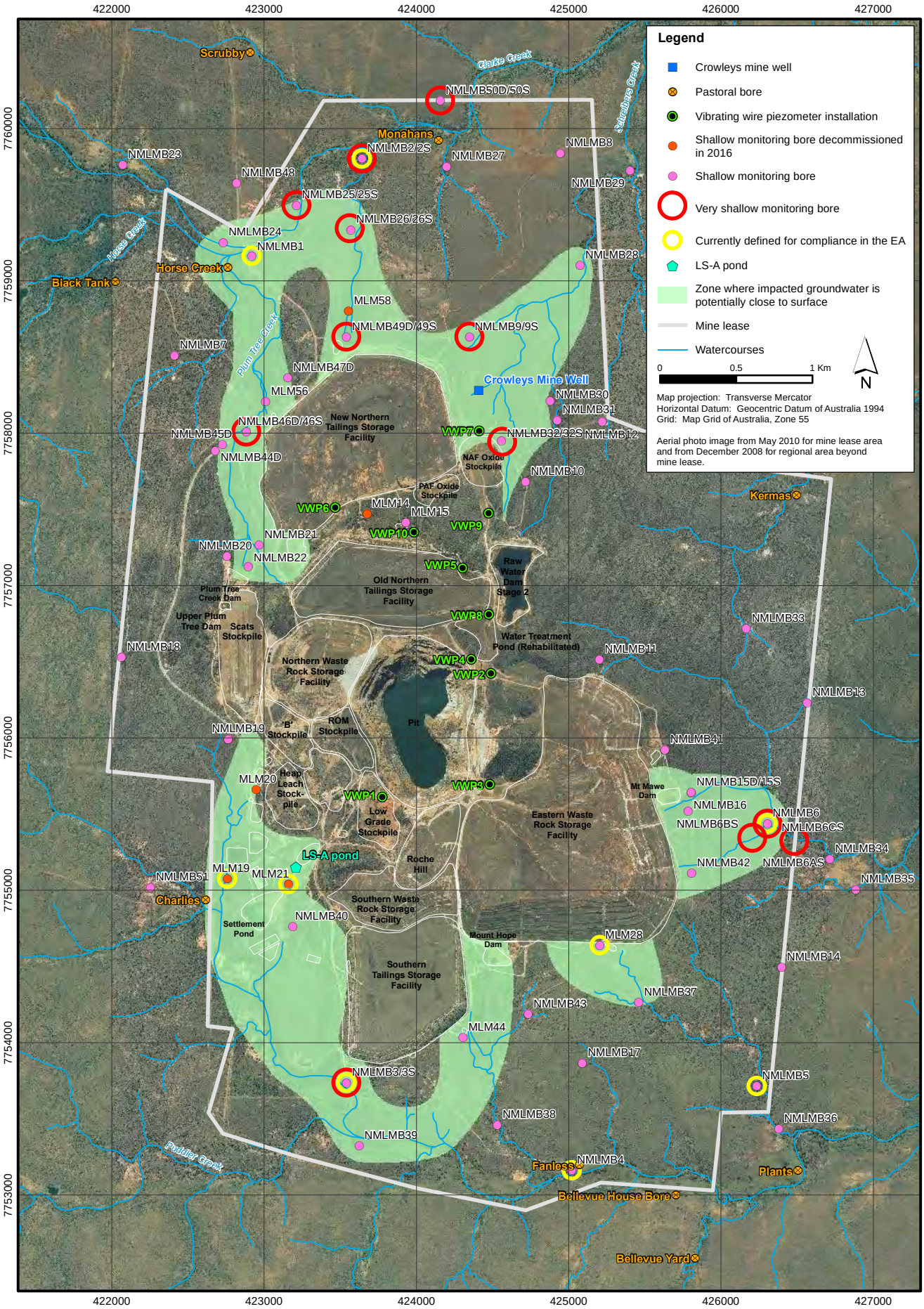

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BIG DOG HYDROGEOLOGY

Priority monitoring zones at surface

Figure 25

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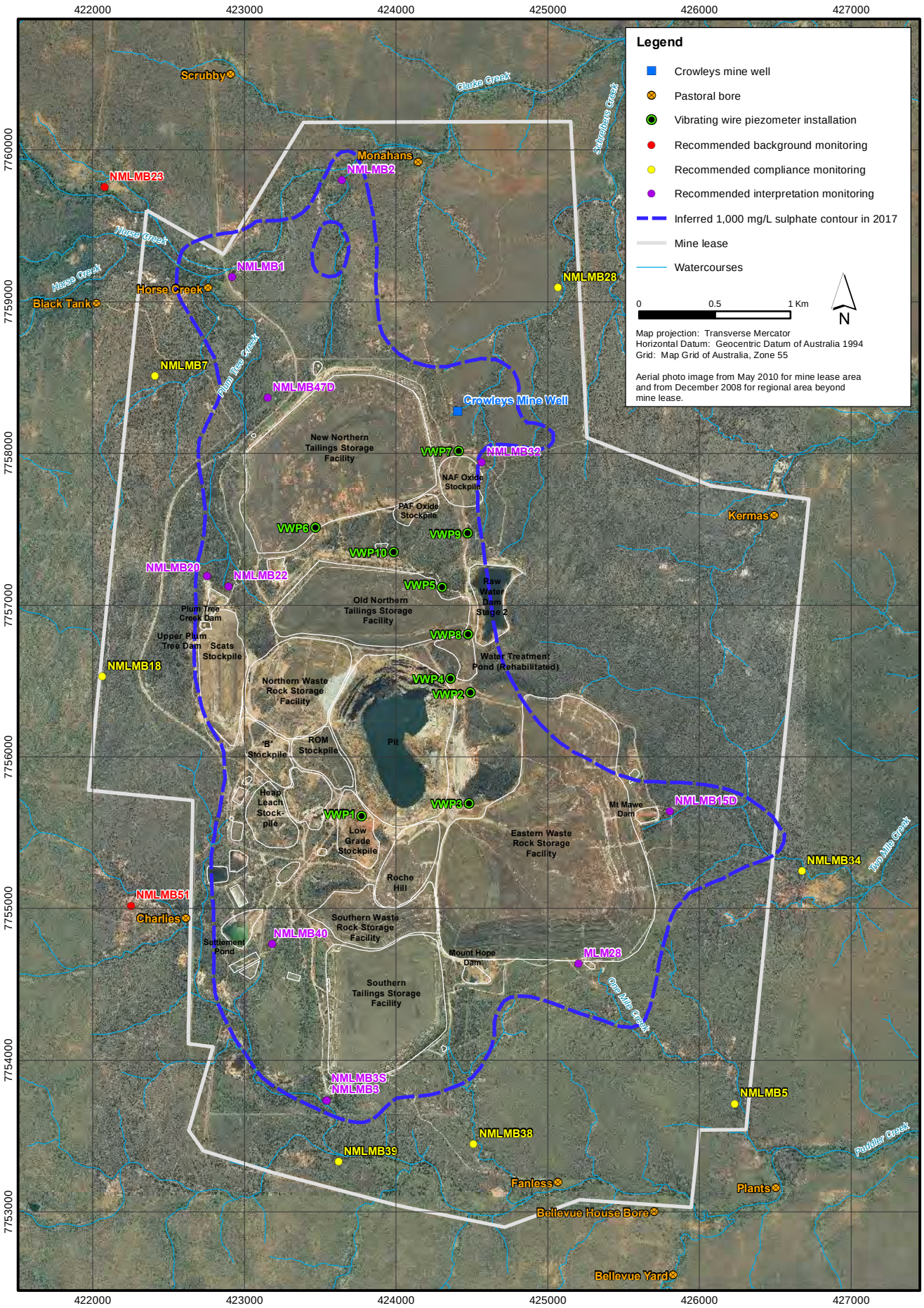

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BIG DOG HYDROGEOLOGY

Recommended locations for groundwater sampling

Figure 26

Date: December 2017

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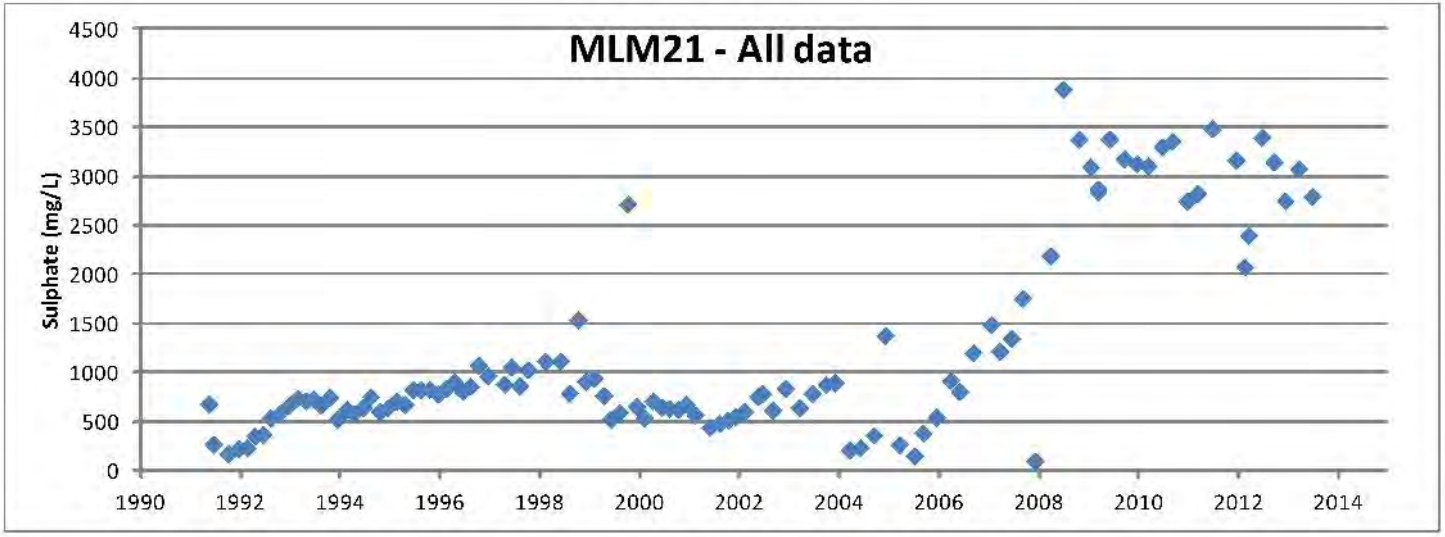

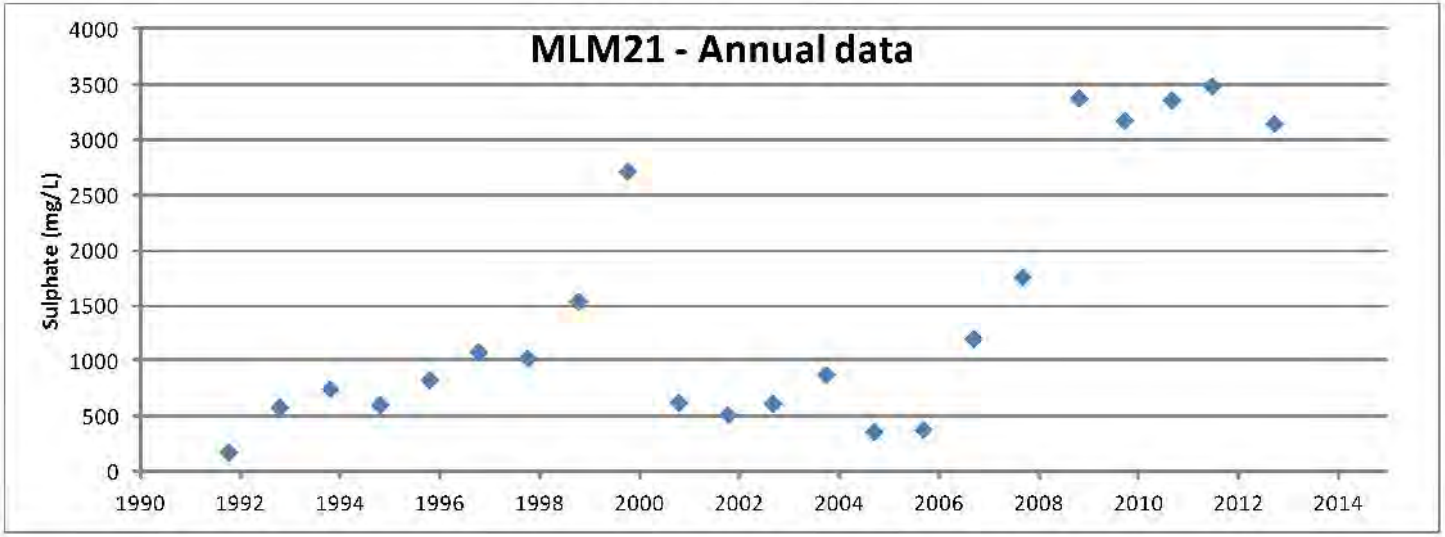

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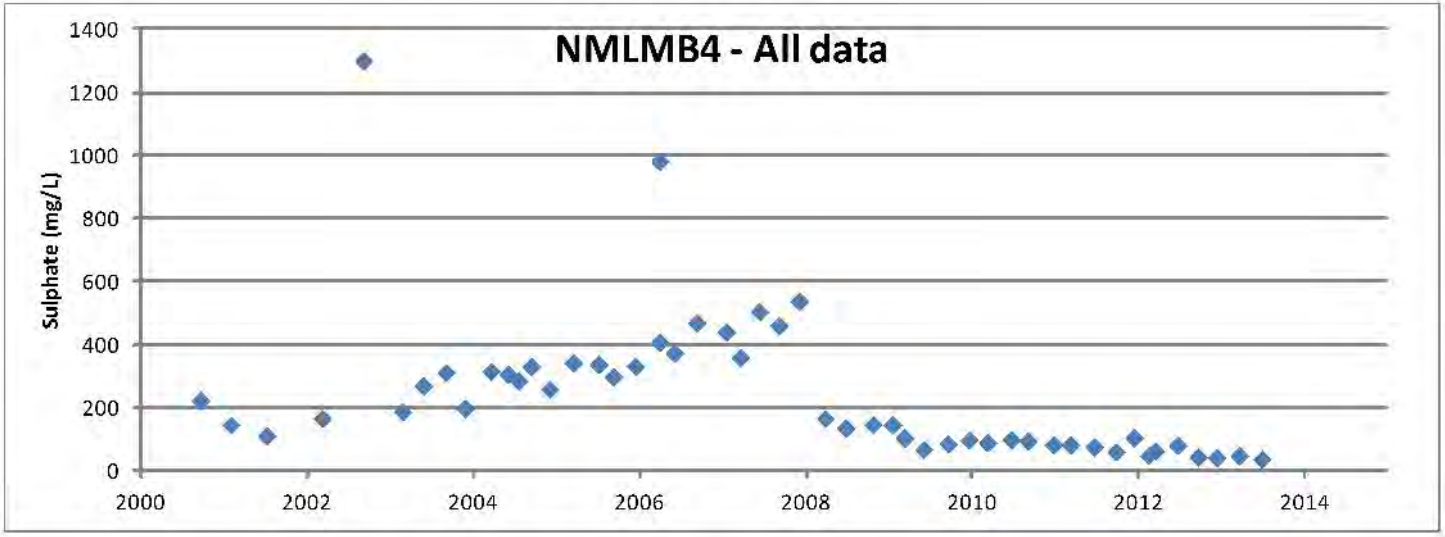
BIG DOG HYDROGEOLOGY

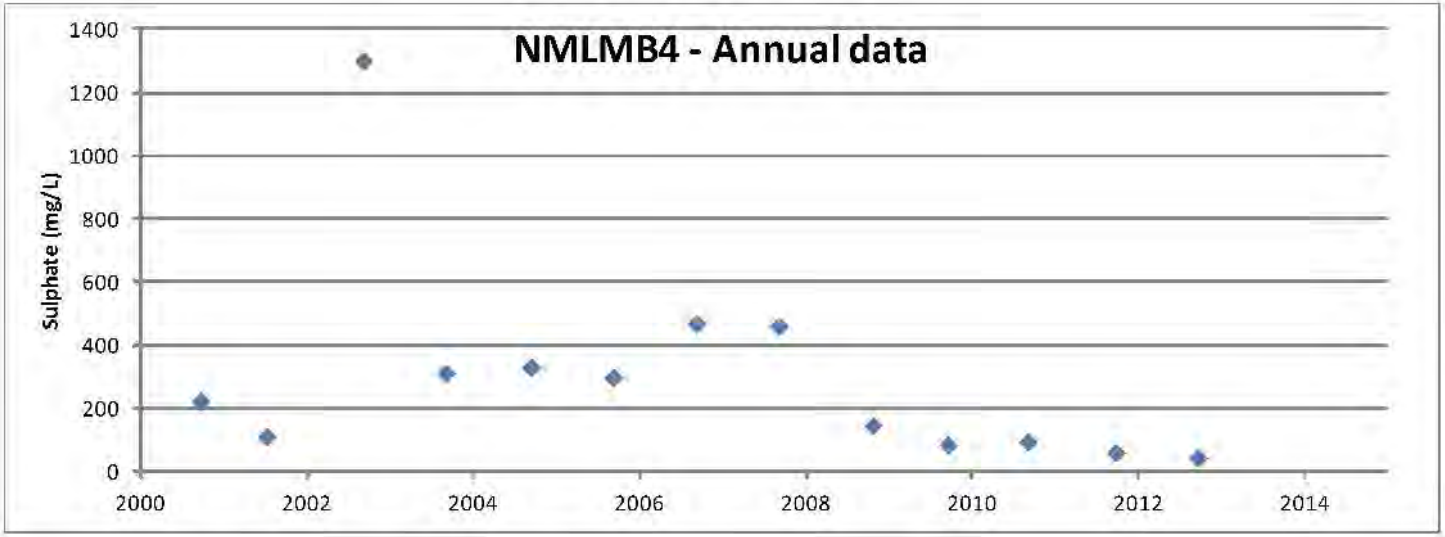
MLM21 sulphate concentrations

Figure 27

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F





BIGDOG HYDROGEOLOGY

NMLMB4 sulphate concentrations

Figure 28

Date: December 2017

Report: Mt Leyshon Groundwater Management Plan Rev F

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Appendix A
Completion diagrams for recommended groundwater sampling bores

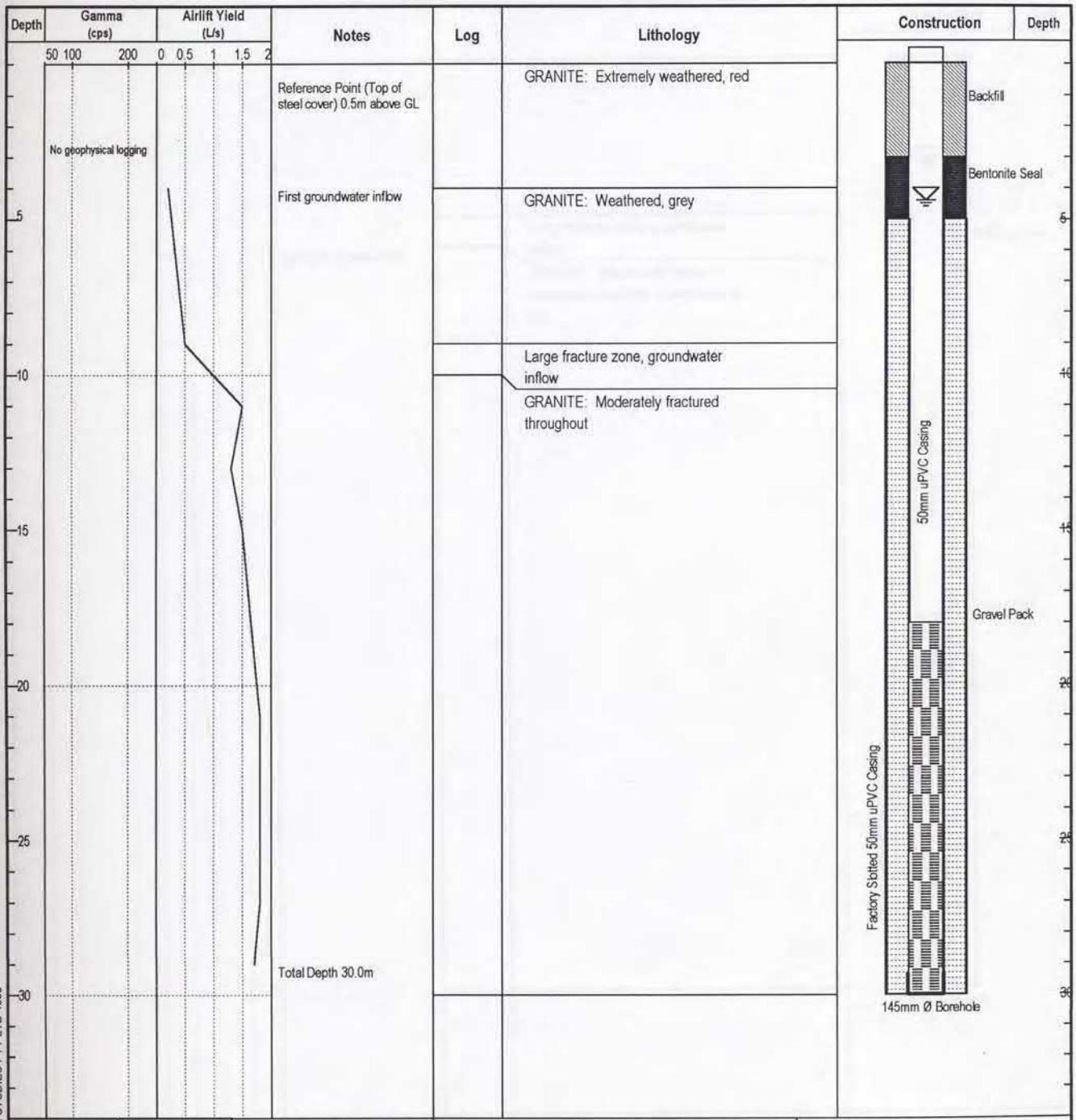
Water Studies Pty Ltd
ABN 59 090 062 294

NMLMB1

Construction log - Hydrogeological Monitoring Bore

Hole No:	MB1
Sheet	1 of 1

Project:	Groundwater Monitoring Bore Construction			Office Job No:	J019-2
Client:	Normandy Mt Leyshon Limited	Drill Method:	Air Hammer Rotary	Hole Commenced:	24 August 2000
Principal:	Normandy Mt Leyshon Limited	Rig Type:	BR W15 Boss	Hole Completed:	24 August 2000
Driller:	BrownDrill Pty Ltd	Hole ND:	300mm	Logged By:	John Beare
Northing:	7,759,736mAMG	Inclination:	-90 deg	RL:	Unknown
Easting:	423,853mAMG	Total Depth:	30.0 mbGL	Datum:	N/A



Drawn:	APM	
Approved:		
Date:	27/08/01	
Drawing No:	A1	

LC : Lost Circulation
ALY : Air Lift Yield
TD : Total Depth
TA : Top Primary Aquifer
BA : Base Primary Aquifer
OH : Open Hole

classification symbols & soil description based on UCS

Field Water Quality

pH: N/R EC: N/R µ/S/cm Temp: N/R

Hydraulic Data

SWL: 3.9mbGL Top of aquifer: 4 mbGL
Date: 30/8/00 Aquifer Thickness: na

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Water Studies Pty Ltd
ABN 59 090 062 294

NMLMB2

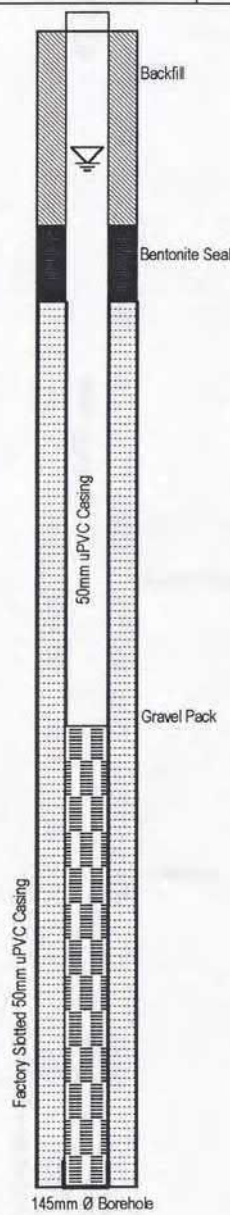
Construction log - Hydrogeological Monitoring Bore

Hole No:	MB2
Sheet	1 of 1

Project:	Groundwater Monitoring Bore Construction			Office Job No:	J019-2
Client:	Normandy Mt Leyshon Limited	Drill Method:	Air Hammer Rotary	Hole Commenced:	24 August 2000
Principal:	Normandy Mt Leyshon Limited	Rig Type:	BR W15 Boss	Hole Completed:	24 August 2000
Driller:	BrownDrill Pty Ltd	Hole ND:	300mm	Logged By:	John Beare
Northing:	7,758,987mAMG	Inclination:	-90 deg	RL:	Unknown
Easting:	422,835mAMG	Total Depth:	30.0 mbGL	Datum:	N/A

Depth	Gamma (cps) 50 100 200	Airlift Yield (L/s) 0 0.5 1 1.5 2	Notes	Log	Lithology
	No geophysical logging		Reference Point (Top of steel cover) 0.5m above GL		GRANITE: Extremely weathered, red
5			First groundwater inflow		Large fracture zone, groundwater inflow
					GRANITE: Moderately fractured throughout, red-grey, quartz band at 9m
10					
15					
20					
25					
30			Total Depth 30.0m		

Construction



Drawn:	APM
Approved:	
Date:	27/08/01
Drawing No:	A2

LC : Lost Circulation
ALY : Air Lift Yield
TD : Total Depth
TA : Top Primary Aquifer
BA : Base Primary Aquifer
OH : Open Hole

classification symbols & soil description based on UCS

Field Water Quality

pH: N/R EC: N/R µS/cm Temp: N/R

Hydraulic Data

SWL: 3.5mbGL Top of aquifer: 5 mbGL
Date: 30/8/00 Aquifer Thickness: na

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NMLMB3

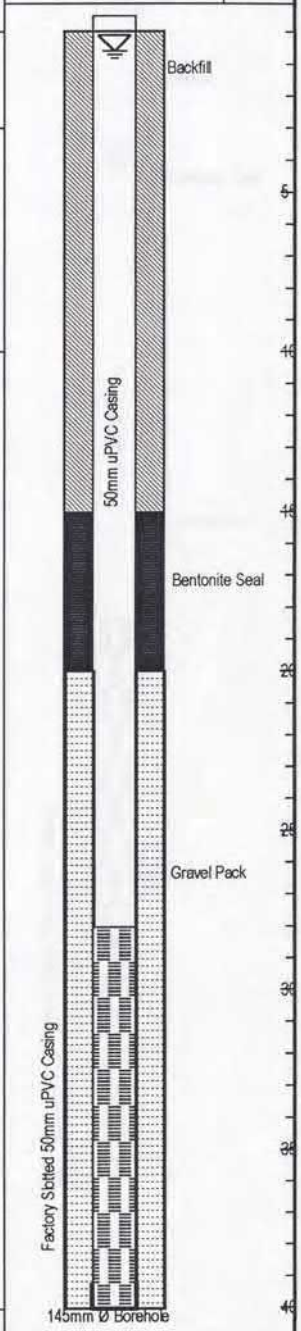
Water Studies Pty Ltd
ABN 59 090 062 294

Hole No:	MB3
Sheet	1 of 1

Construction log - Hydrogeological Monitoring Bore

Project:	Groundwater Monitoring Bore Construction			Office Job No:	J019-2
Client:	Normandy Mt Leyshon Limited	Drill Method:	Air Hammer Rotary	Hole Commenced:	21 August 2000
Principal:	Normandy Mt Leyshon Limited	Rig Type:	BR W15 Boss	Hole Completed:	21 August 2000
Driller:	BrownDrill Pty Ltd	Hole ND:	300mm	Logged By:	John Beare
Northing:	7,753,217mAMG	Inclination:	-90 deg	RL:	Unknown
Easting:	423,373mAMG	Total Depth:	40.0 mbGL	Datum:	N/A

Depth	Gamma (cps) 50 100 200	Airlift Yield (L/s) 0 0.5 1 1.5 2	Notes	Log	Lithology
	No geophysical logging		Reference Point (Top of steel cover) 0.5m above GL		Clayey Gravel: moist, brown
5			Tailings seepage and odor		ROCK: fractured, moist, some clay weathering product
10					ROCK: Fresh, grey
15			First groundwater inflow		
20					
25					
30					
35					
40			Total Depth 40.0m		



Drawn:	APM	LC : Lost Circulation ALY : Air Lift Yield TD : Total Depth TA : Top Primary Aquifer BA : Base Primary Aquifer OH : Open Hole	classification symbols & soil description based on UCS
Approved:			**Field Water Quality**
Date:	27/08/01		pH: N/R EC: N/R µS/cm Temp: N/R
Drawing No:	A3		

Hydraulic Data

SWL: 0.6mbGL Top of aquifer: 16 mbGL
Date: 30/8/00 Aquifer Thickness: na

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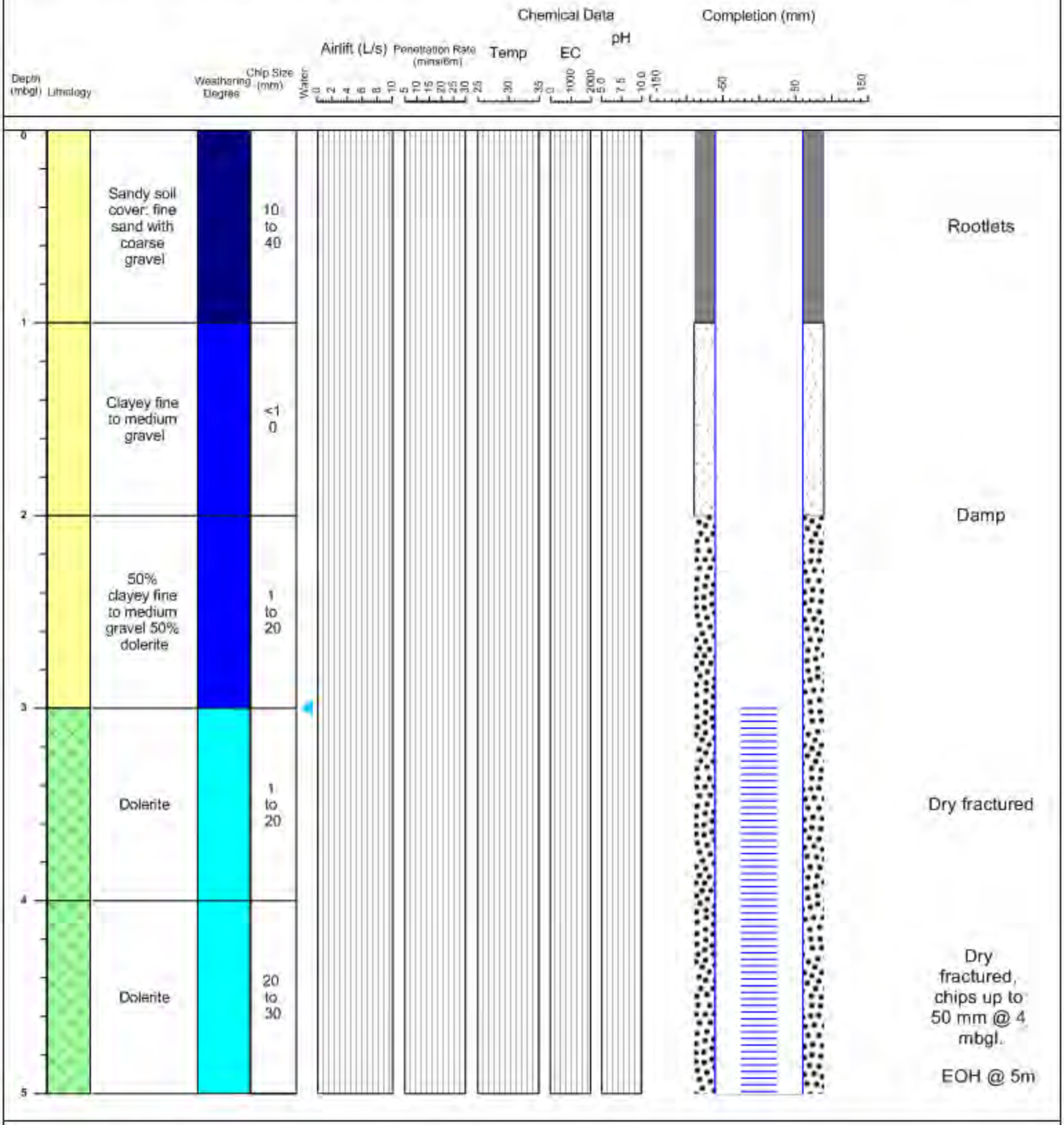
NMLMB3S

423542 E 7753737 N

Rig: Brown Drill RAB
Date Drilled: 09-Nov-11



Major geological units

Top Soil | Dolerite | Other

Weathering Degree

Very High (VH) | High (H) | Medium (M) | Low (L) | Very Low (VL)

Completion

Steel casing | PVC casing | Grout seal | gravel | Sand

Chemical Data

- Temp (°C)
- pH
- EC (mS/cm)

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion
- Airlift flow during development (L/s)

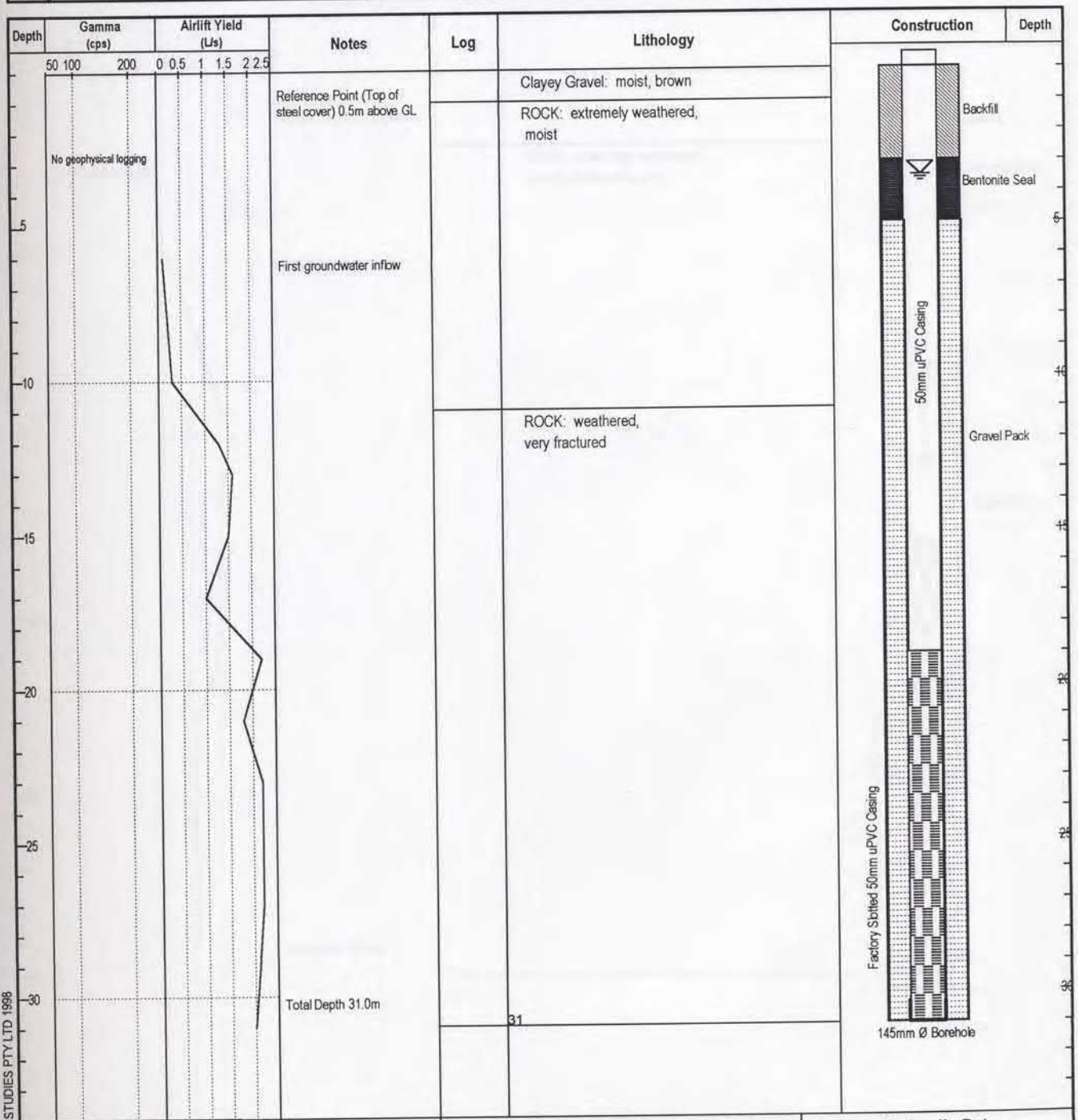
NMLMB5

Water Studies Pty Ltd
ABN 59 090 062 294

Hole No:	MB5
Sheet	1 of 1

Construction log - Hydrogeological Monitoring Bore

Project:	Groundwater Monitoring Bore Construction			Office Job No:	J019-2
Client:	Normandy Mt Leyshon Limited	Drill Method:	Air Hammer Rotary	Hole Commenced:	25 August 2000
Principal:	Normandy Mt Leyshon Limited	Rig Type:	BR W15 Boss	Hole Completed:	25 August 2000
Driller:	BrownDrill Pty Ltd	Hole ND:	300mm	Logged By:	John Beare
Northing:	7,753,726mAMG	Inclination:	-90 deg	RL:	Unknown
Easting:	425,805mAMG	Total Depth:	31.0 mbGL	Datum:	N/A



Drawn:	APM	LC : Lost Circulation
Approved:		ALY : Air Lift Yield
Date:	27/08/01	TD : Total Depth
Drawing No:	A5	TA : Top Primary Aquifer
		BA : Base Primary Aquifer
		OH : Open Hole

classification symbols & soil description based on UCS

Field Water Quality

pH: N/R EC: N/R µS/cm Temp: N/R

Hydraulic Data

SWL: 3.5mbGL Top of aquifer: 6 mbGL

Date: 30/8/00 Aquifer Thickness: na

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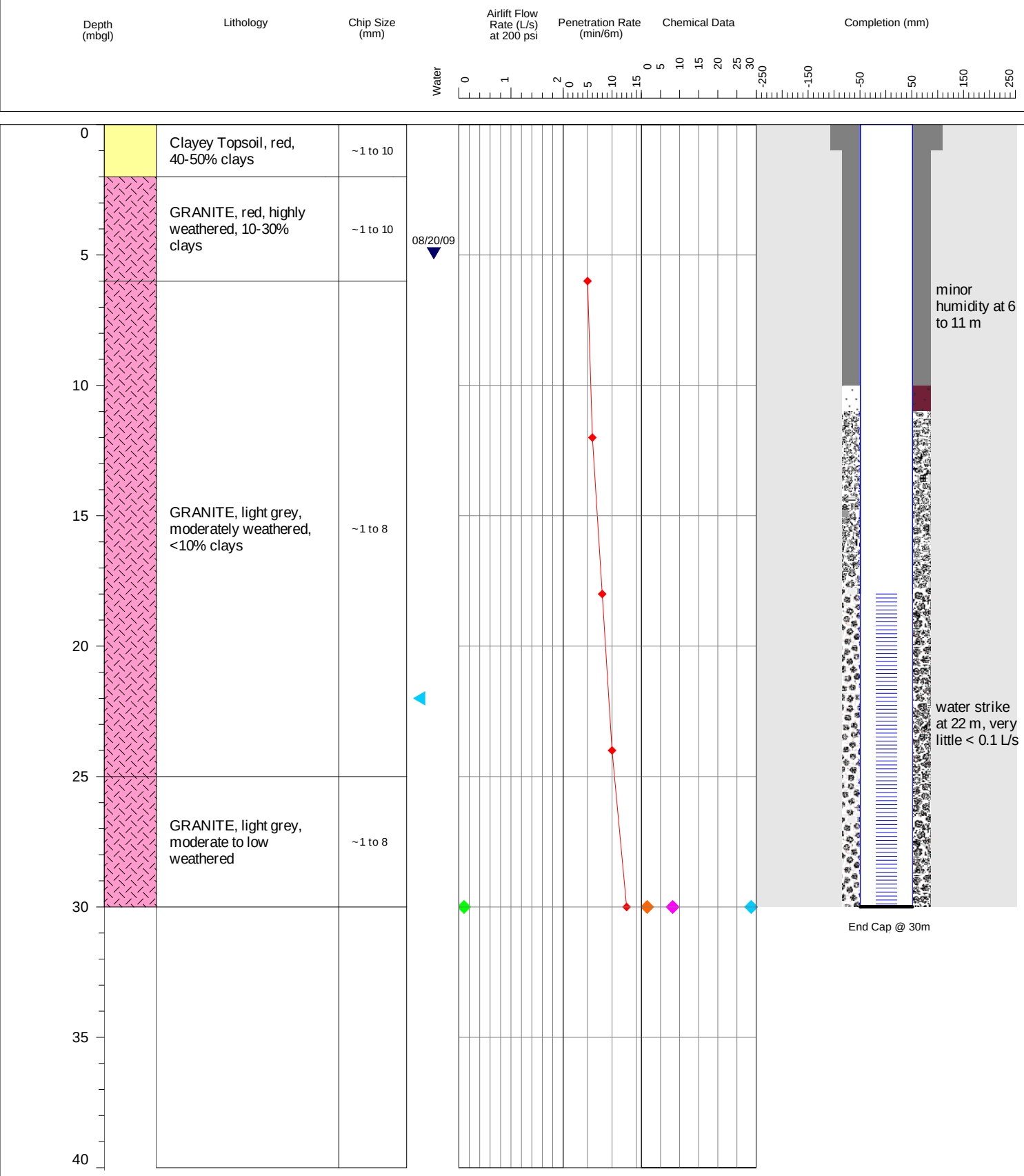
NMLMB7

0422415 mE 7758512 mN

Rig: Brown Drill RAB
Date Drilled:28/07/09



Major geological units

Top Soil | Granite | Dolerite Intrusive

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion

Completion

steel casing | PVC casing | grout seal | gravel | sand

Chemical Data

- Temp (ºC)
- pH
- EC (mS/cm)

Confidential and subject to Legal Professional Privilege

NMLMB15D

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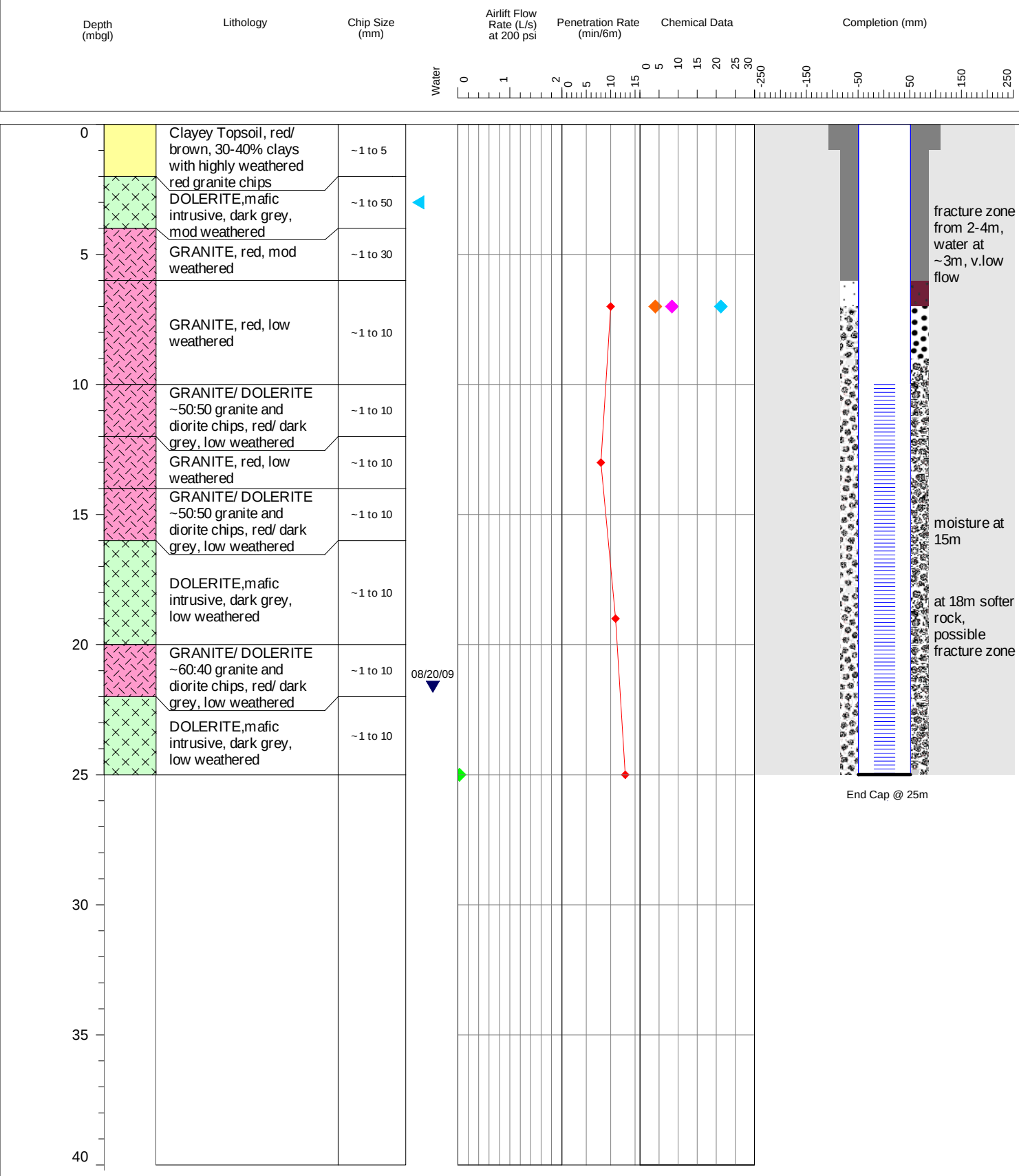

Major geological units

- Top Soil
- Granite
- Dolerite Intrusive

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion

Completion

- steel casing
- PVC casing
- grout seal
- gravel
- sand

Chemical Data

- Temp (ºC)
- pH
- EC (mS/cm)

Confidential and subject to Legal Professional Privilege

NMLMB18

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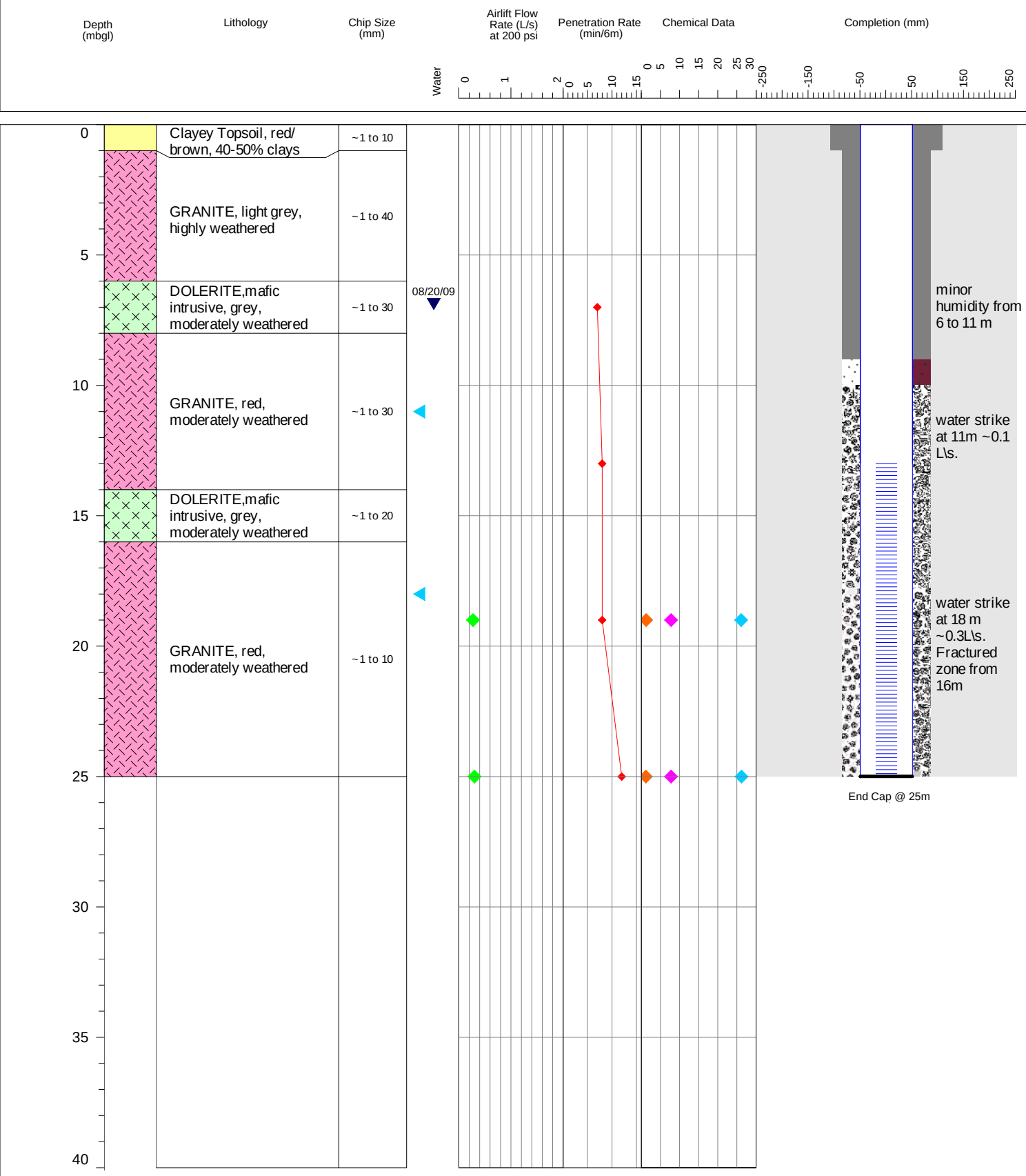
Rig: Brown Drill RAB
Date Drilled:29/07/09



Major geological units

Top Soil | Granite | Dolerite Intrusive

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion

Completion

steel casing | PVC casing | grout seal | gravel | sand

Chemical Data

- Temp (ºC)
- pH
- EC (mS/cm)

Confidential and subject to Legal Professional Privilege

NMLMB20

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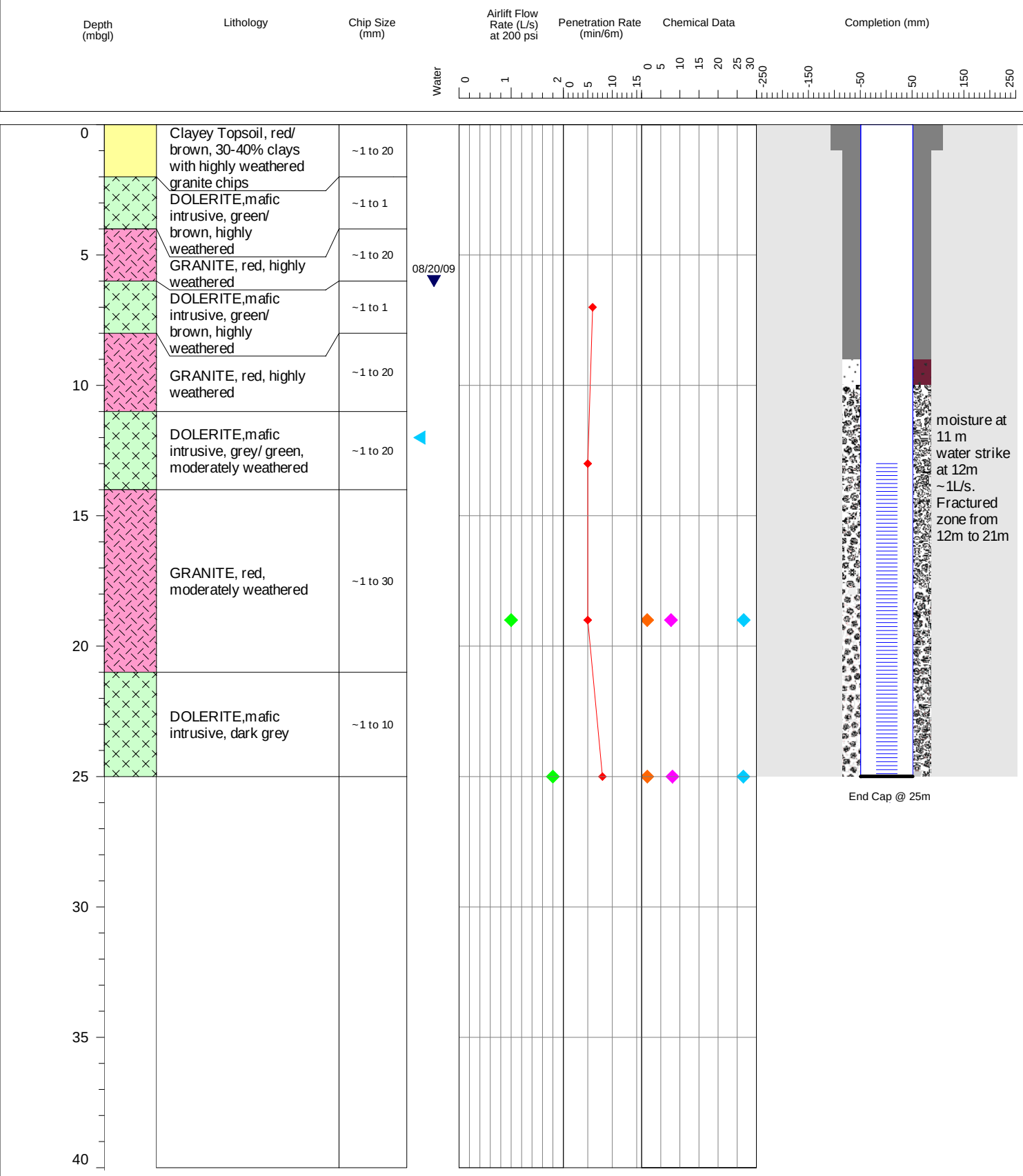
Rig: Brown Drill RAB
Date Drilled:30/07/09



Major geological units

Top Soil | Granite | Dolerite Intrusive

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion

Completion

steel casing | PVC casing | grout seal | gravel | sand

Chemical Data

- Temp (ºC)
- pH
- EC (mS/cm)

Confidential and subject to Legal Professional Privilege

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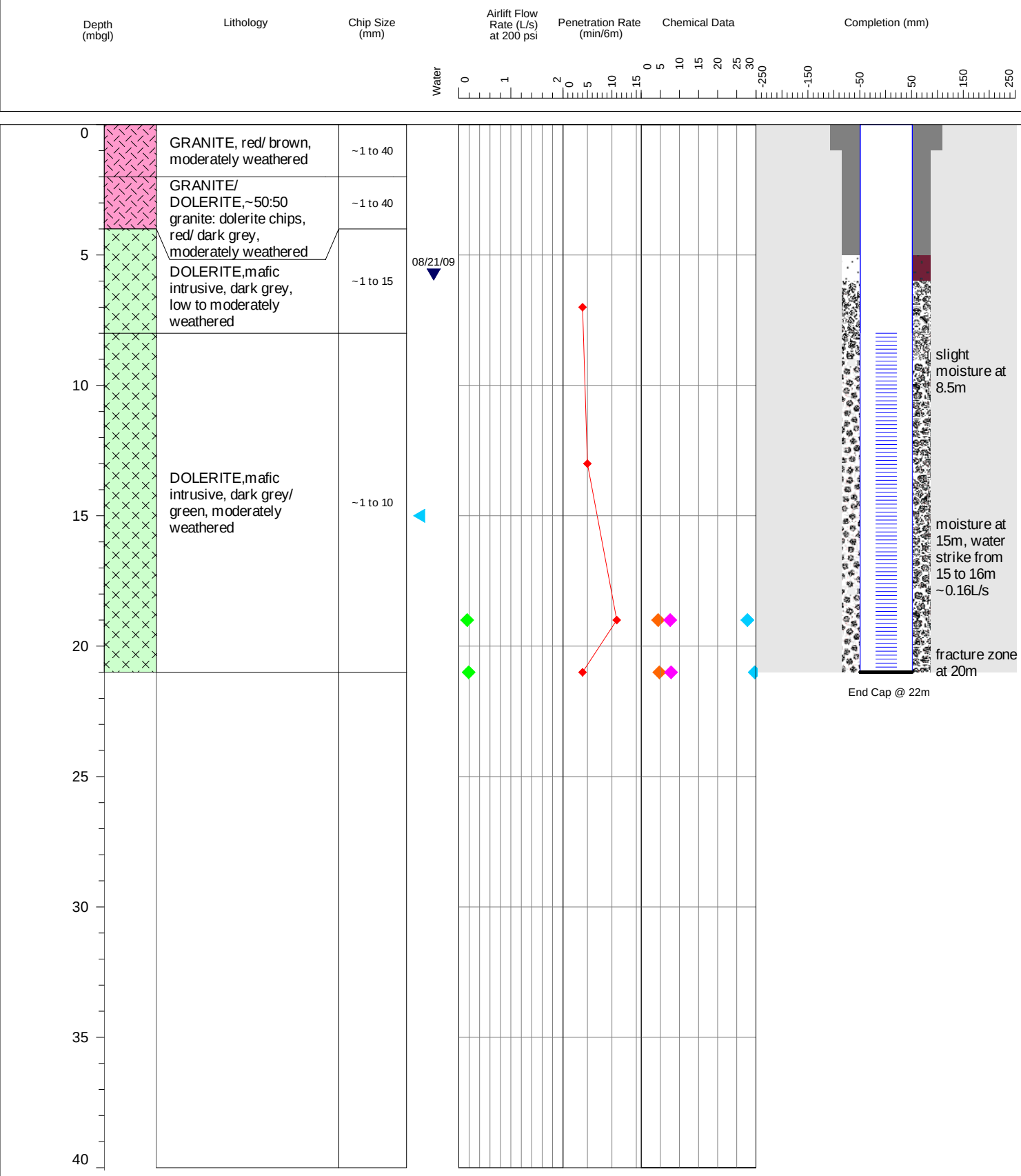
Date Drilled:20/08/09



Major geological units

Top Soil | Granite | Dolerite Intrusive

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion

Completion

steel casing | PVC casing | grout seal | gravel | sand

Chemical Data

- Temp (ºC)
- pH
- EC (mS/cm)

Confidential and subject to Legal Professional Privilege

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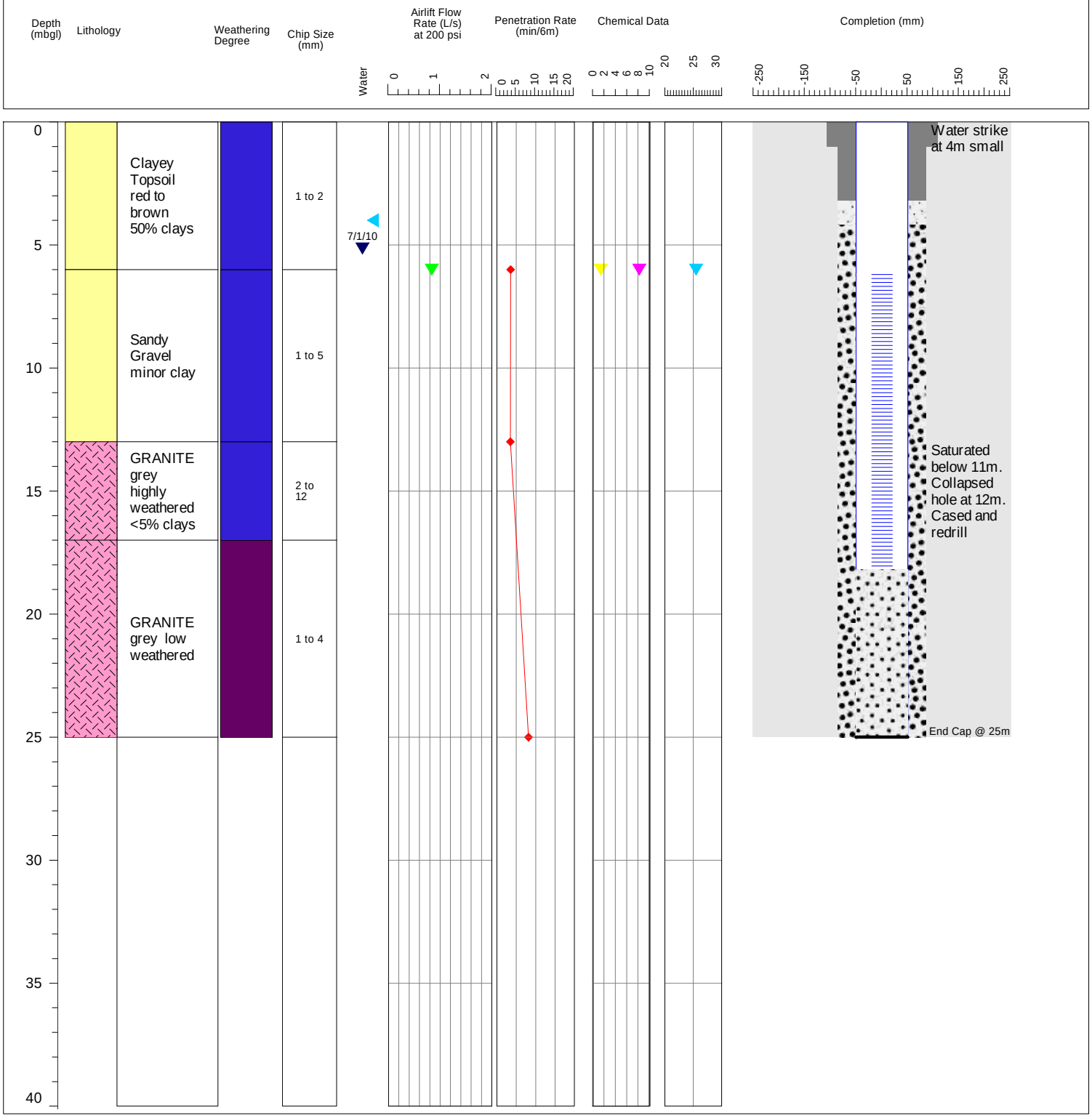
Rig: Brown Drill RAB
Date Drilled:10/06/2010



Major geological units

Top Soil | Grey Granite | Dolerite Intrusive | Red Granite

Weathering Degree

High | Medium | Low

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion
- Airlift flow during development (L/s)

Completion

steel casing | PVC casing | grout seal | gravel | sand

Chemical Data

- Temp (ºC)
- pH
- EC (mS/cm)

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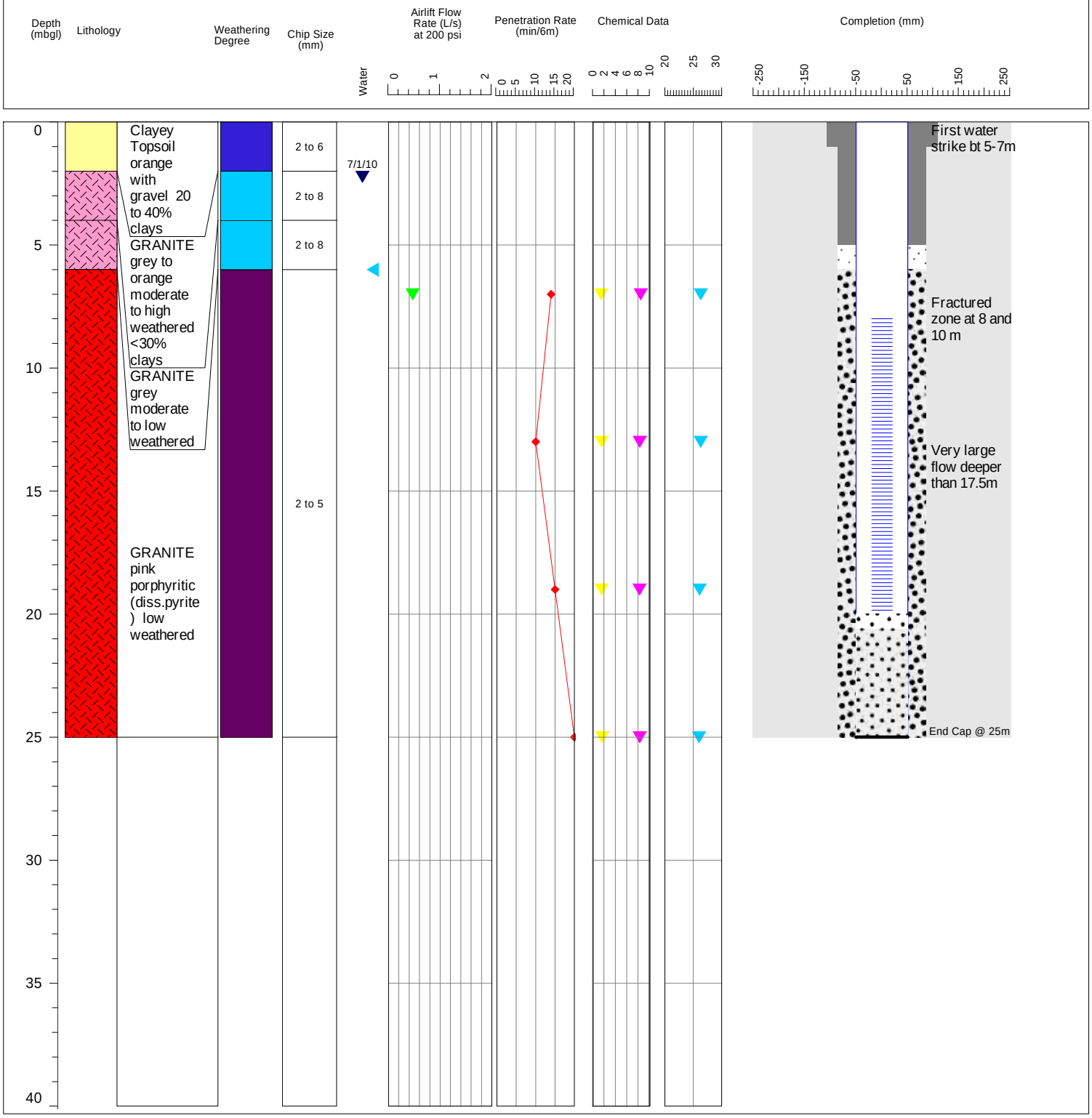
Rig: Brown Drill RAB
Date Drilled:22/06/2010



Major geological units

Top Soil | Grey Granite | Dolerite Intrusive | Red Granite

Weathering Degree

High | Medium | Low

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion
- Airlift flow during development (L/s)

Completion

steel casing | PVC casing | grout seal | gravel | sand

Chemical Data

- Temp (ºC)
- pH
- EC (mS/cm)

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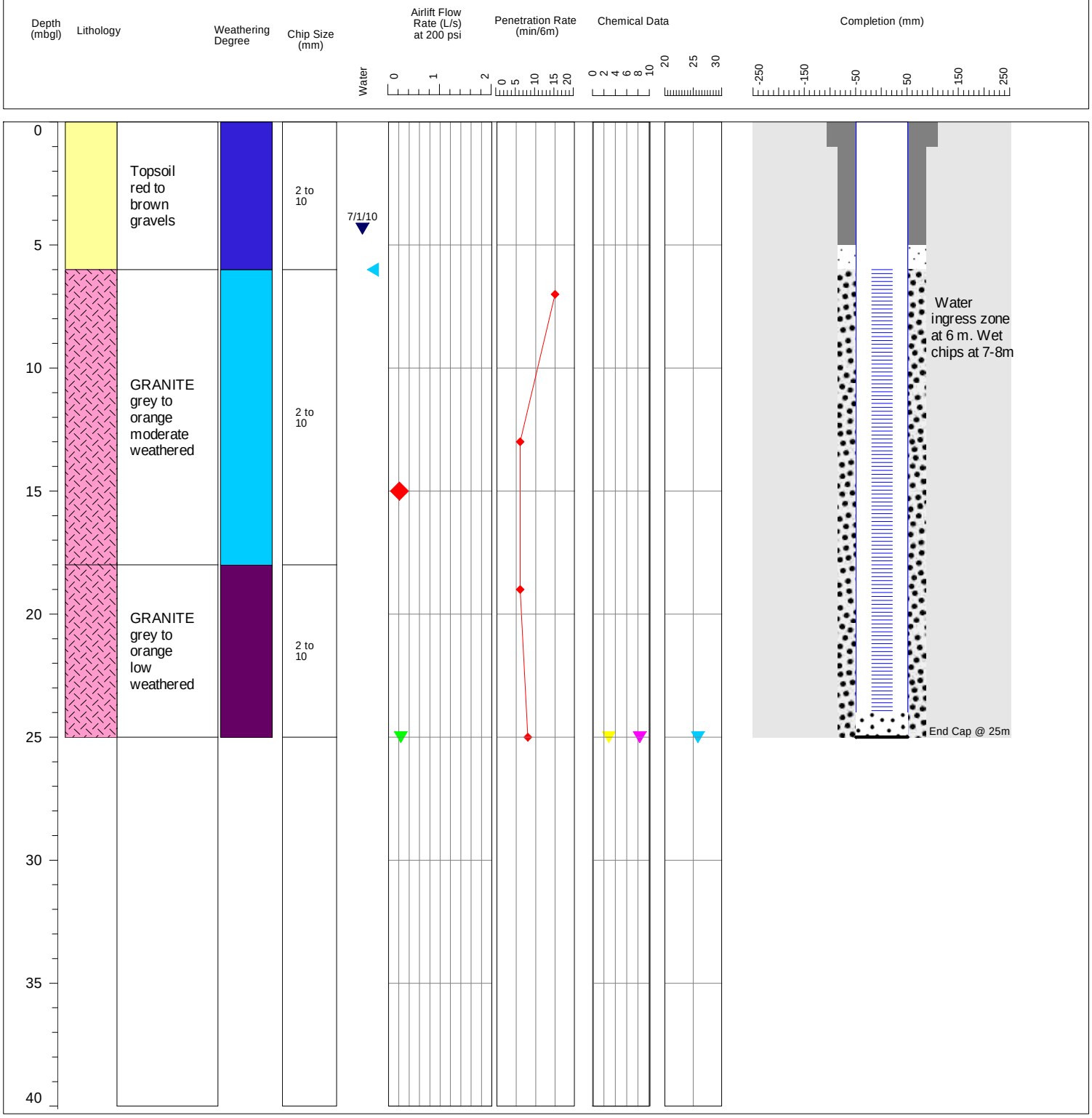
Rig: Brown Drill RAB
Date Drilled:22/06/2010



Major geological units

Top Soil | Grey Granite | Dolerite Intrusive | Red Granite

Weathering Degree

High | Medium | Low

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion
- Airlift flow during development (L/s)

Completion

steel casing | PVC casing | grout seal | gravel | sand

Chemical Data

- Temp (ºC)
- pH
- EC (mS/cm)

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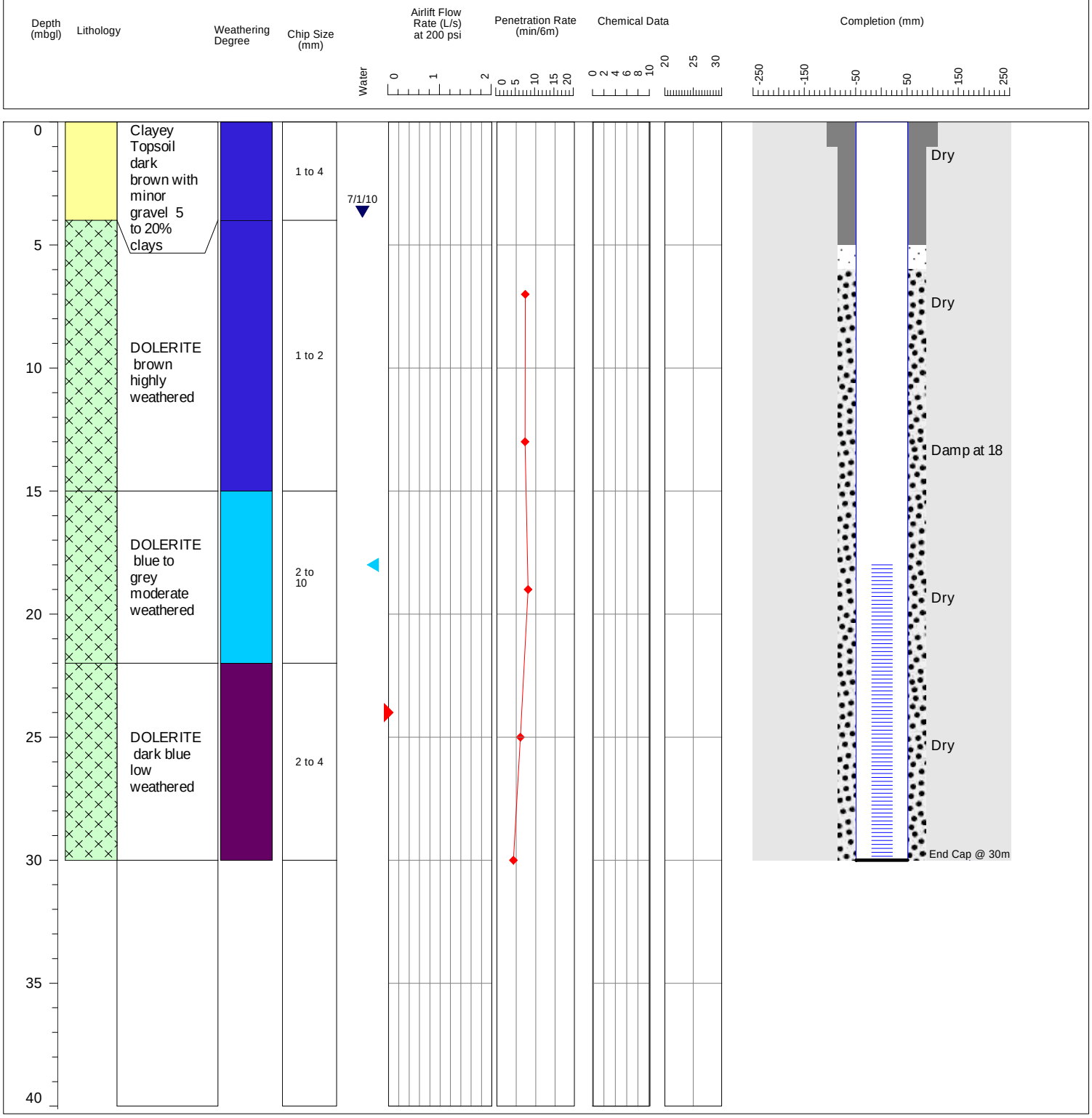

Major geological units

Top Soil | Grey Granite | Dolerite Intrusive | Red Granite

Weathering Degree

High | Medium | Low

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion
- Airlift flow during development (L/s)

Completion

steel casing | PVC casing | grout seal | gravel | sand

Chemical Data

- Temp (ºC)
- pH
- EC (mS/cm)

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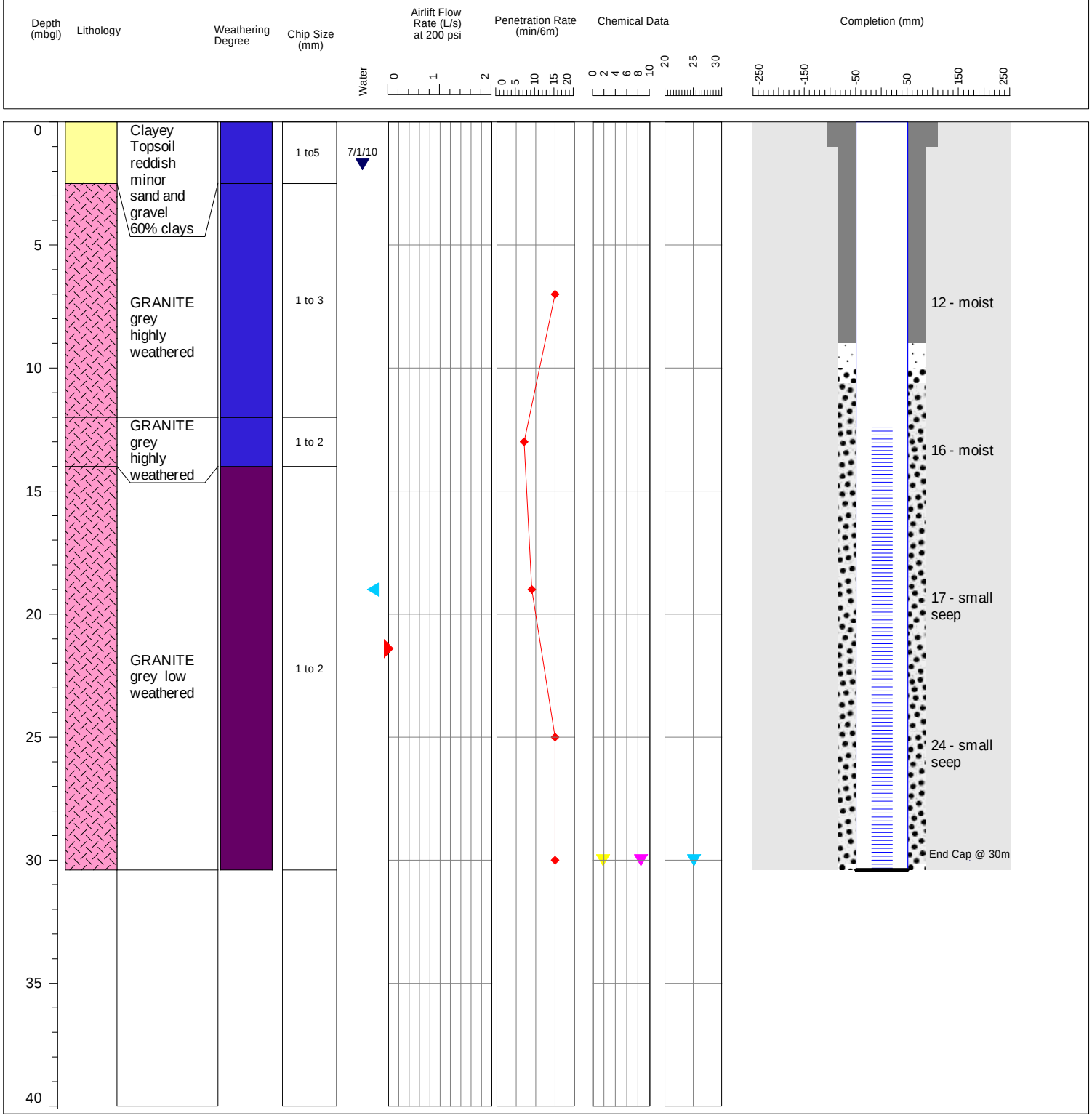

Major geological units

Top Soil | Grey Granite | Dolerite Intrusive | Red Granite

Weathering Degree

High | Medium | Low

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion
- Airlift flow during development (L/s)

Completion

steel casing | PVC casing | grout seal | gravel | sand

Chemical Data

- Temp (ºC)
- pH
- EC (mS/cm)

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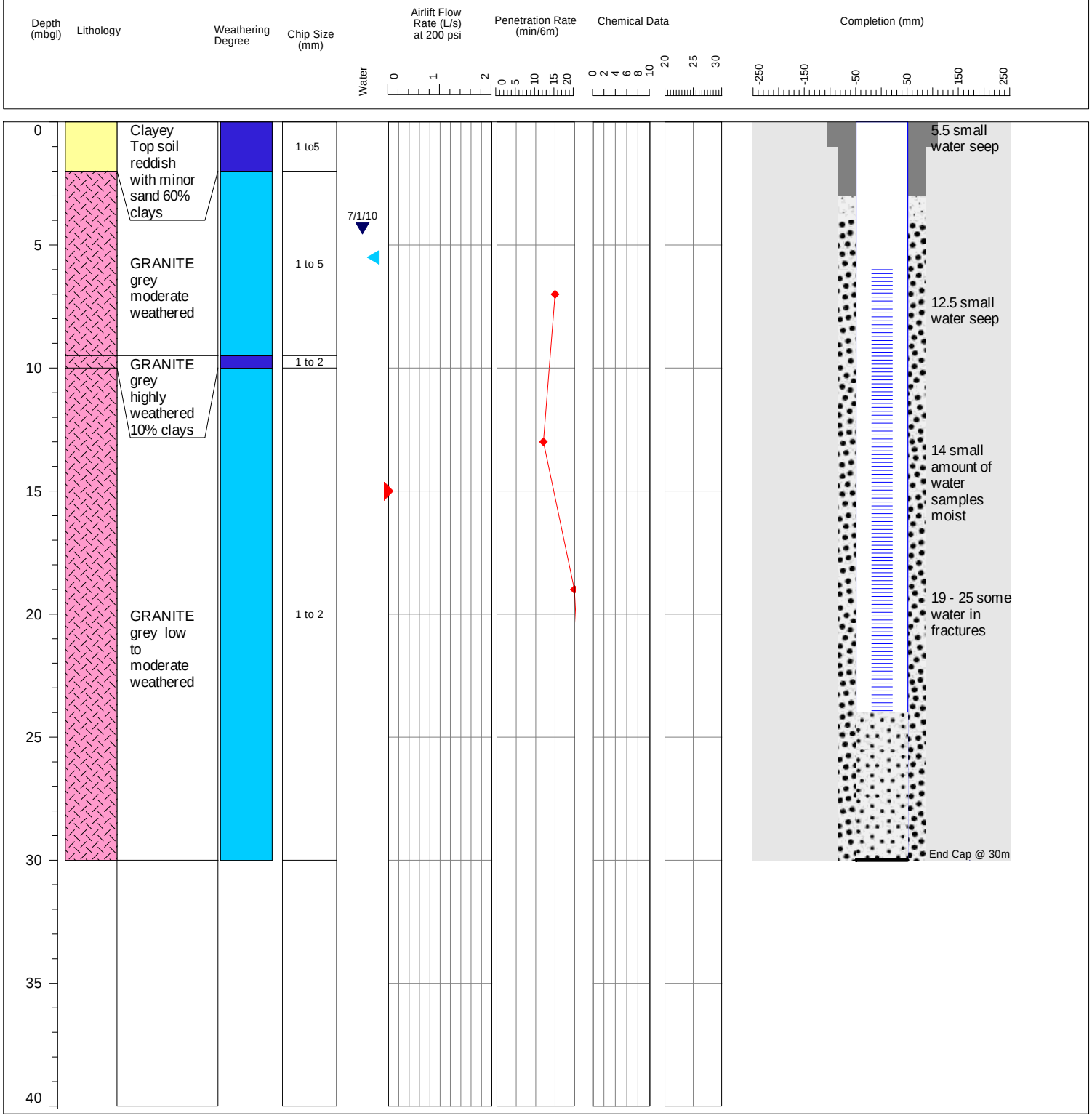
Rig: Brown Drill RAB
Date Drilled:11/06/2010



Major geological units

Top Soil | Grey Granite | Dolerite Intrusive | Red Granite

Weathering Degree

High | Medium | Low

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion
- Airlift flow during development (L/s)

Completion

steel casing | PVC casing | grout seal | gravel | sand

Chemical Data

- Temp (ºC)
- pH
- EC (mS/cm)

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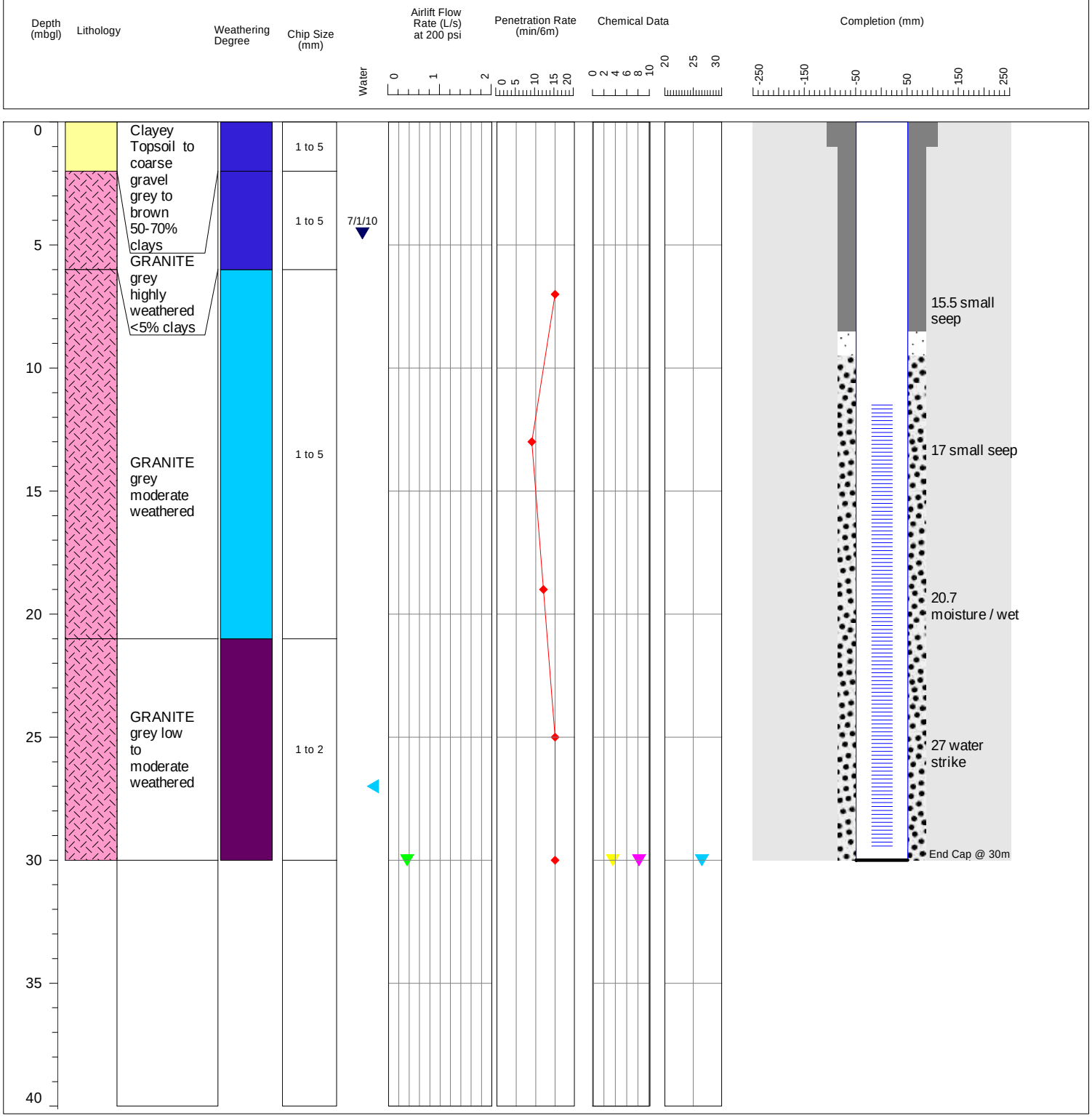
Date Drilled:09/06/2010



Major geological units

Top Soil | Grey Granite | Dolerite Intrusive | Red Granite

Weathering Degree

High | Medium | Low

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion
- Airlift flow during development (L/s)

Completion

steel casing | PVC casing | grout seal | gravel | sand

Chemical Data

- Temp (ºC)
- pH
- EC (mS/cm)

NMLMB47D

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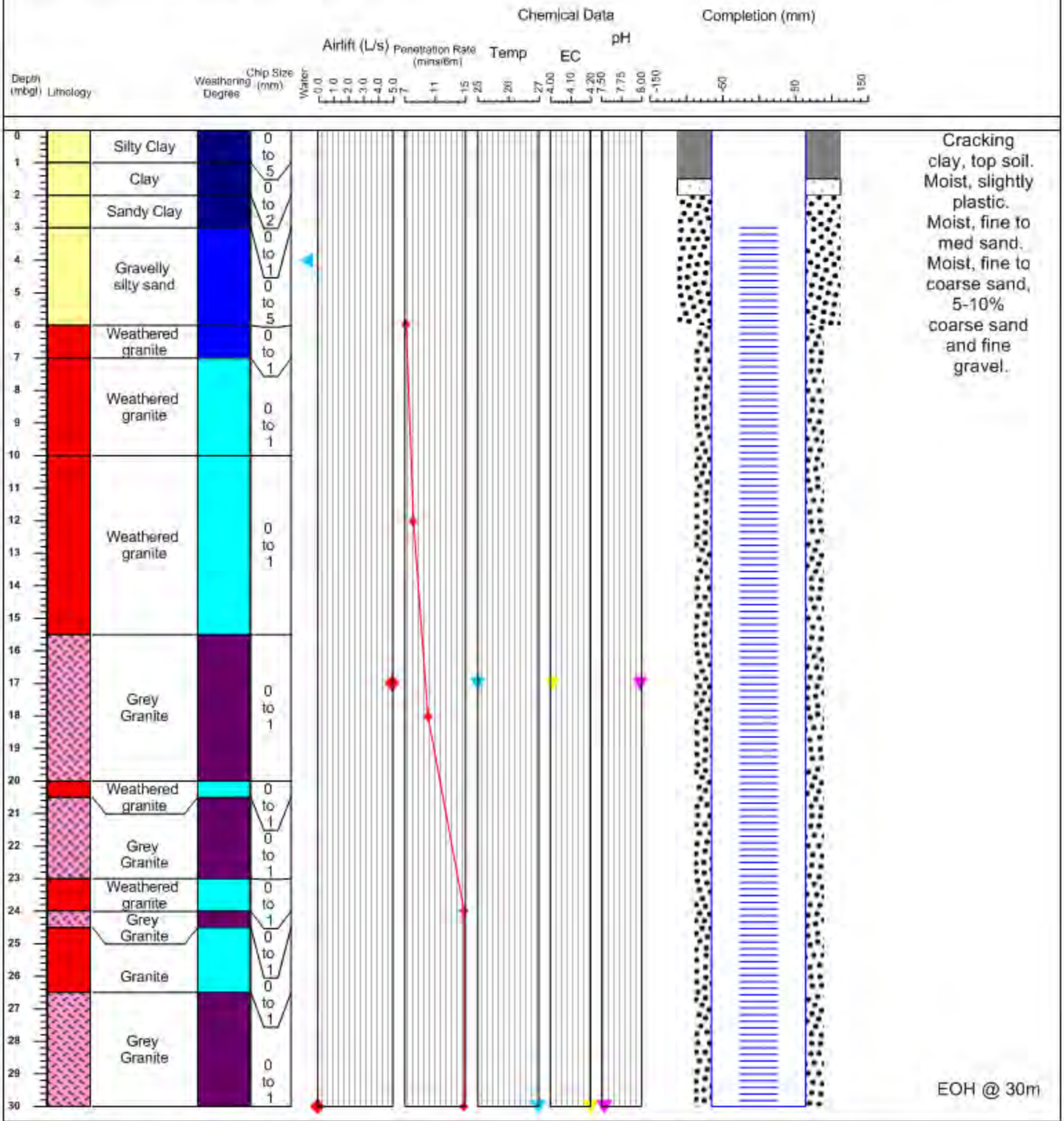

Major geological units

Top Soil | Duricrust | Granite | Weathered Granite

Weathering Degree

Very High (VH) | High (H) | Medium (M) | Low (L) | Very Low (VL)

Completion

steel casing | PVC casing | grout seal | gravel | sand

Chemical Data

- Temp (°C)
- pH
- EC (mS/cm)

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion
- Airlift flow during development (L/s)

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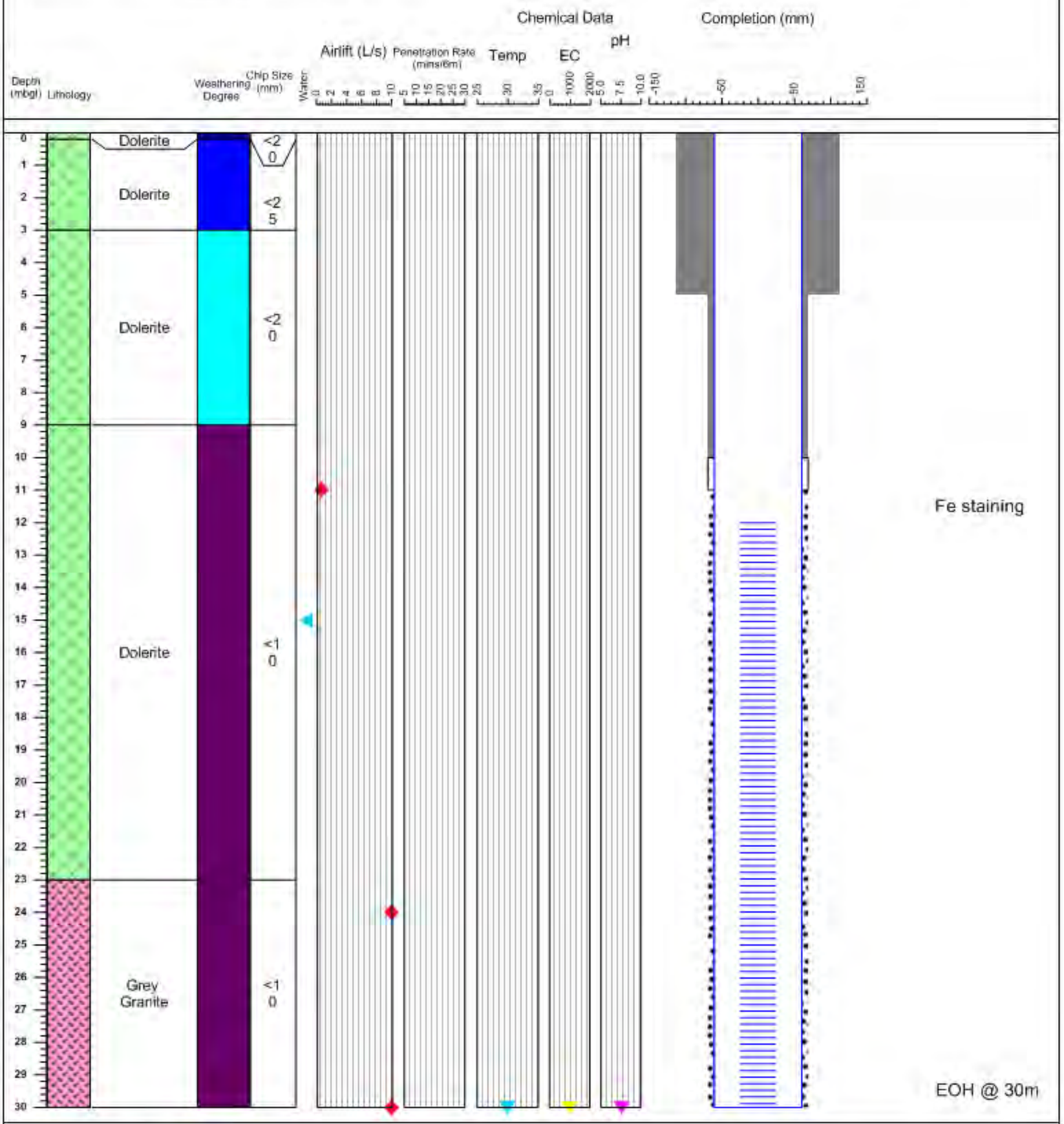
Date Drilled: 07-Nov-11



Major geological units

Top Soil | Dolerite | Grey Granite

Weathering Degree

Very High (VH) | High (H) | Medium (M) | Low (L) | Very Low (VL)

Completion

steel casing | PVC casing | grout seal | gravel | sand

Chemical Data

- Temp (°C)
- pH
- EC (mS/cm)

Water Data

- Water strike (mbgl) during drilling
- Water level (mbgl) after completion
- Airlift flow during development (L/s)

Appendix B:
Mt Leyshon Water Management Plan

NEWMONT AUSTRALIA

Water Management Plan

Mt Leyshon Mine

October 2020

M13000_021

www.engeny.com.au
P: 07 3221 7174
Level 7, 500 Queen St Brisbane QLD 4000 | PO Box 10183 Brisbane QLD 4000

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M13000_018 MT LEYSHON 2019 EA COMPLIANCE SERVICES					
\\EGIBRAPP02\management$\Projects\M13000_Newmont Asia Pacific\M13000_021 Mt Leyshon Mine 2020 EA Compliance Services\07 Deliv\Docs\Report\Revs\M13000_021-REP-001-8- Mt Leyshon WMP.docx					
REV	**DESCRIPTION**	**AUTHOR**	**REVIEWER**	**APPROVED BY**	**DATE**
Rev 0	Final	Ben Kiernan & Amir Joorabchi	Andrew Vitale	Andrew Vitale	26 September 2013
Rev 1	Audit Amendments	Ben Kiernan	Andrew Vitale	Andrew Vitale	4 February 2014
Rev 2	Final	Amir Joorabchi	Andrew Vitale	Andrew Vitale	27 October 2014
Rev 3	Final	Amir Joorabchi	Andrew Vitale	Andrew Vitale	29 October 2015
Rev 4	Final	Aaron Baldwin	Andrew Vitale	Andrew Vitale	31 October 2016
Rev 5	Final	Aaron Baldwin	Andrew Vitale	Andrew Vitale	31 October 2017
Rev 6	Final	Aaron Baldwin	Andrew Vitale	Andrew Vitale	26 October 2018
Rev 7	Final	Aaron Baldwin	Andrew Vitale	Andrew Vitale	30 October 2019
Rev 8	Final	Amy Hersant	Aaron Baldwin	Andrew Vitale	30 October 2020
Signatures					

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Abbreviations

AEP	–	Annual Exceedance Probability
AHD	–	Australian Height Datum
ARD	–	Acid Rock Drainage
ARI	–	Average Recurrence Interval
BoM	–	Bureau of Meteorology
DEHP	–	Department of Environment and Heritage Protection
DERM	–	Department of Environment and Resource Management
DES	-	Department of Environment and Science
DNRM	–	Department of Natural Resources and Mines
DSA	–	Design Storage Allowance
EA	–	Environmental Authority
EC	–	Electrical Conductivity
EMP	–	Environmental Management Plan
EP Act	–	Environmental Protection Act 1994
ES&C	–	Erosion and Sediment Control
EV	–	Environmental Values
HDPE	–	High Density Polyethylene
LRL	–	Leyshon Resources Limited
ML	–	Mining Lease
MRL	–	Mandatory Reporting Level
PAF	–	Potential Acid Forming
RDOP	–	Regulated Dam Operational Plan
REMP	–	Receiving Environment Monitoring Plan
RL	–	Reduced Level
TDS	–	Total Dissolved Solids
WMP	–	Water Management Plan

1. INTRODUCTION

This Water Management Plan is the main document for the regulation of water management at the closed Mt Leyshon Mine which is owned by Newmont Australia (Newmont). It defines the impacts and processes associated with the generation, use and management of water during the post-closure monitoring and rehabilitation stage of the project.

This Water Management Plan (WMP) has been prepared to comply with conditions of the Environmental Authority (EA) No. EPML00863713 issued by the Department of Environment and Science, DES (formerly Department of Environment and Heritage Protection, DEHP) and the *Environmental Protection Act 1994*.

1.1 Water Management Plan Objectives

The key objectives of the WMP are:

- Identify existing environmental values that could be potentially impacted.
- Determine the source and nature of potential contaminants.
- Identify potential impacts to receiving environments; and,
- Define management actions to minimise the risks of environmental harm to receiving environments.

This WMP is a dynamic document that forms an integral part of the Environmental Management Plan (EMP) for the site and may require updating in circumstances including, but not limited to:

- Major changes to site landforms or drainage patterns.
- Structural or operational changes to the site water management system.
- Amendments to the site EA; and,
- Changes to site organisational structure and responsibilities.

1.2 Legislative Requirements

Under the *Environmental Protection Act 1994* all proposed and existing Level 1 mining projects must prepare a WMP for the mining project. This requirement is identified in Condition (C10-1) of the Mt Leyshon EA (EPML00863713). The legislation that applies to the management of water at Mt Leyshon Mine includes:

- *Environmental Protection Act 1994* (Qld).
- *Environmental Protection Regulation 2008* (Qld).
- *Mineral Resources Act 1989* (Qld).
- *Mineral Resources Regulation 2003* (Qld).
- *Environmental Protection (Water) Policy 2009* (Qld).
- *Water Act 2000* (Qld); and,
- *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth).

1.3 Standards and Guidelines

Key standards and guidelines that have been used to inform the preparation and implementation of this WMP include:

- Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (DEHP, 2016b).
- Guideline for Preparation of Water Management Plans for Mining Activities (DEHP, 2012).
- Best Practice Erosion and Sediment Control (IECA, 2008).
- Establishing draft environmental values, management goals and water quality objectives (DEHP, 2013); and,
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000).

2. SITE DESCRIPTION

2.1 Mine History

The Mount Leyshon Mine is located 24 km south of Charters Towers. The mine was an open cut mine producing gold and silver. Operations commenced in September 1986, initially as a heap leach operation of oxide ore and expanding in 1989 to Carbon-In-Pulp (CIP) processing of primary un-oxidised ore. Mining ceased due to depletion of the ore body in early 2001, after which ore was sourced from low grade stockpiles which were processed until their exhaustion in March 2002.

Initial decommissioning and rehabilitation earthworks were completed, and the site is now in the post-closure monitoring and rehabilitation stage. Engineered covers have been placed over the tailings storage facilities and waste rock dumps and these landforms have been vegetated with various grass species.

Under previous management arrangements for the Mt Leyshon Mine, the responsibility for operation and maintenance of the site was delegated by the EA holder at the time, Leyshon Resources Limited (LRL), to Newmont. In 2016, Newmont acquired the Mt Leyshon Mine from LRL and is now the current EA holder.

The project is comprised of five mining leases (Table 2.1). ML 10149 (water storage and supply) was surrendered in 2002.

Newmont has purchased all pastoral properties immediately adjacent to the mining leases. These properties are utilised by Newmont for cattle grazing purposes.

Table 2.1 Mt Leyshon Mining Leases

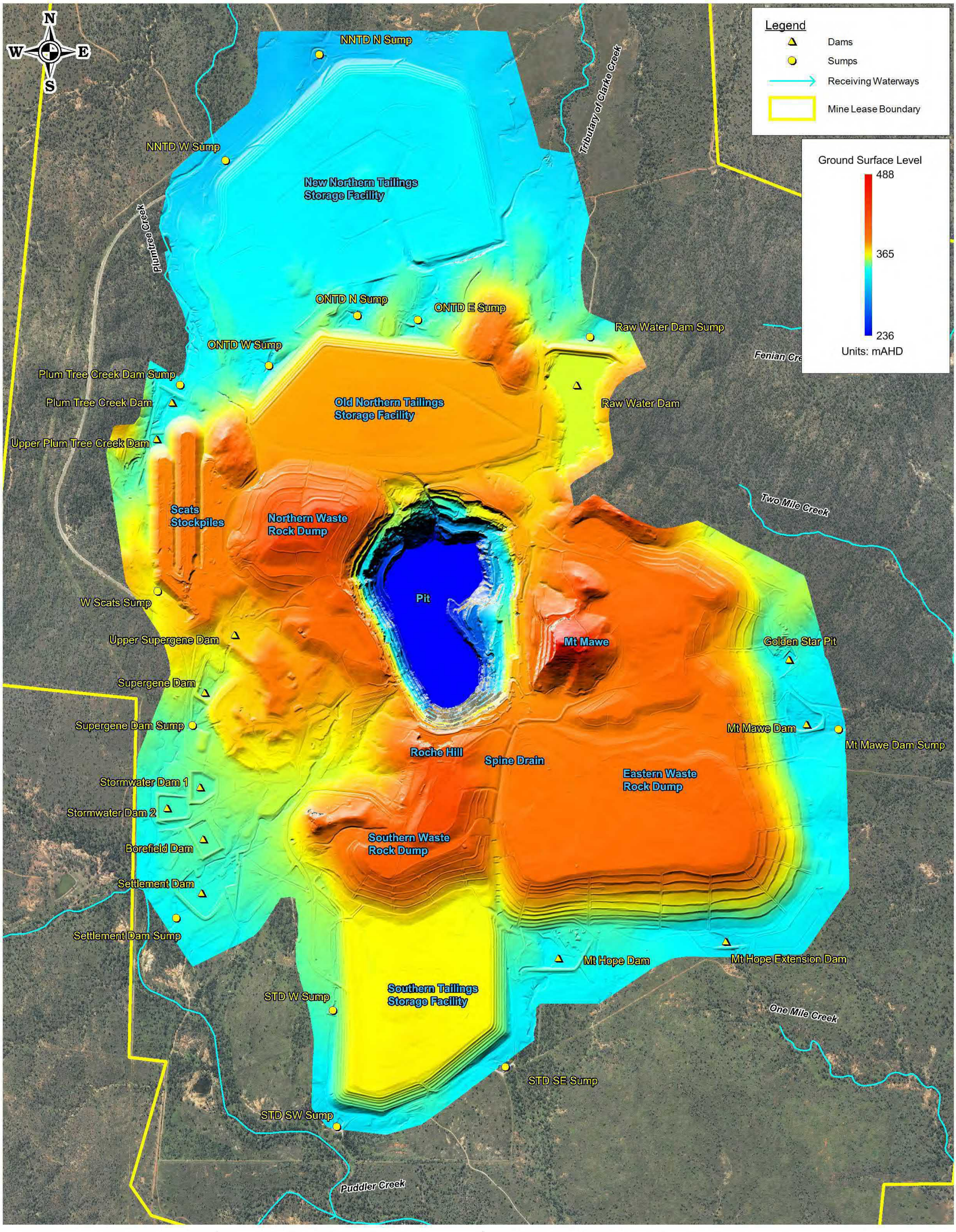
Mining Lease	Area (ha)	Operational Activities
10144	2482	Mining, stockpiling, reserves, waste disposal, environmental buffer, tailings disposal, plant, heap leach pads, water storage
10148	36	Access for water quality monitoring
10172	1	Satellite reserve, waste disposal
10173	18	Satellite reserve, waste disposal
1546	9	Satellite reserve, waste disposal

2.2 Landforms

The primary landforms at the mine site are as follows (refer Figure 2.1):

- Waste rock dumps – Southern Waste Rock Dump, Northern Waste Rock Dump and Eastern Waste Rock Dump, all covered and vegetated.
- Tailings storage facilities – Southern Tailings Storage Facility, Old Northern Tailings Storage Facility and New Northern Tailings Storage Facility, all covered and vegetated.
- Scats stockpiles – two stockpiles of scats material (low grade ore which was determined to be too hard to process during the mining period) at natural angle of repose, not covered or vegetated.
- Remnant ROM, heap leach and low-grade ore stockpiles (between Southern Waste Rock Dump and Northern Waste Rock Dump) – generally removed and revegetated.
- Final void – centre of mine site, partially filled with water.
- Water containment and storage dams distributed around the perimeter of the mine disturbance footprint.
- A network of seepage sumps located downstream of water containment dams and tailings storage facilities.
- Several natural hills including Mt Mawe (eastern side of pit) and Roche Hill (north of Southern Waste Rock Dump).
- Drainage gullies and creeks between the mine disturbance footprint and the mine lease boundary.

Photographs of the site landforms are provided in Appendix A.



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NEWMONT

0 0.3 0.6

Scale in Kilometres (1:15,000 @ A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

Mount Leyshon Mine
Water Management Plan

Figure 2.1

Landform and Topography

Job Number: M13000_007
Revision: A
Drawn: JNA
Date: 20 Sept 2013

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2.3 Climate

The Mt Leyshon Mine is located in the vicinity of Charters Towers which is located in the dry tropics and has a climate characterised by relatively hot summers and mild winters. The area has a summer dominant wet season, typically occurring between the months of December and March. The majority of the wet season rainfall typically occurs in a relatively small number of short duration, high intensity rainfall events. As a result, the surface water features within and down-gradient of the mine lease are ephemeral, flowing only during the wet season. During the dry season, these features may be completely dry or reduced to small disconnected surface water pools. Average climate statistics for Charters Towers (BoM Station 034002) are shown in Table 2.2.

Table 2.2 Average Climate Data Statistics for Charters Towers (BoM, 2013)

Month	Mean Rainfall (mm)	Mean No. of Days of Rain >1mm	Mean Maximum Temperate (°C)	Mean Minimum Temperate (°C)	Pan Evaporation (mm)[1]
Jan	136.9	8.8	33.7	21.9	198
Feb	130.1	8.3	32.6	21.7	161
Mar	103.5	6.4	31.6	20.5	170
Apr	43.4	3.5	29.9	17.9	140
May	24.0	2.4	27.2	14.8	113
Jun	26.5	2.5	24.8	12.1	92
Jul	16.8	1.9	24.5	11.0	101
Aug	13.0	1.1	26.6	12.1	130
Sep	14.8	1.4	29.6	14.7	171
Oct	22.0	2.1	32.4	17.6	215
Nov	41.4	3.4	34.1	19.9	219
Dec	86.9	5.6	34.8	21.2	219
Annual	659.2	47.4	30.2	17.1	1930

1. Data obtained through SILO data drill.

2.4 Site Topography

The original topography at the Mt Leyshon site prior to mining was dominated by rocky outcrop hills including Mt Leyshon and Mt Mawe. These hills formed a regional topographic high and coincided with several catchment boundaries, with natural surface water drainage being generally away from the site to the north, south and east.

The original topography at the Mt Leyshon Mine has been significantly altered by the previous mining activities. The open pit removed much of the original Mt Leyshon, and the waste rock and tailings storage facilities are significant landforms which were constructed within all of the original catchments draining the site.

The tailings storage facilities and waste rock dumps occupy a large part of the current mine disturbance area. These facilities have a relatively flat top surface with steeply sloped batters extending down to natural ground level.

Ground elevations within the mine disturbance area are shown on Figure 2.1. The highest elevation is 488 m AHD on the top of Mt Mawe. The lowest elevations are in the open cut pit below the pit lake. Ground elevations on the top of the major mine landforms are summarised in Table 2.3.

Table 2.3 Ground Elevations on Top of Mine Landforms

Landform	Top Ground Elevation (m AHD)
Mt Mawe	488
Northern Waste Rock Dump	435
Southern Waste Rock Dump	425
Eastern Waste Rock Dump	409
Old Northern Tailings Storage Facility	382
New Northern Tailings Storage Facility	340
Southern Tailings Storage Facility	367
Scats stockpiles	394
Water containment dams	332 to 374[1]
Clarke Creek at downstream lease boundary	290
Puddler Creek at downstream lease boundary	310

Landform	Top Ground Elevation (m AHD)
Two Mile Creek at downstream lease boundary	315
Pit lake level (July 2020)	253
Pit floor (prior to in-pit tailings deposition)	31

1. At embankment crest elevation.

2.5 Drainage Patterns

2.5.1 Site Drainage

Stormwater runoff from the mine disturbance area is generally directed outwards from the rim of the pit in the centre of the mine lease area. Stormwater runoff flows are conveyed from the top of the mine landforms to the edge of the mine disturbance area via a network of drop structures and open drainage channels. Impacted surface water and seepage flows are intercepted by water containment dams located around the perimeter of the mine disturbance area and pumped into the pit. Stormwater runoff from natural and successfully rehabilitated areas is discharged at the edge of the mine disturbance area and flows to the receiving waterways and mine lease boundary in natural ephemeral drainage gullies and creeks.

Figure 2.2 shows the primary surface drainage paths within the mine disturbance area and the catchment boundaries for the water containment dams and flow paths that drain to the mine disturbance perimeter. It is noted that surface drainage paths and catchment boundaries are regularly improved and modified as part of on-going rehabilitation works. The site drainage configuration shown in Figure 2.2 is that current at the time of preparation of this report.

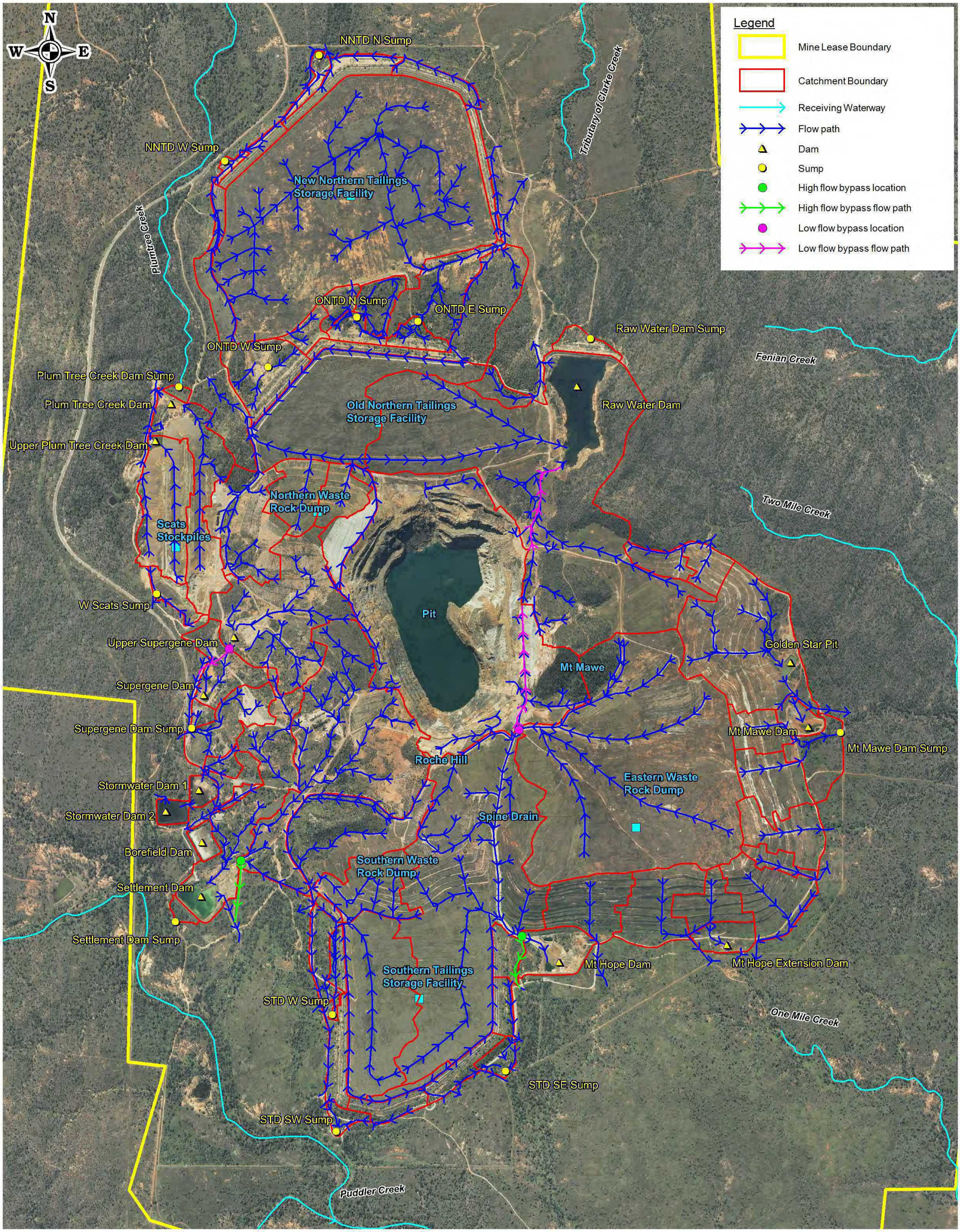
Figure 2.3 shows the parts of the mine disturbance area that drain:

- To a water containment dam, seepage sump or the pit (regulated catchment areas).
- Directly to receiving waterways (unregulated catchment areas).
- To a high flow bypass structure (low flows drain to dam and high flows drain directly to environment); and,
- To a low flow bypass structure (low flows drain directly to environment, high flows drain to dam).

A breakdown of the different drainage destination areas is shown in Table 2.4. Approximately half of the mine disturbance area drains to a regulating storage (dam, sump or pit), with the remainder discharging directly to the environment.

Table 2.4 Drainage Destinations for the Mine Disturbance Area

Destination	Area Draining to Destination (ha)	% of Mine Disturbance Area
Dam, sump or pit	382	40
Receiving waterways	342	34
High flow bypass	114	23
Low flow bypass	30	3



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Scale in Kilometres (1:15,000 @ A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
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Mount Leyshon Mine Water Management Plan

Catchments and Flowpaths

Figure 2.2

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Drawn: JNA
Date: 20 Sept 2013

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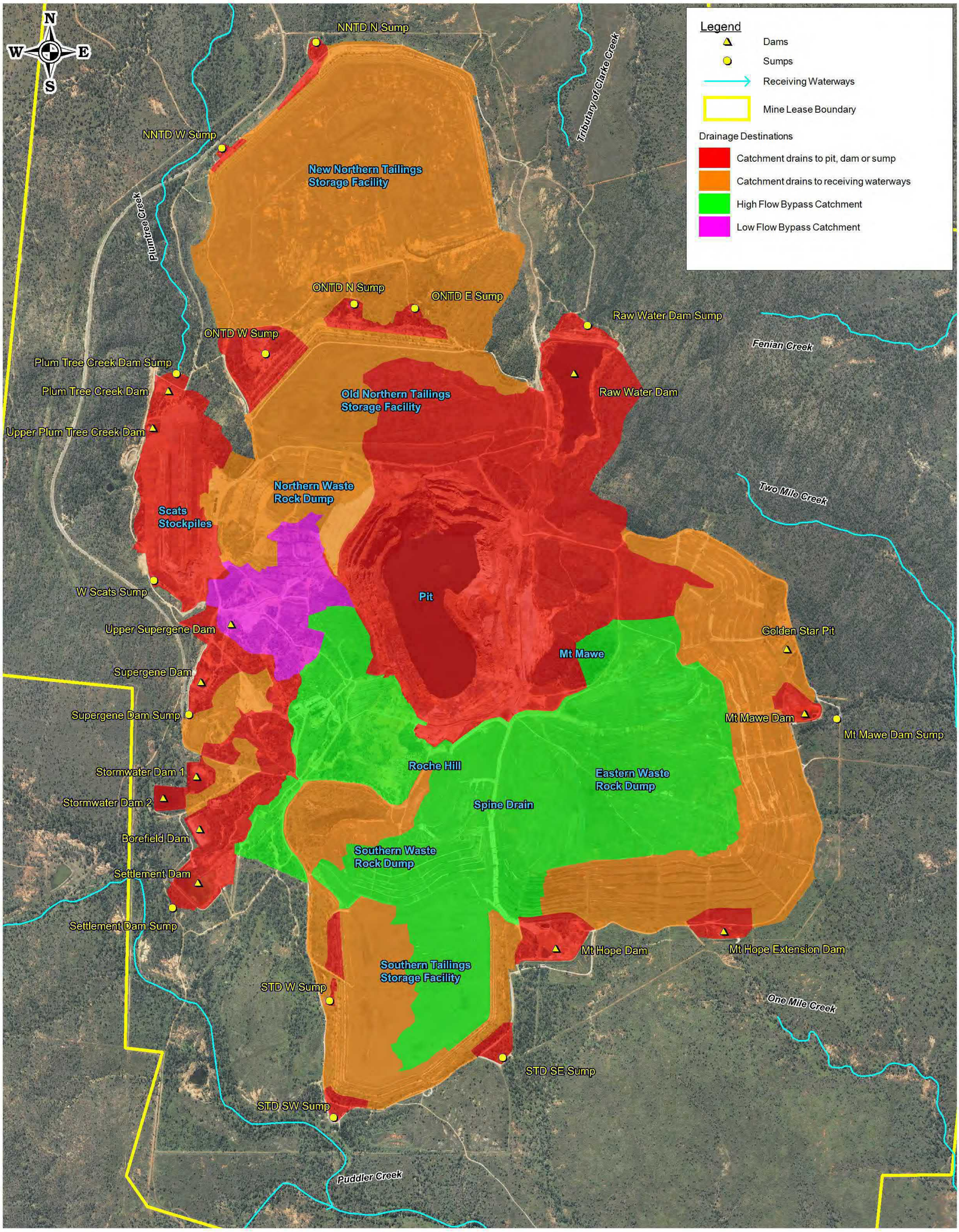

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Mount Leyshon Mine
Water Management Plan

Figure 2.3

Drainage Destinations

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2.5.2 Local Receiving Waterways

Ephemeral waterways between the edge of the mine disturbance area and the mine lease boundary are identified in Figure 2.4. In the limited periods when runoff occurs, the topography within the mine lease area drains to:

- The north towards Clarke Creek (flows in an easterly direction along the northern mine lease boundary).
- The south towards Puddler Creek (flows in an easterly direction along southern mine lease boundary).
- The east towards Two Mile Creek (flows in an easterly direction across eastern mine lease boundary).
- The south-east towards One Mile Creek (flows in a south-easterly direction across eastern mine lease boundary; and,
- The north-east towards Fenian Creek (flows in a north-easterly direction across eastern mine lease boundary).

Clarke Creek and Puddler Creek are the two largest waterways in the immediate vicinity of the mine. Clarke Creek and Puddler Creek flow along the northern and southern boundaries of the mine lease area respectively. The upstream catchments of these two waterways extend to the west of the mine. All other site waterways originate within the mine lease area.

Plum Tree Creek (downstream of scats stockpiles and Plum Tree Creek Dam) receives runoff from the Northern Waste Rock Dump and the Old Northern Tailings Storage Facility. Plum Tree Creek discharges into Clarke Creek within the mine lease area.

Two drainage gullies are located downstream of the Raw Water Dam and combine before discharging across the north-east corner of the mine lease boundary, in the periods when flow occurs. The New Northern Tailings Storage Facility drains to one of these gullies. The combined gully discharges into Clarke Creek a short distance downstream of the lease boundary.

The southern part of the mine disturbance area drains to Puddler Creek via a number of drainage gullies which flow in periods when precipitation of sufficient intensity is received in the wet season. One Mile Creek is located downstream of the Mt Hope Extension Dam and receives runoff from the southern batter slopes of the Eastern Waste Rock Dump. One Mile Creek discharges across the south-eastern corner of the mine lease boundary before discharging into Puddler Creek.

Two Mile Creek flows across the eastern boundary of the mine lease area in the wet season. This waterway receives runoff from the eastern batter slopes of the Eastern Waste Rock Dump.

The Fenian Creek catchment is located to the north of the Two Mile Creek catchment and also flows across the eastern boundary of the mine lease area in the wet season. A small part of the mine lease area within the environmental buffer zone (not disturbed by mining activities) drains to Fenian Creek. A topographic ridge is located between the rehabilitated mine facilities on the eastern side of the mine and Fenian Creek.

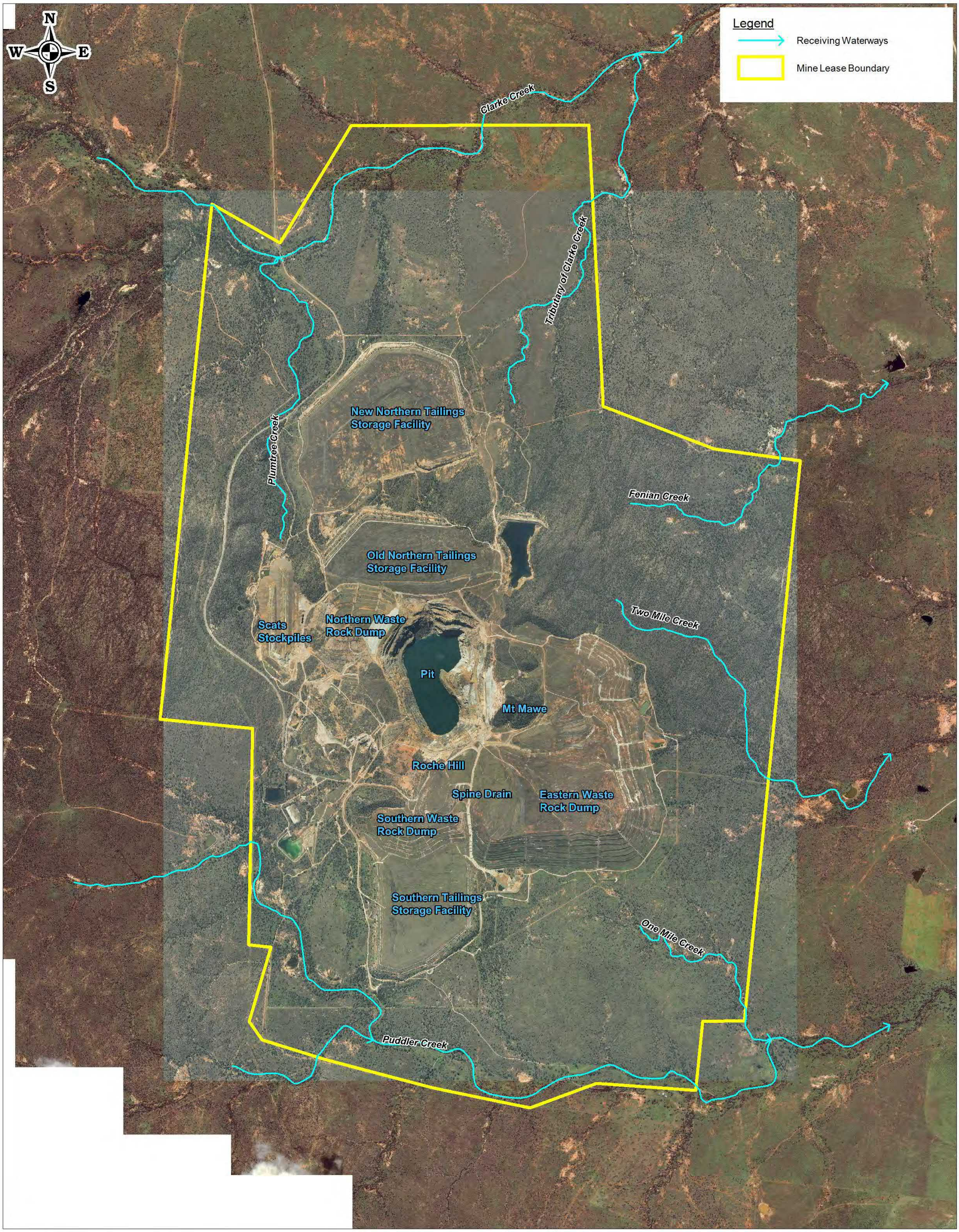
Sections of the larger waterways downstream of the Mt Leyshon Mine (e.g. Clarke Creek, Puddler Creek, Seventy Mile Creek and the Broughton River) receive groundwater contributions to stream flows. This typically occurs as baseflow during and immediately following significant rainfall events and spring-fed recharge of waterholes during the dry season.

The main drainage divisions between these receiving waterways are shown in Figure 2.4. The fraction of the mine lease area draining to the three main receiving waterways is detailed in Table 2.5.

Table 2.5 Drainage Destinations for the Mine Lease Area

Receiving Waterway	Area Draining to Receiving Waterway[1] (ha)	% of Mine Lease Area
Clarke Creek	1,168	45.7
Puddler Creek	865	33.8
Two Mile Creek	437	17.1
Pit	88	3.4

1. Includes catchments draining to the water containment dams and seepage sumps.



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Mount Leyshon Mine
Water Management Plan

Figure 2.4

Local Receiving Waterways

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Date: 20 Sept 2013

2.5.3 Regional Receiving Waterways

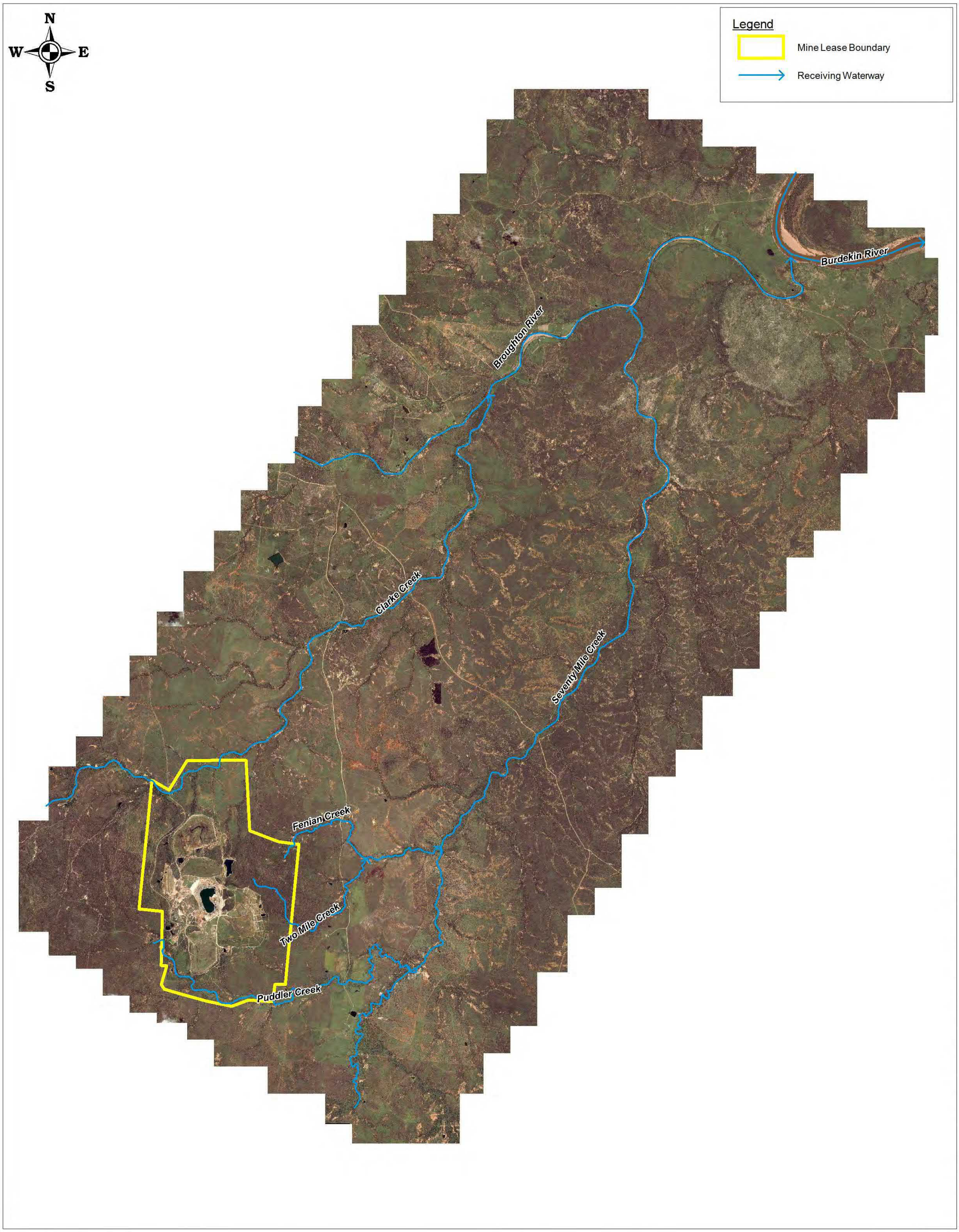
The receiving waterways downstream of the mine lease area are shown in Figure 2.5. All of the local receiving waterways eventually discharge into the Broughton River, which flows into the Burdekin River 25 km to the north-east of the mine site (straight line distance).

Stream flow gauging data for the Broughton River (DERM Gauging Station No. 120014A Broughton River at Oak Meadows) indicates that the Broughton River flows approximately 16% of the time upstream of the Clarke Creek confluence. The Burdekin River is a perennial waterway, with stream flow gauging data upstream of the Broughton River confluence (DERM Gauging Station No. 120002C Burdekin River at Sellheim) indicating the river flows more than 95% of the time.

The sequence and connectivity of waterways downstream of the mine lease area is summarised in Table 2.6.

Table 2.6 Connectivity of Receiving Waterways Downstream of the Mine Lease Area

Waterway	Receiving Waterway
Clarke Creek	Broughton River
Two Mile Creek	Fenian Creek
Fenian Creek	Seventy Mile Creek
Puddler Creek	Seventy Mile Creek
Seventy Mile Creek	Broughton River
Broughton River	Burdekin River



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Mount Leyshon Mine
Water Management Plan

Figure 2.5

Regional Receiving Waterways

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2.6 Groundwater

2.6.1 Regional Groundwater Systems

The surface geology of the Charters Towers region is dominated by the Ordovician-Devonian Ravenswood Granodiorite Complex in the north. This granite complex intruded into the neoproterozoic basement schists approximately 100 million years ago. In the south, near Mount Nolan, surficial Quaternary alluvium and Tertiary Campaspe Beds are more prevalent. The alluvium is comprised of silt, sand and gravel, while the Campaspe beds consist of sands and gravels [SKM & SMI, 2010].

The two main hydrostratigraphic units of the Charters Towers region are the alluvial aquifer and the fractured rock aquifer. The alluvial aquifer consists of Tertiary and Quaternary gravel, sand and silt. The fractured rock aquifer consists of the basement schist and the younger intrusive granites. Groundwater flow within fractured rock units is facilitated mainly via secondary porosity such as faults and fractures. This aquifer underlies the alluvial aquifer in the south of the region and is present at the surface where the alluvial aquifer is absent in the north of the region. The degree of hydraulic connection between the two aquifers is largely unknown [SKM & SMI, 2010].

2.6.2 Local (On-Lease) Groundwater Systems

Characterisation of the groundwater systems at the Mt Leyshon Mine has been undertaken by Schlumberger Water Services (2012) and Big Dog Hydrogeology (2017) based on several geophysical surveys, and the results from drilling and collecting monitoring data at over 100 groundwater monitoring locations.

There are two main groundwater transmitting systems at Mt Leyshon Mine, being:

- The shallow groundwater system; and,
- The deep groundwater system.

Shallow Groundwater System:

The shallow groundwater system has been defined to comprise the upper weathered and fractured surface of the basement rocks, typically occurring between around 5 and 25 m below ground level (mBGL). It takes the form of either; sandy and gravely weathered basement material or less weathered material where relict structural features remain.

Recent groundwater investigations (Schlumberger Water Services, 2012 and Big Dog Hydrogeology, 2017) have identified that:

- Precipitation is the primary input of water to the Mt Leyshon Mine site, driving intermittent runoff flows in the surface water systems, and seasonal recharge to the groundwater systems. Groundwater elevations respond to the larger daily

precipitation events, to seasonal conditions, and also to long term trends in annual precipitation totals.

- Groundwater flow directions follow the general surface topography and the main watercourses, being to the northeast (towards Clarke Creek), to the east (following Two Mile Creek), and to the southeast (following Puddler Creek). Very little groundwater flow occurs to the west.

- Groundwater likely leaves the shallow groundwater system as surface discharge into the surface drainage systems down-gradient of the mine facilities, where structures are present which allow vertical movement of groundwater.

- Groundwater elevations near the pit are in the range 368 to 375 m AHD, which is more than 100 m higher than the pit lake elevation. This suggests there is minimal depressurisation within the shallow groundwater system associated with groundwater flow towards the open pit, with most flow being radially away from the pit.

- Despite the hydraulic conductivity of the shallow groundwater system being locally variable, there is regional continuity of hydraulic connection within the system.

- The shallow groundwater system represents the primary means by which groundwater flows away from the Mt Leyshon Mine.

Deep Groundwater System

The deep groundwater system comprises fracture zones within the deep unweathered basement rocks, which include the breccias close to the open pit, and the surrounding dolerite and granite country rocks. Most of the basement rocks across the Mt Leyshon Mine demonstrate relatively high resistivity, consistent with a low degree of fracturing (porosity) and limited presence of pore waters. Fracturing may be present in the basement rocks at depths of up to 200 m, but is limited to the area close to, and to the northeast of the open pit. This is consistent with observations during mining that the main structural feature in the area was the Mine Fault, which was primarily identified within the open pit. The available data indicate that there is little development of fracturing beyond about 1 to 2 km from the open pit, and the granite/dolerite country rocks in the surrounding area have limited fracturing.

Groundwater responses within the deep groundwater system have been monitored through the use of vibrating wire piezometer (VWP) sensors. Most sensors display a smoothed response to seasonal precipitation trends, indicative of wet season recharge, which may occur as direct infiltration to exposed fractured basement rocks in the pit area, or as downward leakage from the shallow groundwater system.

VWP sensors indicate that within the deep groundwater system:

- In locations more than around a few hundred metres from the margins of the open pit, and at most depths, hydraulic gradients indicate groundwater flow directions are away from the pit. The drawdown cone within the deep groundwater system surrounding the pit is relatively steep and close to the pit, consistent with the inferred relatively low hydraulic conductivity in this system.

- A fracture zone intersected northeast of the pit at around 200 m AHD contains groundwater at lower pressures. The depressurised area potentially extends up to 500 m from the pit boundary.

- VWP sensors installed at depths equivalent to the base of the pit demonstrate high groundwater pressures, comparable to pressures measured at shallow depths, and consistent with groundwater flow towards the pit for the basement rocks at depth and close to the pit.

The shallow groundwater system is present in all locations at Mt Leyshon Mine, other than in the open pit, or at localised discrete locations where unweathered basement rocks may crop out at surface. The deep groundwater system is limited in occurrence to the area close to the open pit (typically within 1 to 2 km), and the greatest extent of fracturing occurs at around 200 m AHD, within 500 m of and northeast of the open pit.

In locations where both the shallow groundwater system and the deep groundwater system are present (near the open pit), these two groundwater transmitting systems are separated vertically by unweathered and mostly unfractured breccia, granite and dolerite. Mechanisms which may act to provide vertical connection through these basement rocks potentially include pervasive zones of fracturing associated with major structural features, or artificial connection created by un-grouted drill holes installed near the ore body during the development and mining periods.

Based on the groundwater elevations measured in the VWP sensors, in all locations vertical groundwater gradients act downwards, with the groundwater elevation being higher in the shallow groundwater system. In any locations where vertical hydraulic connection is present, this suggests the occurrence of downward seepage from the shallow groundwater system into the deeper groundwater system. There are no locations in which the groundwater pressure in the deep system suggests that discharge could occur into the shallow system where pathways are present.

(Above information sourced from Big Dog Hydrogeology, 2017).

3. EXISTING ENVIRONMENT

3.1 Background Water Quality

3.1.1 Surface Water

A comprehensive review of background water quality data was undertaken as part of an Environmental Evaluation (Schlumberger Water Services, 2011). The key findings of this assessment in relation to the background water quality upstream of the Mt Leyshon Mine are summarised below:

Clarke Creek up-gradient of mine:

- In typical/average conditions, TDS around 900 mg/L, SO_4 around 20 mg/L, total Al around 0.03 mg/L, total Cd around 0.002 mg/L, total Co around 0.03 mg/L, total Cu around 0.003 mg/L, total Mn around 0.3 mg/L, total Pb around 0.001 mg/L, total U around 0.002 mg/L, and total Zn around 0.01 mg/L.

- In low flow or first flush conditions, when the influence of groundwater discharge may potentially be increased, or in periods when turbid flow occurs, mineralisation influences may be present. Concentrations may increase up to 1,000 mg/L for SO_4, may exceed 10 mg/L for total Al, and reach 0.005 mg/L for total Cd, 0.1 mg/L for total Co and total Cu, may exceed 10 mg/L for total Mn, 0.01 mg/L for total Pb and 1 mg/L for total Zn.

- Elevated Sulphate and filtered metals levels including Aluminium, Cobalt, Copper, Manganese, Uranium, Zinc have been observed in Clarke Creek with exceedances of EA limits occurring on a number of occasions (taking into account hardness correction).

Puddler Creek Up-Gradient of Mine:

- In typical/average conditions, $S0_4$ around 20 mg/L, TDS around 800 mg/L, total Al around 0.2 mg/L, total Cd around 0.0003 mg/L, total Co and total Pb below detection, total Cu around 0.004 mg/L, total Mn around 0.03 mg/L, total U around 0.007 mg/L and total Zn around 0.004 mg/L.

- In high flow/turbid conditions, some mineralisation influence may be present. Contaminant concentrations in Puddler Creek may increase to as much as 10 mg/L for total Al, 0.003 mg/L for total Cd, 0.01 mg/L for total Cu, 0.2 mg/L for Mn and 0.1 mg/L for Zn.

- Concentrations of filtered Uranium and Aluminium have been observed to exceed the limits for the protection of 80 % of aquatic species on a number of occasions within the Puddler Creek (taking into account hardness correction).

Seventy Mile Creek Up-Gradient of Mine:

- SO_4 around 6 mg/L, TDS around 800 mg/L, total Al around 0.01 mg/L, total Cd around 0.0001 mg/L, total Co, Cu, Pb and Zn below detection, total Mn around 0.3 mg/L, and total U around 0.004 mg/L.
- No local mineralisation influence is identified in the surface water, although Cd, Mn and U are present associated with the nature of the regional catchments.
- Filtered Uranium concentrations have been observed to exceed the limits for the protection of 80 % of aquatic species in Seventy Mile Creek (taking into account hardness correction).

Broughton River Up-Gradient of Mine:

- SO4 around 15 mg/L, TDS around 500 mg/L, total Al around 0.05 mg/L, total Cd around 0.001 mg/L, total Co, Cu, Pb, Zn below detection, total Mn around 0.2 mg/L, and total U around 0.005 mg/L.
- No local mineralisation influence is identified in the surface water, although Cd, Mn and U are present associated with the nature of the regional catchments.
- Filtered Uranium concentrations have been observed to exceed the limits for the protection of 80 % of aquatic species in the Broughton River (taking into account hardness correction).

The elevated background levels have been attributed to the nature of the intermittent flow regime, the mineralisation within the regional catchments, and the naturally alkaline pH of the surface waters. In particular Aluminium concentrations likely relate to suspended fine colloids and clays during turbid flows associated with peak flow events, and Uranium concentrations likely relate to naturally occurring minerals in the granitoids that make up the regional catchments, combined with the relatively high pH of surface waters (Newmont, 2011).

3.1.2 Groundwater

As mining commenced prior to the collection and analysis of any groundwater samples on site, no true background chemistry data are available to define groundwater quality in the absence of any mining influences. The monitoring bores have been reviewed to determine which bores are expected to be located up-gradient of the mine facilities, or so far down-gradient of the facilities that they are unlikely to have been influenced by the mine. Samples collected from these bores during the mining and closure periods have then been used to define the range in groundwater chemistry which would have potentially been observed prior to mining (Big Dog Hydrogeology, 2017).

Shallow Groundwater System:

Background water quality in the shallow groundwater system is indicated to have a total dissolved solids (TDS) concentration between 650 mg/L and 2,000 mg/L, with an average around 1,000 mg/L. Correspondingly electrical conductivity (EC) is indicated to be in the range 800 to 2,500 µS/cm. The pH is generally alkaline, having an average of 7.2, and total alkalinity averages 600 mg/L as $CaCO_3$, being composed wholly of HCO_3. Major ions are dominated by Na, Cl and HCO_3, with minor Mg and Ca present as well. Background concentrations of sulphate are indicated to be in the range 6 mg/L to 194 mg/L with an average of 38 mg/L. Unfiltered concentrations of metals are generally low, although Cu, Co, and Zn were present at detectable concentrations in some samples (Big Dog Hydrogeology, 2017).

Deep Groundwater System:

Groundwater sampled from the deep basement unit is generally comparable to the shallow groundwater unit, with pH being around 8, alkalinity being around 200 mg/L as $CaCO_3$, and sulphate concentrations being around 2,000 mg/L. Sulphate and metals concentrations are much lower than observed in the pit lake, while pH is much higher, and these do not indicate any influence of the pit lake waters on the deep groundwater unit. Total metals concentrations appear slightly higher than typically observed in the shallow groundwater unit, which may reflect the influence of the mineralisation influences close to the pit, or the influence of facilities such as the water treatment pond during mining (Big Dog Hydrogeology, 2017).

3.2 Site Water Quality

3.2.1 Surface Water

A review of all available surface water chemistry data was conducted for Mt Leyshon Mine in 2009. This review was based on samples collected during both the mining and closure periods, and targeted at discharges at the mine facilities, mixed seepage and runoff flows retained in the water containment dams and sumps, and surface water flows in the waterways down-gradient of the water containment dams (Schlumberger Water Services, 2009). An update on the surface water chemistry was included in a wet season performance report compiled in 2010 (Schlumberger Water Services, 2010). The observations and conclusions in those reports generally indicate that:

- All of the tailings and waste rock storage facilities and stockpiles contain material which may be PAF and generate acid drainage in the long term.
- Mixed shallow seepage and surface runoff retained within the water containment dams varies significantly with location and season, and in response to the ongoing drainage modifications implemented at the site, it can be typically described as having:

- pH in the range 3 to 6.
- Sulphate concentrations between 1,000 to 20,000 mg/L.
- Cadmium concentrations between 0.01 and 10 mg/L.
- Copper concentrations in the range 0.1 to 100 mg/L.
- Lead concentrations up to 0.5 mg/L; and,
- Zinc concentrations up to 1,000 mg/L.

- Arsenic, Mercury, and Cyanide are generally at much lower concentrations.
- Other contaminants such as uranium and aluminium may be elevated at some locations but are not primary constituents of concern across the whole site.

A significant database of surface water chemistry observations is available for the intermittent streams where they exit the mine lease boundary, and for portions of these streams close to the mine facilities. A statistical review of these hydrochemical data (Schlumberger Water Services, 2011) indicates that the mine facilities contribute in differing degrees to the concentrations of:

- SO_4, TDS, and total Cd, Cu, Co, Mn, U and Zn in surface water flows in Clarke Creek (with SO_4, TDS and total Co demonstrating the most significant changes compared to background values).
- SO_4, TDS, and total Cd, Cu, Co, Mn, U and Zn in surface water flows in Puddler Creek (with SO_4, TDS, total Co, Cu, Mn and Zn demonstrating the most significant changes compared to background values).
- SO_4, TDS, and total Cd, Cu, Mn, Pb, U and Zn in surface water flows in Two Mile Creek (with SO_4, TDS, total Cu and Zn demonstrating the most significant changes compared to background values).

3.2.2 Groundwater

The most significant change to water quality in the shallow groundwater unit in response to the mining operations is an increased sulphate concentration in groundwater below and down-gradient of the mine facilities and extending a maximum of around 2 km from the closed mine facilities. As a result of the natural alkalinity in groundwater in the shallow groundwater unit, in most locations the pH remains above 7, and concentrations of metals are low compared to concentrations measured in the seepage flows.

Two main types of seepage are identified from the facilities, the closed tailings facilities tend to generate seepage with neutral pH, sulphate concentrations around 3,000 mg/L, and moderate metals concentrations, while ARD generating rock material (waste rock storage facilities, scats stockpiles) tends to produce seepage with a low pH, sulphate concentrations which average around 10,000 mg/L, and significantly elevated concentrations of Cd, Co, Cu and Zn.

(Information above sourced from Big Dog Hydrogeology, 2017).

3.3 Environmental Values

Environmental Values are the qualities of waterways that need to be protected from the effects of pollution, waste discharges and other threats to ensure aquatic ecosystems are healthy and continue to provide essential ecosystem services, and waterways are safe for community use. Water Quality Objectives are long-term goals for water quality management for receiving waters to support and protect the designated EVs for those waters.

The uses of water down-gradient of the Mt Leyshon Mine have been identified in an Environmental Values Study for the Mt Leyshon Mine (Engeny, 2013a) on the basis of the collection and review of existing information on the Broughton River catchment and through stakeholder consultation.

A summary of the Environmental Values for the receiving waters of the Mt Leyshon Mine (downstream to confluence of Broughton River and Burdekin River) is provided in Table 3.1. Different environmental values are assigned for surface waters and groundwater in the following zones:

- Newmont-owned properties down-gradient of the mine lease; and,
- Areas down-gradient of the Newmont-owned properties (to confluence of Broughton River and Burdekin River).

The dominant human use of water (surface water and groundwater) in these zones is for stock watering. Surface water is used for crop irrigation in the lower reaches of the Broughton River. Surface water and groundwater is used as a back-up water supply for drinking water and domestic use (rainwater tanks are primary supply) in the pastoral properties downstream of the Newmont-owned properties. The waterways downstream of the Newmont-owned properties are also used for primary and secondary recreation by riparian landholders.

Table 3.1 Environmental Values for the Receiving Waters of the Mt Leyshon Mine

Symbol	Environmental Value	Surface Water (down-gradient of Newmont Properties)	Surface Water (Newmont properties)	Groundwater (down-gradient of Newmont Properties)	Groundwater (Newmont properties)
	Aquatic ecosystems (slightly to moderately disturbed)	✓	✓	✓	✓
	Irrigation	✓	X	X	X
	Farm or property use	✓	X	✓	X
	Stock watering	✓	✓	✓	✓
	Aquaculture	X	X	X	X
	Human consumption of aquatic foods	✓	X	X	X
	Primary recreation	✓	X	✓	X
	Secondary recreation	✓	X	X	X
	Visual appreciation	✓	X	X	X
	Drinking water	✓	X	✓	X
	Industrial use	X	X	X	X
	Cultural and spiritual values	✓	✓	✓	✓

3.4 Water Quality Objectives

The establishment of water quality objectives for Queensland waters occurs under the Environmental Protection (Water) Policy 2009 and the supporting Queensland Water Quality Guidelines (DERM, 2009). These policies and guidelines help to achieve the objectives of the *Environmental Protection Act 1994* which are to protect Queensland's water environment while allowing for ecologically sustainable development.

3.4.1 Surface Water

The current Mt Leyshon Mine EA nominates receiving water contaminant limits that must not be exceeded at downstream receiving water monitoring locations (Condition C7-3). Receiving water contaminant trigger levels are also specified which, if exceeded, trigger the need for an investigation into the potential for environmental harm (Condition C7-2). The receiving water contaminant limits and trigger levels are summarised in Table 3.2.

Newmont (2013b) has developed and implemented a Receiving Environment Monitoring Program (REMP) which represents the first stage in the development of site-specific impact-based water quality limits for the Mt Leyshon Mine.

Table 3.2 Receiving Water Contaminant Limits and Trigger Levels (from Table 9 and Table 10 of EA EPML00863713)

Quality Characteristic	Contaminant Limit[1] (mg/L)	Trigger Level[2] (µg/L)
pH (pH units)	To be determined via REMP	To be determined via REMP
EC (µS/cm)	To be determined via REMP	To be determined via REMP
Sulphate	1,000	To be determined via REMP
Turbidity (NTU)	To be determined via REMP	15
Suspended Solids	To be determined via REMP	To be determined via REMP
Aluminium	5	55
Arsenic	0.5	13
Cadmium	0.01	0.2
Chromium	1	1
Cobalt	1	2.8
Copper	1	1.4
Iron	N/A	300
Lead	0.1	3.4
Manganese	N/A	1,900
Molybdenum	0.15	0.034

Quality Characteristic	Contaminant Limit[1] (mg/L)	Trigger Level[2] (µg/L)
Nickel	1	11
Selenium	0.02	11
Uranium	0.2	8
Zinc	20	8
Unionised Cyanide (as CN)	N/A	7
Cyanide (Free)	0.22	N/A

[1] *All metals and metalloids must be measured as total (unfiltered) concentrations.*

[2] *All metals and metalloids must be measured as dissolved (filtered) concentrations.*

3.4.2 Groundwater

The current Mt Leyshon Mine EA nominates groundwater contaminant limits that must not be exceeded in compliance monitoring bores (Condition C15-3). Groundwater contaminant trigger levels are also specified which, if exceeded, trigger the need for an investigation into the potential for environmental harm (Condition C15-2). The groundwater contaminant limits, and trigger levels are summarised in Table 3.3.

Table 3.3 Groundwater Contaminant Limits and Trigger Levels (from Table 13 of EA EPML00863713)

Quality Characteristic	Contaminant Limit[1] (mg/L)	Trigger Level[2] (µg/L)
pH (pH units)	To be determined via REMP	To be determined via REMP
EC (µS/cm)	To be determined via REMP	To be determined via REMP
Sulphate	1,000	To be determined via REMP
Aluminium	5	55
Arsenic	0.5	13
Cadmium	0.01	0.2
Chromium	1	1
Cobalt	1	2.8
Copper	1	1.4

Quality Characteristic	Contaminant Limit[1] (mg/L)	Trigger Level[2] (µg/L)
Lead	0.1	3.4
Nickel	1	11
Zinc	20	8
Cyanide (Free)	0.22	7

[1] *All metals and metalloids must be measured as total (unfiltered) concentrations.*

[2] *All metals and metalloids must be measured as dissolved (filtered) concentrations.*

4. CONTAMINANT SOURCES

Surface water runoff from mine landforms and disturbed areas contains a variety of contaminants including sediment, heavy metals and soluble salts. There are a number of landforms at Mt Leyshon Mine with similar characteristics in terms of geology, interaction with surface water and function during operations. These potential sources include:

- Tailings storage facilities.
- Waste rock dumps.
- Dams and sumps.
- ROM and stockpile areas; and,
- Final void.

A comprehensive review of the Mt Leyshon Mine surface water chemistry database for dams and sumps was used as an indicator to identify the contaminant characteristics and associated sources (Schlumberger Water Services, 2011). A summary of the contaminant sources, flow paths and destinations are summarised in Table 4.1.

Table 4.1 Contaminant Source Summary

Source	Transport Mechanisms	Potential Destination	Key Contaminants
Tailings Storage Facilities	Seepage via infiltration through covers Surface runoff	Groundwater Final void (via seepage sumps and water containment dams) Water containment dams and seepage sumps Clarke Ck and Puddler Ck	Sulphate, Cadmium, Manganese, Copper, Zinc, Dissolved Salts, Cobalt, Uranium
Waste Rock Dumps	Seepage via infiltration through covers Surface runoff	Groundwater Final void (via seepage sumps and water containment dams) Water containment dams and seepage sumps Clarke Ck, Puddler Ck and Two Mile Ck	Low pH Sulphate, Cadmium, Manganese, Copper, Zinc, Dissolved Salts
ROM and Stockpile Areas	Seepage via infiltration Surface water runoff	Groundwater Final void (via water containment dams) Water containment dams Puddler Ck	Low pH Sulphate, Cadmium, Manganese, Copper, Zinc
Scats Stockpile	Seepage via infiltration	Groundwater Final void (via Plum Tree Creek Dam) Plum Tree Creek Dam	Low pH Sulphate, Copper, Cadmium, Dissolved Salts, Copper, Uranium, Zinc
Final Void	Pumped water from water containment dams and seepage sumps Seepage from waste rock dumps	None (currently groundwater flow is into void)	Low pH Sulphate, Cadmium, Manganese, Copper, Zinc, Dissolved Salts, Cobalt, Uranium

Source	Transport Mechanisms	Potential Destination	Key Contaminants
Seepage Sumps	Seepage through floor of sumps Pumping to water containment dams and final void Overflows during heavy rainfall	Groundwater Final void and water containment dams Clarke Ck, Puddler Ck and Two Mile Ck	Sulphate, Cadmium, Manganese, Copper, Zinc, Dissolved Salts, Cobalt, Uranium
Water Containment Dams	Seepage through floor of dams Pumping to water final void Overflows during heavy rainfall	Groundwater Final void Clarke Ck, Puddler Ck and Two Mile Ck	Low pH Sulphate, Cadmium, Manganese, Copper, Zinc, Dissolved Salts, Cobalt, Uranium

5. POTENTIAL IMPACTS ON WATER RESOURCES

5.1 Potential Impacts

5.1.1 Surface Water

The potential impacts of the mine on surface water environmental values are identified based on the known contaminants, their sources and the performance of the site water management system. These impacts are expected to include:

- Reduction in annual stream flow volumes due to capture of runoff from the mine lease area in water containment structures, with potential impact to downstream riparian ecosystems.
- Leaching of acid drainage through potentially acid forming materials in mine landforms with the potential to discharge to surface waters and corresponding impacts to riparian ecosystems and downstream water users.
- Migration of groundwaters with elevated sulphate levels with corresponding discharge to surface waters and potential impacts to riparian ecosystems and downstream water users.
- Transport of sediment from non-rehabilitated areas and failed drainage works resulting in potential impacts to riparian vegetation and aquatic ecosystems.
- Release of dissolved salts through shallow seepage or overflows from water containment structures with the potential for accumulation within the receiving waters during dry periods. Potential impacts to stock, riparian and aquatic ecosystems.
- Release of dissolved metals through shallow seepage or overflow from water containment structures to surface waters. Potential impacts to stock, aquatic and riparian ecosystems.

5.1.2 Groundwater

The potential impacts of the mine on groundwater environmental values have been identified in the Mt Leyshon Groundwater Management Plan (Big Dog Hydrogeology, 2017) as:

- If the zone of impacted groundwater which continues to have neutral pH but to have elevated TDS and sulphate concentrations were to reach locations where groundwater is abstracted for use, the ability to use that groundwater for stock watering or potable use may be compromised.

- If the zone of impacted groundwater which continues to have neutral pH but demonstrates total Co concentrations above 0.05 mg/L were to reach locations where groundwater is abstracted for use, the ability to use that groundwater for crop irrigation could be compromised.

- If impacted groundwater should discharge into the receiving streams down-gradient of the site, the TDS, sulphate or Co concentrations could potentially cause environmental harm to aquatic organisms in the surface water systems.

- If phreatophytic vegetation is present in the environment, which has roots in the permanently saturated zone below the water table, the migration of groundwater with elevated TDS into this zone could potentially cause stress to that vegetation.

- If the natural buffering capacity of the groundwater system were to be overcome by acid rock drainage (ARD) seepage from the closed mine facilities, the pH of the groundwater could reduce, and a range of metals in addition to Co could become mobile in the groundwater, potentially causing harm if that groundwater reaches any of the groundwater receptors.

- Once the pit lake is allowed to rise to 340 m AHD, if any pathways are present which allow the lake water to enter the shallow groundwater system down-gradient of the pit, this could potentially cause harm if the groundwater subsequently reaches groundwater receptors.

5.2 Observed Impacts

5.2.1 Surface Water

Newmont has conducted a number of investigations (Newmont, 2009 and 2011) into the impacts to receiving waterways for the Mt Leyshon Mine in response to being issued with Notices to Conduct or Commission an Environmental Evaluation (EEN) by DERM in 2008 (following January/February discharge incident) and 2010.

These investigations are summarised in Newmont's Environmental Evaluation reports (Newmont, 2009 and 2011). The 2011 Environmental Evaluation report made the following conclusions on the extent and potential impacts of contaminants in surface water and sediments on the receiving environment downstream of the Mt Leyshon Mine (primarily associated with the 2008 discharge incident):

- Impacts on surface water quality extend as far downstream as the lower reaches of the Broughton River.

- Surface water in the receiving environment may be consumed by stock and native fauna such as kangaroos, wallabies, honeyeaters, egrets and cormorants. On occasions when Cadmium, Cobalt, Copper, Lead, Zinc, Sulphate and dissolved salts have exceeded stock drinking limits with the potential for harm.

- Taking account of hardness correction, there have been occasions when 80% Ecosystem Protection Limits (EPL) have been exceeded for surface water for:
- Elevated Cobalt levels in the mine area and on Clarke Creek, Puddler Creek and Two Mile Creek.
- Elevated Copper, Manganese and Zinc (Zn) in the mine area and on Two Mile Creek.
- Although metals concentrations in stream sediments commonly exceeded Interim Sediment Quality Guideline (ISQG-low) values for some metals there was limited bioavailability of metals and:
  - A low risk of eco-toxicity for Arsenic, Cobalt, Chromium, Mercury, Nickel, Antimony and Silver.
  - A low risk of eco-toxicity for Cadmium, Copper, Lead and Zinc downstream of the mine lease but potential for some eco-toxicity in the mine area or immediately downstream.
- Where default trigger values for aquatic ecosystem protection were exceeded in surface water and sediments, there was the potential for adverse impacts to the aquatic ecosystems beyond those nominally acceptable for highly disturbed ecosystems.
- The duration of impacts on the receiving aquatic ecosystems resulting from the 2008 discharge incident was likely to have been less than two months.
- Effects on riparian habitats from flood flows, weeds and erosion make it difficult to determine conclusive effects from poor water quality discharged from the Mt Leyshon Mine.

5.2.2 Groundwater

The most significant and widespread change in groundwater chemistry in the shallow groundwater system is identified in sulphate concentrations. Long-term monitoring data demonstrate “breakthrough” type events in monitoring bores located down-gradient of the mine facilities, which occurred during both the operating and closure periods. Sulphate concentrations in groundwater also vary in response to major precipitation events, consistent with the competing influences of good quality recharge to the system in the down-gradient areas, and high sulphate recharge to the system close to the mine facilities. TDS concentrations in groundwater have also increased during the operating and closure periods, which is attributed to the changes in sulphate concentrations.

These changes in groundwater chemistry identified in the shallow groundwater system are consistent with the influence of Acid Rock Drainage (ARD) seepage being generated by the mine facilities during both the operating and closure periods, and entering the groundwater system (Big Dog Hydrogeology, 2017).

The extent of elevated sulphate concentrations in groundwater has been inferred by Schlumberger Water Services (2012) based on groundwater quality monitoring data (refer Figure 5.1) and indicates that:

- The zone of groundwater above 1,000 mg/L sulphate is largely restricted to being within the mine lease.
- The edge of the zone of groundwater with elevated sulphate has a relatively sharp boundary in most locations, and the 1,000 mg/L contour, and the inferred 500 mg/L contour generally plot close together.
- In areas where historical monitoring data indicate there has been a more extensive influence, the boundary tends to be more diffuse (extending northeast from the New Northern Tailings Storage Facility, southeast from the Southern Tailings Storage Facility, and southeast from the Eastern Waste Rock Dump).
- Over the mining and closure period, elevated sulphate in groundwater has had a maximum extent from the mine facilities in the north of the site (extending more than 1 km from the New Northern Tailings Storage Facility) and in the southeast of the site (extending up to 2 km from the Southern Tailings Storage Facility and Eastern Waste Rock Dump). The extent of elevated sulphate in February 2012, which is consistent with the extent in June 2013, is significantly less than the maximum extent inferred over the mining and closure period.
- There is very limited extent of sulphate in groundwater to the west of the mine facilities.
- The monitoring data confirm that the more extensive areas of elevated sulphate in the shallow groundwater system tend to be aligned with the weathering zones which follow the current surface water drainage systems.

A numerical groundwater flow and solute transport model of the Mt Leyshon area has been constructed and calibrated to provide predictions of future sulphate conditions around the mine facilities (Schlumberger Water Services, 2013). The model simulated the shallow groundwater system and was calibrated against time variant groundwater level data at 53 separate locations and time variant sulphate concentration data at 76 separate locations. The ability of the model to reproduce these observations was assessed using hydrographs, contour plots and scatter plots. In particular the models' ability to match the observed 1,000 mg/L and inferred 500 mg/L sulphate concentrations in February 2012 was considered the highest priority, to confirm that the regional changes in sulphate concentration with time were being accurately simulated.

The calibrated model was modified and extended to allow the simulation of several predictive scenarios. These were run for 200 years into the future to provide an extremely long-term forecast. The scenarios considered future sulphate conditions around the mine under similar conditions to those currently observed, under a

particularly wet or dry climate, with limited up-gradient throughflow and included a preliminary assessment of the influence on sulphate conditions of altering seepage conditions in the facilities.

The results showed that with the calibrated parameters and average rainfall conditions the maximum future extent of sulphate concentration is unlikely to change a great deal from the extent observed in 2012. In two areas (to the northeast and southeast) continued migration away from the facilities is predicted, but this is limited to about an additional 1 to 2 km to the east in the year 2212 as shown in Figure 5.2 and Figure 5.3.

The prediction of limited future expansion of the zone of elevated sulphate in groundwater under average conditions in the model results from a combination of factors, including:

- As the area of influence increases, the total volume of groundwater in the system to accommodate the fixed sulphate load increases rapidly.
- As the area of influence increases, the proportion of the area which is exposed to good quality natural groundwater recharge significantly increases.
- The more the area of influence extends, the more creek systems it covers, which provides more potential locations for the model to remove sulphate from the groundwater system by discharging it to surface water on a seasonal basis.
- The extent of the sulphate influenced zone in 2012 reflects higher than average rainfall conditions over preceding years. The predictive model assumes a return to average rainfall conditions, and so there is an immediate recession in groundwater elevations and sulphate concentrations in the early part of the predictive period.

(Information above sourced from Big Dog Hydrogeology, 2017).

5.3 Water Management Strategies to Minimise Impacts

5.3.1 Water Management Strategies

Currently, the strategy for disposal of the impacted water contained within the water management system is to pump it to the lake which has formed in the residual mine void (open cut pit). It is recognised by Newmont that this strategy may not be feasible in the long term, if the net amount of impacted water generated on the site should exceed the capacity of the final void to accept these flows, without the final void in turn becoming a potential source of environmental harm. The water management strategy includes provision for the operation of an active water treatment facility, should this become the most appropriate option for disposal of the impacted flows.

The following water management strategies are currently employed as components of the water management system:

- Engineered covers installed on the tailings storage facilities and waste rock dumps to minimise contact of water with waste material.

- Interception of impacted surface runoff and shallow seepage flows via a network of drains routed to water containment dams located around the perimeter of the disturbed footprint of the mine.

- Interception of seepage flows which may discharge through the containment dam embankments via seepage sumps located downstream of the water containment dams.

- Interception of shallow seepage flows caused by rainfall infiltration through the covers of the tailings storage facilities using a network of seepage sumps and trenches at the toe of these facilities.

- Disposal of impacted water intercepted by the water containment dams and seepage sumps to the residual mine void via pumping systems. Water levels in the sumps and dams are maintained at low levels using the pumping facilities to minimise seepage losses from these storages.

- Use of high flow bypass facilities to maximise the storage volumes available within the water containment dams for containment of impacted surface runoff and seepage flows. This system has been implemented at two dam sites and aims to capture the poorest quality inflows to the dams (typically seepage flows and small surface runoff flows) while allowing larger surface runoff flows (improved water quality) to bypass around the dams to the receiving environment.

- Use of low flow bypass facilities to maximise the storage volumes available within the water containment dams for containment of impacted surface runoff and seepage flows. This system aims to divert a proportion of typically clean surface runoff around the dams using low flow pipes, with larger surface flows discharging into the dams. This system is being trialled as an interim catchment diversion measure that is relatively simple to construct and will be simple to decommission in the event that the water quality is not suitable for diversion.

- Installation of pressure sensors on the main water containment dam electric duty pumps to detect pipeline bursts/leaks and automatically switch off the pumps if this occurs. This is only required on pumped transfers where the pipeline is within a catchment that drains off-lease and the leakage will not be captured by a containment dam or sump.

- Diversion of surface runoff from rehabilitated and/or successfully covered catchment areas directly to receiving waterways.

- Drainage and flood protection work to ensure that flood waters from external un-impacted catchment areas outside of the mine disturbance footprint do not overflow into the water containment dams and seepage sumps.

- Use of constructed drainage channels with suitable scour protection to convey surface runoff flows from the top of the site landforms to the water containment dams and receiving waterways without causing erosion.

- The rehabilitation of Roche Hill in 2017 to cover exposed PAF material, repair existing erosion gullies and improve drainage off the hillside. The rehabilitation of Roche Hill is expected to improve the surface water runoff quality which reports to the Settlement Dam high flow bypass facility.

- Control of access to surface water in the mine lease and in the down-gradient properties. Newmont has purchased all pastoral holdings adjacent to the Mt Leyshon Mine.

- Monitoring of water levels, flows and water quality in receiving waterways and at key locations within the mine site to detect the discharge of impacted water from the mine lease area, assess the effectiveness of the water management strategies, refine and improve the design of the water management system and provide an increased understanding of the hydrological and water chemistry characteristics of the mine site and how they vary with both location and season.

- Emergency response procedures including notifying down-gradient landholders in the event of a containment dam overtop.

- Studies to determine site specific guidelines for surface water quality, which will allow the potential impacts associated with surface water discharge to be better understood.

5.3.2 Groundwater

Management strategies to minimise impacts on groundwater systems have been identified in the Mt Leyshon Groundwater Management Plan (Big Dog Hydrogeology, 2017) and Mt Leyshon Sulphate Management Plan (Big Dog Hydrogeology, 2013b):

- Continuation of works to improve the cover and drainage systems on the closed mine facilities to minimise infiltration.

- Control of access to groundwater in the mine lease and in the down-gradient properties and ensuring that any future changes in land use maintain these restrictions. Newmont has purchased all pastoral holdings adjacent to the Mt Leyshon Mine (Figure 5.3).

- Concurrent studies to determine site specific guidelines for surface water quality, which will allow the potential impacts associated with groundwater discharge to surface waters to be better understood.

- On-going monitoring to further define the level of risk associated with the potential impacts.

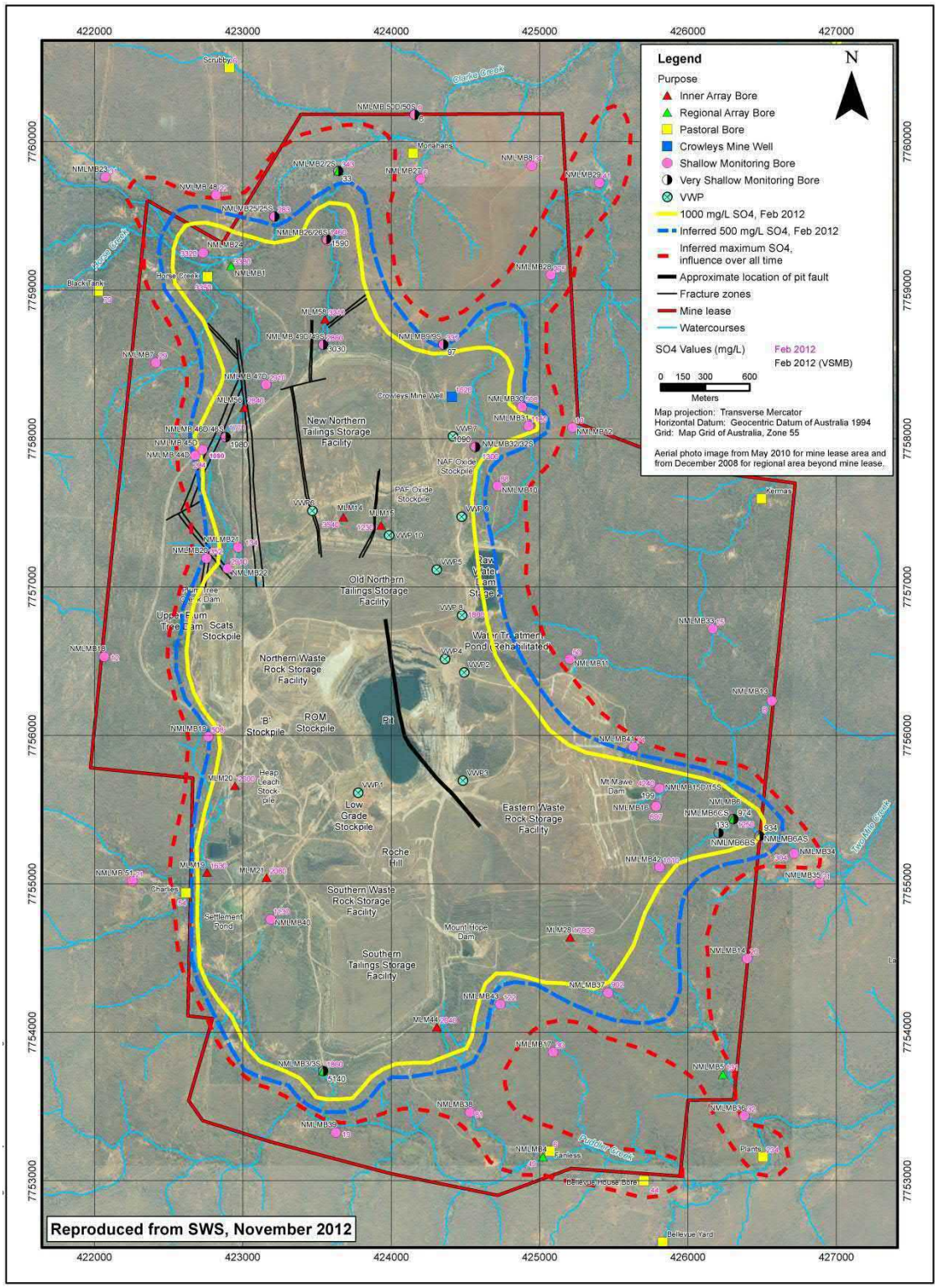


Figure 5.1 2012 Extent of Sulphate in Groundwater (Schlumberger Water Services, 2012)

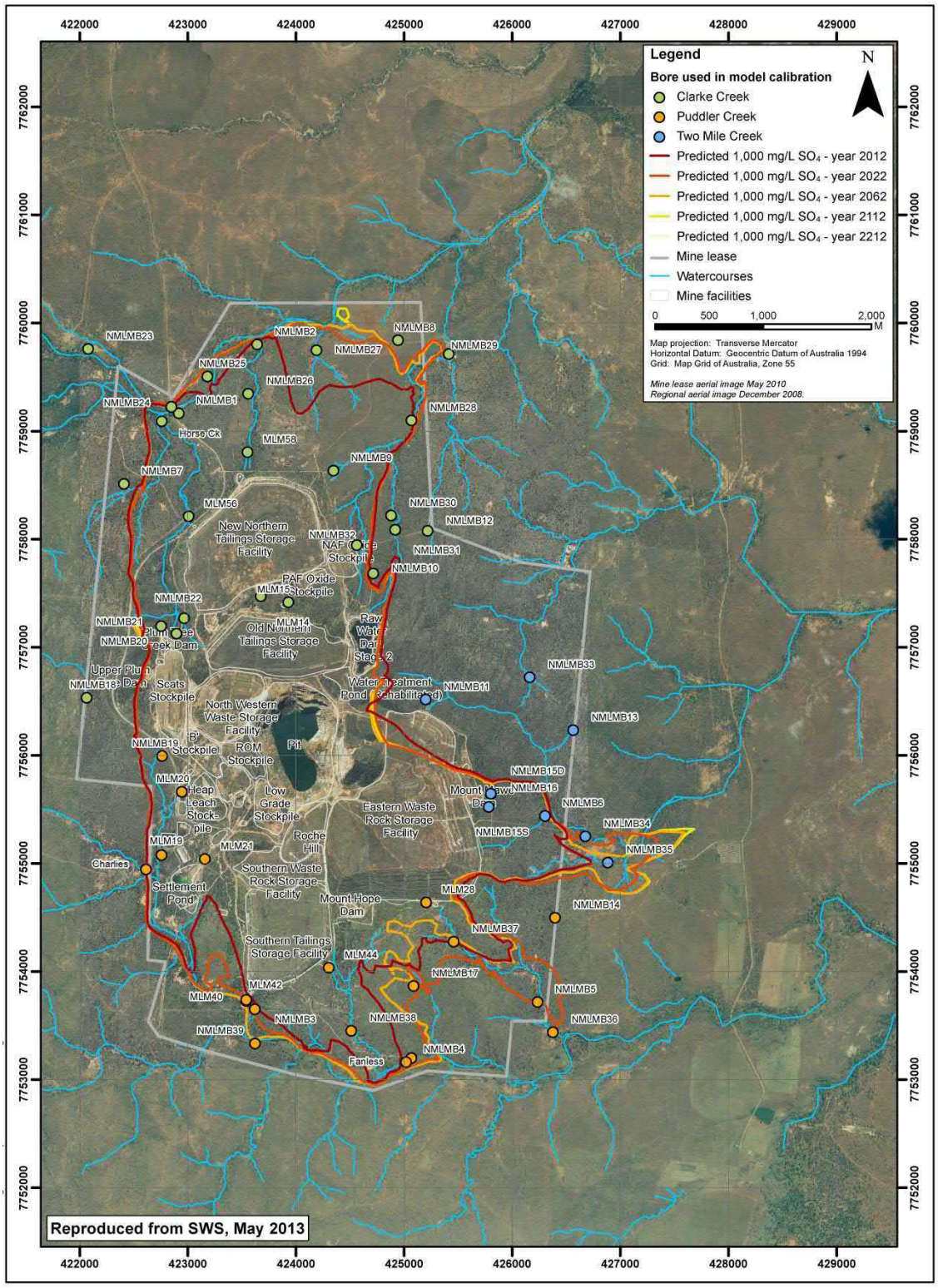


Figure 5.2 Predicted Future Extent of 1,000 mg/L Sulphate Contour (Schlumberger Water Services, 2013)

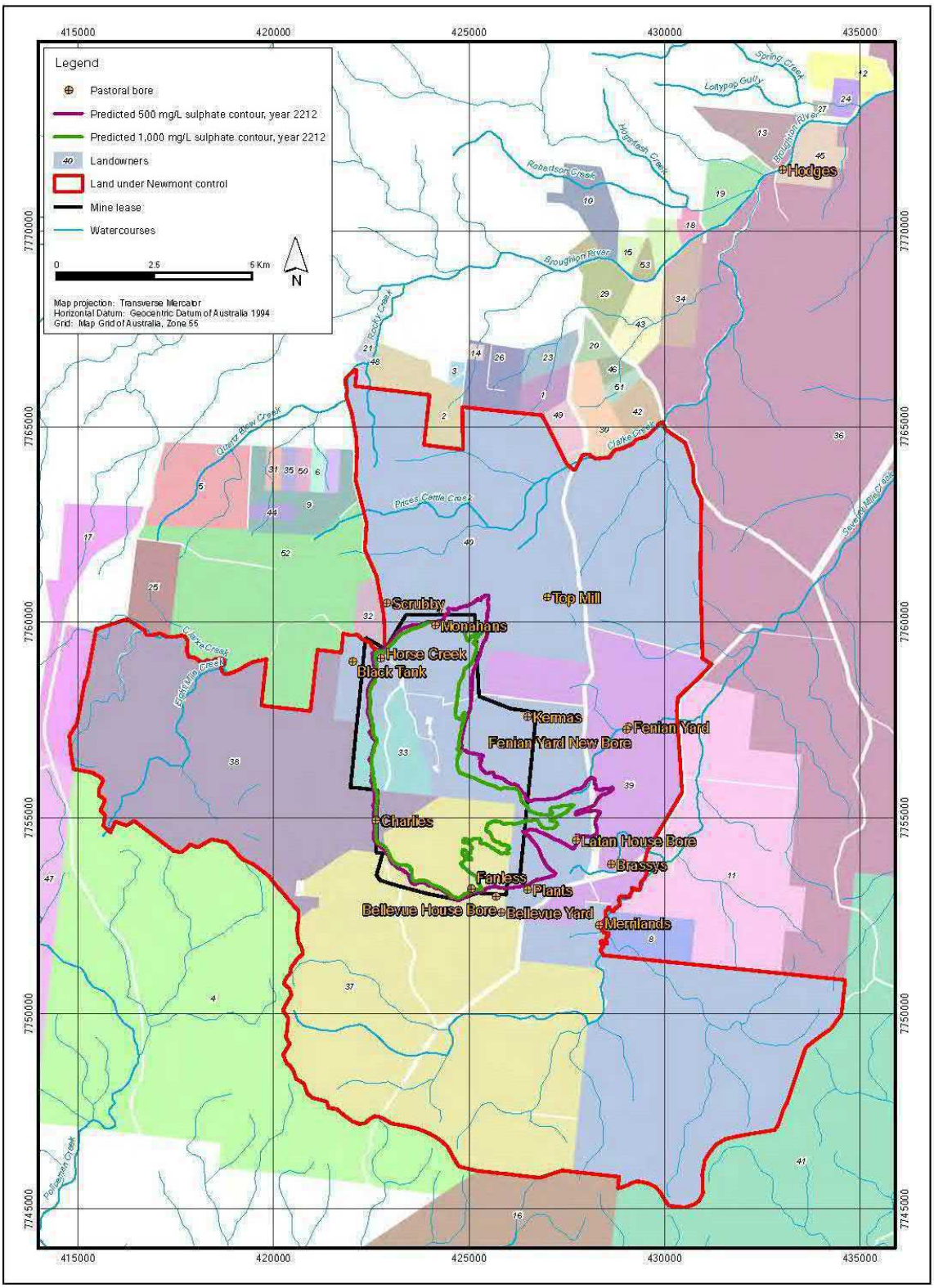


Figure 5.3 Predicted Future Extent of 1,000 mg/L Sulphate Contour including Property Ownership (Schlumberger Water Services, 2013)

6. WATER MANAGEMENT INFRASTRUCTURE

6.1 Constructed Drainage Channels

The primary surface drainage paths within the mine disturbance area are shown in Figure 2.2. Because the surface topography and landforms within the mine disturbance area have been significantly modified as a result of mining activities, the majority of the surface drainage paths are in the form of constructed open drainage channels. Since many of these drainage channels have a steep longitudinal gradient they are typically lined with rock to prevent flow-induced scouring of the channel base. A number of the larger drop structures on the batters of the major landforms are stabilised with grouted rock.

The larger constructed drainage channels include:

- The Spine Drain – engineered waterway located between the Eastern Waste Rock Dump and Southern Waste Rock Dump comprising a stepped profile with drop structures constructed from rock gabions and rock mattresses. The Spine Drain discharges into the Mt Hope Dam.
- Drains on the top surfaces of the waste rock dumps and tailings storage facilities – drainage on these landforms typically involves smaller feeder drains or contour banks that intercept overland flow and convey these flows into larger drainage channels.
- Main drainage channel that discharges into the Settlement Dam.
- Diversion drainage channels around the eastern side of Wallaby Tail Hill and downstream of the Golden Star Pit; and,
- Drop structures that drain the batters of the waste rock dumps and tailings storage facilities – these drains are typically lined with large diameter rock to prevent erosion and dissipate flow energy.

The Spine Drain was designed to convey the peak catchment discharge for the 1 in 100 Annual Exceedance Probability (AEP) flood event (GHD Pty Ltd, 2005). The water quality of the Spine Drain flows has been impacted by the contact of subsurface flows in the rock and filter layers of the drain with underlying mine waste material. Newmont installed a clay liner in the upper reaches of the Spine Drain during 2009. The liner minimises contact between the water flowing in the drain and the underlying waste material and should lead to an improvement in the water quality in the Spine Drain.

The flow capacity of the main drainage channels on the three tailings storage facilities and the Eastern Waste Rock Dump was assessed by GHD Pty Ltd in 2010 (GHD Pty Ltd, 2010a). It was found that the main drainage channels on the Old Northern Tailings Storage Facility and Eastern Waste Rock Dump were generally adequate to convey the

1 in 100 AEP flood discharge, however the main drainage channels on the New Northern Tailings Storage Facility and Southern Tailings Storage Facility have insufficient flow capacity. Drainage upgrade works were identified to improve the drainage on these landforms.

Newmont has reconstructed drop structures on the batters of the Eastern Waste Rock Dump. The drop structures on the batters of the Southern Waste Rock Dump are in poor condition and require rehabilitation.

The flow capacity of many of the other constructed drainage channels has not been technically assessed or documented. However, over the last few years Newmont has observed the performance of the drainage channels during the wet seasons and has undertaken extensive rehabilitation works on the drainage channels at the mine based on field observations of where the channels may be prone to erosion or overtopping.

Photographs of the major constructed drainage channels are provided in Appendix B.

6.2 High Flow Bypass Facilities

High flow bypass facilities are located upstream of the Settlement Dam and Mt Hope Dam.

The intended purpose of these facilities is to bypass moderate to high catchment runoff flows around the dams (i.e. directly to the receiving waterways), with low flows directed into the dams for subsequent pumping to the pit. The high flow bypass concept is based on Newmont's observations and monitoring during rainfall events which indicate that the water quality of seepage flows following rainfall events is significantly poorer than that of the surface runoff generated from the catchment area contributing to the dams during the peak period of significant rainfall events. In previous wet seasons, surface runoff from the dam catchment areas has filled and overflowed the dams during significant rainfall events. The lack of spare storage capacity at the end of rainfall events can cause poor quality seepage flows to continue to overflow the dam after the rainfall has ceased. The high flow bypass facilities allow spare storage capacity to be maintained in the dams to prevent the overflow of poor quality first flush flows and extended seepage flows to the environment.

The two high flow bypass facilities operate automatically under gravity flow conditions and consist of the following components:

- Diversion embankment across the main inflow drain upstream of the dam.
- Pipes through the embankment wall to allow low flows to drain into the downstream dam.
- Overflow spillway on the side of the diversion embankment to direct high flows into the bypass channel; and,

- Open channel downstream of the overflow spillway to convey high flows around the dam and into the receiving waterways downstream of the dam.

The low flow capture capacity is dependent on the number of low flow pipes. This capacity can be readily reduced in the future by the operation of control valves on the ends of the low flow pipes (i.e. closing off one or more of the low flow pipes).

Automated monitoring instrumentation is provided in the bypass channels to monitor the timing, flow rate, and water quality of bypass flows.

As-constructed details of the two high flow bypass facilities were provided in the Construction Report for Settlement Pond and Mt Hope Dam High Flow Bypass Facilities (GHD Pty Ltd, 2008).

Photographs of the two high flow bypass facilities are included in Appendix C.

6.2.1 Settlement Dam High Flow Bypass Facility

The Settlement Dam high flow bypass facility was constructed in 2008, immediately upstream of the dam at the location of an original bypass structure. This structure utilised a system of distribution weirs that diverted low to medium flows into the Settlement Dam and higher flows around the dam via a bypass channel. The original bypass structure has not been utilised for many years (the bypass channel was intentionally blocked).

The catchment area contributing to the high flow bypass facility is 49.6 ha and includes parts of the plant area, ROM stockpile, low grade stockpile and Southern Waste Rock Dump. A separate drainage channel (draining the area in the vicinity of the heap leach stockpile) enters the Settlement Dam to the west of the high flow bypass structure. The residual catchment area that now drains directly to the Settlement Dam downstream of the high flow bypass facility is 21.6 ha. Figure 2.2 shows the location of the high flow bypass facility and the boundary of the catchment upstream of this structure.

The high flow bypass facility consists of the following components:

- Compacted earth embankment with excavated upstream sump area.
- Diversion of existing rock-lined drain from the plant area into the existing drainage path upstream of the bypass structure.
- Pipes (8/280 mm HDPE with 5 of the pipes currently closed by valves) through the embankment to allow low flows to drain into the Settlement Dam.
- High-level overflow spillway (earth bund with concrete grouted rock protection) to allow medium to high flows to spill into the bypass channel; and,

- Excavated earth bypass channel to allow medium to high flows to be discharged around the eastern side of the Settlement Dam to the environment. The bypass channel discharges into the lower reaches of the Settlement Dam spillway channel.

The flow capacity of the operational low flow pipes (3/280 mm HDPE) is approximately 0.45 m^3/s. The capture and bypass performance of the bypass facility during a rainfall event depends on the temporal (time) distribution of the rainfall. Short duration, high intensity rainfall events will result in a greater proportion of the catchment inflow bypassing the dam, while long duration, low intensity rainfall events will result in a smaller proportion of the catchment inflow bypassing the dam (i.e. greater capture in the dam).

6.2.2 Mt Hope Dam High Flow Bypass Facility

The Mt Hope Dam high flow bypass facility was constructed in 2008, in the lower reaches of the Spine Drain and a short distance upstream of the dam. The Spine Drain is the primary catchment inflow drain to the Mount Hope Dam.

The catchment area contributing to the high flow bypass facility is 64.4 ha and includes parts of the Eastern Waste Rock Dump, Southern Waste Rock Dump and Southern Tailings Storage Facility. Additional low flows from the 83.0 ha top surface of the Eastern Waste Rock Dump catchment area are also diverted into the Spine Drain from a low flow bypass facility in the upper reaches of the Spine Drain. The residual catchment area that now drains directly to the Mt Hope Dam downstream of the high flow bypass facility is 6.0 ha.

Figure 2.2 shows the location of the high flow bypass facility and the boundary of the catchment upstream of this structure. The high flow bypass facility consists of the following components:

- Compacted earth embankment across the Spine Drain.
- Low-level pipes (6/280 mm HDPE with half of pipes currently closed by valves) through the embankment to allow low flows to drain into the Mt Hope Dam.
- Overflow section on the right bank (looking downstream) of the Spine Drain to allow medium to high flows to spill into the bypass channel; and,
- Bypass channel to allow medium to high flows to be discharged around the western side of the Mt Hope Dam to the environment. The bypass channel combines with the downstream end of the Mt Hope Dam spillway channel.

The bypass embankment is constructed at an angle across the Spine Drain and extends well beyond the right bank of the Spine Drain, acting as a guide bank for downstream bypass flows. The southern end of the bypass embankment joins onto an existing low earth bund that continues in a southerly direction to the spillway channel of the Mt Hope

Dam. The bypass embankment and existing earth bund ensure that bypass flows do not flow back into the Mt Hope Dam after exiting the Spine Drain.

The Spine Drain was originally constructed with a 600 mm thick layer of rock protection over a 700 mm thick rock filter layer. The bypass embankment was founded on top of the rock filter layer (i.e. the rock protection layer of the Spine Drain was removed below the bypass embankment).

A dedicated bypass channel has not been constructed downstream of the opening in the bank of the Spine Drain. Bypass flows travel in a southerly direction within a wide, flat area between the toe of the Southern Tailings Storage Facility and the existing low earth bund that continues at the end of the bypass embankment. Bypass flows discharge to the downstream receiving waterway (tributary of Puddler Creek) directly beside the Mt Hope Dam spillway channel.

The low flow pipes are buried within the rock protection layer of the Spine Drain upstream of the bypass embankment and are at the bed level of the Spine Drain (i.e. top of rock protection) downstream of the bypass embankment. The operational low flow pipes (3/280mm HDPE) have a flow capacity of approximately 0.3 m^3/s at the commencement of bypassing. Since the bypass embankment was constructed on top of the rock filter layer of the Spine Drain, subsurface flow within the filter layer of the Spine Drain is expected to occur beneath the bypass embankment. Accordingly, it is difficult to quantify the low flow capacity of the bypass facility.

6.3 Low Flow Bypass Facilities

A number of low flow bypass facilities have been constructed at the outlets of catchments that are considered to be generally suitable for direct discharge of stormwater runoff to receiving waterways, but where insufficient rehabilitation materials have been available to construct dedicated diversion structures. These facilities have been implemented as interim diversion works that were relatively simple to construct and will be simple to decommission in the event that the water quality is not suitable for permanent diversion to the receiving waterways. The low flow bypass facilities operate in a similar manner to the high flow bypass facilities, however the low flows are the diverted flows and the high flows represent the original flow path.

The following low flow bypass facilities have been constructed at the mine:

- Supergene Dam low flow bypass facility – diverts low flows from the Upper Supergene Dam to the environment around the Supergene Dam. High flows overflow into the Supergene Dam.

- Eastern Waste Rock Dump low flow bypass facility – diverts low flows from the top surface of the Eastern Waste Rock Dump to the Raw Water Dam. High flows overflow into the top of the Spine Drain and flow towards the Mt Hope Dam high flow bypass facility.

Figure 2.2 shows the locations and bypass flowpaths of the two low flow bypass facilities. Photographs of these facilities are included in Appendix D.

6.3.1 Supergene Dam Low Flow Bypass Facility

The Supergene Dam low flow bypass facility was constructed during 2010. This facility is located between the Upper Supergene Dam and the Supergene Dam.

The catchment area upstream of the low flow bypass facility is 24.7 ha (i.e. catchment area of Upper Supergene Dam) and includes parts of the Northern Waste Rock Dump and ROM stockpile. Newmont has observed that the water quality of rainfall runoff from this catchment is typically of a standard suitable for direct discharge to the environment.

- The low flow bypass facility consists of the following components.
- Low flow pipes (3/280mm HDPE) through the embankment of the Upper Supergene Dam and extending into upper reservoir area of the Supergene Dam.
- Control valves on the downstream ends of the low flow pipes. These valves are normally cracked open to drain very small flows from the Upper Supergene Dam into the Supergene Dam.
- Branch in low flow pipes near their downstream ends with branch pipes (3/280 mm HDPE) discharging around the western side of the Supergene Dam. These pipes discharge into the drain that flows along the western side of the Supergene Dam and eventually discharges into Puddler Creek. Low flows (in excess of the small discharge capacity of the control valves on the main pipes) are bypassed from the Upper Supergene Dam directly to the environment (i.e. bypassing the Supergene Dam).
- High flows in excess of the low flow bypass capacity overtop the Upper Supergene Dam spillway and discharge into the Supergene Dam via the concrete grouted rock lined spillway and downstream rock lined chute.

The flow capacity of the low flow pipes is approximately 0.5 m^3/s. The capture and bypass performance of the bypass facility during a rainfall event depends on the temporal (time) distribution of the rainfall. Hydrologic modelling of the low flow bypass facility indicates that overflows from the Upper Supergene Dam to the Supergene Dam are expected to occur very infrequently.

6.3.2 Eastern Waste Rock Dump Low Flow Bypass Facility

The Eastern Waste Rock Dump low flow bypass facility was constructed during 2009. This facility is located in the upper reaches of the Spine Drain at the outlet of the drainage network on the top surface of the Eastern Waste Rock Dump.

The catchment area upstream of the low flow bypass facility is 83.0 ha and comprises the top surface of the Eastern Waste Rock Dump. Newmont has observed that the water quality of rainfall runoff from this catchment is typically of a standard suitable for direct discharge to the environment. The objective of the low flow bypass is to reduce the catchment area draining to the pit by diverting a proportion of the rainfall runoff from the top surface of the Eastern Waste Rock Dump to the Raw Water Dam (water disposal by evaporation from the large ponded area of the Raw Water Dam) and Spine Drain (proportion of water discharged to the environment via the Mt Hope Dam high flow bypass facility). All low flow bypass pipes are currently closed, and the bypass facility directs all flow to the Mt Hope Dam high flow bypass facility.

The low flow bypass facility consists of the following components:

Compacted earth embankment across the Spine Drain at the inflow location from the drainage channels on the top surface of the Eastern Waste Rock Dump.

- Low flow pipes (4/280 mm HDPE) through the side wall of the Spine Drain upstream of the embankment. These pipes drain toward the Raw Water Dam, running between the top of the pit and the toe of the Mt Mawe cutting and discharging into an open channel that continues to the north-eastern corner of the pit. Six pipes (6/280 mm HDPE) then extend from the end of the open channel to the top of the reservoir area of the Raw Water Dam.

- Concrete grouted rock protected overflow section on the embankment across the Spine Drain. High flows overtop this weir and drain into the downstream section of the Spine Drain (flows towards the Mt Hope Dam high flow bypass facility).

The pipes directing flow through the side wall of the Spine Drain towards Raw Water Dam are currently closed. All runoff off the top of the Eastern Waste Rock Dump is being directed to the Mount Hope Dam high flow bypass facility.

6.4 Rehabilitated Area Drainage Diversions

Approximately a third of the mine disturbance area drains directly to the receiving waterways. These are typically successfully rehabilitated areas that generate runoff of suitable water quality for discharge to the environment with little or no mixing of seepage and runoff flows. Parts of the site that drain directly to the receiving waterways include:

- New Northern Tailings Storage Facility.

- Western half of Old Northern Tailings Storage Facility.

- Majority of the Northern Waste Rock Dump.

- Western half of the Southern Tailings Storage Facility; and,

- Majority of the drop structures on the batter slopes of the tailings storage facilities and waste rock dumps.

Newmont has previously constructed a number of rehabilitated area drainage diversions to reduce the catchments areas of a number of the water containment dams. These include:

- Diversion of the western half of the Southern Tailings Storage Facility via a new drop structure at the north-west corner of the Southern Tailings Storage Facility (previously drained to the Settlement Dam).
- Diversion of a drop structure on the southern batter slopes of the Eastern Waste Rock Dump around the north-eastern corner of the Mt Hope Dam via a diversion drain (previously drained to the Mt Hope Dam).
- Diversion of three drop structures on the southern batter slopes of the Eastern Waste Rock Dump around the eastern and western corners of the Mt Hope Extension Dam via a diversion drain and a diversion bank (previously drained to the Mt Hope Extension Dam).
- Diversion of two drop structures on the eastern batter slopes of the Eastern Waste Rock Dump around the south-western corner of the Mt Mawe Dam via a diversion drain (previously drained to the Mt Mawe Dam).
- Diversion of the catchment area and overflow from the Golden Star Pit (eastern batter slopes of the Eastern Waste Rock Dump) around the north-eastern corner of the Mt Mawe Dam via a diversion drain (previously drained to the Mt Mawe Dam).

Figure 2.2 shows the catchments and routes of these drainage diversions.

6.5 External Catchment Segregation

The majority of the mine site drains outwards from the pit rim towards the receiving waterways in the environmental buffer zone of the mine lease area. There are a number of locations around the perimeter of the mine disturbance area where flows from external or undisturbed catchments have the potential to spill into drainage systems upstream of dams and sumps during significant rainfall events.

Following the occurrence of a large flood event in January 2008 (180 mm of rain on 15 January 2008), Newmont has constructed the following works to ensure the segregation of external catchment flows from the mine site drainage system:

- Diversion drain around the northern and western sides of Wallaby Tail Hill (natural hill to the west of the Southern Waste Rock Dump). This diversion drain prevents runoff from Wallaby Tail Hill flowing into the Settlement Dam.

- Levee bank and drain on the western side of the scats stockpiles. These works prevent the external catchment area to the west of the scats stockpiles and including the two Freshwater Dams from overflowing into the scats stockpiles, Upper Plum Tree Creek Dam and Plum Tree Creek Dam. The flow capacity of these drainage segregation works has been assessed by GHD Pty Ltd as being in excess of the 1 in 100 AEP flood event (GHD Pty Ltd, 2010b).

- Levee bank around the South-West Seepage Sump at the Southern Tailings Storage Facility. This levee bank will prevent Puddler Creek from spilling into the seepage sump during a large flood event.

6.6 Dams

A number of water containment dams are located around the perimeter of the mine disturbance area as shown in Figure 2.1. All of these dams were constructed during the mining operational period. Most of the dams were used to temporarily contain and treat facility discharge before release or use as process water.

During the closure period, these dams have been modified and incorporated into the surface water management system to intercept impacted surface runoff and shallow seepage flows and retain them for disposal. Although the dams have been modified to improve their performance as much as possible, they were not designed or constructed to perform their current containment role. This approach was adopted due to the potential disturbance implications of constructing purpose designed containment facilities down-gradient of the mine facilities. Pumping systems are located at a number of the water containment dams to dispose of the retained water. In the current surface water management system, the disposal approach is to pump the water to the lake in the open pit. In the longer term, other disposal options may be instituted, including the potential operation of an active water treatment plant.

The Raw Water Dam was previously the major storage for water used in the processing plant. Water was pumped from the Gap Creek Dam (off-stream storage adjacent to the Burdekin River) to the Raw Water Dam. The Raw Water Dam was never originally intended to act as a containment dam for impacted surface water. Contamination of the Raw Water Dam occurred in circa 1999 as a result of a spill from the Water Treatment Pond, which was an operational facility which has been removed and rehabilitated as part of the closure operations. Rehabilitation of the contamination area occurred during 2007 resulting in improved water quality in the Raw Water Dam. The water quality in the Raw Water Dam is not currently of a standard suitable for discharge to the environment due to marginally elevated concentrations of cadmium. Seepage flow from the adjacent Old Northern Tailings Storage Facility into the Raw Water Dam is the most likely source of this change in water quality.

The catchment areas draining to the water containment dams are shown in Figure 2.2. The Plum Tree Creek Dam and Supergene Dam have separate containment storages located upstream of their impoundment areas. A number of the dams have high flow

bypass or low flow bypass facilities that divert a fraction of upstream inflows around the dams. Figure 2.2 shows the locations of high and low flow bypass facilities at the mine. Details of these facilities are provided in Sections 6.2 and 6.3.

The majority of the water containment dams (all except for the Raw Water Dam) were surveyed by Rowlands Surveys Pty Ltd in May 2010. Key details of the water containment dams are provided in Table 6.1. Photographs are provided in Appendix E.

The water containment dams at the Mt Leyshon Mine are of earth embankment construction (the Raw Water dam is an earth and rockfill structure) and do not have liners. A significant amount of seepage typically occurs below the dam embankments and seepage sumps are located downstream of a number of the dams at topographic lows to intercept these seepage flows.

Table 6.1 Water Containment Dam Details

Dam	Direct Catchment Area (ha)	Additional HFB/LFB Catchment Area[1] (ha)	Full Supply Level (m AHD)	Storage Capacity (ML)	Pumps to	Overflows to
Settlement Dam	21.6	49.6	344.69	97	Pit	Puddler Creek
Upper Supergene Dam	24.7	0	373.96	26	No pump	Supergene Dam
Supergene Dam	6.5	24.7	358.33	31	Pit	Puddler Creek
Mt Hope Dam	6.0	147.3[2]	342.00	66	Pit	Puddler Creek
Mt Hope Extension Dam	3.4	0	331.68	8	Mt Hope Dam	Puddler Creek
Mt Mawe Dam	2.5	0	334.39	45	Pit	Two Mile Creek
Raw Water Dam	91.2	0[2]	371.75	1,517	No pump	Clarke Creek
Upper Plum Tree Creek Dam	13.0	0	343.46	2.8	No pump	Plum Tree Creek Dam
Plum Tree Creek Dam	14.6	0	341.92	35	Pit	Clarke Creek

1. *Additional catchment upstream of high or low flow bypass facility that could contribute runoff into the dam.*
2. *Assuming Eastern Waste Rock Dump low flow bypass is not operational*

6.6.1 Regulated Dams Requirements

Operational aspects of regulated dams are described in the Regulated Dams Operational Plan (Engeny, 2016a).

Consequence Category Assessment

The consequence categories of all water storages were assessed (Engeny, 2014a) to identify current regulated structures at the Mt Leyshon Mine.

The consequence assessment involved the assignment of a consequence category to the dams in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (DEHP, 2014a). Under the DEHP Manual, dams that are assigned either a Significant or High consequence category are classified as 'regulated dams' and are required to comply with minimum performance standards.

A summary of the consequence category assessment for the regulated structures at the Mt Leyshon Mine is provided in Table 6.2.

Table 6.2 Summary of Consequence Category Assessments for Regulated Structures

Storage Name	Failure to Contain - Overtopping	Dam Break	Overall Consequence Category
Mt Hope Dam	Significant	Significant	Significant
Mt Mawe Dam	Low	Significant	Significant
Plum Tree Creek Dam	Significant	Significant	Significant
Raw Water Dam	Low	Significant	Significant
Settlement Dam	Significant	Significant	Significant
Supergene Dam	Significant	Significant	Significant

Hydraulic Performance Requirements

Hydraulic performance requirements for the regulated dams at the Mt Leyshon Mine required by the Environmental Authority (EA) No. EPML00863713 (DEHP, 2016a) and the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (DEHP, 2016b) are presented in Table 6.3.

Table 6.3 Hydraulic Performance Requirements for Regulated Dams

Regulated Dam	Consequence Category: Failure to Contain - Overtopping	Design Storage Allowance Critical Wet Period	Mandatory Reporting Level / Extreme Storm Storage	Consequence Category: Dam Break	Spillway Capacity Critical Design Storm
Settlement Dam	Significant	1:20 AEP	1:10 AEP 72hr duration storm or 1:10 AEP wave allowance	Significant	1:100 AEP
Supergene Dam	Significant	1:20 AEP	1:10 AEP 72hr duration storm or 1:10 AEP wave allowance	Significant	1:100 AEP
Mt Hope Dam	Significant	1:20 AEP	1:10 AEP 72hr duration storm or 1:10 AEP wave allowance	Significant	1:100 AEP
Mt Mawe Dam	Low	N/A	N/A	Significant	1:100 AEP
Raw Water Dam	Low	N/A	N/A	Significant	1:100 AEP
Plum Tree Creek Dam	Significant	1:20 AEP	1:10 AEP 72hr duration storm or 1:10 AEP wave allowance	Significant	1:100 AEP

Mandatory Reporting Levels

The Mandatory Reporting Level (MRL) is defined in the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (DEHP, 2016b) as a level at which the dam has a remaining available volume equivalent to the Extreme Storm Storage (ESS) allowance. The ESS is defined as the highest volume required to allow either of the following to be retained within the dam (Significant Consequence dams):

- The runoff from a 1:10 AEP 72 hour duration storm; and,
- A wave allowance at 1:10 AEP.

Condition H4-3 of the EA requires the EA holder to notify the administering authority (Department of Environment and Heritage Protection) when the level of the contents of a regulated dam reaches the Mandatory Reporting Level.

Mandatory Reporting Levels for the regulated dams at the Mt Leyshon Mine are identified in the Regulated Dams Operational Plan (Engeny, 2016a) and summarised in Table 6.4.

Table 6.4 MRL Calculations for Regulated Dams

Dam[1]	1:10 AEP 72 hr Storm Containment		1:10 AEP Wave Containment		Mandatory Reporting Level (m AHD)
	Flood Inflow (ML)	Maximum Water Level (m AHD)	Wave Run-up + Wind Set-up Height (m)	Maximum Water Level (m AHD)	
Settlement Dam	76.6	342.19	0.67	344.02	342.19
Supergene Dam	6.2	357.72	0.40	357.93	357.72
Mt Hope Dam	45.4	340.70	0.44	342.36	340.70
Plum Tree Creek Dam	17.8	340.56	0.19	341.73	340.56

[1] MRL is not applicable to the Mt Mawe Dam and Raw Water Dam since the consequence category for these structures is Low for the failure to contain – overtopping scenario.

Design Storage Allowance

In accordance with Condition H5-2 of the EA, regulated structures must have sufficient storage capacity as at 1 November each year (i.e. the nominal start of the wet season) to accommodate the Design Storage Allowance (DSA) as defined in the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (DEHP, 2016b).

The Mt Leyshon Mine water management system is a shared containment system, with water collected in seepage sumps and water containment dams pumped to the pit lake which is currently 125 m lower than the rim of the pit.

The Manual requires a 1:20 AEP containment standard (i.e. the probability of uncontrolled discharges occurring from the regulated dams must be less than 1:20 (5%) in any one year) for the regulated dams at the mine that have a significant consequence category for the failure to contain – overtopping scenario.

Design Storage Allowance volumes and levels for the regulated dams at the Mt Leyshon Mine are identified in the Regulated Dams Operational Plan (Engeny, 2016a) and summarised in Table 6.5. It is noted that the 1:20 AEP containment levels for some dams are higher than the MRLs (due to the assumption of 100 % runoff for the MRL calculations). The DSA levels for the dams have been set as the lower of the 1:20 AEP containment levels and the Mandatory Reporting Levels).

Table 6.5 DSA Volumes and Levels for Regulated Dams

Regulated Dam[1]	1:20 AEP Wet Season Water Inventory Increase (ML)	1:20 AEP Containment Level (m AHD)	Adopted DSA Level[2] (m AHD)
Settlement Dam	59.3	342.97	342.19
Supergene Dam	6.3	357.72	357.72
Mt Hope Dam	31.4	341.49	340.70
Plum Tree Creek Dam	7.9	341.39	340.56

[1] DSA is not applicable to the Mt Mawe Dam and Raw Water Dam since the consequence category for these structures is Low for the failure to contain – overtopping scenario.

[2] Lower of 1:20 AEP containment level and MRL.

Spillway Capacity

The spillways for the regulated dams that have a Significant consequence category for the dam break scenario are required to safely pass a minimum 1:100 AEP flood event in accordance with Table 6 of the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (DEHP, 2016b).

Key spillway levels and dimensions are summarised in Table 6.6.

Table 6.6 Regulated Dam Spillway Details

Structure	Full Supply Level (m AHD)	Min Embankment Level[1] (m AHD)	Spillway Type	Spillway Location	Spillway Dimensions
Settlement Dam	344.69	345.25	Rock lined channel with rock lined weir (concrete capped) at upstream end of channel	North-eastern end of dam wall	Trapezoidal shape (weir) – base width 7.3 m with 1 in 3.1 side slopes
Supergene Dam	358.33	358.71	Rock lined channel with raised sill at upstream end of channel	North-western end of dam wall	Trapezoidal shape (upstream sill) – base width 5.9 m, left side slope 1 in 2.9, right side slope 1 in 4.4

Structure	Full Supply Level (m AHD)	Min Embankment Level[1] (m AHD)	Spillway Type	Spillway Location	Spillway Dimensions
Mt Hope Dam	342.80	344.15	Rock lined channel with rock lined weir (concrete capped) at downstream end of channel	Western end of dam wall	Trapezoidal shape (channel) – base width 4 m, left side slope 1 in 2.6, right side slope 1 in 2.2
Mt Mawe Dam	334.39	334.81	Rock lined weir (concrete capped) with minor blockage from three rocks supporting pipe over spillway	South-western end of dam wall	12.8 m clear opening (excluding rocks)
Raw Water Dam	371.75	372.27	Informal spillway across access road with a rock lined downstream channel excavated through the left abutment	Western end of dam wall	Approx. 25 m width along sag point in road
Plum Tree Creek Dam	341.92	342.34	Rock lined weir (concrete capped) discharging to access road	Western end of dam wall	Trapezoidal shape (weir) – base width 19.8 m, left side slope 1 in 7.4, right side slope 1 in 3.5

[1] *Minimum level on top of embankment (excluding vehicle safety bunds on edges of embankment).*

Hydrologic modelling was undertaken to determine if the existing dam spillways have sufficient capacity to pass the 1:100 AEP flood flows without causing overtopping of the dam embankments (Engeny, 2016a). All regulated dams have sufficient spillway capacity to pass the 1:100 AEP flood event.

6.7 Seepage Sumps

6.7.1 Water Containment Dam Seepage Sumps

The water containment dams at the Mt Leyshon Mine are of earth embankment construction (the Raw Water Dam is an earth and rockfill structure). The materials used

within the dam embankments and standard of dam construction are generally not well documented with the exception of the Raw Water Dam.

Seepage flows can be observed downstream of the majority of the water containment dams, indicating that the dams leak water through the embankment foundations even at relatively low operating levels. High capacity pumping systems are available at the water containment dams to maintain low water levels in the dams and minimise these seepage flows. Seepage sumps have been constructed downstream of a number of the dams at topographic low points (in the original stream bed) to intercept the seepage flows through the dam embankments and pump this water back into the dams (for subsequent pumping to the pit) or directly to the pit.

The seepage sumps typically consist of an excavated sump on the drainage gully downstream of the dam wall and a pump.

The locations of the seepage sumps are shown in Figure 2.1. Because of the need to locate the seepage sumps a distance downstream of the dam wall to intercept the seepage flows, some external catchment area drains into the sumps. The purpose of the sumps is to capture seepage flows during dry weather or following rainfall events, however the sumps will potentially overflow during significant rainfall events due to external catchment runoff inflows. Because the sumps are typically operated at low water levels, the volume of impacted water in the sumps will be small compared to the runoff inflows from the upstream catchment area during times that the sumps overflow.

No detailed ground survey information is available for the seepage sumps. The footprint of the excavated area of the sumps can be defined from recent aerial survey, however the depth of the sumps cannot be determined from the aerial survey data because of water and vegetation growth in the sumps. The sumps have a typical depth of 2 to 3 m and have a relatively small volume (less than 1 ML).

Key details of the water containment dam seepage sumps are provided in Table 6.7. Photographs are provided in Appendix F.

Table 6.7 Water Containment Dam Seepage Sump Details

Seepage Sump Location	Estimated Catchment Area (ha)	Estimated Sump Area (m^2)	Pumping Destination
Settlement Dam	0.8	130	Settlement Dam
Supergene Dam	1.0	230	Supergene Dam or Settlement Dam
Mt Mawe Dam	17.7	100	Mt Mawe Dam
Raw Water Dam	2.2	270	Pit

6.7.2 Tailings Storage Facility Seepage Sumps

A network of seepage sumps is located around the down-gradient toe of the tailings storage facilities. These sumps are typically excavated trenches or sumps with pumping equipment to transfer the intercepted seepage water to the water containment dams (either directly or via other sumps) for subsequent pumping to the pit.

The majority of these seepage sumps have been utilised since the mine was operating. The sump system is modified as necessary in response to regular inspections of the facilities to identify any seepage flows.

The locations of the seepage sumps are shown in Figure 2.1. Where possible, drains have been constructed to divert external catchment runoff around the seepage sumps, however some part of the batter slopes of the tailings storage facilities typically drains into the seepage sumps (refer Figure 2.1). As for the water containment dam seepage sumps, it is possible for some of the tailings storage facility seepage sumps to potentially overflow during significant rainfall events.

No detailed ground survey information is available for the seepage sumps. The footprint of the excavated area of the sumps can be defined from recent aerial survey, however the depth of the sumps cannot be determined from the aerial survey data because of water and vegetation growth in the sumps. The sumps have a typical depth of 2 to 3 m but are larger in area (and volume) than the water containment dam seepage sumps.

Key details of the tailings storage facility seepage sumps are provided in Table 6.8. Photographs are provided in Appendix F. Pumping systems at the sumps are described in Section 6.8.

Table 6.8 Tailings Storage Facility Seepage Sump Details

Seepage Sump Location	Estimated Catchment Area (ha)	Estimated Sump Area (m^2)	Pumping Destination
Southern Tailings Dam South-West Sump	1.5	3,200	Settlement Dam
Southern Tailings Dam South-East Sump	2.0	800	Southern Tailings Dam South-West Sump
Southern Tailings Dam West Sump	2.8	1,400	Southern Tailings Dam South-West Sump [1]
Old Northern Tailings Dam West Sump	8.9	600	Plum Tree Creek Dam

Seepage Sump Location	Estimated Catchment Area (ha)	Estimated Sump Area (m^2)	Pumping Destination
Old Northern Tailings Dam North Sump	2.3	360	Pit
Old Northern Tailings Dam East Sump	2.4	450	Old Northern Tailings Dam North Sump
New Northern Tailings Dam West Sump	0.7	600	Plum Tree Creek Dam
New Northern Tailings Dam North Sump	1.7	3,900	Plum Tree Creek Dam

1. *Gravity pipe flow (no pump).*

6.7.3 Other Sumps

The Western Scats Sump is an excavated sump located at the southern toe of the scats stockpiles and intercepts seepage and runoff flows from the southern-most end of the scats stockpiles. The majority of the small (2.5 ha) catchment area draining to the sump constitutes the scats stockpiles and accordingly the inflows to the sump are relatively small. The small inflows to the sump suggest that much of the rainfall that falls on the sump catchment area infiltrates into the scats stockpiles and drains away to the north towards the two Plum Tree Creek Dams. A pump is located at the sump and pumps water as necessary over the drainage divide to the north and into a drain that flows into the western side of the scats stockpiles (i.e. upstream of the Upper Plum Tree Creek Dam).

The Golden Star Pit is an old exploration pit located at the toe of the Eastern Waste Rock Dump to the north of the Mt Mawe Dam. The pit is relatively deep (floor elevation is unknown) and intersects the groundwater table. The pit typically contains groundwater that is of good quality and is often used as a water source for mine rehabilitation activities. A formal overflow spillway is located at the southern edge of the pit and discharges into an excavated diversion drain that flows around the northern edge of the Mt Mawe Dam and discharges into the downstream waterway (tributary of Two Mile Creek). There is no permanent pumping facility at the Golden Star Pit.

Key details of these additional sumps are provided in Table 6.9. Photographs are provided in Appendix F.

Table 6.9 Additional Sump Details

Seepage Sump Location	Estimated Catchment Area (ha)	Estimated Sump Area (m^2)	Pumping Destination
Western Scats Sump	2.5	1,300	Drain upstream of Upper Plum Tree Creek Dam
Golden Star Pit	21.5	6,400	No pump

6.8 Water Transfer and Disposal Systems

6.8.1 Water Transfer Systems

As described in previous sections of this report, the current water management system at the Mt Leyshon Mine is founded on the following main principles:

- Discharge of surface runoff from successfully rehabilitated areas directly to receiving waterways.
- Interception of impacted seepage flows and surface runoff within seepage sumps and water containment dams; and,
- Pumping of impacted seepage flows and surface runoff to the pit.

Pumping systems are provided that allow the transfer of water from the seepage sumps to the water containment dams and from the water containment dams to the pit. A number of gravity flow transfers between storages are also available.

Dedicated pumping facilities are available at the main water containment dams (Settlement Dam, Supergene Dam, Plum Tree Creek Dam, Mt Mawe Dam and Mt Hope Dam) to transfer impacted water to the pit. Each of these dams is provided with:

- An electrically powered duty pump that starts and stops automatically based on float-type level switches; and,
- A diesel powered standby/emergency pump that requires manual start-up and shut-down.

The Mt Hope Dam also includes a gravity outlet pipeline to allow water to be transferred to the pit via the STD SE Sump and STD SW Sump pumping facilities. This facility is only used during the dry season to maintain the dam at low water levels.

Outlet works (single pipe through dam embankments equipped with a control valve) are provided at the Settlement Dam and Mt Hope Extension Dam to allow gravity releases of water to the downstream receiving waterways. These facilities are not currently used.

Outlet works are also provided at the Upper Plum Tree Creek Dam to allow releases of water to the downstream Plum Tree Creek Dam.

The Mt Hope Extension Dam has a relatively small catchment area and is equipped with a diesel-powered pump that transfers water to the Mt Hope Dam for subsequent pumping to the pit.

A variety of electric and diesel-powered pumps are installed at the seepage sumps and are operated to transfer seepage flows to the water containment dams for subsequent pumping to the pit.

Mobile replacement pumping systems are maintained in readiness on site to replace any pump which may fail, and portable pumping equipment is maintained for deployment in any non-equipped location where accumulated water may require transfer into the containment system.

The delivery pipelines for the pumped and gravity transfer systems are HDPE (high density poly-ethylene) pipes with diameters (outer diameters) ranging from 2 inches to 10 inches. All of the rising mains from the water containment dams to the pit are 10 inch (280 mm) diameter HDPE pipes. Separate delivery pipelines are available for the electric and diesel-powered pumps at the water containment dams. Flow meters are installed on the rising mains from the water containment dams to the pit. The pipelines are a combination of above-ground and below-ground installations, with the smaller diameter pipes typically buried and the larger 10 inch diameter pipelines typically above-ground.

Pressure sensors have been installed on the main water containment dam electric duty pumps to detect pipeline bursts/leaks and automatically switch off the pumps if this occurs. This is only required on pumped transfers where the pipeline is within a catchment that drains off-lease and the leakage will not be captured by a containment dam or sump.

A summary of the water transfer systems at the Mt Leyshon Mine is provided in Table 6.10. Photographs of the water transfer systems are provided in Appendix G.

The pumping systems at the water containment dams are operated to minimise the volume of water in the dams at all times in order to provide the maximum amount of available storage for future rainfall events and minimise the hydraulic head within the dam which may drive seepage through the embankment.

6.8.2 Water Disposal Systems

The primary method currently utilised at the mine for disposal of impacted surface runoff and seepage flows is interception and pumping to the pit. The water level in the pit is lower than the surrounding groundwater levels in the shallow and deep groundwater systems and so the pit currently acts as a sink for groundwater flows. This means that

impacted water pumped into the pit will remain within the pit lake for the period that the pit lake level is lower than the surrounding groundwater level.

The Mt Leyshon Groundwater Management Plan (Big Dog Hydrogeology, 2017) has identified a pit lake level of 340 m AHD at which lake water may begin to enter the shallow groundwater system down-gradient of the pit. Newmont's closure objective is that the pit lake acts a groundwater sink to the shallow groundwater system and therefore the closure criteria is that the pit lake elevation is to remain below RL 340 m AHD. This will require an alternative water disposal strategy for the water containment dams and seepage sumps that currently pump to the pit lake.

Table 6.10 Summary of Water Transfer Systems at Water Containment Dams and Seepage Sumps

Source	Destination	Pump	Pipeline	Flow Rate (L/s)
Dams				
Settlement Dam	Pit	110 kw Electric Powered 8" dia. Centrifugal Pump	280mm dia. HDPE 1310m length	90
Settlement Dam	Pit	Diesel Powered 8" dia. Centrifugal Pump	280mm dia. HDPE 1310m length	130[1]
Supergene Dam	Pit	37 kw Electric Powered 6" dia. Submersible Pump	280mm dia. HDPE 1500m length	50
Supergene Dam	Pit	Diesel Powered 8" dia. Centrifugal Pump	280mm dia. HDPE 1500m length	130[1]
Plum Tree Creek Dam	Pit	75 kw Electric Powered 5" dia. Centrifugal Pump	280mm dia. HDPE 1570m length	80
Plum Tree Creek Dam	Pit	Diesel Powered 8" dia. Centrifugal Pump	280mm dia. HDPE 1570m length	130[1]
Upper Plum Tree Creek Dam	Plum Tree Creek Dam	None Gravity Through Spillway	280mm HDPE 40m Blocked (Seeps Only)	0.5

Source	Destination	Pump	Pipeline	Flow Rate (L/s)
Mt Mawe Dam	Pit	185 kw Electric Powered 8" dia. Centrifugal Pump	280mm dia. HDPE 1510m length	130
Mt Mawe Dam	Pit	37 kw Electric Powered 6" dia. Submersible Pump	280mm dia. HDPE 1510m length	50
Mt Mawe Dam	Pit	Diesel Powered 8" dia. Centrifugal Pump	280mm dia. HDPE 2010m length	130[1]
Mt Hope Dam	Pit	185 kw Electric Powered 8" dia. Centrifugal Pump	280mm dia. HDPE 1430m length	130
Mt Hope Dam	Pit	Diesel Powered 8" dia. Centrifugal Pump	280mm dia. HDPE 1430m length	130[1]
Mt Hope Dam	STD SE Sump	None Gravity Flow	110mm dia. HDPE - 520m length	10 (max)
Mt Hope Extension Dam	MT Hope Dam	Diesel Powered 4" dia. Centrifugal Pump	225mm dia. HDPE 680m length	30[1]
Sumps				
Settlement Dam Sump	Settlement Dam	11 kw Electric Powered 3" dia. Submersible Pump	110mm dia. HDPE - 130m length	Not Determined

Source	Destination	Pump	Pipeline	Flow Rate (L/s)
Settlement Dam Sump	Settlement Dam	1.5 kw Electric Powered 1.75" dia. Submersible Pump	50/110mm dia. HDPE - 130m length	Not Determined
Settlement Dam Sump	Settlement Dam	Diesel Powered 3" dia. Centrifugal Pump	110mm dia. HDPE - 130m length	Not Determined
Supergene Dam Sump	Supergene Dam	11 kw Electric Powered 3" dia. Submersible Pump	110mm dia. HDPE - 160m length	Not Determined
Supergene Dam Sump	Settlement Dam	1.5 kw Electric Powered 1.75" dia. Submersible Pump	110mm dia. HDPE - 370m length	Not Determined
Supergene Dam Sump	Supergene Dam	Diesel Powered 3" dia. Centrifugal Pump	110mm dia. HDPE - 160m length	Not Determined
Raw Water Dam Sump	Pit	2.2 kW Solar Powered 4" dia. Vertical Multi-stage Pump	110/200mm dia. HDPE 1090m length	3
Mt Mawe Dam Sump	Mt Mawe Dam	11 kw Electric Powered 3" dia. Submersible Pump	110mm dia. HDPE - 140m length	Not Determined
Mt Mawe Dam Sump	Mt Mawe Dam	Diesel Powered 4" dia. Centrifugal Pump	110mm dia. HDPE - 140m length	30[1]
STD SW Sump	Pit	37 kw Electric Powered 6" dia. Submersible Pump	280mm dia. HDPE 1330m length	40

Source	Destination	Pump	Pipeline	Flow Rate (L/s)
STD SW Sump	Pit	Diesel Powered 6" dia. Centrifugal Pump	280mm dia. HDPE 1330m length	70[1]
STD SE Sump	STD SW Sump	37 kw Electric Powered 2.75" dia. Centrifugal Pump	150/200/110mm dia. HDPE - 820m length	35
STD W Sump	STD SW Sump	None - Gravity Flow	280/150mm dia. HDPE 490m length	Not Determined
ONTD W Sump	Plum Tree Creek Dam	11 kw Electric Powered 3" dia. Submersible Pump	110mm dia. HDPE - 610m length	Not Determined
ONTD N Sump	Pit	37 kw Electric Powered 6" dia. Submersible Pump	225/280mm dia. HDPE - 1110m length	35
ONTD N Sump	Pit	Diesel Powered 6" dia. Centrifugal Pump	225/280mm dia. HDPE - 1110m length	70[1]
ONTD E Sump	ONTD N Sump	11 kw Electric Powered 3" dia. Submersible Pump	110mm dia. HDPE - 260m length	Not Determined
NNTD E Sump	Plum Tree Creek Dam	37 kw Electric Powered 2.75" dia. Centrifugal Pump	150/280mm dia. HDPE - 1630m length	35
NNTD W Sump	Plum Tree Creek Dam	22 kw Electric Powered 6" dia. Submersible Pump	110/280mm dia. HDPE - 1230m length	30

Source	Destination	Pump	Pipeline	Flow Rate (L/s)
NNTD W Sump	Plum Tree Creek Dam	Diesel Powered 4" dia. Centrifugal Pump	110/280mm dia. HDPE - 1230m length	30[1]
Western Scats Sump	Upper Plum Tree Creek Dam	Diesel Powered 4" dia. Centrifugal Pump	110mm dia. HDPE - 180m length	30[1]

1. Typical flow rate. Diesel pumps have a variable speed drive and the flow rates can be varied.

7. SITE WATER BALANCE

A water balance model of the Mt Leyshon Mine site was developed by GHD Pty Ltd in 2007 (GHD Pty Ltd, 2007). The water balance model was developed using the GoldSim software. GoldSim is a general-purpose computer program for carrying out dynamic, probabilistic simulations of systems and processes. The site water balance model was updated in 2010 with the inclusion of validated catchment runoff parameters, incorporation of bypass facilities and inclusion of a rainfall dependant seepage model (Engeny, 2011).

7.1 Purpose

The water balance model operates on a daily time step and simulates the quantity and quality of water within the water containment dams and seepage sumps at the mine, the residual open cut void, and waterways that have the potential to receive discharges of mine-impacted surface water during large rainfall events. The model aims to provide a basis for:

- Estimation of Design Storage Allowance (DSA) for regulated structures prior to the commencement of the wet season and assess the potential for overflows.
- Estimation of inflows and outflows from storages to critically assess the performance of the water management system at the end of the wet season; Forecasting of the likely future final void water level rise.
- Undertaking operational forecasts of water inventories in mine water storages in response to actual and predicted rainfall events.

Condition (C11-2) of the EA requires the water balance model to be run prior to the wet season and after rainfall events greater than 100 mm within a 24 hour period.

7.2 Model Description

A detailed description of the water balance model setup and functionality is provided in the 2010/11 Wet Season Review – Mt Leyshon Mine (Engeny, 2011). However, the following Sections provide an overview of the model inputs, assumptions and validation. A schematic of the water balance model is provided in Figure 7.1.

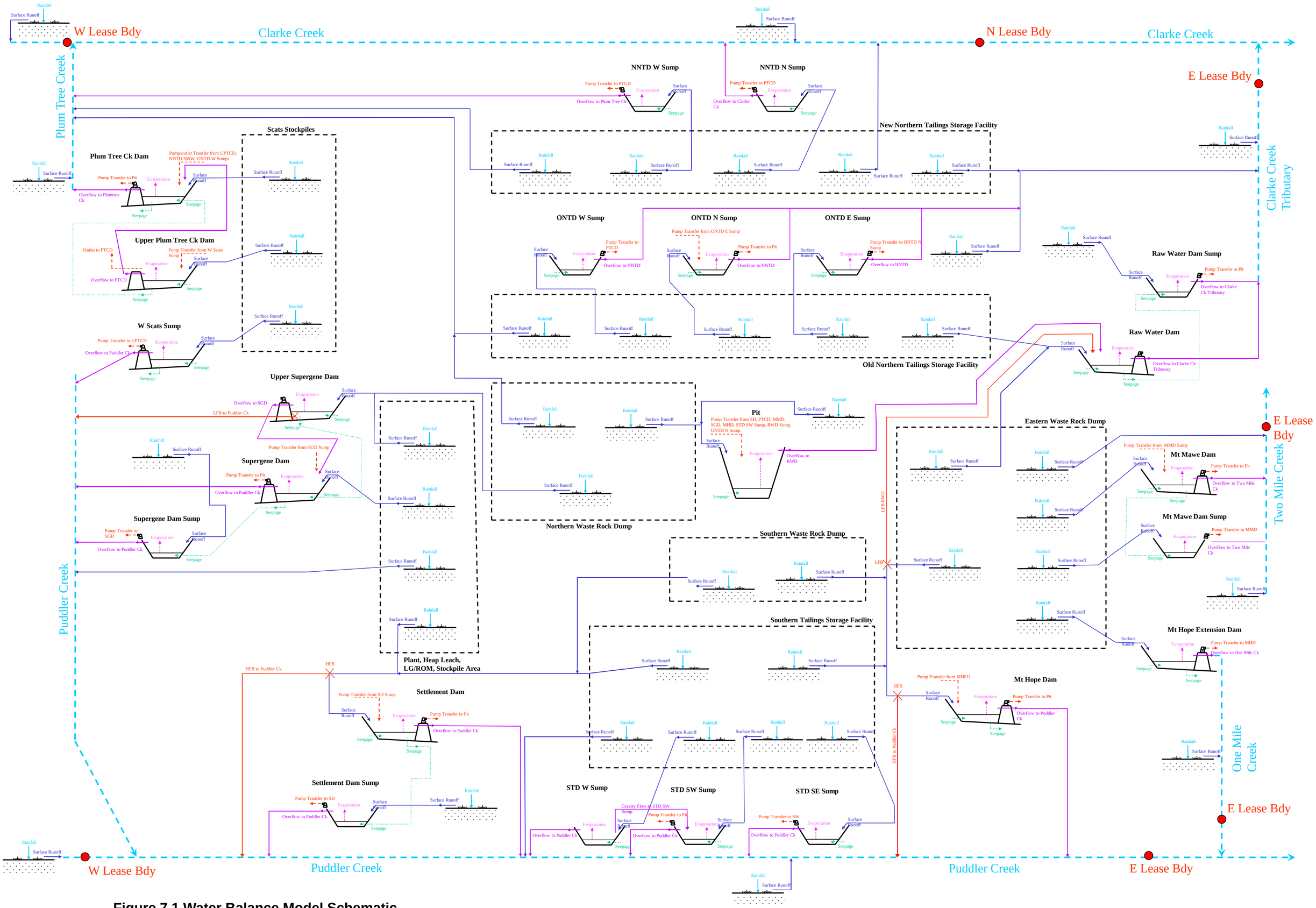


Figure 7.1 Water Balance Model Schematic

7.2.1 Catchment Runoff Model Parameters

The site water balance model calculates rainfall runoff from the following catchment types:

- Ponded areas – 100% runoff.
- Natural areas – AWBM daily rainfall runoff model.
- Disturbed areas – US Dept. of Agriculture Soil Conservation Service daily rainfall runoff model.
- Scats stockpile areas – AWBM daily rainfall runoff model; and,
- Exposed pit walls – US Dept. of Agriculture Soil Conservation Service daily rainfall runoff model.

The catchment runoff models utilised in the site water balance model are described in the 2010/11 Wet Season Review – Mt Leyshon Mine (Engeny, 2011).

7.2.2 High and Low Flow Bypass Facilities

The site water balance model represents the operation of the following high and low flow bypass facilities at the mine:

- Settlement Dam high flow bypass facility.
- Mt Hope Dam high flow bypass facility.
- Low flow bypass facility on top of Eastern Waste Rock Dump; and,
- Low flow bypass facility at Upper Supergene Dam.

The low flow pipes directing to Raw Water Dam at the EWRD low flow bypass facility are modelled as closed to reflect the current operation. Details of how the facilities have been incorporated into the water balance model are described in the 2010/11 Wet Season Review – Mt Leyshon Mine (Engeny, 2011).

7.2.3 Site Seepage Model

A conceptual site seepage model was originally included in the water balance model to facilitate estimation of the following rainfall dependent seepage flows at the mine:

- Seepage inflows from the mine landforms into seepage sumps and water containment dams.
- Rainfall dependent direct seepage inflows to the pit lake.

Review of the pit lake level monitoring data indicates that groundwater inflows to the pit lake from the regional groundwater systems are negligible.

The conceptual site seepage model developed for the Mt Leyshon Mine is described in the 2010/11 Wet Season Review – Mt Leyshon Mine (Engeny, 2011). Modifications to the site seepage model parameters used for the seepage inflows to the pit lake were made in the 2015/16 Wet Season Review – Mt Leyshon Mine (Engeny, 2016b).

The conceptual site seepage model results in an over-prediction of the pit lake level rise in lower rainfall years. The conceptual site seepage model has been replaced with parabolic seepage flow relationships that have been inferred from available pit lake level and seepage pumping flow metering data as shown in Figure 7.2 (seepage flows into dams and sumps) and Figure 7.3 (direct seepage inflows to the pit lake). The seepage flow relationships are based on a rolling 2 year rainfall total which reflects the observed compounding effect of consecutive dryer or wetter years on the site seepage flows.

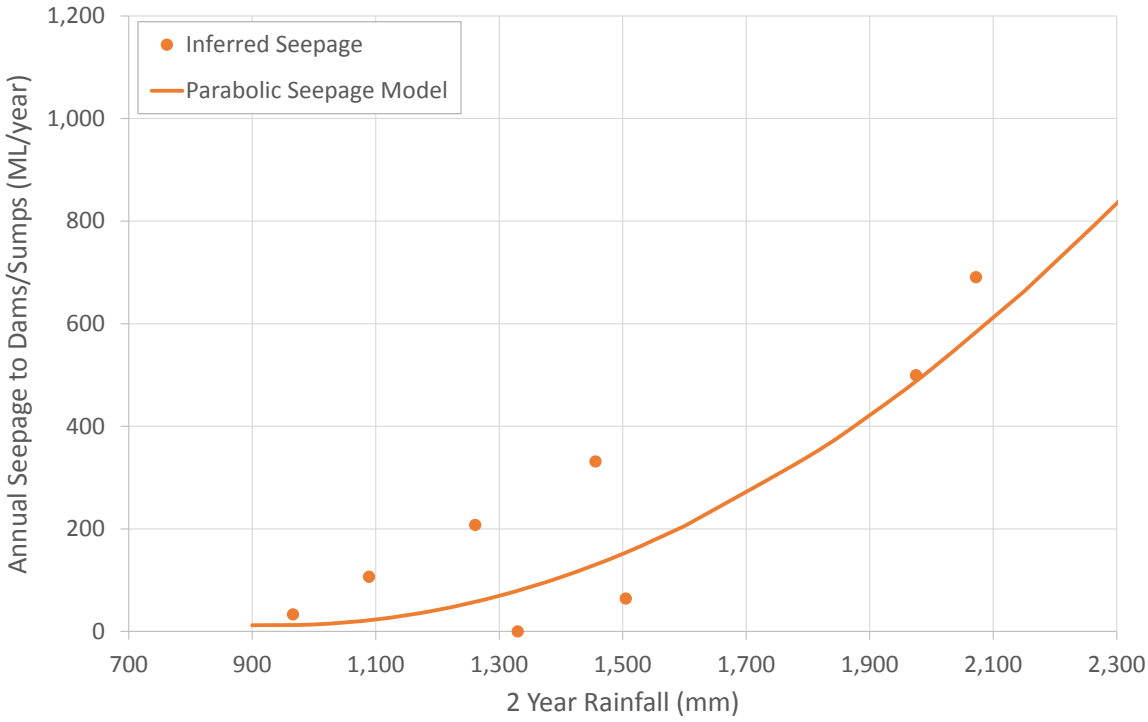


Figure 7.2 Inferred Seepage Flow Model for Seepage Flows Reporting to Dams and Sumps

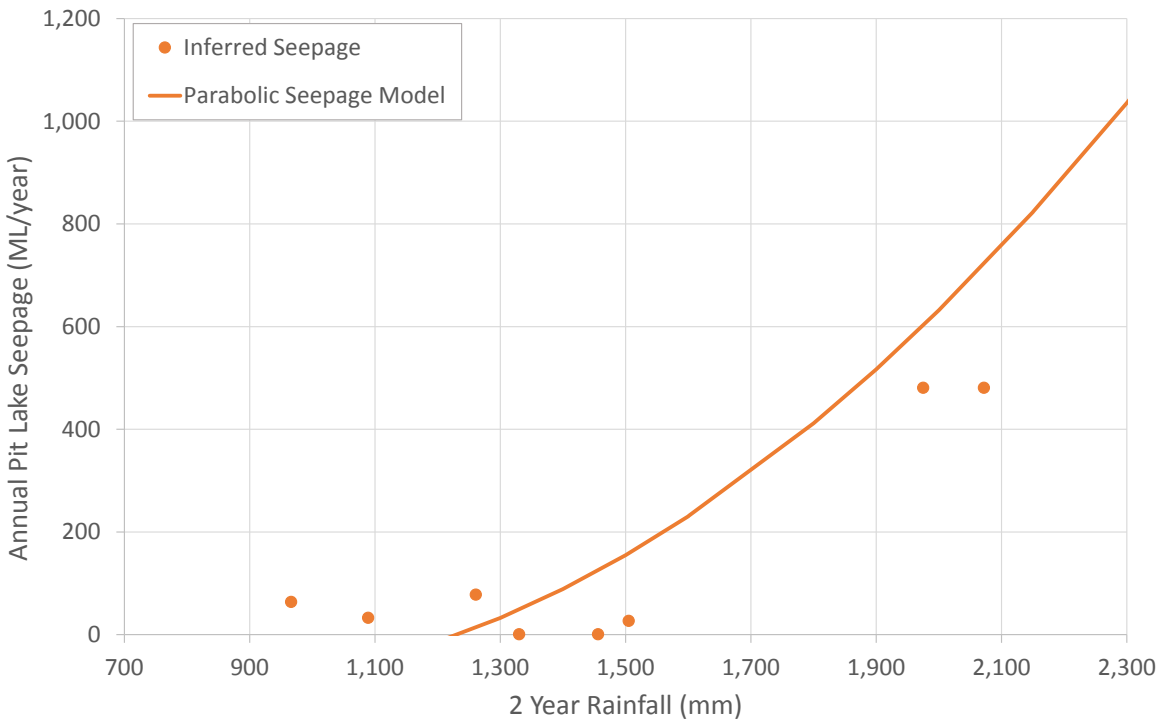


Figure 7.3 Inferred Seepage Flow Model for Direct Seepage Flows to the Pit Lake

7.2.4 Water Storage Characteristics

Storage curves representing level-area and level-volume relationships for the water storage dams were derived from GPS ground survey undertaken by Rowlands Surveys Pty Ltd in April and May 2010. In the absence of ground survey information, photogrammetric survey captured by AAM Pty Ltd in 2010 was adopted. Full Supply Levels (FSL), overflow and seepage destinations for water storage dams and sumps have also been obtained from the same sources.

7.2.5 Internal Water Transfers

Details of internal pumping destinations, logic and nominal pump rates have been adopted based on information supplied by Newmont. Where possible, pump rates have been checked against onsite flow metering.

7.3 Water Balance Model Validation

Validation of the water balance model was undertaken for the historical period 2002 to 2020 (18 years). The predicted rise in the pit lake level is compared to the pit lake level monitoring data in Figure 7.4.

The pit lake level rise predicted by the updated water balance model compares well with the observed pit lake levels during the period 2002 to 2020. The water balance model

validation was also used to derive the site seepage relationships shown in Figure 7.2 and Figure 7.3.

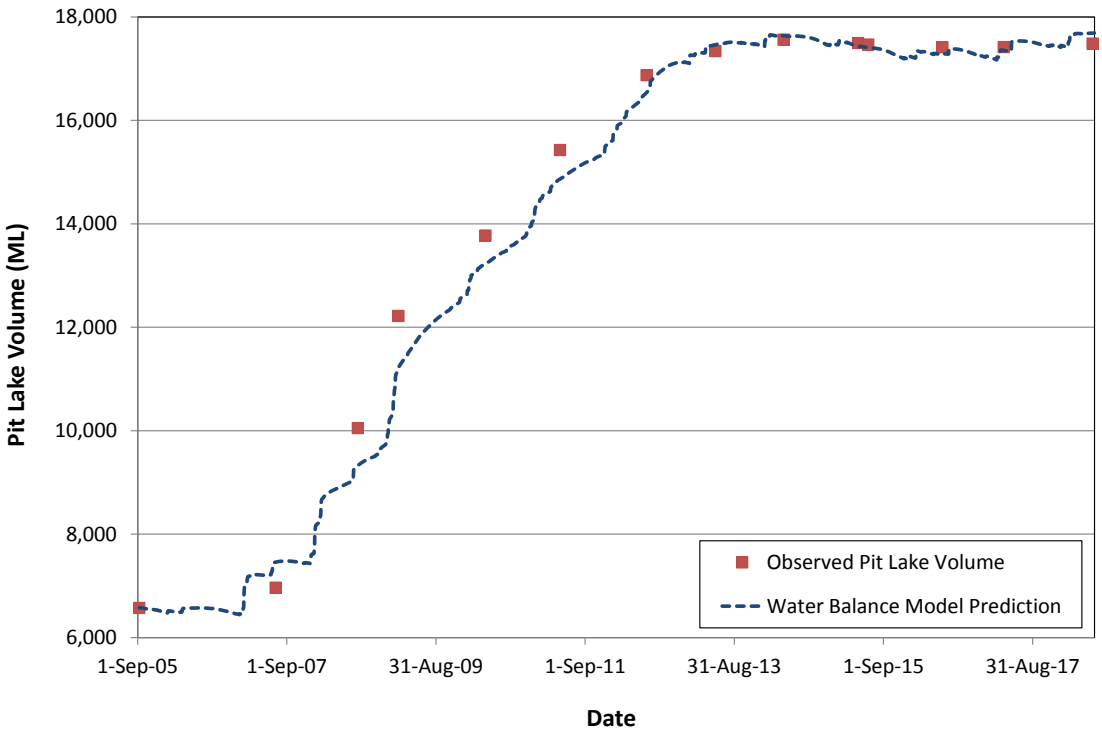


Figure 7.4 Water Balance Model Validation Results – 2005 to 2019

7.4 Water Management System Performance

The site water balance model was utilised to assess the wet season containment capacity of the regulated dams (Engeny, 2016a). The water balance model indicates that provided pumping systems remain operational, all regulated dams are able to contain a 1:20 AEP wet season.

The site water balance model was also used to forecast the likely future rise in the pit lake level assuming that the current water management system at the mine remains the same (i.e. mine affected water continued to be pumped to the pit lake).

Recent groundwater investigations by Schlumberger Water Services have identified the following preliminary values of the minimum elevation at which the pit lake could begin to impact on the adjacent groundwater systems.

- RL 295 m AHD: localised deep fracture zone.
- RL 350 m AHD: deep basement groundwater system; and,
- RL 365 m AHD: regional shallow groundwater system.

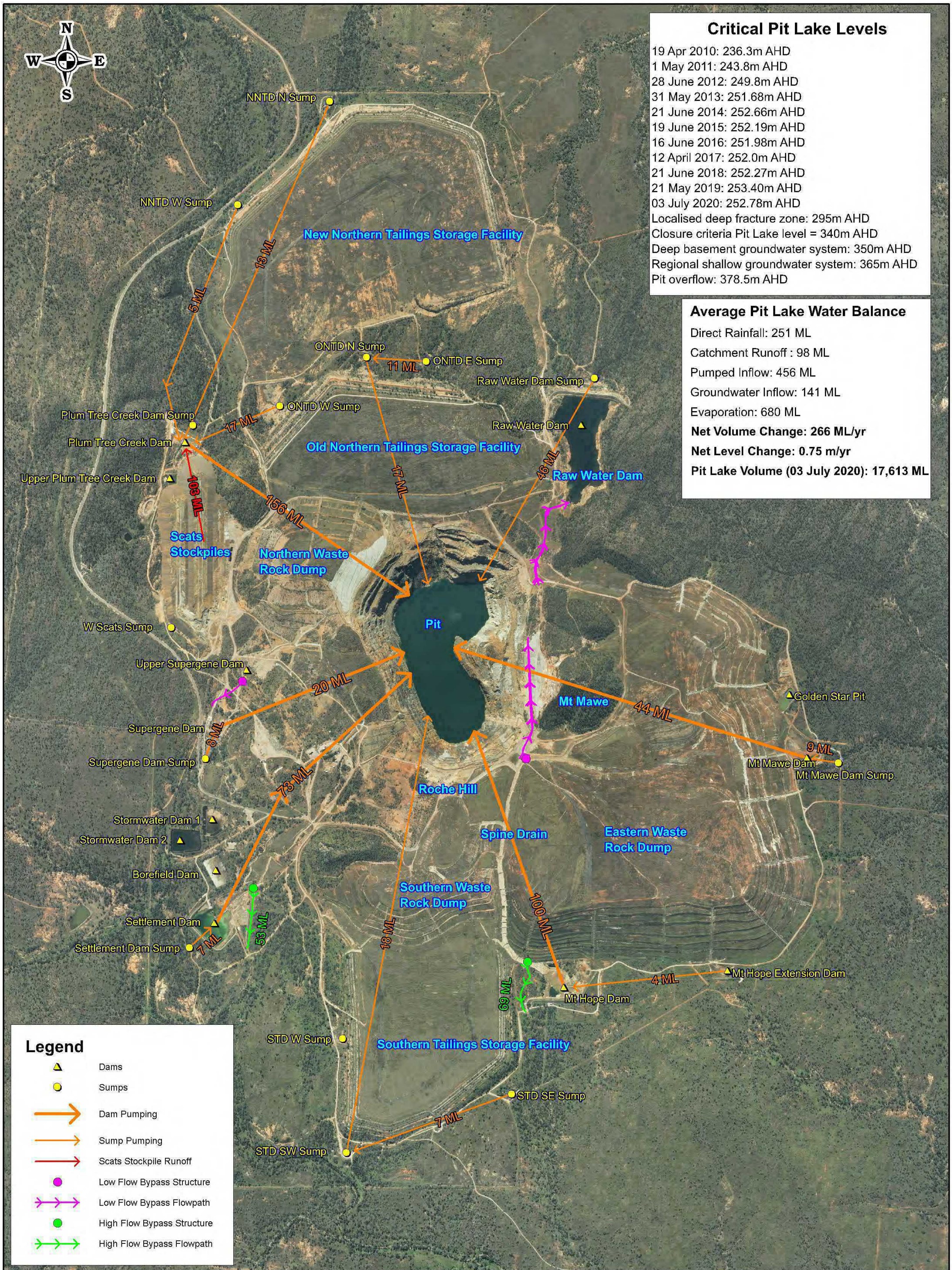
The level at which the pit lake would begin to overflow the pit rim is 378.5 m AHD. Newmont's closure objective is that the pit lake acts a groundwater sink to the shallow groundwater system and therefore the closure criteria is that the pit lake elevation is to remain below RL 340 m AHD. This will require an alternative water disposal strategy for the water containment dams and seepage sumps that currently pump to the pit lake.

The predicted time for the pit lake level to increase from the current level (252 m AHD) to these threshold levels is provided in Table 7.1. A significant amount of time is available before the pit lake will fill to the closure objective of RL 340 m AHD. If the pumping to the pit lake ceases when the pit lake level reaches RL 340 m AHD then the pit lake level is unlikely to ever reach the shallow groundwater system.

The average water balance for the pit lake is summarised in Figure 7.5.

Table 7.1 Predicted Range of Filling Times for the Pit Lake

Pit Lake Level (m AHD)	Minimum Filling Time (years)	Average Filling Time (years)	Maximum Filling Time (years)
295 (localised deep fracture zone)	10	32	63
340 (closure objective for maximum pit lake level)	67	110	146
350 (deep basement groundwater system)	122	148	201
365 (regional shallow groundwater system)	180	238	273
378.5 (pit lake overflow level)	May be exceeded under more extreme rainfall conditions than what is included in the historical climate sequence		



Critical Pit Lake Levels

19 Apr 2010: 236.3m AHD
1 May 2011: 243.8m AHD
28 June 2012: 249.8m AHD
31 May 2013: 251.68m AHD
21 June 2014: 252.66m AHD
19 June 2015: 252.19m AHD
16 June 2016: 251.98m AHD
12 April 2017: 252.0m AHD
21 June 2018: 252.27m AHD
21 May 2019: 253.40m AHD
03 July 2020: 252.78m AHD
Localised deep fracture zone: 295m AHD
Closure criteria Pit Lake level = 340m AHD
Deep basement groundwater system: 350m AHD
Regional shallow groundwater system: 365m AHD
Pit overflow: 378.5m AHD

Average Pit Lake Water Balance

Direct Rainfall: 251 ML
Catchment Runoff : 98 ML
Pumped Inflow: 456 ML
Groundwater Inflow: 141 ML
Evaporation: 680 ML
Net Volume Change: 266 ML/yr
Net Level Change: 0.75 m/yr
Pit Lake Volume (03 July 2020): 17,613 ML

Newmont AUSTRALIA

ENGENY WATER MANAGEMENT

0 300 600
Scale in metres (1:15,000 @ A3)
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

		NEWMONT AUSTRALIA	
DATE	29/09/2020	Mt Leyshon Mine 2019/20 Wet Season Review Average Pit Lake Water Balance	
DRAWN	TH		
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8. EROSION AND SEDIMENT CONTROL PLAN

The majority of the landforms at Mt Leyshon Mine have been capped and revegetated since closure. As a result, there are limited areas with exposed soils and the main mechanism for transport of sediment offsite is erosion within existing drainage structures. The following Sections outline the measures and ongoing operational requirements for erosion and sediment control which have been developed in accordance with the Best Practice Erosion and Sediment Control guidelines (IECA, 2008). This Erosion and Sediment Control Plan is intended to meet the requirements of conditions C12-1 and C12-2 of the Mt Leyshon Mine EA (EPML00863713).

8.1 Principles

The following principles provide the foundation for the Mt Leyshon Mine Erosion and Sediment Control Plan:

- Minimise surface disturbance and restrict access to undisturbed areas.
- Progressively rehabilitate and stabilise disturbed areas with vegetation.
- Separate catchment runoff from disturbed and undisturbed areas where practicable.
- Contaminant sources are adequately managed and maintained to prevent mobilisation.
- Staff are suitably trained to manage sediment control inspections and maintenance.
- Reduce potential for erosion through velocity controls and reduced runoff volume.
- Use of suitably sized and protected drainage structures to manage surface runoff.
- Use of existing onsite containment structures for the capture of sediment laden surface water runoff; and,
- Regular monitoring and maintenance to ensure continual operation of the individual erosion and sediment control elements.

8.2 Erosion and Sediment Control Plan

8.2.1 Performance Criteria

The following performance criteria are required to be met in relation to erosion and sediment control:

- Total suspended solids (TSS) concentrations of surface water discharges from the mine disturbance areas must be lower than 50 mg/L (contaminant release limit in Schedule C Table 2 of the EA).

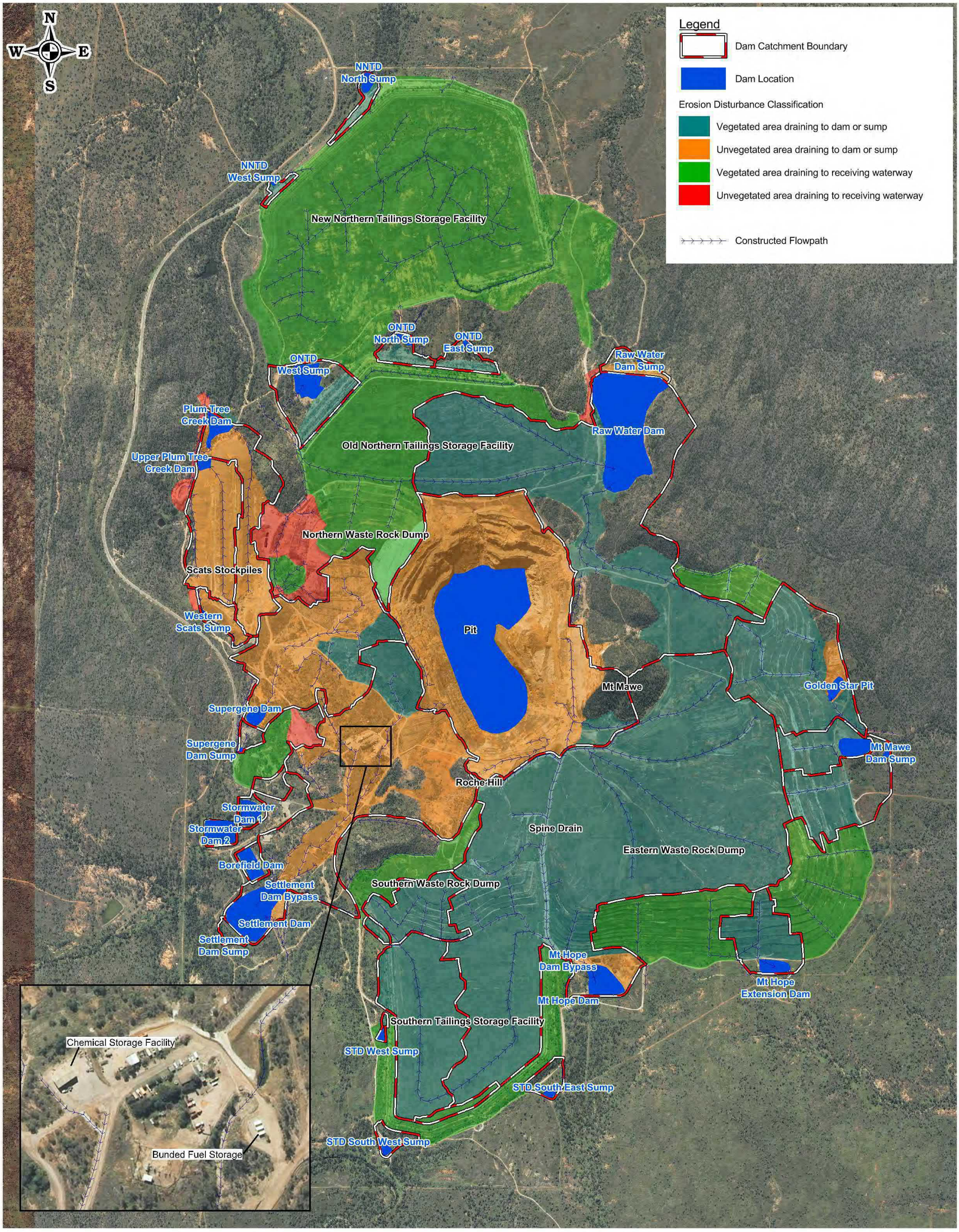
- Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters or cause a material build-up of sediment in such waters (EA Condition C12-3).
- All potential contaminants including fuels and chemicals are stored in suitable in designated storage areas which are bunded or roofed to prevent contaminant mobilisation in the event of spillage (EA Condition C1-2).
- Erosion protection measures and sediment control measures must be implemented and maintained to minimise erosion and the release of sediment and contamination of storm water (EA Conditions C4-7, C12-4).
- The maintenance and cleaning of vehicles and any other equipment or plant must not be carried out in areas from which contaminants can be released into any receiving waters (EA Condition C1-2).

8.2.2 Erosion and Sediment Control Infrastructure

The existing erosion and sediment control infrastructure located at the Mt Leyshon Mine are provided in the Erosion and Sediment Control Plan (Figure 8.1). A summary of the requirements associated with the operation of this infrastructure is provided in Table 8.1.

Table 8.1 Erosion and Sediment Control Infrastructure Elements

Infrastructure Element	Sediment Source	Design Criteria
Sediment Dams	Rehabilitated areas, exposed surfaces and roads	Sediment basins typically design to contain 1:1 AEP 5 day 90th percentile storm volume. However, the existing dams provide a dual function to manage mine affected water with release limited by pumping capacity to the pit.
Sumps	Rehabilitated areas and exposed surfaces	Sumps are provided to manage contaminated shallow seepage from dams and final landforms. Sumps perform a secondary role for minor sediment capture from exposed and rehabilitated surfaces.
Rock Lined Drains	Rehabilitated areas and exposed surfaces	Design to capture and convey all runoff from disturbed surfaces with rock lining and drop structures provided to limit the potential for scour.



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Scale in Kilometres (1:15,000 @ A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

Mount Leyshon Mine
Water Management Plan

Figure 8.1

Erosion and Sediment Control Plan

Job Number: M13000_007
Revision: B
Drawn: JNA
Date: 31 Jan 2014

8.2.3 Erosion and Sediment Control Operational Requirements

The following operational requirements should be provided in conjunction with the existing infrastructure elements to manage erosion and sediment control:

- The extent of disturbance (including trafficable areas) is minimised and identified using barriers and signage.
- A combination of temporary and permanent measures may be necessary for any disturbance associated with new construction and/or rehabilitation works.
- All fuels and chemicals are to remain in designated bunded or roofed areas when not in use.
- Runoff from undisturbed catchments is diverted around the disturbance areas via diversion drains and banks to discharge into natural watercourses, where practicable.
- High flow bypasses are provided where practicable to limit the potential for discharge from water containment structures.
- All erosion and sediment control measures are to remain in place until exposed areas are successfully rehabilitated and stabilised.

8.2.4 Monitoring and Inspection

Monitoring and inspection of erosion and sediment control infrastructure is to be undertaken in accordance with the following requirements:

- Erosion and sediment controls (dams, contour banks, channels and diversions) to be inspected after significant rainfall events.
- Monitoring of surface water discharge quality in accordance with the requirements of the EA.
- Dams and sumps to be inspected at least annually prior to the wet season to ensure the integrity of the system is maintained.
- Rock lining of drains and drop structures to be inspected prior to the wet season to identify the need for any remedial works to repair scour.
- All water containment structures to be inspected annually to assess the need for sediment removal with de-silting required if the reduced storage capacity is expected to reduce the sedimentation performance of the structure.

8.3 Ongoing Requirements

Any future site works that have the potential to generate sediment through exposed surfaces may require additional sediment control infrastructure and operational procedures. These works may include but are not limited to:

- Future and ongoing rehabilitation works that may result in disturbance of existing exposed surfaces or poorly performing areas of rehabilitation.
- Drainage works including modifications to dam spillways, new drainage works, major drainage line repairs or high/low flow bypass construction.
- Decommissioning or construction of a new dam.
- New access road construction; and,
- Disturbance of natural or previously rehabilitated areas through opening of borrow pits for rehabilitation.

Table 8.2 outlines the trigger for the implementation of additional temporary erosion and sediment controls that may be required in the future at Mt Leyshon Mine. Large scale works including major rehabilitation works will require specific erosion and sediment control plans to be prepared as part of the detailed design of these works.

Table 8.2 Requirements for Ongoing Erosion and Sediment Control Works

Works	Design Works Required	Indicative Works Required	Design Life
Rehabilitation Works	Project specific erosion and sediment control plan to be prepared as part of design	• Clean water diversion drains • Sediment basin • Dirty water catchment drains • Rock armouring • Stabilised access roads • Sediment fences	To be implemented and maintained until revegetation is established
Drainage Works	None	• Rock armouring • Sediment fences • Diversion bunds	<6 months
Dam Decommissioning	Project specific erosion and sediment control plan as part of design	• Clean water diversion drains • Sediment basin • Dirty water catchment drains • Rock armouring and check dams • Stabilised access roads • Sediment fences • Topsoil and seeding	To be implemented and maintained until revegetation is established

Works	Design Works Required	Indicative Works Required	Design Life
Road Construction	None	• Sediment fences • Clean water diversion drains • Rock armouring of table drains	<6 months
Borrow Pit Opening	Project specific erosion and sediment control plan as part of design	• Clean water diversion drains • Sediment basin • Dirty water catchment drains • Rock armouring • Stabilised access/haul roads	Permanent

9. WATER MANAGEMENT REQUIREMENTS

9.1 Roles and Responsibilities

The EA holder (Newmont Landco Pty Ltd) is responsible for the operation of the water management system to ensure operations meet the requirements documented in this Plan.

The Site Closure Superintendent is responsible for the day-to-day operation and maintenance of the water management system, while the Regional Sustainability Manager – Systems and Services is responsible for the overall planning and regulatory compliance of the system. Water management responsibilities are summarised in Table 9.1.

Table 9.1 Water Management Responsibilities

Water Management Task	Responsible Person
Operation and maintenance of water management system	Site Closure Superintendent
Monitoring activities	Site Closure Superintendent
Closure planning	Regional Sustainability Manager – Systems and Services
Compliance reporting	Regional Sustainability Manager – Systems and Services
Review and update of water management documentation	Regional Sustainability Manager – Systems and Services

9.2 Water Management Documentation

Documentation relevant to the Mt Leyshon Mine water management system is listed in Table 9.2.

Table 9.2 Water Management Documentation

Document	Relevant EA Conditions
Water Management Plan (this document)	(C10-1), (C10-2)
Erosion and Sediment Control Plan (Section 8 of this document)	(C12-1), (C12-2)
Groundwater Monitoring Program (Big Dog Hydrogeology, 2017)	(C13-1)
Sulphate Management Plan (Big Dog Hydrogeology, 2013b)	(C1-8)
Receiving Environment Monitoring Program (Newmont, 2013b)	(C8-1), (C8-2)
Consequence Category Assessment of Water Storages (Engeny, 2014a)	(H1-1), (H1-2)
Regulated Dams Operational Plan (Engeny, 2016a)	(H3-3)
Emergency Response Plan (Newmont, 2019b)	(A5-1), (A5-2)
Closure Plan (Newmont, 2019a)	(F10-1)(F10-2)

9.3 Reporting Requirements

Water management reporting requirements are summarised in Table 9.3.

Table 9.3 Water Management Reporting Requirements

Reporting Requirement	Relevant EA Conditions	Reporting Frequency	Reporting To
Any emergency or incident which results in the release of contaminants not in accordance, or reasonably expected to be not in accordance with the conditions of the EA	(A6-1), (A6-2)	Within 24 hours of becoming aware of incident	DES
Any monitoring result that indicates an exceedance of any environmental authority limit	(A6-1), (A6-2)	Within 24 hours of becoming aware of incident	DES
Update of monitoring data and associated trigger levels and contaminant limits	(C1-4)	Annual (prior to 6 February)	DES
Development of Sulphate Management Plan	(C1-8)	By 31 October 2013	DES
Notification of exceedance of contaminant release limits	(A6-1), (C2-3)	Within 24 hours of becoming aware of exceedance of contaminant release limits	DES
Investigation into the potential for environmental harm due to exceedance of contaminant release trigger levels	(C2-4)	Within 3 months of exceedance of contaminant release trigger levels	DES
Notification of exceedance of release limits for high flow releases	(A6-1), (C4-3)	Within 24 hours of becoming aware of exceedance of release limits for high flow releases	DES
Investigation into potential for environmental harm in the mixing zone immediately downstream of the high flow bypass release points	(C4-4)	By 30 June 2014	DES
Notification of commencement of release event	(C5-1)	Within 24 hours of commencement of release event	DES
Notification of cessation of release event	(C5-2)	Within 24 hours of cessation of release event	DES
Reporting of release event information	(C5-2)	Within 20 business days after cessation of release event	DES
Investigation into the potential for environmental harm due to exceedance of receiving waters contaminant trigger levels	(C7-2)	Within 3 months of exceedance of receiving	DES

Reporting Requirement	Relevant EA Conditions	Reporting Frequency	Reporting To
		waters contaminant trigger levels	
Notification of exceedance of receiving waters contaminant limits	(A6-1), (C7-3)	Within 24 hours of becoming aware of exceedance of receiving waters contaminant limits	DES
Development of Receiving Environment Monitoring Program	(C8-1), (C8-2)	By 1 November 2013	DES
Report on findings of the Receiving Environment Monitoring Program	(C8-3)	By 1 May 2015 and thereafter every 12 months	DES
Investigation into the potential for environmental harm due to exceedance of stream sediment trigger levels	(C9-2)	Within 4 months of exceedance of stream sediment trigger levels	DES
Notification of exceedance of stream sediment contaminant limits	(A6-1), (C9-3)	Within 24 hours of becoming aware of exceedance of stream sediment contaminant limits	DES
Development of Water Management Plan	(C10-1), (C10-2)	By 30 September 2013	DES
Review of Water Management Plan	(C10-3)	Annually (by 1 November)	DES
Development of Erosion and Sediment Control Plan	(C12-1), (C12-2)	By 28 February 2014	DES
Development of Groundwater Monitoring Program	(C13-1), (C13-2)	By 30 November 2013	DES
Review of Groundwater Monitoring Program	(C13-3)	Annually (by 1 October)	DES
Investigation into the potential for environmental harm due to exceedance of groundwater trigger levels	(C15-2)	Within 3 months of exceedance of groundwater trigger levels	DES
Notification of exceedance of groundwater contaminant limits	(A6-1), (C15-3)	Within 24 hours of becoming aware of exceedance of groundwater contaminant limits	DES
Annual groundwater monitoring report	(C16-1)	Annually (by 1 February)	DES
Assessment of consequence category of dams	(H1-1) to (H1-3)	Prior to design and construction of new dam or prior to any change in dam	DES

Reporting Requirement	Relevant EA Conditions	Reporting Frequency	Reporting To
		purpose or nature of stored contents	
Design Plan for regulated structure	(H2-1) to (H2-5)	Prior to design and construction of new regulated structure	DES
Certification of construction of regulated structure	(H2-6)	Following completion of construction of new regulated structure	DES
System design plan for regulated structure	(H3-2)	Prior to operation of new regulated structure	DES
Notification of exceedance of Mandatory Reporting Level in regulated dams	(H4-3)	Within 48 hours of becoming aware of exceedance of MRL	DES
Annual inspection of regulated structures by suitably qualified and experienced person	(H6-1) to (H6-3)	Annually (prior to 1 November)	Newmont
Recommendations from the annual inspection report and any action being taken in response to those recommendations	(H6-4)	Within 20 business days of receipt of annual inspection report from inspecting engineer	DES
Provision of copy of annual inspection report for regulated structures	(H6-4)	Within 10 business days of receipt of request from DEHP	DES
Register of Regulated Dams	(H9-6)	Annually (with annual return)	DES

9.4 Monitoring Requirements

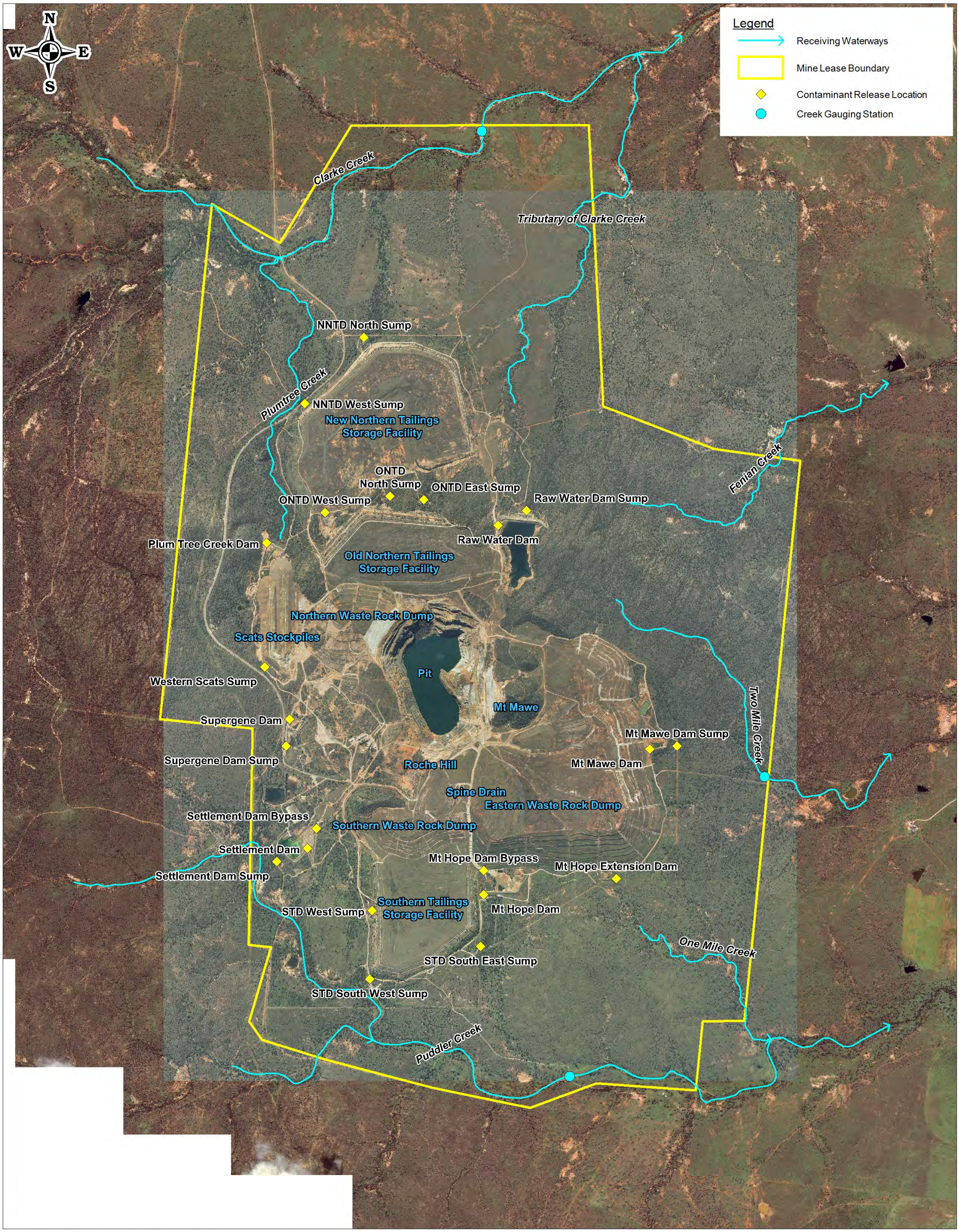
9.4.1 Regulatory Monitoring Requirements

Water management regulatory monitoring requirements are summarised in Table 9.4.

Table 9.4 Water Management Regulatory Monitoring Requirements

Type of Monitoring	Monitoring Locations	Parameters Monitored	Monitoring Frequency	Monitoring Limits
Contaminant release water quality (Condition C2-2)	Schedule C Table 1 (refer Figure 9.1)	Schedule C Table 2	Daily during release (Schedule C Table 1)	Schedule C Table 2
Contaminant release quantity (Condition C4-2)	Schedule C Table 1 (refer Figure 9.1)	Daily quantity of contaminants released	Daily	N/A
Stream flows downstream of release points (Condition C3-1)	Schedule C Table 3 (refer Figure 9.1)	Stream flow rate	Continuous	Stream flow rate greater than 20 times release flow rate (Condition C4-1)
High flow bypass water quality (Condition C4-3)	Mt Hope Dam Bypass and Settlement Dam Bypass (Schedule C Table 1) (refer Figure 9.1)	Schedule C Table 2	Daily during release (Schedule C Table 1)	Schedule C Table 4
Onsite water storage water quality (Condition C6-1)	Schedule C Table 5 (refer Figure 9.3)	Schedule C Table 6	Annually (Schedule C Table 5)	Schedule C Table 6
Receiving water quality (Condition C7-1)	Schedule C Table 7 (refer Figure 9.2)	Schedule C Table 9 (receiving water contaminant trigger levels) Schedule C Table 10 (receiving water contaminant limits)	Event based sampling of release or flow events (Schedule C Tables 9 and 10)	Schedule C Table 9 (receiving water contaminant trigger levels) Schedule C Table 10 (receiving water contaminant limits)
Monitoring in accordance with the REMP (Conditions C8-1 and C8-2)	As per REMP	As per REMP	As per REMP	As per REMP
Stream sediment quality (Condition C9-1)	Schedule C Table 8 (refer Figure 9.4)	Schedule C Table 11	Annual (end of wet season) (Condition C9-1)	Schedule C Table 11
Groundwater quality (Condition C15-1)	Schedule C Table 12 (refer Figure 9.5)	Schedule C Table 13	Quarterly – background and compliance bores Annually – interpretation bores	Schedule C Table 13

Type of Monitoring	Monitoring Locations	Parameters Monitored	Monitoring Frequency	Monitoring Limits
			(Schedule C Table12)	
Groundwater level (Condition C15-1)	Schedule C Table 12 (refer Figure 9.5)	Groundwater level	Quarterly (Schedule C Table12)	N/A



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Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994. (GDA94)
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

Mount Leyshon Mine
Water Management Plan

Figure 9.1

Contaminant Release Locations & Gauging Stations

Job Number: M13000_007
Revision: A
Drawn: JNA
Date: 20 Sept 2013

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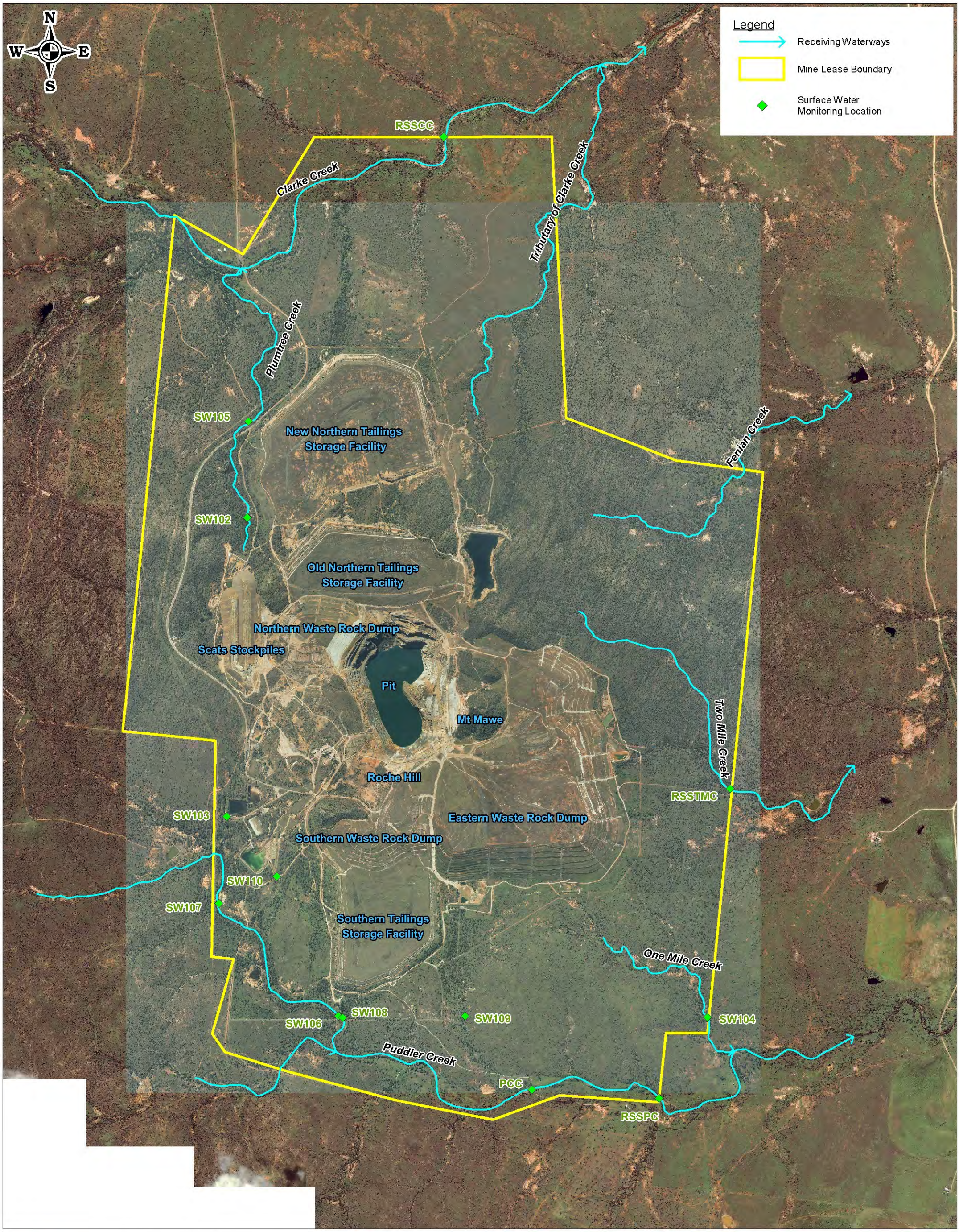

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Figure 9.2

Table 7
Surface Water Monitoring Locations

Job Number: M13000_011
Revision: 1
Drawn: AJ
Date: 20 Oct 2015

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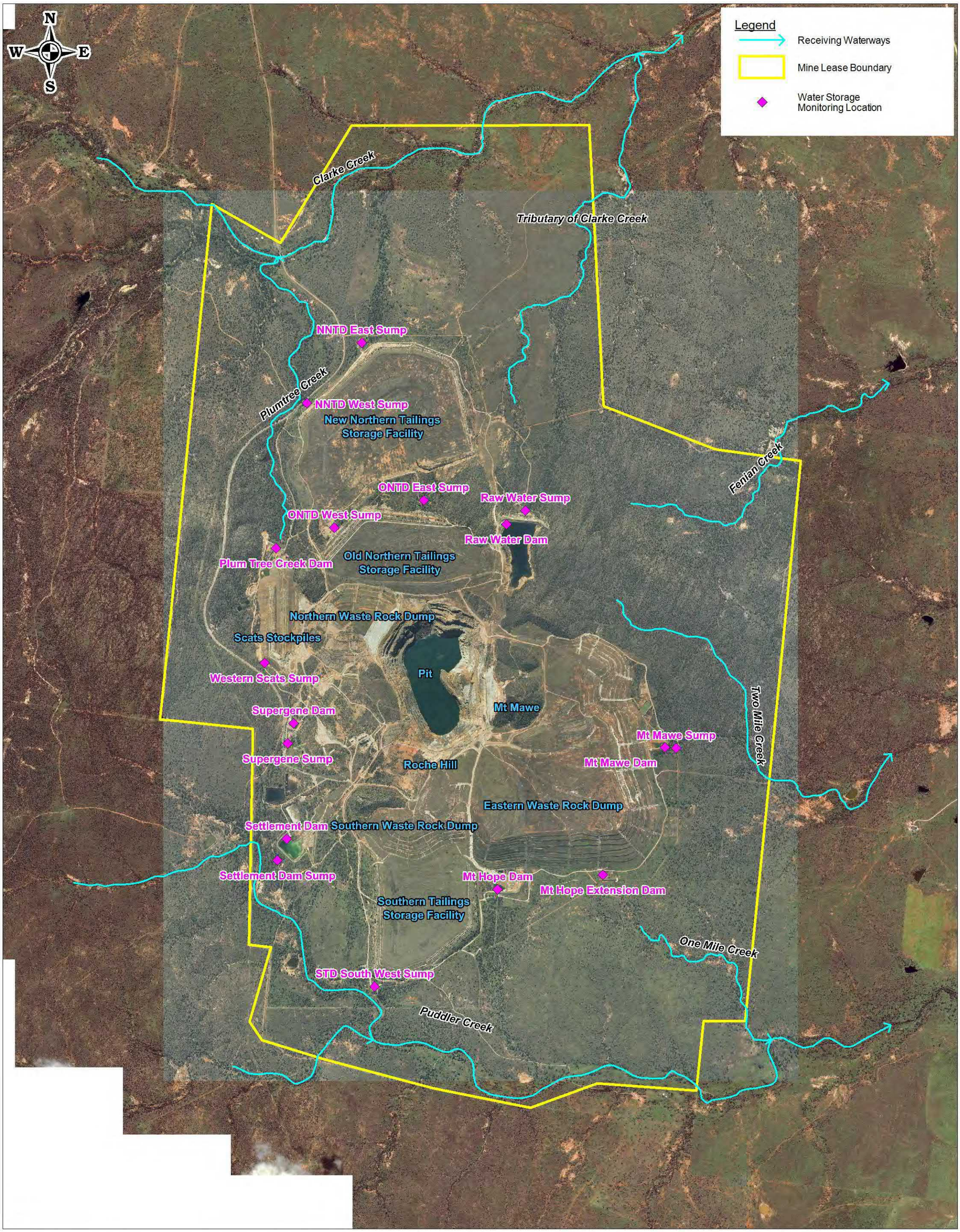

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Figure 9.3

Water Storage Monitoring Locations

Job Number: M13000_007
Revision: A
Drawn: JNA
Date: 20 Sept 2013

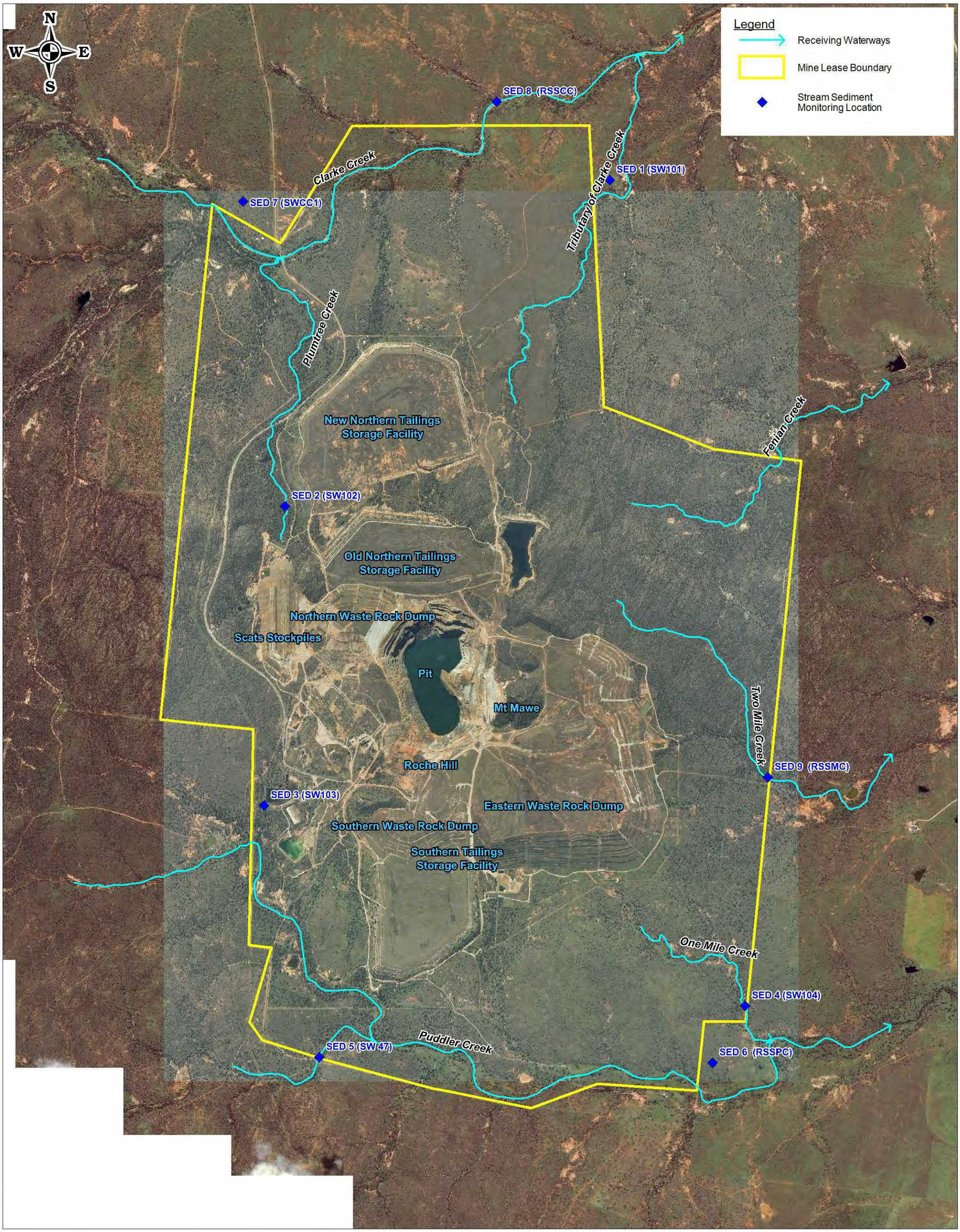

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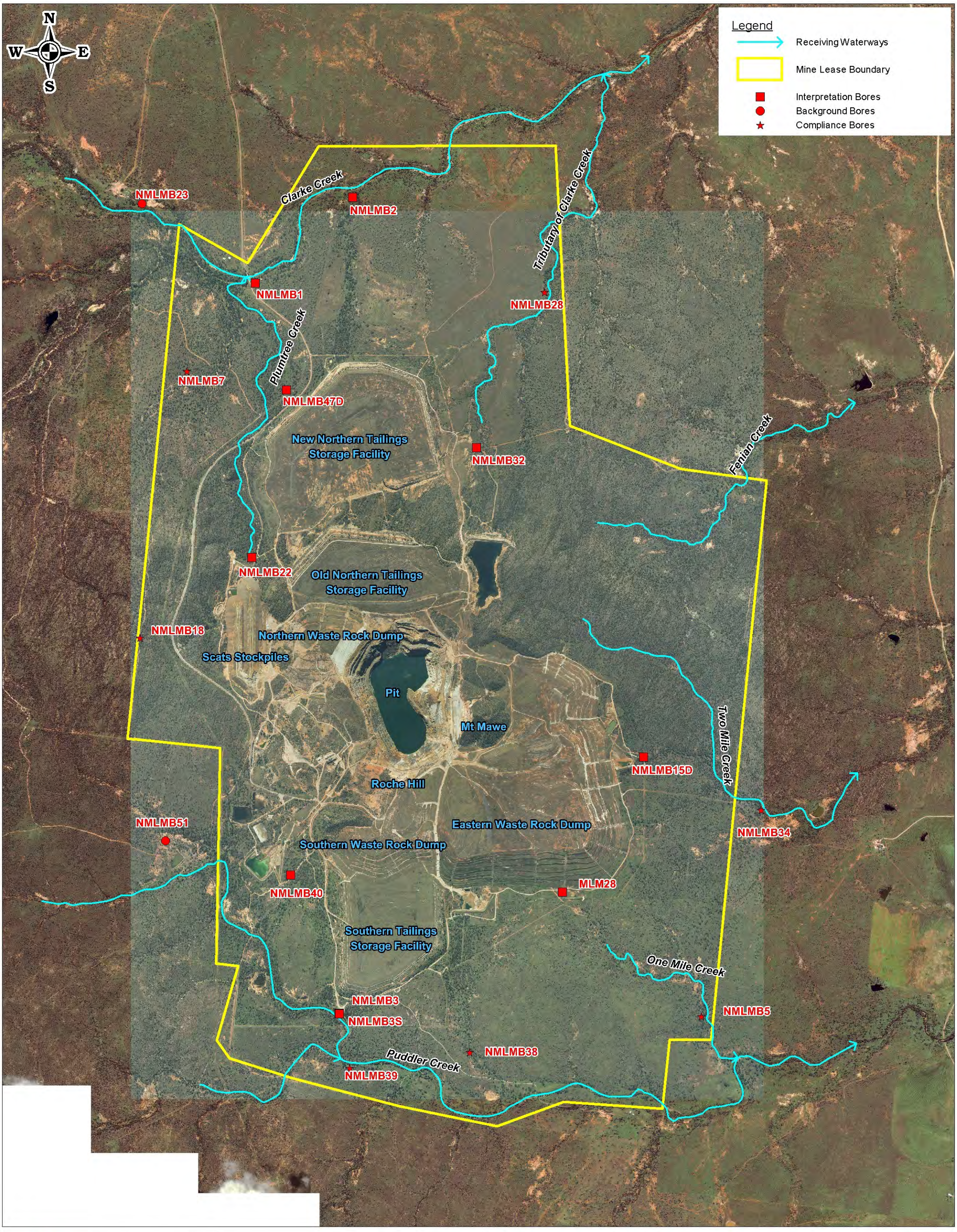
Figure 9.4

Table 8
Stream Sediment Monitoring Locations

Job Number: M13000_007
Revision: 1
Drawn: RJM
Date: 12 Sept 2014



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Mount Leyshon Mine
Water Management Plan

Figure 9.5

Table 12
Groundwater Monitoring Locations

Job Number: M13000_011
Revision: 1
Drawn: AJ
Date: 20 Oct 2015

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A Receiving Environment Monitoring Program (REMP) has been developed (Newmont, 2013b) and implemented to monitor and record the effects of the release of contaminants on the receiving environment with the aim of identifying and describing the extent of any adverse impacts on local environmental values and to monitor any changes in the receiving water (including groundwater). The REMP will lead to the development of site-specific impact-based water quality limits. The REMP identifies the locations, methods and frequency of monitoring of stream flows, physical and chemical parameters, toxicants, and biological monitoring indicators.

9.4.2 Strategic Monitoring

A range of additional strategic monitoring (additional to compliance monitoring requirements) activities are undertaken at the Mt Leyshon Mine to:

- Provide an improved understanding of the surface water and groundwater regimes within and down-gradient of the mine lease.
- Assess the performance of the water management system and identify areas for improvements in the water management system or to inform on-going site rehabilitation works.
- Provide real-time monitoring data to assist with operation of dams, sumps and pumping systems.
- Identify the nature and extent of discharges of mine affected water down-gradient of the mine lease such that downstream water users can be notified.

Strategic Surface Water Monitoring

An automated water monitoring network was installed at the Mt Leyshon Mine by Greenspan Technical Services. The majority of the monitoring instrumentation was installed during the 2008/09 wet season and a monitoring station was subsequently installed in the pit between June and October 2009.

The monitoring network consists of seventeen different sites and includes:

- A weather station (was already operating prior to the establishment of the automated monitoring network).
- Water level and water quality monitoring stations at five creek sites (three on-lease sites and two downstream off-lease sites).
- Water level and water quality monitoring stations at the Settlement Dam and Mt Hope Dam high flow bypass facilities.
- Water level sensors and flow meters on pumps at five water containment dams.

- Water level sensors in three groundwater monitoring bores.
- Water level and water quality monitoring probe within the residual mine pit (currently out of service).

Each separate monitoring site is solar powered, contains a data logger, and is equipped with mobile phone telemetry that sends the monitoring data back to an internet-based data server.

The locations of the on-lease and off-lease monitoring stations are shown in Figure 9.6 and Figure 9.7 respectively. Photographs of the monitoring systems are provided in Appendix H.

Newmont has subsequently installed battery-operated flow meters on the majority of the seepage sump pumping systems. These meters provide a measure of the volume of seepage water that accumulates and is pumped out of the seepage sumps.

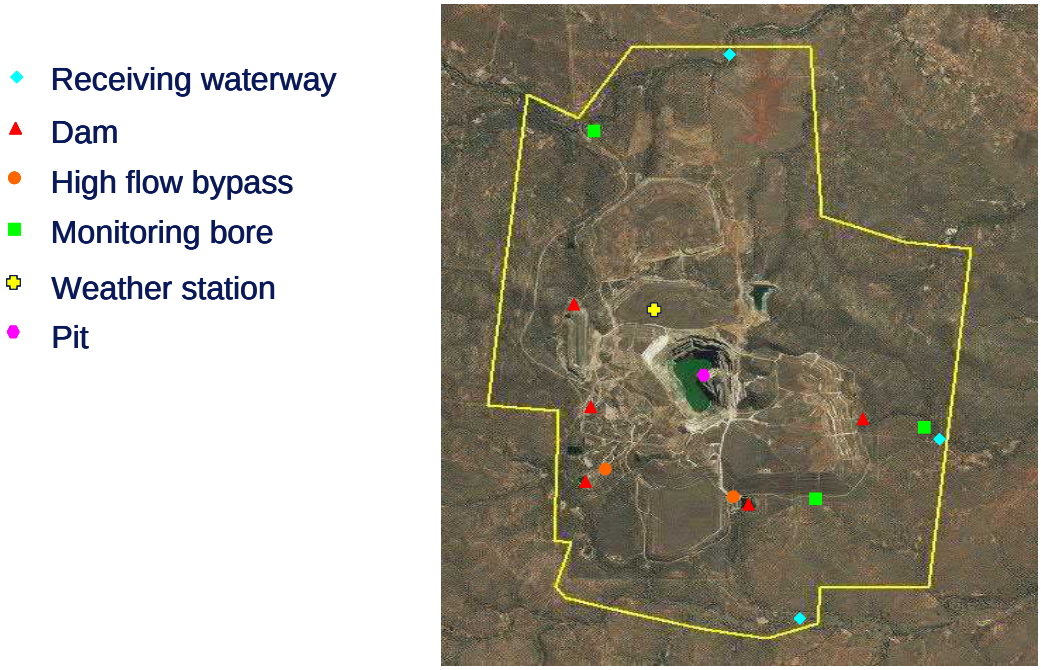

Figure 9.6 Location of On-lease Automated Surface Water Monitoring Stations (from GHD, 2011)

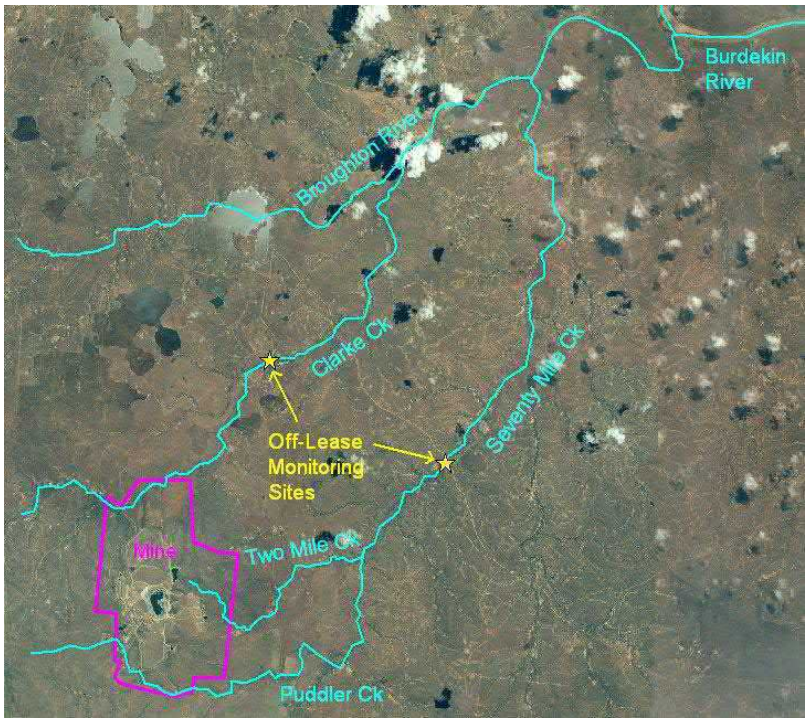

Figure 9.7 Location of Off-lease Automated Surface Water Monitoring Stations (from GHD, 2011)

Strategic Groundwater Monitoring

Strategic groundwater monitoring installations for the Mt Leyshon Mine include:

- 15 inner array and regional array monitoring bores (some of these are compliance monitoring locations).
- 19 pastoral bores and wells.
- 58 shallow monitoring bores that were installed between 2009 and 2011; and,
- 10 deep investigation holes to depths up to 300 m with vibrating wire piezometers installed at different depths (46 individual VWP).

Based on an assessment of the potential pathways for migration of environmental harm, the following monitoring is recommended for the shallow groundwater system in the Mt Leyshon Groundwater Management Plan (Big Dog Hydrogeology, 2017):

- Annual sampling of two bores indicated to be hydraulically up-gradient of the site to define background groundwater chemistry.
- Annual sampling of nine bores which are close to the mine facilities and within the known zone of impacted groundwater for interpretation purposes. Sampling of these bores is intended to define any changes in the influence of seepage from the mine facilities.

- Annual sampling of eight bores which are located immediately outside the zone of impacted groundwater for compliance purposes. Results will identify any future migration of the impacted groundwater and confirm that the predictions from the numerical groundwater flow model remain valid.

- Measuring depth to groundwater in all 74 available monitoring bores twice per year, in order to identify any localised increase in groundwater elevations near the mine facilities, and to provide early warning of when regional groundwater elevations are higher, in response to seasonal conditions, which increases the risk of groundwater discharge to the surface water environment.

The primary interaction for the deep groundwater system is with the lake in the open pit, and the risk of environmental harm associated with the deep groundwater system is assessed to be very low. Monitoring which is recommended for the deep groundwater system is continuous monitoring of the 46 installed VWP sensors. Responses in these sensors will identify the interactions between the pit lake and the deep basement groundwater system as the elevation of the pit lake increases. (Big Dog Hydrogeology, 2017)

10. EMERGENCY AND CONTINGENCY PLANNING

Contingency planning for an emergency is required under EA condition (A5-1). The Mt Leyshon Emergency Response Plan (Newmont, 2019b) describes the activities that will be initiated at the mine in the event of any emergency. A table of emergency contacts and the order in which they should be contacted in case of any emergency conditions associated with the water management system is shown in Table 10.1.

Table 10.1 List of Emergency Contacts

Emergency Contact	Priority
Site Closure Superintendent	1
Site Senior Executive (SSE)	2
Regional Sustainability Manager – Systems and Services	3
Dam Certifying Engineer via Regional Sustainability Manager – Systems and Services	4
DES via Regional Sustainability Manager – Systems and Services	5

The following Emergency Response Plans have been developed to assist the Newmont in planning for specific incidents. These procedures are to be referred to regularly as preventative measures and also in cases of events occurring which impact on the normal operation of the site water management systems.

10.1.1 High Intensity Rainfall Events

Table 10.2 Emergency Response Plan for High Intensity Rainfall Events

High Intensity Rainfall Emergency Response Plan	
Policy	To limit the potential for environmental impacts within the Mt Leyshon Mine receiving waters as a result of contaminated overflows from onsite water containment structures. Due to exceedance of rainfall characteristics (intensity and duration) that exceed the performance characteristics of water management infrastructure.
Objectives	To take the necessary precautionary measures to manage infrastructure and related activities to prevent environmental harm caused by high (intensity and duration) rainfall events. All operation, maintenance and monitoring of water management infrastructure is to be undertaken in accordance with this Water Management Plan.

High Intensity Rainfall Emergency Response Plan	
Controls	Operation of dams at low levels to provide sufficient DSA prior to the commencement of the wet season. High flow and low flow diversions to limit the volume of contaminated water reporting to water containment structures. Wet weather access is maintained to pump infrastructure for starting of diesel pumps, delivery of fuel, repairs and inspections. Electrical pumps are maintained and functioning correctly, and standby diesel pumps have sufficient fuel supply to ensure continued operation.
Monitoring	The Site Closure Superintendent is responsible for regular inspections and routine maintenance of water management infrastructure. Inspections to be undertaken after high rainfall events to ensure there are no visible signs of erosion or damage to infrastructure.
Corrective Action	All corrective actions will be managed through site inspection procedures. All incidents and corrective actions resulting from audits and inspections are to be recorded.

10.1.2 Failure of Containment Structures

Table 10.3 Emergency Response Plan for Failure of Containment Structures

Failure of Containment Structures Emergency Response Plan	
Policy	To limit the potential for environmental impacts within the Mt Leyshon Mine receiving waters as a result of containment structure failure.
Objectives	To take the necessary precautionary measures to manage infrastructure and related activities to prevent environmental harm caused by failure of a containment structure. All operation, maintenance and monitoring of water management infrastructure is to be undertaken in accordance with this Water Management Plan.
Controls	Dams are provided with a suitable spillway capacity to prevent overtopping of the embankment. Regulated dams are inspected annually prior to the wet season to identify any geotechnical issues that could lead to potential failure. Dams are operated at low levels as much as possible to limit the volume that could be released in the event of dam failure.

Failure of Containment Structures Emergency Response Plan	
Monitoring	Routine (monthly) and annual inspections of regulated structures. Inspection of dam embankment following any spillway discharge to assess potential erosion impacts.
Corrective Action	All corrective actions will be managed through site inspection procedures. All incidents and corrective actions resulting from audits and inspections are to be recorded.

10.1.3 Power Loss Management

Table 10.4 Emergency Response Plan for Power Loss Management

Power Loss Management Emergency Response Plan	
Policy	To limit the potential for environmental impacts within the Mt Leyshon Mine receiving waters due to overflows or discharge due to power failure.
Objectives	To take the necessary precautionary measures to manage infrastructure and related activities to prevent environmental harm caused by power loss. All operation, maintenance and monitoring of water management infrastructure is to be undertaken in accordance with this Water Management Plan.
Controls	Routine servicing of electrical equipment, and backup diesel pumps and control infrastructure.
Monitoring	Regular inspections of electric pumps and electrical reticulation infrastructure. Monitoring of water metering data to ensure electric pumps are operating correctly.
Corrective Action	All corrective actions will be managed through site inspection procedures. All incidents and corrective actions resulting from audits and inspections are to be recorded.

10.1.4 Inability to Obtain Critical Equipment and Spare Parts

Table 10.5 Emergency Response Plan for Inability to Obtain Critical Equipment and Spare Parts

Inability to Obtain Critical Equipment and Spare Parts Emergency Response Plan	
Policy	To limit the potential for environmental impacts within the Mt Leyshon Mine receiving waters due to lack of critical equipment or spare parts in the event of breakdown or failure of water management infrastructure.

Inability to Obtain Critical Equipment and Spare Parts Emergency Response Plan	
Objectives	To take the necessary precautionary measures to manage infrastructure and related activities to prevent environmental harm due to water management system failure and inability for immediate repair. All operation, maintenance and monitoring of water management infrastructure is to be undertaken in accordance with this Water Management Plan.
Controls	Available inventory of infrastructure consumables onsite for immediate replacement. Routine servicing of equipment to limit the potential for breakdown or failure. Identification of suitable local suppliers for the purchase of spare parts or hiring of critical equipment. Standby diesel pumps are operable with sufficient fuel supplies in the event of electric pump component failure.
Monitoring	Regular inspections of all water management infrastructure (pumps, pipelines, values, bypass structures) Monitoring of water metering data to ensure electric pumps are operating correctly.
Corrective Action	All corrective actions will be managed through site inspection procedures. All incidents and corrective actions resulting from audits and inspections are to be recorded.

10.1.5 Inability to Access Critical Control and Monitoring Points in all Weather Conditions

Table 10.6 Emergency Response Plan for Inability to Access Critical Control and Monitoring Points in all Weather Conditions

Inability to Access Critical Control and Monitoring Points Emergency Response Plan	
Policy	To limit the potential for environmental impacts within the Mt Leyshon Mine receiving waters due to lack of access to pumps and monitoring locations.
Objectives	To take the necessary precautionary ensure monitoring and control equipment is maintained and operable to prevent system failure or inability to monitor and report potential impacts. All operation, maintenance and monitoring of water management infrastructure is to be undertaken in accordance with this Water Management Plan.
Controls	Routine grading of access roads to critical control sites and monitoring infrastructure. All weather access roads with adequate levels of flood immunity to allow access. Use of solar powered monitoring equipment including regular servicing and calibration. Arrangements in place for emergency helicopter access to the site
Monitoring	Annual monitoring and calibration of monitoring equipment. Inspection of control equipment and access roads prior to commencement of the wet season.

Inability to Access Critical Control and Monitoring Points Emergency Response Plan	
Corrective Action	All corrective actions will be managed through site inspection procedures. All incidents and corrective actions resulting from audits and inspections are to be recorded.

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12. QUALIFICATIONS

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APPENDIX A

Photographs Landforms

Landforms Looking North (Southern Tailings Dam in Foreground)

Final Void Looking North

Scats Stockpiles

APPENDIX B

Photographs Constructed Drainage Channels

Spine Drain

Spine Drain

Inflow drain to Settlement Drain

Drain on Roche Hill

Drop structure on Roche Hill

Diversion of drop structure above Mt Mawe Dam

Wallaby Tail Hill diversion channel

Golden Star Pit diversion channel around Mt Mawe Dam

Plum Tree Creek Dam external catchment diversion channel

Southern Tailings Storage Facility Diversion

Diversion bund around eastern side of Mt Hope Extension Dam

Diversion drain around western side of Mt Hope Extension Dam

Flood protection levee around STD SW Sump

APPENDIX C

Photographs High Flow Bypass Facilities

Settlement Dam high flow bypass facility

Settlement Dam high flow bypass facility

Settlement Dam high flow bypass facility

Mt Hope Dam high flow bypass facility

Mt Hope Dam high flow bypass facility

Mt Hope Dam high flow bypass facility

Mt Hope Dam high flow bypass facility

APPENDIX D

Photographs Low Flow Bypass Facilities

Eastern Waste Rock Dump low flow bypass facility

Eastern Waste Rock Dump low flow bypass facility

Eastern Waste Rock Dump low flow bypass facility

Supergene Stormwater Dam low flow bypass facility

Supergene Stormwater Dam low flow bypass facility

Supergene Stormwater Dam low flow bypass facility

APPENDIX E

Photographs Dams

Settlement Dam

Settlement Dam

Supergene Dam

Supergene Dam

Upper Supergene Dam

Upper Supergene Dam

Plum Tree Creek Dam

Plum Tree Creek Dam

Upper Plum Tree Creek Dam

Upper Plum Tree Creek Dam

Raw Water Dam

Raw Water Dam

Mt Mawe Dam

Mt Mawe Dam

Mt Hope Extension Dam

Mt Hope Extension Dam

Mt Hope Dam

Mt Hope Dam

Stormwater Dam No. 1

Stormwater Dam No. 2

Borefield Dam

APPENDIX F

Photographs Seepage Sumps

Settlement Dam Sump

Supergene Dam Sump

Plum Tree Creek Dam Sump

Raw Water Dam Sump

Mt Mawe Dam Sump

STD SW Sump

STD SE Sump

STD W Sump

ONTD W Sump

ONTD N Sump

ONTD E Sump

NNTD W Sump

NNTD N Sump

Western Scats Sump

Golden Star Pit

APPENDIX G

Photographs Water Transfer Systems

Settlement Dam electric pump

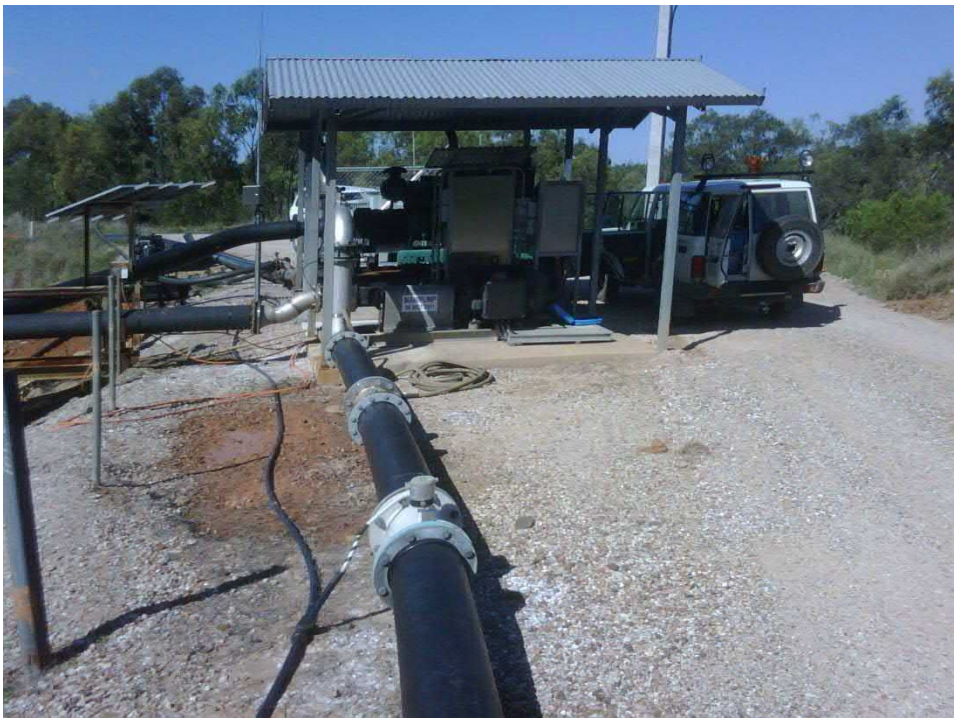
Settlement Dam diesel pump

Supergene Dam electric pump (submersible pump)

Supergene Dam diesel pump

Plum Tree Creek Dam electric pump

Plum Tree Creek Dam diesel pump

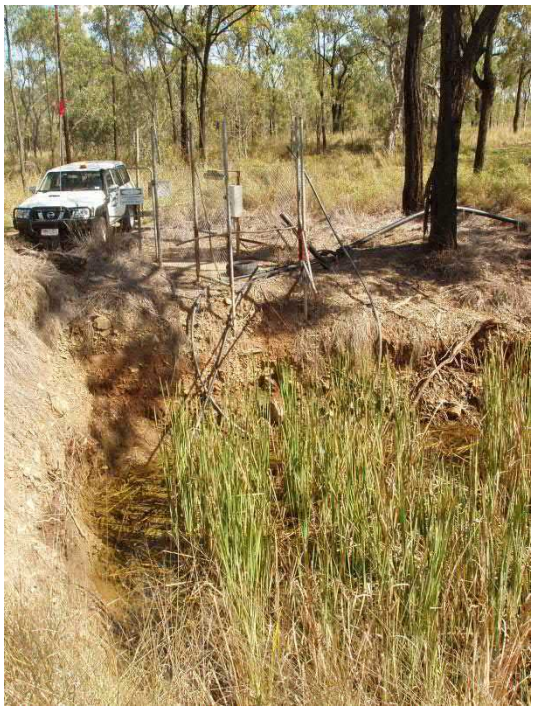


Mt Mawe Dam electric pump

Mt Mawe Dam diesel pump

Mt Hope Extension Dam diesel pump

Mt Hope Dam electric and diesel pumps



Settlement Dam Sump electric pump (submersible pump)

Supergene Stormwater Dam Sump electric pump (submersible pump)

Raw Water Dam Solar Pump

Mt Mawe Dam Sump diesel pump

STD SW Sump electric pump (submersible pump)

STD SE Sump electric pump

ONTD W Sump electric pump (submersible pump)

ONTD N Sump electric pump

ONTD E Sump electric pump (submersible pump)

NNTD W Sump electric pump

NNTD N Sump electric pump

Western Scats Sump diesel pump

APPENDIX H

Photographs Monitoring Systems

Automatic weather station

Automatic weather station – tipping bucket rain gauge

On-lease receiving waterway automatic monitoring station – Clarke Creek

On-lease receiving waterway automatic monitoring station – Clarke Creek

Automatic sampler unit

Automatic sampler unit

Settlement Dam high flow bypass automatic monitoring station

Mt Hope Dam high flow bypass automatic monitoring station

Typical dam automatic monitoring station

Typical dam automatic monitoring station – flow meter on pump discharge pipeline

Typical monitoring bore automatic monitoring station

Off-lease receiving waterway automatic monitoring station – Seventy Mile Creek

Off-lease receiving waterway automatic monitoring station – Seventy Mile Creek

Appendix C:
Environmental Management Overview Strategy

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Mount Leyshon Gold Mine

October 1993

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5. Hydraulic calculations for runoff control banks

6. Standard Operating Procedures

7. Baseline surface water quality survey

8. Design and operation of the Runoff Control Scheme

1. INTRODUCTION

In accordance with the Environmental Management Policy for Mining, this Environmental Management Overview Strategy (EMOS) has been prepared for Mt Leyshon Gold Mine, and has been written to comply with guidelines presented in the Preparation Guide for Environmental Management Planning Documents (DME 1991). This EMOS addresses environmental issues and strategies to life-of-mine, currently considered as 2004 (including two years for decommissioning and site clean-up). A summary of the principal components of the Environmental Management Overview Strategy is shown in Table 12. These principal components provide the basis for auditing Plans of Operation against the EMOS.

Many references are made in this EMOS to other documentation. This documentation is either listed in the bibliography or included as an Appendix. Documents listed in the bibliography have either already been submitted to the DME, or are available on request.

2. PROJECT DESCRIPTION

Mt Leyshon Gold Mine, operated by Mt Leyshon Gold Mines Ltd (MLGM), is a producer of gold, silver and copper. The mine is situated approximately 24 km south of Charters Towers. Figure 1 shows the general location of the mine. Figure 2 shows site layout and current lease boundaries. Not shown on this plan, but included under this EMOS are four additional leases; ML 1385, ML 1398, ML 1545 and ML 1488. These leases, known as the Sunburst tenements, are located in Charters Towers and are used exclusively for exploration. They are described in full in the current Plan of Operations (MLGM 1991).

Table 1 summarises the activities carried out on these leases. Mining activities are described in detail in the current Plan of Operations, and in an amendment to this plan dealing with the processing of supergene ore (MLGM 1992). A summary is presented below.

Operations at Mt Leyshon Gold Mine commenced in September 1986, with mining of the Mt Leyshon ore body and heap leaching of oxide ore. Carbon-in-pulp processing of primary ore began in January 1989, at a nominal throughput of 2.0 Mtpa. Primary ore throughput was increased in stages to reach the current rate of 4.0 Mtpa. The processing of oxide ore was completed in 1992 as availability diminished. Processing of supergene ore began in August 1992 at the rate of 0.5 Mtpa, using a two stage heap leach process. During 1993, CIP throughput will be increased to 5 Mtpa.

Under resolution at the time of writing was a proposal to amalgamate all current leases at Mt Leyshon Gold Mine and an additional area under a new title, namely ML 10144. The boundaries of this proposed lease are shown in Figure 3. The additional area is required for new tailings and waste dump areas, and will provide a buffer between mining activities and other land uses. Mining Lease ML 10144 will provide for the entire land requirements of the operation to closure.

Table 1. Summary of Mt Leyshon Gold Mine leases covered by this EMOS.

Tenement	Area (ha)	Landowners(s)	Activities carried out on lease
Mt Leyshon mine			
ML 1288	106.0	D.S., P.K., M.L.G.M., J.B., C.H.	Mining, stockpiling
ML 1289	108.0	P.K., J.B.	Reserves, waste disposal
ML 1341	2.0	P.K.	Mining
ML 1469	14.6	J.B., C.H.	Reserves, waste disposal
ML 1482	74.5	P.K.	Environmental buffer, waste disposal
ML 1484	8.4	D.S., P.K., M.L.G.M., M.L.G.M., C.H.	Tailings disposal
ML 1533	137.9		Tailings disposal, waste disposal, plant and heap leach
ML 1534	113.2	P.K.	Water storage, tailings disposed
ML 1535	109.0	J.B.	Tailings and waste disposal
ML 1536	126.8	J.B.	Tailings and waste disposal
ML 1582	2.2	P.K.	Water storage, tailings disposal
ML 1583	4.8	M.L.G.M., J.B., C.H.	Mining, stockpiling
ML 1630	3.0	J.B., C.H.	Waste disposal
ML 1738	86.9	D.S, M.L.G.M., P.K.	Tailings and waste disposal
ML 10031	3.9	P.K.	Tailings disposal
ML 10034	2.9	P.K., J.B.	Satellite reserves
ML 10035	1.1	J.B.	Satellite reserves
ML 10148	36.0	J.B.	Environmental buffer
Total	941.3		
Sunburst leases			
ML 1385	0.97	Many	Exploration only
ML1398	128.6	Many	Exploration only
ML1545	31.2	Many	Exploration only
ML1488	42.8	Many	Exploration only
Total	203.6		

Landowner key:

J.B. = John Brownson
C.H. = Charles Hughes
D.S. = Dalrymple Shire (road reserves)
P.K. = Phillip Knuth
MLGM = Mount Leyshon Gold Mine

3. STATUTORY AND LEGAL REQUIREMENTS

3.1 Statutory requirements

The principal statutory requirements relating to environmental management at the mine are those invoked under the Mineral Resources Act, the Water Resources Act, the Contaminated Lands Act and the Clean Waters Act.

Special Lease Conditions for the Mt Leyshon Gold Mine leases (Table 1) are shown in Appendix 1 (no EIS exists for the mine, hence there are no EIS related commitments). The granting of ML 10144 will result in the replacement of all current lease conditions with a new set of conditions.

Water Resources Commission dam licence conditions are shown in Appendix 2. These conditions, detailing monitoring, inspection and reporting requirements, are specifically referred to in Sections 4 and 6.

Under application to the Department of Environment and Heritage at the time of writing is a licence to discharge, required for the operation of the site runoff control scheme (Section 4.3.3).

Compliance with the Contaminated Lands Act is discussed in Section 4.

All activities on Mt Leyshon Gold Mine leases will be conducted in accordance with statutory requirements. Compliance with these requirements will reviewed annually.

3.2 Compensation agreements

The landowners of the area covered by the mine leases are listed in Table 1. Compensation agreements exist with John Brownson, Charles Hughes and Phillip Knuth. As these agreements are

confidential, they have not been reproduced in full in this EMOS. The only environmentally related conditions contained in these agreements are (1) "satisfactory rehabilitation of the Mining Lease Land in accordance with the Acts (Mining Act and Mineral Resources Act) and the Queensland Department of Primary Industry", (2) "the landowner will be consulted regarding the particular requirements for grasses and revegetation of disturbed areas" and (3) "removal of Parthenium weed and rubber vine at the time of surrender".

There are no conditions in any of the compensation agreements that specify post-mining land capability or productivity targets. The agreements state that either:
(1) the compensation payable "shall be received and acknowledged by the landowner in full satisfaction of all claims of compensation, in respect of the Mining Lease Land and in full satisfaction of all claims for compensation which the landowner has or may have, whether under the provisions of the Acts or otherwise."
(2) the compensation payable includes compensation for "diminution of the value of the land", "diminution of the use made or which may be made of the land", "actual damage caused to the land by reason of activities of the Company permitted under the terms of the mining lease" and "any loss of profits to the Landowner that might arise as the result of the Mining Lease".

An agreement has been reached between Knuth and MLGM that allows for the transfer to the company of all the area now owned by Knuth that will be included within the boundaries of ML 10144 (Figure 3). This transfer includes the area covered by the existing compensation agreement with Knuth. At the time of writing, the agreement was being processed by the Department of Lands.

All activities on Mt Leyshon Gold Mine leases will be conducted in accordance with compensation agreements. Compliance with these requirements will reviewed annually.

4. ENVIRONMENTAL IMPACTS AND CONTROL

4.1 Introduction

The impact of mining on the environment at Mt Leyshon can be defined in terms of changes in the following.

- Land resources.
- Water resources.
- Noise.
- Air quality.
- Conservation values.
- Heritage and cultural values.
- Social values.

Within this section, each of these issues is examined with regard to potential sources of impact, acceptable levels of impact, and proposed control strategies.

4.2 Land Resources

4.2.1 Description of the resource

Mt Leyshon Gold Mine comprises 17 mining leases, covering a total area of 941.3 ha. Figure 2 shows the surface contours and principal features of the mine area. The soils are typically stony and shallow, the dominant type being red/yellow duplex soils. Areas of sandy alluvium are found associated with waterways. The soils are non-saline and nutritionally limiting. Undisturbed areas at the mine support open eucalypt woodland and grassland. There are no permanent watercourses on or near the mine area. The area has experienced mining activity since 1871.

4.2.2 Impacts of mining

4.2.2.1 Introduction

The long term impact of mining on the land resources can be defined principally in terms of changes in land use capability and chemical contamination. The most appropriate method of land capability assessment is that presented by Rosser *et al.* (1974), summarised in Appendix 3. The Contaminated Land Act provides a method of classifying land with regard to chemical contamination.

4.2.2.2 Land capability

(1) Pre-mining capability

There was no detailed survey of land capability before mine development, however, it was estimated that land capability classifications for the area covered by the Mt Leyshon Gold Mine leases fell mainly into Classes VI, VII and VIII. The principal factors considered limiting to pastoral development were shallow low nutrient soils with considerable areas of rockiness and stoniness, steep topography in places, lack of a groundwater resource, and lack of permanent surface water (AGC Woodward-Clyde 1990). These ratings indicate that most of the site was unsuitable for cultivation, and that some areas were well suited for pastoral use but others possessed sufficiently severe limitations to make any agricultural use inappropriate.

A pre-mining land capability survey for areas to be affected by mining (scale 1:25000) will be conducted by 1994. A variation to the EMOS will be produced if the land capability estimates shown in Table 2 are significantly in error.

In the region surrounding the mine, severe gully and rill erosion is a very common feature of the landscape, due to the widespread

overgrazing of pasture. Overgrazing in the region is largely the result of the great temporal variation in summer rainfall, and hence variation in site productivity.

(2) Post-mining land capability

Figure 3 shows the approximate boundary within which major disturbance due to mining activities will be confined (excluding roads, drill pads and other minor disturbances). Any major disturbance beyond these boundaries will be preceded by an approved variation to the EMOS.

The primary priorities for rehabilitation of disturbed land at Mt Leyshon Gold Mine are the control of acid mine drainage, and the establishment of stable post-mining landforms. A return to agricultural capability is seen as a secondary priority, for the following reasons: the relatively small area involved; the low capability of the site pre-mining; the potential for damage to the integrity of rehabilitation works by erosion resulting from overgrazing; the absence of any condition in any of the compensation agreements that specify post-mining land capability or productivity targets, and the provision in the compensation agreements for any reduction in land capability (as explained in Section 3.2). The benefit to the community of mining operations at Mt Leyshon Gold Mine is considered to outweigh any cost resulting from a decline in land capability.

The targeted changes in land capability are discussed below. The capability criteria for the nominated classes are presented as proposed by Rosser *et al* (1974), eg. Class VIIIe8m5d4 refers to a Class VIII site on which: under grazing, water erosion losses are in excess of the acceptable level (e8), moisture availability is too unreliable to allow cropping (m5), and effective soil depth lies between 25 to 45 cm (d4). A full key to the capability criteria is given in Appendix 3.

ste dumps and tailings dams. Following rehabilitation of vaste dump and tailings dam areas, the potential high cost of pairing erosion damage to rehabilitation works precludes both ropping and grazing on these areas. Other less critical mitations to land capability are unreliable moisture content or cropping) and limited soil depth (currently a nominal 30 m). The appropriate land use classification according to Rosser *al* (1974) is therefore Class VIIIe8m5d4.

y borrow pits. The mine has already demonstrated successful stablishment of pasture species on over 50 ha of borrow pits. e prescriptions described in Section 4.2.3.3 and 4.2.3.4 will ield a land capability classification of Class VId6m5r3.

water dam. The raw water dam will be retained as a aluable resource for the district. The main potential uses for s dam will be stock watering or irrigation.

p leach pads. Following removal of heap leach dead ore and lastic liner from the heap leach pads, the prescriptions cribed in Section 4.2.3.3 and 4.2.3.4 will yield a land apability classification of Class VI5m5r5. The oxide waste sent as a bed beneath the pads will provide an adequate growth ia once cultivated and fertilised, being non-acid producing. alinity or sodicity is not expected to be too severe for pasture cies as there is no evidence of widespread leakage through the iners.

unoff dams. The runoff control dams will be breached, cleaned any hazardous material and rehabilitated to the same apability as other general disturbed areas on site. The rescriptions described in Section 4.2.3.3 and 4.2.3.4 will yield and capability classification of Class VId6m5r3.

i and surrounds. Rehabilitation of the pit and immediate irrounds will entail the removal of all plant, and the

implementation of measures to prevent the entry of stock or accidental entry of persons (Section 4.2.3.7). Use of the land capability classification is not very appropriate in this case, however, given the extreme topography and lack of a growth medium, a classification of Class VIIIt8d6 can be given.

Miscellaneous disturbance. On other disturbed areas on the site, such as haul roads and plant areas, land use limitations will be similar to those that existed prior to disturbance by mining (limited water availability, shallow soils, rockiness). The prescriptions described in Section 4.2.3.3 and 4.2.3.4 will yield a land capability classification of Class VId6m5r3.

These target land capability changes are summarised in Table 2. Also shown in Table 2 are pre- and post-mining land uses (the landuse category of fauna habitat is a general one, and includes for example the provision of a food source for the macropods that are commonly seen in the locality).

Table 2 does not allow a direct comparison of pre- and post-mining land capability class areas. The information required for this comparison will not be available until the pre-mining capability study is conducted (described above). Such a tabulated comparison will be supplied as a variation to the EMOS by June 1994.

Land will be accepted as suitable for the nominated landuse when (a) the land capability classes shown in Table 2 have been achieved and (b) the nominated land use will not be impaired by any chemical contamination. Capability criteria for the determination of post-mine capability will be mapped at a scale of 1:10000. The criteria to be used will be taken from Rosser *et al.* (1974), and will include, but not be inclusive to, pH, salinity, slope percentage, gravel content, depth of rooting zone and soil texture.

Table 2. Proposed impacts on land resources

Type of disturbance	Max. area to be disturbed[1] (Ha.)	Land capability classification[2]		Land use	
		Pre-mining	Post-mining (targeted)	Pre-mining	Post-mining
Waste dumps	270	VI (<30 %) to VIII	VIIIe8m5d4	Woodland, light grazing	fauna habitat
Tailings dams	197	"	VIIIe8m5d4	"	fauna habitat
Clay borrow pits	72	"	VId6m5r3	"	woodland, light grazing
Raw water dam	27	"	VI[3]	"	water storage
Runoff dams	5	"	VId6m5r3	"	woodland, light grazing
Plant areas	7	"	VId6m5r3	"	"
Haul roads and tracks	5	"	VId6m5r3	"	"
Heap leach pads	27	"	VI5m5r5	"	"
Pit and surrounds	50	"	VIIIt8d6	"	non-use
Life-of mine total	670				

1. Total projected life-of-mine.

2. After Rosser *et al.* (1974).

3. Stock water use.

Any change in area of greater than 15 % to the post-mine land capability classes shown in Table 2 will be preceded by a variation to the EMOS.

4.2.2.3 Land contamination

The investigation threshold criteria shown in Table 3 will be used as triggers to determine if specific responses regarding waste disposal are required in the EMOS or in a variation to the EMOS. Investigations will be initiated if levels of available contaminants listed in Table 3 are exceeded.

Under the Contaminated Land Act, land may be classified as a "confirmed" site if there exists a level of contamination that represents a health or environmental hazard. The application of this Act to mining land is currently under review. The mine will meet any relevant obligations under the Act. At the time of writing, this requires that no "confirmed sites" as will remain on lease areas at lease surrender, unless otherwise agreed to by the Department of Environment and Heritage.

An inventory of contaminated land for the site will be established by the end of 1993 (a hazardous materials register is already maintained on-site).

Compliance requirements with regard to the Contaminated Land Act will be reviewed by the end of 1994 (following amendments to this Act and the Mineral resources Act in 1993/94).

Achievement of these objectives will be dependent on:
(a) the successful implementation of appropriate rehabilitation strategies for disturbed areas (Section 4.2.3),
(b) the successful implementation of measures to control the risk of chemical contamination (Section 4.3.3).

Table 3. Investigation threshold criteria for contaminated land*

Parameter	Investigation threshold criteria (available)
Salinity	1 mS/cm
WAD cyanide	0.2 ppm
pH	<5.0 (1:5)
% S	0.5 %
Copper	15 ppm
Zinc	15 ppm

* the level above which specific investigation of disposal requirements will be conducted.

4.2.3 Control strategies

4.2.3.1 Introduction

Land will be considered successfully rehabilitated when undertakings relating to the following issues are achieved:

- control of acid mine drainage (Section 4.2.3.2),
- establishment of stable post-mining land forms on disturbed areas (Section 4.2.3.3),
- establishment of stable and productive vegetation associations on rehabilitated areas (Section 4.2.3.4),
- removal of plant infrastructure (Section 4.2.3.5),
- control of loss of contaminants (cyanides and salts) from the tailings dams (Sections 4.2.3.6 and 4.3.3),

- control of access to the pit (Section 4.2.3.7).

An additional objective of site rehabilitation strategies is progressive rehabilitation:
(1) Disturbed areas will generally be rehabilitated within 2 years of becoming available. The schedule of rehabilitation will be nominated in each Plan of Operations. In some cases, it may be inefficient to rehabilitate areas within two years, most likely due to materials scheduling considerations. In these cases, the area will be nominated as reserved in the relevant Plan of Operations and the reason for this designation identified. At the time of writing, less than 15 ha of waste dump area had not been rehabilitated (recontoured and sealed), i.e., there was no significant backlog of waste dump rehabilitation.
(2) The rehabilitation backlog will be maintained to within the limit allowed by lease conditions.

The chosen rehabilitation strategies are discussed in the following Sections.

4.2.3.2 Control of acid mine drainage

Description of the issue

Much of the primary waste rock at the mine contains significant levels of sulphides. Following oxidisation of these sulphides, acid conditions are generated, which may be followed by the production of acid mine drainage. This drainage typically shows elevated levels of various metals. Tailings wastes may also be potentially acid forming. In contrast, the oxide wastes, including spent heap leach dead ore, contain very low levels of sulphides and metals, do not produce significant acid, and can be used as growth media or seal materials.

All materials with a sulphur content exceeding 0.5 % will be treated as potentially acid producing. This criteria will be reviewed following the completion of the AMD research programme (described below).

All potentially acid forming materials at the mine will be rehabilitated in such a manner that:
(1) the products of acid mine drainage do not result in significant impairment of downstream water quality, according to the target water quality criteria given in Table 8.
(2) the products of acid mine drainage do not prevent the successful revegetation of rehabilitated areas according to the criteria for revegetation success presented in Section 4.2.3.4.
(2) these objectives are achieved predominantly by means of passive control measures that avoid the requirement for long-term active management.

The current rehabilitation strategy for the primary waste dumps and any other acid producing waste is based on the accepted practice of sealing sulphidic material with a compacted layer to minimise the entry of water and oxygen, and is summarised as follows:

(1) whenever available, placement of oxide waste over primary waste to a depth of several metres (this is not a critical component of the strategy, sealing with a compacted layer being the principal method of controlling oxidation rate),
(2) reprofiling to approximately 14 degrees,
(3) application of a 30 cm compacted heap leach layer,
(4) application of 30 cm of growth media (described in Section 4.2.3.4),
(5) installation of erosion control structures,
(6) revegetation.

Washed heap leach is used as a seal due to its low permeability when compacted, and the limited availability of clay on or around the mine area. The compaction prescription is currently 95% of

standard compaction, which yields a bulk density of approximately 1.93 and a saturated hydraulic conductivity of 1×10^{-6} m/s. The seal specification has been designed with regard to heap leach availability and total estimated waste dump area, the compaction/permeability curve for this material, and cost per hectare.

Heap leach dead ore used as a rehabilitation material will be washed before use so that the concentration of any contaminants in the material does not exceed the criteria listed in Table 3.

The strategy for control of AMD at Mt Leyshon Mine is still being defined. This reflects the incomplete understanding of AMD issues by the scientific community, the lack of long term monitoring data from other rehabilitated sites, and the necessity for site-specific testwork. Figure 4 summarises the methodology being followed at Mt Leyshon Gold Mine to determine the optimum AMD control strategy (the research activities are presented in more detail in Table 10). For the current northern and southern waste dumps, the performance of the seal is less critical, as both these areas lie within the catchments of the two current tailings dams.

The rehabilitation strategies for all acid producing materials will be reviewed following the completion of the AMD research programme. This will be by the end of 1996, unless altered through a variation to the EMOS (the research programme is still being defined).

Sealing of the tailings dams may be required, depending on the outcome of laboratory testwork now underway (Table 10). If sealing is required, then the prescription will be similar to that for the waste dumps. Experience gained with upstream lifting of the dams has shown that, given a rest period, beach strengths sufficient to support a capping layer can readily be achieved.

For the purposes of budgeting of rehabilitation materials it will be assumed that the tailings dams will be rehabilitated using the same sealing prescription as the waste dumps, until it is demonstrated that an alternative strategy is acceptable. The rehabilitation strategy for the tailings dams will be finalised by 1995/1996 (the year before commencement of rehabilitation of current storages).

Existing heap leach dead ore reserves on site are sufficient to cater for projected life-of-mine rehabilitation requirements, as summarised in Appendix 4.

4.2.3.3 Establishment of stable post-mining land forms

Rehabilitation strategies will achieve post-mining landforms that are resistant to erosion processes. Specifically, they will be designed to:

(1) prevent rates of soil loss greater than 1.5 standard deviations of the rate on land units with the same land capability near the mine. If comparable areas are not available, a target of less than 40 t/ha/year for a cumulative 3 month wet season greater than a 0.2 AEP will be adopted unless another target is preceded by an approved variation to the EMOS,

(2) avoid development of rill or gully erosion on rehabilitated sites of a depth such that any seal layer is exposed for more than 5 % of the total seal area,

(3) reduce to low levels the probability of development of gully erosion exceeding 0.2 m in depth.

Criteria for assessing success

Landform stability will be principally assessed through direct measurement of on-site erosion and site productivity:

(a) on-site erosion rates will be monitored using profile gauges, as described by Csurhes (1988). Measurement will be made of both revegetated and bare sites. Erosion rates on comparable land units near the mine will also be measured for comparative purposes if such data is not available from other sources.

(b) Land productivity criteria are discussed in Section 4.2.3.4.

On and off-site erosion rates will be reviewed in 1996 (after the collection of results from field monitoring). The erosion criteria used to assess site stability will be restated in a variation to the EMOS taking into account the results of this monitoring.

Methods for achieving objectives

The principal strategy for achieving stable post-mining landforms at Mt Leyshon mine has three components, namely (1) the adoption of appropriate post-mining landforms, (2) implementation of engineered runoff control structures and (3) establishment of stable vegetative cover.

The final landform criteria to be applied in rehabilitation works will be as shown in Tables 4 and 5. The criteria shown will be reviewed in 1996 together with erosion rates to determine if management objectives are being met and if the criteria require modification. Until such time as these criteria are proven, rehabilitation costings will be based on the use of proven technology.

If there is significant alteration to the final landform criteria as shown in Tables 4 and 5, it will be preceded by a variation to the EMOS detailing the changes.

(a) Waste dumps.

The design criteria now in use for waste dump rehabilitation are shown in Table 4. They were formulated using methods presented in the Soil Conservation Handbook (DPI undated). Design calculations are shown in Appendix 5. Contour banks are laid out along the slope to intercept runoff. These feed spine drains that run down the slope and transfer collected runoff safely away from the site. The heap leach dead ore used as the growth media is non-dispersive and has a high gravel content. Consequently, it is relatively erosion resistant. It is expected that once ground cover is established on rehabilitated waste dump areas, erosion rates will be very low (large scale waste dump rehabilitation was complete at by late 1992 but monitoring results for revegetated areas were not yet available for assessment).

Because the waste dumps are to be built off the slopes of existing elevated areas, the post-mining landform will conform closely to existing topography and be unobtrusive from an aesthetic viewpoint.

(b) Tailings dams.

Provisional final landform plans for the surface of the Southern and Northern Tailings Dams are shown Figures 5 and 6. Similar concepts are expected to be implemented for a third tailings dam (probably to be located immediately north of the Northern Tailings Dam). Over the surface of the dams, use will be made of the natural beach slope (approximately 1 in 50) to remove rainfall runoff from the site, via a central drain.

Downstream batter slope on the tailings dam walls is a function of the construction techniques used for the various stages, as shown in Figures 7 and 8. Table 5 summarises the proposed rehabilitation strategies for these different slopes. The steeper

slopes on the lower sections of the walls are considered acceptable due to their oxide rock covering and small catchments, and their ability to support a vigorous vegetative cover. Reprofiling of these steeper slopes is not a favoured strategy, because it would use large volumes of oxide waste,

Table 4. Final Landform design criteria for waste dumps*

Criteria	Specification
General maximum batter slope	14 degrees
General top of dump slope	<6 degrees
Maximum contour bank spacing (1) batters (2) top of dumps	 30 m along the slope** 90 m along the slope
Maximum contour bank length	100 m
Contour bank construction	Rock-lined channel. Rock to be selected for low sulphide content. Base of channel to rest on top of compacted seal.
Contour bank slope	1 degree
Spine drain construction	As for contour banks. Placed at approximately 200 m intervals along the slope
Design storm for banks and spine drains	1 in 100 year design storm

* Subject to confirmation or modification by ongoing assessment.

** Hydraulic calculations are shown in Appendix 5.

Table 5. Rehabilitation strategies for tailings dam walls

Wall section	Rehabilitation strategy*
Upstream lifts (11 degrees average)	Retain stepped profile to control water movement downslope. Deep-rip top of benches (former crests). Apply topsoil to top of benches. Revegetate.
Downstream lifts (variable slopes)	Minimise catchment by use of a diversion drain along the top of the original wall crest, feeding rock-lined spine drains at intervals along wall (Figure 7). Drains designed to meet 1 in 100 year event. Revegetate

* Subject to confirmation or modification by ongoing assessment.

which can be better used in the rehabilitation of other areas such as primary waste dumps.

It is a Special Condition of tailings dam licence conditions that proposals for rehabilitation be approved by the WRC. This approval will be obtained prior to implementation of final rehabilitation works.

(c) Heap leach pads.

All supergene heap leach dead ore will be transfered to the waste dump and buried (to be treated as for other sulphidic waste), unless testwork shows that it is suitable for other uses. Most or all of the oxide heap leach dead ore will be used for tailings dam lifts and waste dump and tailings dam rehabilitation. The bare site will then be deep ripped before revegetation works. Average surface slopes (excluding batters) will be less than 5%. The existing batters on the western edge of the heaps will be retained and revegetated. Any significant alteration to this strategy will be preceded by a variation to the EMOS.
This approval will be obtained prior to implementation of final rehabilitation works.

4.2.3.4 Establishment of stable and productive vegetative cover

Revegetation success will be assessed according to the following criteria.

(1) Demonstration that ground covers equal to or greater than 40 % are achieved during wet seasons with average or greater rainfall. A point intercept method will be used (Csurhes 1988). A general guideline is that soil erosion due to water is significantly reduced by a ground cover of 20 to 30 % (Bell 1987).

(2) Demonstration that mean above-ground herbaceous dry matter

yields are not less than 1.5 standard deviation of the mean for nearby pastures of the same land capability over three successive years.

(3) Demonstration, through reference to scientific literature, that the vegetation association achieved possesses characteristics that predispose to long-term stability, namely self-sustainability, tolerance of fire and resistance to grazing, drought and pests.

(4) Direct measurement of tree stocking in areas where revegetation with trees is an objective. The criteria for successful rehabilitation will be a stocking rate of mature trees (>4 m in height) exceeding 30 stems per hectare.

(5) Demonstration that the natural soil micro-organisms, in particular mycorrhizas and nitrogen cycling bacteria, have begun to colonise rehabilitated sites, via (1) survey of mycorrhizal establishment on the roots of tree and grass species and (2) measurement of growth media organic matter content. Success will be assessed by demonstration that these parameters are approaching those levels measured from relatively undisturbed areas of vegetation on-site.

Because the disturbed area at the mine is small in regional terms, the reintroduction of original vegetation associations is not seen as critical to the success of the revegetation strategies. However, in areas of tree and shrub establishment, locally endemic species will be used. On areas of sealed waste dump or tailings, revegetation will be restricted to grasses and shallow-rooted shrubs (<1 m tall). This prescription may alter on the basis of any studies becoming available concerning the effect of tree roots on the long-term performance of compacted seals (the life-of-mine at Mt Leyshon Gold Mine is not sufficient for meaningful results to be obtained from trials on-site in a timely manner).

Methods for achieving objectives

Table 6 summarises the revegetation prescriptions to be followed. These may be varied in response to the results of monitoring of trials. Significant alteration to the revegetation prescriptions shown in Table 6 will be preceded by a variation to the EMOS detailing the changes.

Because of the limited availability of soil resources, the principal growth medium to be used in the rehabilitation of waste dump areas will be washed heap leach dead ore. The heap leach revegetation trial (described in the 1991 Plan of Operations) demonstrated that high cover crop yields, ground cover and native tree establishment rates could be readily obtained on this material, with or without topsoil addition. However, to accelerate the colonisation of rehabilitated sites by normal soil micro-organisms, topsoil will be thinly spread over the heap leach material.

The feasibility of using in-situ tailings material as a growth medium in the rehabilitation of the tailings dams is being investigated (Table 10). In the event that capping of the tailings is required, heap leach will be used as a growth medium.

Heap leach dead ore used as a rehabilitation material will be washed before use so that the concentration of any contaminants in the material does not exceed the criteria listed in Table 3.

On areas of borrow pit, plant/office areas, decommissioned dams and other miscellaneous disturbed areas, in-situ material will be used as the principal growth media.

Table 6. Revegetation prescriptions for disturbed land at Mt Leyshon Gold Mine*

Area	Prescription
(A) Rehabilitated waste dump and tailings areas	(1) Establishment of growth media layer over sealing layer, predominantly of flushed heap leach material**. (2) Application of thin layer of topsoil to surface of the heap leach. (3) Deep ripping to 20 cm depth along contour. (4) Application of diammonium phosphate at 800 kg/ha. (5) Application of pasture grass and legume species at 2 kg/ha per species (4 to 5 species in total). (6) Light surface cultivation along the contour.
(B) Borrow pits, plant/office areas, decommissioned dams, costeans, drillpads and tracks	(1) Deep-ripping of in-situ material (0.5 m). (2) Seed and fertiliser addition and cultivation as for (A) but with the additional inclusion of native tree seed at the rate of 2 kg/ha per species.

* Subject to confirmation or modification by ongoing assessment.

** Growth media thickness is currently 30 cm total. This prescription may be modified on the basis of modelling and trial monitoring.

All soil in areas to be used for waste disposal, dam construction or other major works is removed to stockpiles or rehabilitation areas. Soil stockpile management is documented in Standard Operating Procedure No. 706. (Appendix 6). Wherever possible, direct placement is practiced in preference top stockpiling before use. Depth of soil stripping is nominally 30 cm, however, deeper areas of organic soil are exploited when available.

Material availability

Existing topsoil and heap leach dead ore reserves on site are sufficient to cater for projected life-of-mine growth media requirements, as summarised in Appendix 4.

4.2.3.5 Removal of plant infrastructure

Following mine closure, all plant infrastructure will be dismantled and removed or buried at depth, or left on site with the owners consent and approval from the DME. Any material containing greater than 0.5 ppm WAD cyanide will be disposed of in tailings dams. All plastic lining will be buried under waste or tailings to a depth below surface exceeding 2 m or removed from site. Disturbed sites will be recontoured to give a natural appearance and revegetated.

4.2.3.6 Control of loss of contaminants from the tailings dams

Following decommissioning and rehabilitation of tailings dams, seepage discharge may continue for a period.

The existing seepage containment facilities at the tailings dams will be maintained until discharge complies with the stock water quality criteria shown in Table 8.

4.2.3.7 Control of access to the pit

Following mine closure, access to the pit will be restricted by the construction of a rock bund around its full perimeter, of dimensions 2 m high and 4 m wide, and a four-strand fence (standard stock fence) outside this bund, to exclude stock and accidental entry by persons.

4.2.3.8 Exploration activity

Site disturbance associated with exploration activity on the areas covered by this EMOS will be limited to drilling, unless preceded by a variation to the EMOS. All exploration activities will conform to the Standard Operating Procedure shown in Appendix 6.

4.3 Water resources

4.3.1 Description of resource

Mt Leyshon Gold Mine is drained by many gullies and creeks that flow into Puddler creek and Clarke Creek (Figure 3). Flow in these waterways is seasonal, and use of this resource near the mine is limited to occasional beef cattle watering. Stock watering could be expected to occur occasionally up to the lease boundaries. Human consumption of surface waters downstream of lease areas until at least the Burdekin River (a minimum distance of at least 10 km) would be very rare. There are no permanent aquatic ecosystems in waterways between the mine and the Burdekin River.

A study of baseline surface water quality in the Mt Leyshon area was undertaken in 1985. The results of the survey are shown in Appendix 7. A summary is presented as follows.

The level of suspended solids varied greatly between and within flood events, but were always somewhat high (ranging between 214 and 19900 mg/l). The highest value was recorded for Clarke Creek upstream of Mt Leyshon for the Christmas 1985 flood, and was thought to reflect the accumulated sediments mobilised from grazed areas during extreme rainfall events. Nitrogen was generally below detection limits. Iron levels were high, ranging from 0.67 to 28.8 mg/l. Arsenic, zinc, nickel, chromium and cyanide concentrations were always low or below detection limits. From sites in Clarke Creek and Puddler Creek downstream of Mt Leyshon, lead and mercury were detected at or close to the critical limits shown in Table 8 (the maximum levels recorded were 0.04 mg/l for lead and 0.002 mg/l for mercury). The mercury contamination was attributed to the use of the amalgamation process in early mining. The lead contamination was attributed partly to the leaching of old mine spoil in the Mt Leyshon area, and partly to contamination in the upper catchment of both Puddler and Clarke Creeks. Values of pH generally ranged between 6.0 and 6.5. Flow from the Mt Leyshon area was generally more acidic than upstream waters.

In a regional sense, the mine lies close to an area designated as "not proclaimed" by the Queensland Water Resources Commission, implying the absence of any significant groundwater resource. Exploration by the mine for potential borefield sites has confirmed this assessment. Local windmills are typically used for stock watering and yield low volumes of shallow groundwater from watercourse underflow and near surface fractures (local supplies for human consumption are generally provided by rainwater tanks, and in any case, the nearest human habitation is more than 1.4 km from current lease boundaries). A baseline groundwater quality study was not carried out.

4.3.2 Impact of mining

4.3.2.1 Potential sources of contamination

The potential sources of water contamination at Mt Leyshon Gold Mine are listed in Table 7. The main potential mechanisms of contamination are seepage (dams, ponds and waste dumps/ore stockpiles) and accidental spillage (vessels and pipelines).

Significant potential sources of impact on water quality besides those shown in Table 7 will not be introduced unless preceded by a variation to the EMOS.

The mine will conduct an annual survey of potential sources of water contamination on lease areas.

4.3.2.2 Potential disruption of resources

The potential for disruption of groundwater or surface water resources due to mining activities is small. No permanent waterways are located on or near the lease area. For the purposes of optimising the site water balance, runoff from undisturbed areas is diverted around containment structures wherever practical. No groundwater resources are used within lease boundaries.

4.3.2.3 Water quality impacts to-date

The Leyshon Gold Mine has operated a comprehensive environmental water sampling programme since mid 1989, as described in Section [illegible]. Water quality impacts to-date are described in detail in the 1991 Plan of Operations. A summary is presented below (water sampling sites are shown in Figure 2).

Table 7. Potential sources of surface water and groundwater contamination at Mt Leyshon Gold Mine.

SOURCE	POTENTIAL CONTAMINANTS
Tailings dams	Cyanide, alkalinity, dissolved metals, acidity (with time).
CIP tailings pipelines	Cyanide, alkalinity, dissolved metals, rock slurry.
CIP decant pipelines	Cyanide, alkalinity, dissolved metals.
Supergene tailings and decant pipelines	Dissolved metals.
Process ponds, heap leach pads	Cyanide, alkalinity, dissolved metals.
Tanks and vessels	Cyanide, alkalinity, dissolved metals, rock slurry.
Waste rock dumps and ore stockpiles and the pit (dewatering)	Acidity, dissolved metals, sulphates, suspended solids.
Runoff from other disturbed areas	Sediments, dissolved nutrients
Fuels and oil storage, workshops	Fuels and oils
Sewage systems	human waste

Surface waters:

1. On-site water sampling sites receiving drainage from waste dumps and ore stockpiles have typically shown low pH's and elevated metal contents, indicating the presence of acid mine drainage processes. Significant seepage at these locations has only been found during or following extended periods of rainfall.
2. Off-site sampling points show that regional water quality has remained similar to that reported for pre-mining baseline conditions.
3. Surface waters sampled on-site have occasionally shown significant (but relatively low) cyanide levels, typically related to minor process water or tailings spillages.
4. Surface waters sampled off-side have rarely shown cyanide levels above 0.05 mg/l.

Groundwater:

1. Borehole sampling has shown that the products of AMD have not contaminated groundwater to any significant extent.
2. Boreholes immediately downstream of the tailings dams typically show moderately elevated cyanide levels, as do adjacent seepage sumps. However, cyanide levels are rapidly attenuated with distance from the storages, so that boreholes closer to lease boundaries show total cyanide levels well below drinking water standards.
3. Boreholes close downstream of the general plant area and heap leach pads typically show very low to trace cyanide levels.

4.3.3 Control strategies

Water quality control strategies will be implemented to (a)

reduce to very low levels the probability of significant adverse effect on the natural environment downstream of lease boundaries, and (b) to prevent significant impairment of water quality for downstream users, with particular regard to consumption by stock and people.

Criteria for assessing success

The mine runoff control scheme (described below) will be monitored to ensure compliance with the terms of any discharge or overflow licence issued by the Department of Environment and Heritage (a licence application is currently being processed). The terms of the discharge or overflow licence issued by the Department of Environment and Heritage for the mine runoff control scheme will be issued in a variation to the EMOS when available.

The success with which the other losses listed in Table 7 are contained will be assessed through reference to accepted water quality standards, the most relevant of which are shown in Table 8. Water quality management will aim at achieving levels of contaminants at the lease boundaries below critical limits for beef cattle, as this is the principal potential water use at lease boundaries. Levels of contamination greater than those shown in Table 8 beyond the lease boundaries will be a trigger to seek advice from the Department of Environment and Heritage.

In interpreting water quality results, cognisance will be taken of water quality contamination existing before mining operations by Mt Leyshon Gold Mines Ltd (Section 4.3.1).

Under certain scenarios, the use of the critical limits shown in Table 8 is inappropriate. For example, during periods of short-term or intermittent exposure, higher critical limits may be valid. The use of different critical limits to those presented

in Table 8 will only occur if validated by expert scientific opinion or research.

The mine will conduct an annual survey of downstream water users within 5 km of the lease boundaries, with regard to the control of impacts on groundwater and surface water resources.

Table 8. General Water Quality Criteria

Parameter	limit (mg/l)			
	Stock (beef cattle)		Humans	
Total salinity	9000 TDS	(Gill 1984)	9000 TDS	
pH	6 - 9	(Hart 1974)	6 - 9	(Hart 1974)
Calcium	700 mg/l	(Hart 1974)	200 mg/l	(Hart 1974)
Magnesium	400 mg/l	(Gill 1984)	150 mg/l	(Hart 1974)
Nitrate	100 mg/l	(Gill 1984)	0.01 mg/l	(Hart 1974)
Sulphate	500 mg/l		250 mg/l	(Hart 1974)
Copper	1.0 mg/l		1.0 mg/l	(Hart 1974)
Iron	10 mg/l	(Hart 1974)	0.3 mg/l	(Hart 1974)
Lead	0.5 mg/l	(Hart 1974)	0.05 mg/l	(Hart 1974)
Zinc	20 mg/l	(Hart 1974)	0.05 mg/l	(Hart 1974)
Arsenic	1.0	(Hart 1974)	0.05 mg/l	(Hart 1974)
Mercury	0.002 mg/l	(Hart 1974)	0.002 mg/l	(Hart 1974)
Cadmium	0.01	(Hart 1974)	0.01 mg/l	(Hart 1974)
WAD cyanide	0.20		0.20 mg/l	(Hart 1974)

Methods for achieving management objectives

The main strategies for controlling impacts on water quality are described below. Table 9 summarises water management design criteria for the operation.

(a) Acid mine drainage

The long-term control strategy to limit the impact of acid mine drainage on surface water quality is effective waste rehabilitation. This issue has been dealt with in Section 4.2.3.2. During mine operation however, there will always be active areas of waste dump and ore stockpiles. To control the impact of these and other sources of acid mine drainage, the mine has implemented a runoff control strategy. The design and operation of this scheme is dealt with in detail in Appendix 8. To summarise:

1. At low to medium flow rates, AMD heading off site is entirely contained by runoff control dams. All water contained by these dams is restored to neutral pH through slaked lime addition. This process precipitates copper, allowing the water to be pumped to the Raw Water Dam, the Southern Tailings Dam, or directly to the plant, with no detrimental effect on cyanide consumption.

2. At high flow rates, such as seen during severe storms, a proportion of the runoff is automatically bypassed around the runoff dams, to leave the lease. The diversion weirs that achieve this shedding of water are sized so that clean runoff from adjacent catchments is sufficient in volume to dilute contaminants to below harmful levels at lease boundaries.

Table 9. Summary of water management design targets for the mine

Infrastructure	Estimated AEP	Minimum design storm (72 hour)	Spillway design storm	Licensing
Runoff control dams	1:10	1:10	1:100	WRC licences granted/ pending
Tailings dams	1:100	1:100	1:1000	Both licensed to final height
Tailings dam seepage sumps	1:100	1:100	-	n.a.
Supergene Runoff Dam	1:100	1:100	1:100	Licence pending
Heap Leach Stormwater Ponds	1:100	1:100	-	Licence pending
Raw Water Dam	-	-	1:100	Licensed
Diversion drains (for dams)	-	1:10	-	n.a.

The mine runoff control strategy was completed in late 1991

(before this, control of acid mine drainage was achieved by containing runoff and pumping it directly into tailings dams, without pH adjustment). Rain received during the 1991/92 and 1992/93 wet seasons was insufficient to generate acid runoff, and so the performance of the system has yet to be tested. Comprehensive monitoring equipment has been installed (Section 6.2.3) to allow "fine tuning" of the system following several storm events.

The Runoff Control Strategy will be operated generally in accordance with the proposals detailed in design documents produced by McIntyre and Associates.

All Water Resource Licence conditions for the runoff dams will be complied with.

Modification or expansion of the system will be carried out when required, in order to meet the design objectives. These alterations will be documented a variation to the EMOS.

(b) Process water/tailings spillage

Strategies for the control of process water and tailings spillage include the following.

1. Any large spillage from the CIP or supergene plant areas (that is not contained by local bunding) will drain to a runoff control dam. These dams are to be operated to maintain a minimum freeboard in excess of the volume of the largest vessel or tank within its catchment. In this way, any major structural failure will not lead to loss of contents off-site.
2. CIP tailings lines and decant return lines are routed so that, in the event of pipeline failure, spillage will flow (a) to a tailings dam, or (b) to either the New Settlement

Pond or the New Plumtree Creek Dam. Minimum freeboard requirements for these dams are sufficient to contain at least 24 hours of tailings or decant output.

3. Supergene tailings and decant return lines are routed so that, in the event of pipeline failure, spillage will be directed to (a) the Supergene Runoff Dam, (b) the New Settlement Pond or (c) the Southern Tailings Dam (Figure 2). Minimum freeboard requirements for these dams are sufficient to contain at least 24 hours of tailings or decant output.
4. Seepage sumps downstream of the Southern and Northern Tailings Dams are designed to contain/return all seepage from the dam as well as flow resulting from a 1 in 100 year 72 hour storm.
5. All tailings/decant pipeline routes and all seepage sumps are inspected at least once per shift (12 hours) by the Shift Controller.
6. Storm flow from the acid heaps associated with supergene processing is directed to the Supergene Runoff Dam, which has sufficient capacity to contain all runoff resulting from a 1 in 100 year 72 hour storm.
7. Storm flow from the cyanide heaps (both supergene and the now discontinued oxide pads) is directed to the two plastic-lined Stormwater Ponds, which have sufficient capacity to contain in excess of all runoff resulting from a 1 in 100 year 72 hour storm.
8. All tailings dam walls have a cross fall on the crest that will direct spilt tailings into the dam in the event of leakage from the tailings line or spigots.
9. Substantial mobile pumping capacity is maintained on-site available for emergency spillage or seepage containment.

Operational strategies for the control of process water and tailings spillage, as described above, will be implemented, and modified when required, to achieve the objectives.

Tailings dams will be operated in accordance with Water Resources Commission licence conditions. These are shown in Appendix 2. In particular, the dams will be operated to comply with the "Guidelines on Prevention of Water Pollution from Cyanide Use in Gold Ore Processing" ("High" hazard category).

(c) Groundwater contamination

The principal potential impacts on groundwater are seepage from tailings dams and from waste dumps. The issue of acid mine drainage control is dealt with in Section 4.2.3.2. Described below are the strategies in place for limiting the impact of seepage from the tailings dams.

1. Both tailings dams are operated with the objectives of minimising decant volumes and maximising beach density. Both these objectives will act to reduce seepage rates. Decant volumes are maintained to within 20 Ml by monitoring and adjusting daily decant reclaim rates (following rainfall, decant return is maximised in order to restore decant size as rapidly as practicable). Tailings density is maximised by maintaining sub-aerial deposition around the periphery of each dam and maximising time between reapplication of tailings at any particular location. Standard Operating Procedures have been established to achieve these objectives.

2. Should the strategies outlined above be insufficient to control groundwater contamination from tailings dams, additional control will be achieved through the installation of cut-off trenches or borehole dewatering pumps.

(d) Water quality in the pit post mining

Unless otherwise determined, the water management strategy for the pit will be to minimise entry of runoff water (and to exclude access by stock, the public and native fauna). This will not require licensed diversions, as water flow will follow the general contours of the rehabilitated waste dump (there will be very little natural catchment involved). In this case, long term water quality in the pit is not a significant issue, given the absence of a significant groundwater resource in the locality, and provision in the compensation agreements for any reduction of land capability. A water balance study for the pit and final decommissioning plan will be completed by June 1995. This will be followed by a variation to the EMOS if there is a change in the strategy outlined here.

4.4 Noise

Noise generated from activities at Mt Leyshon Mine does not constitute a significant public nuisance, and this situation is unlikely to change. This is due to the relative isolation of the mine from outside human activity. The closest permanent dwelling is approximately 2.3 km from existing lease boundaries.

Given the small environmental impact now existing, no special noise control strategies are proposed for the mine.

The mine will respond to assist the resolution of any conflict resulting from a change in the status of noise impacts. The mine will review annually whether the implementation of a formal noise monitoring programme is required, and whether any special noise control provisions should be implemented.

4.5 Air quality

The only significant impact on air quality at Mt Leyshon is dust generation, resulting from the crushing plant, and to a lesser extent, blasting and vehicular traffic. This impact is largely limited to within lease boundaries. Given that the closest permanent dwelling is approximately 2.3 km from lease boundaries, dust generation is not considered a public nuisance.

Typically, 0.4 to 0.5 Ml/day is applied to roads at Mt Leyshon to control dust generation (in the absence of rainfall). This is principally carried out for safety reasons, but is also effective in controlling environmental impact. Upgrading of the current crusher train, as part of the mine optimisation, will include effective dust suppression facilities, further reducing dust load at the site.

The mine will respond to assist the resolution of any conflict resulting from a change in the status of air quality impacts. The mine will review annually whether the implementation of a formal noise monitoring programme is required, and whether any additional dust control measures should be implemented.

4.6 Conservation values

There are no known conservation issues within or near lease boundaries. The vegetation on the lease area has been substantially disturbed by previous mining activity and grazing. No rare or endangered species of plant or animal are known to use the area. Comparable habitats are common in the area surrounding the lease area (Ison 1986).

The mine will respond to assist the resolution of any conflict resulting from a change in the status of conservation values. Unnecessary disturbance to fauna and flora will be minimised.

4.7 Heritage and cultural values

An archaeological investigation (Hollingsworth Consultants 1986) revealed no aboriginal archeological sites within current lease boundaries. No structures of known historical or cultural importance exist on-site.

The mine will respond to assist the resolution of any conflict resulting from a change in the status of heritage or cultural values on-site.

4.8 Social issues

Social issues relating to mining activities have been addressed in preceding sections as follows:
Section 4.2 Land use changes
Section 4.3 Water quality impacts
Section 4.4 Noise levels
Section 4.5 Dust levels

Visual aesthetics are not a significant issue at the mine. The processing plant is not visible from any public road outside the lease boundaries, except for several hundred metres immediately before the main entrance gate (from where a view of the supergene plant is obtained). From Charters Towers the northern waste dump is the only visible feature of the operation, forming a very minor component of the landscape and being almost indiscernible from other hills in vicinity. The mine is not visible from the Gregory Development Road (Figure 1). On the access road to the mine, the northern waste dump becomes more visually dominant, but its rounded contours will merge successfully into the surrounding landscape when good vegetation cover is achieved. In any case, population density in the locality is very low and there is no passing traffic.

Pre-mining educational or recreational values at the mine site were at a very low level, comparable with that provided by large areas of country around Charters Towers. The mine frequently hosts visits from schools and professional groups, so in this sense it is providing an educational resource for the community.

5. RESEARCH

The principal objectives of rehabilitation are the long-term control of acid mine drainage, and the establishment of a stable post-mining landform. Because of the complexity of the systems involved, and the limited availability of comparative studies, the mine has initiated a research programme, with the aim of defining cost-effective strategies for achieving these objectives. This programme is summarised in Table 10. Highlighted in bold are milestone completion dates (the provision of information that may require a variation to the EMOS). Most of the studies yet to be commenced deal with rehabilitation strategies for the control of AMD. Mt Leyshon Gold Mine is reviewing a proposal by the Australian Nuclear Science and Technology Organisation (ANSTO) for an extensive program of testwork and modelling dealing with this issue. Work has already commenced on Project 1.1 of this programme.

Table 10. Mt Leyshon Gold Mine environmental research programme (bold type under "Status" indicates a milestone date)

Study	Status
1. Acid Mine Drainage Control.	**Target completion end of 1995**
1.1 Mine Waste Characterisation Study No. 1. An initial study aimed at characterising the main pit lithologies with respect to metal content, sulphur content and net acid producing potential (NAPP). (Conducted by AGC Woodward-Clyde).	Completed 1/1992.
1.2 Mine Waste Characterisation Study No. 2. A continuation of work carried out in Study No. 1, providing provisional criteria for a selective waste handling strategy, based on metal and NAPP values. (Conducted by AGC Woodward-Clyde).	Completed 9/1992.
1.3 Other static testwork. Static testwork (metals, sulphur and NAPP) on tailings and scats samples to help determine final rehabilitation requirements. (Conducted by AGC Woodward-Clyde).	Commenced 10/1992. Ongoing.
1.4 Column testwork. Four laboratory column trials (three waste rock samples and one tailings sample) with the objective of obtaining comparative data on rate of oxidation and leachate quality. (Conducted by AGC Woodward-Clyde).	Commenced 11/1991. Ongoing.
1.5 Northern Waste Dump Rehabilitation Trial. A 4 ha trial aimed at assessing the performance of waste dump sealing techniques. (Conducted by MLGM).	Commenced 1/1991. Ongoing 1992.
1.6 Research Programme for the determination of the optimum waste dump and tailings rehabilitation strategy. A series of projects proposed by the Australian Nuclear Science and Technology Organisation (ANSTO), with emphasis on modelling of waste dump and tailings dam behaviour and quantification of the effects of rehabilitation strategies on sulphur oxidisation rates and the production of AMD. Project summaries as follows.	
- **Performance of layered Systems in reducing the pyrite oxidation rate**. Mathematical modelling, with the aim of quantifying the sensitivity of AMD production to variations in cover properties and thickness, oxidation rate, sulphur content and other bulk properties for the Mt Leyshon waste dumps. Also to provide preliminary design criteria for a cover system.	Commenced 12/1992. Ongoing.
- **Intrinsic oxidation rate measurements.** Kinetic testwork (columns) designed to determine relationships between waste rock type, oxidation rate and subsequent metal release.	Proposed.

Table 10. (cont.)

Study	Status
- **In-situ measurement of oxygen and temperature.** Measurement of oxygen and temperature profiles within existing waste dumps to provide input for Project 1.4.	Proposed.
- **Interpretation of oxygen and temperature profiles.** Determination of in-situ waste dump oxidation rates as a function of space and time.	"
- **Pollutant balance for waste dumps.** Determination of the strength and location of pollutant sources on the site, through the site water monitoring programme and the development of a site water balance.	"
- **In-situ measurement of oxygen and temperature.** Measurement of oxygen and temperature profiles within existing waste dumps to provide input for Project 1.4.	"
- **Interpretation of oxygen and temperature profiles.** Determination of in-situ waste dump oxidation rates as a function of space and time.	"
- **Pollutant balance for waste dumps.** Determination of the strength and location of pollutant sources on the site, through the implementation of a site water monitoring programme and development of a site water balance.	"
- **Drainage System.** Determination of the chemistry of pore water in the waste rock dumps and in drainage waters as a function of time and space and how this is related to sulphide oxidation rates and the chemical composition of the dump material.	"
- **Modelling of Pollution Transport.** Development of descriptive and prescriptive model of pollution transport at the site that will allow assessment of the effects of different rehabilitation strategies on water quality at the site.	"
- **Reassessment of Rehabilitation Strategy.** From the results of previous projects, assess the effectiveness of various rehabilitation strategies in achieving acceptable levels of contaminants in water draining the site.	"
	"

Table 10. (cont.)

Study	Status
1.7 Investigation of Infiltration through sealing layers. Modelling of water infiltration into waste dumps at Mt Leyshon Gold Mine for different sealing, growth media and vegetation prescriptions. To be used as input into modelling described in Section 1.6. (Conducted by the Australian Centre for Tropical Freshwater Research). Divided into two parts:	
Stage 1: Preliminary modelling of system using the "SWIM" computer model, with the objective of determining the most important parameters. Initial sampling of material properties.	Completed 9/1992.
Stage 2: Development of a more complete model, with more extensive sampling of material properties and consideration of two-dimensional effects. Prediction of annual net infiltration through different treatments using historical rainfall data.	Commenced 10/1992. Ongoing.
1.8 Mine Runoff Control Scheme. Development of a strategy for the management of AMD at Mt Leyshon mine, based on computer modelling of local catchments. Detailed in Section 4.3.4. (Conducted by McIntyre and Associates).	Completed 10/1991.
1.9 The Significance of Metal Uptake by Stock Exposed to Infrequent Mine Site Runoff Water. Assessment of the potential impact of AMD from Mt Leyshon Gold Mine on stock in adjacent properties, based on an extensive literature review and the development of models for metal toxicity in cattle. (Conducted by the Australian Centre for Tropical Freshwater Research).	Completed 9/1992.
2.0 Pit water balance study. A study to determine the appropriate water management strategy for the pit, including a final decommissioning plan.	**To be completed by June 1995.**
2. Development of a stable post-mining landform.	
2.1 Heap leach revegetation trial. A direct-seeding trial implemented on a decommissioned heap leach pad. The trial showed that heap leach dead ore, with sufficient fertiliser addition, can support vigorous growth of cover crop and native tree and shrub species. This trial has been concluded and removed to allow heap leach activities (conducted by MLGM staff).	Commenced 1/1990. Completed 4/1991.
2.2 Tailings dam rehabilitation trial. A trial to validate tailings dam rehabilitation strategies	**To be completed 1995/96**

6. ENVIRONMENTAL MONITORING

6.1 Summary of monitoring requirements

The monitoring programmes outlined in Table 11 are required to demonstrate compliance with the undertakings presented in the EMOS. Monitoring results will be presented in each Plan of Operations. The water quality monitoring programme is described in the following section.

No significant reduction to the monitoring programme described in Table 11 will occur without being preceded by a variation to the EMOS.

6.2 Water quality monitoring

6.2.1 Introduction

Mt Leyshon Gold Mine operates a comprehensive environmental water quality monitoring programme, the purpose of which is to measure the impact of mining activities on the surrounding groundwater and surface water resources. This programme has three components:

(1) Routine environmental sampling (boreholes and surface waters).
(2) Monitoring associated with the mine runoff control scheme (rising stage samplers and flow dataloggers).
(3) Ad-hoc sampling carried out at the discretion of the environmental officer.

These components are described in the following sections:

6.2.2 Routine environmental sampling

The locations of monitoring boreholes (MLM's) are shown in Figure 2. Sampling frequency is as follows.

(1) Boreholes downstream of the Northern Tailings Dam are sampled every second month (MLM2A, MLM7, MLM8, MLM13, MLM14 and MLM15).

Table 11. Principal components of the environmental monitoring programme at Mt Leyshon Gold Mine

Type	Aim	Schedule	Reporting
Reporting In-situ measurement of waste dumps	To determine the success of measures to control AMD (Section 4.2.3.2.)	Following large scale waste dump rehabilitation, as determined by research programme	Research reports as data becomes available.
Measurement of erosion rates on rehabilitated areas	To monitor post-mining landform stability (Section 4.2.3.3)	Following large scale rehabilitation, after every wet season	Annual
Inspection for rill/gully erosion and damage to runoff control structures on rehabilitated areas	To permit timely repair to rehabilitation works (prior to vegetative stabilisation)	Following storm events	As required
Measurement of % cover and yield on rehabilitated areas	To monitor revegetation success (Section 4.2.3.4)	Following large scale rehabilitation, after every wet season	Annual
Measurement of tree stocking rate (in areas where revegetation with trees is an objective)	To monitor revegetation success (Section 4.2.3.4)	Following large scale rehabilitation, after every wet season	Annual
Testing for soil micro-organisms and organic matter	To monitor revegetation success (Section 4.2.3.4)	Following large scale rehabilitation, after every wet season	Annual
Monitoring of groundwater and surface waters	To monitor success of runoff control scheme and other control measures for limiting loss of contaminants from site (Section 4.3.4)	Monthly sampling schedule, and following storm events	Monthly

Table 11 Ancillary components of the environmental monitoring programme at Mt Leyshon Gold Mine (cont.)

Type	Aim	Schedule	Reporting
Freeboard monitoring of tailings dams	To ensure compliance with the "Cyanide Guidelines" (Section 4.3.4)	Routine visual monitoring, freeboard survey prior to November 1 each year	As per "Cyanide Guidelines"
Decant volume	To maximise beach densities and minimise seepage (Section 4.3.4)	Daily	Verbal
Freeboard monitoring of runoff dams	To ensure compliance with dam licences and correct operation of Runoff Control Scheme (Section 4.3.4)	Monthly, following large storms	Monthly
Duration and volume of bypass flow at runoff control dam weirs (and quality at lease boundary)	To ensure compliance with dam licences and correct operation of Runoff Control Scheme and allow production of an annual compliance report.	Continuous	Monthly internal reports, annual compliance report to DEH
Maintenance of a contaminated site and a hazardous material register	To ensure compliance with the Contaminated Lands Act	Annually	Annual as required under the Act

(2) Boreholes downstream of the plant area and heap leach pads are sampled every second month (MLM16, MLM17, MLM18, MLM19, MLM20, MLM21, MLM22 and MLM23).

(3) Boreholes located downstream of the Southern Tailings Dam are currently monitored monthly (MLM38, MLM39, MLM40, MLM41, MLM42, MLM43, MLM44, MLM48, MLM50, MLM52 and MLM53).

(4) Local windmills are monitored several times per year.

There are 16 nominated surface water sampling sites ("SWs") in and next to lease areas at Mt Leyshon, at locations shown in Figure 2. Sampling is also regularly carried out at Clarke Creek crossing, north-west of the mine, and in Puddler Creek, south-east of the Southern Tailings Dam. Most of the surface flows are ephemeral, restricting sampling to rain periods. Typically, any site would be sampled at least four times per year. Clarke Creek and Puddler Creek contain water for longer periods, and samples at these locations are taken at least once every two months when possible. The seepage sumps located downstream of the tailings dams are sampled every two months.

Analysis is carried out by an independent NATA registered laboratory, apart from pH and EC, which are measure prior to despatch. Collection, treatment and storage procedures are as recommended in the "Cyanide Guidelines". A summary of the results will be presented in each Plan of Operations. The results are reviewed by mine staff every month.

The mine will modify the water sampling regime in response to changes in site activity, so that any additional potential sources of contaminants are adequately covered by sampling sites.

.3 Monitoring associated with the runoff control scheme

To allow validation and "fine-tuning" of the runoff control scheme, the following monitoring is carried out at the New Settlement Pond, the Plumtree Creek Dam and the Mt Hope Dam:

(1) Rising stage sampling (automatic collection of samples at different heights of flow). Samples are collected following storm events and tested for pH and metals.

(2) Water level monitoring, via electronic data loggers. (Given the level of flow and the weir configuration, duration of discharge from site and volume of flow off site and into treatment dams can be calculated).

In addition, rising stage samplers are also operated in Clarke Creek and Puddler Creek.

6.2.4 Ad-hoc sampling

Water sampling additional to that described above will be carried out from time to time to provide additional information when required.

7. PRINCIPAL COMPONENTS OF THE EMOS

hown in Table 12 is a summary of the principal components of the Environmental Management Overview Strategy (discussed in detail n the text together with supporting information). These principal components provide the basis for auditing Plans of peration against the EMOS. Those marked (*) are milestone components (specifying a date by which certain actions are to be ompleted).

Table 12. Principal components of the Environmental Management Overview rategy.

1. Statutory and legal requirements

1.1 All activities on Mt Leyshon Gold Mine leases will be conducted in accordance with statutory requirements. Compliance with these requirements will viewed annually.

1.2 All activities on Mt Leyshon Gold Mine leases will be conducted in accordance with compensation agreements. Compliance with these requirements will viewed annually.

2. Land resources

2.1 Figure 3 shows the approximate boundary within which major disturbance due o mining activities will be confined (excluding roads, drill pads and other nor disturbances). Any major disturbance beyond these boundaries will be eceded by an approved variation to the EMOS.

2.2 Pre-mining land capability survey for areas to be affected by mining (scale 25000) will be conducted by March 1994. A variation to the EMOS will be oduced if the land capability estimates shown in Table 2 are significantly in ror.

2.3 Table 2 does not allow a direct comparison of pre- and post- mining land ability class areas. The information required for this comparison will not be ilable until the pre-mining capability study is conducted (described above). uch a tabulated comparison will be supplied as a variation to the EMOS by June 994.*

Land will be accepted as suitable for the nominated landuse when (a) the and capability classes shown in Table 2 have been achieved and (b) the nominated and use will not be impaired by any chemical contamination. Capability criteria the determination of post-mine capability will be mapped at a scale of 0000. The criteria to be used will be taken from Rosser *et al.* (1974), and ill include, but not be inclusive to, pH, salinity, slope percentage, gravel ontent, depth of rooting zone and soil texture.

Any change in area of greater than 15 % to the post-mine land capability

asses shown in Table 2 will be preceded by a variation to the EMOS.

6 The investigation threshold criteria shown in Table 3 will be used as triggers to determine if specific responses regarding waste disposal are required in the EMOS or in a variation to the EMOS. Investigations will be initiated if levels of contaminants listed in Table 3 are exceeded.

2.7 No "confirmed sites" as defined by the Contaminated Lands Act will remain on lease areas at lease surrender, unless otherwise agreed to by the Department of Environment and Heritage.

2.8 An inventory of contaminated land for the site will be established by the end of 1993.

9 Compliance requirements with regard to the Contaminated Land Act will be reviewed by the end of 1994 (following amendments to this Act and the Mineral resources Act in 1993/94).

10 Disturbed areas will generally be rehabilitated within 2 years of becoming available. The schedule of rehabilitation will be nominated in each Plan of Operations. In some cases, it may be inefficient to rehabilitate areas within two years, most likely due to materials scheduling considerations. In these cases, the area will be nominated as reserved in the relevant Plan of Operations and the reason for this designation identified.

.11 The rehabilitation backlog will be maintained to within the limit allowed by lease conditions.

.12 Land will be considered successfully rehabilitated when undertakings relating to the following issues are achieved:
control of acid mine drainage,
establishment of stable post-mining land forms on disturbed areas,
establishment of stable and productive vegetation associations on rehabilitated areas,
removal of plant infrastructure,
control of loss of contaminants (cyanides and salts) from the tailings dams,
control of access to the pit.

13 All materials with a sulphur content exceeding 0.5 % will be treated as potentially acid producing. This criteria will be reviewed following the completion of the AMD research programme.

14 All potentially acid forming materials at the mine will be rehabilitated in such a manner that:
1) the products of acid mine drainage do not result in significant impairment of downstream water quality, according to the target water quality criteria given in Table 8,
2) the products of acid mine drainage do not prevent the successful revegetation of the rehabilitated areas according to the criteria for revegetation success presented in Section 4.2.3.4.
3) these objectives are achieved predominantly by means of passive control measures that avoid the requirement for long-term active management.

.15 The current rehabilitation strategy for the waste dumps and any other acid producing waste is based on the accepted practice of sealing sulphidic material with a compacted layer to minimise the entry of water and oxygen, and is summarised as follows:
1) whenever available, placement of oxide waste over primary waste to a depth of several metres (this is not a critical component of the strategy, sealing with compacted layer being the principal method of controlling oxidation rate),
2) reprofiling to approximately 14 degrees,
3) application of a 30 cm compacted heap leach layer, the compaction prescription of which is 95% of standard compaction, which yields a bulk density of approximately 1.93 and a saturated hydraulic conductivity of 1×10^{-6} m/s.
4) application of 30 cm of growth media (described in Section 4.2.3.4),
5) installation of erosion control structures,
6) revegetation.

.16 Heap leach dead ore used as a rehabilitation material will be washed before use so that the concentration of any available contaminants in the material does

exceed the criteria listed in Table 3.

.17 The rehabilitation strategies for all acid producing materials will be reviewed following the completion of the AMD research programme. This will be by the end of 1996, unless altered through a variation to the EMOS (the research programme is still being defined).

.18 Sealing of the tailings dams may be required, depending on the outcome of laboratory testwork now underway (Table 10). If sealing is required, then the description will be similar to that for the waste dumps

.19 For the purposes of budgeting of rehabilitation materials it will be assumed that the tailings dams will be rehabilitated using the same sealing description as the waste dumps, until it is demonstrated that an alternative strategy is acceptable.

.20 The rehabilitation strategy for the tailings dams will be finalised by 95/1996 (the year before commencement of rehabilitation of current storages). licence conditions require that proposals for the rehabilitation of tailings dams receive approval from the Water Resources Commission before implementation. his approval will be obtained prior to implementation of final rehabilitation works.

1 Rehabilitation strategies will achieve post-mining landforms that are esistant to erosion processes. Specifically, they will be designed to:
1) prevent rates of soil loss greater than 1.5 standard deviations of the rate land units with the same land capability near the mine. If comparable areas not available, a target of less than 40 t/ha/year for a cumulative 3 month et season greater than a 0.2 AEP will be adopted unless another target is receded by an approved variation to the EMOS,
2) avoid development of rill or gully erosion on rehabilitated sites of a depth h that any seal layer is exposed for more than 5 % of the total seal area,

3) prevent the occurence of gully erosion exceeding 0.2 m in depth.

2 On and off-site erosion rates will be reviewed in 1996 (after the llection of results from field monitoring). The erosion criteria used to assess ite stability will be restated in a variation to the EMOS taking into account results of this monitoring.

3 The final landform criteria to be applied in rehabilitation works will be s shown in Tables 4 and 5. The criteria shown in Tables 4 and 5 will be reviewed 1996 together with measured erosion rates to determine if management ectives are being met and if the criteria require modification.

4 If there is significant alteration to the final landform criteria as shown Tables 4 and 5, it will be preceded by a variation to the EMOS detailing the anges.

5 All supergene heap leach dead ore will be transfered to the waste dump and ried, unless other uses for this material are confirmed by testwork. Most or l of the oxide heap leach dead ore will be used for tailings dam lifts and e dump and tailings dam rehabilitation. The bare site will then be deep ed before revegetation works. Average surface slopes (excluding batters) will less than 5%. The existing batters on the western edge of the heaps will be tained and revegetated. Any significant alteration to this strategy will be eeded by a variation to the EMOS.

Revegetation success will be assessed according to the following criteria:
) Demonstration that ground covers equal to or greater than 40 % are achieved ring wet seasons with average or greater rainfall.
) Demonstration that mean herbaceous dry matter yields are not less than 1.5 ndard deviation of the mean for nearby pastures of the same land capability er three successive years.
) Demonstration, through reference to scientific literature, that the tation association achieved possesses characteristics that predispose to -term stability, namely self-sustainability, tolerance of fire and resistance grazing, drought and pests.
) Direct measurement of tree stocking in areas where revegetation with trees n objective. The criteria for successful rehabilitation will be a stocking of mature trees (>4 m in height) exceeding 30 stems per hectare.

(5) Demonstration that the natural soil micro-organisms, in particular mycorrhizas and nitrogen cycling bacteria, have begun to colonise rehabilitated sites, via (1) survey of mycorrhizal establishment on the roots of tree and grass species and (2) measurement of growth media organic matter content. Success will be assessed by demonstration that these parameters are approaching those levels measured from relatively undisturbed areas of vegetation on-site.

2.27 Significant alteration to the revegetation prescriptions shown in Table 6 will be preceded by a variation to the EMOS detailing the changes.

2.28 Following mine closure, all plant infrastructure will be dismantled and removed or buried at depth, or left on site with the owners consent and approval from the DME. Any material containing greater than 0.5 ppm WAD cyanide will be disposed of in tailings dams. All plastic lining will be buried under waste or tailings to a depth below surface exceeding 2 m or removed or removed from site. Disturbed sites will be recontoured to a natural appearance and revegetated.

2.29 Following mine closure, access to the pit will be restricted by the construction of a rock bund around its full perimeter, of dimensions 2 m high and 4 m wide, and a four-strand fence (standard stock fence) outside this bund, to exclude stock and accidental entry by persons.

2.30 Site disturbance associated with exploration activity on the areas covered by this EMOS will be limited to drilling and access track construction, unless preceded by a variation to the EMOS. All exploration activities will conform to the Standard Operating Procedure shown in Appendix 6.

3. Water resources

3.1 The existing seepage containment facilities at the tailings dams will be maintained until discharge complies with the stock water quality criteria shown in Table 8.

3.2 The mine will conduct an annual survey of downstream water users within 5 km of the lease boundaries, with regard to the control of impacts on groundwater and surface water resources.

3.3 The mine will conduct an annual survey of potential sources of water contamination on lease areas, as tabulated in Table 7.

3.4 Significant potential sources of impact on water quality besides those shown in Table 7 will not be introduced unless preceded by a variation to the EMOS.

3.5 Control strategies will be implemented to (a) reduce to very low levels the probability of significant adverse effect on the natural environment downstream of lease boundaries, and (b) to prevent significant impairment of water quality for downstream users, with particular regard to consumption by stock and people. Any water released will comply with the stock water quality of Table 8 at lease boundaries. The use of different critical limits to those presented in Table 8 will only occur if validated by expert scientific opinion or research, and preceded by a variation to the EMOS. The EMOS will be varied to comply with conditions of licence as appropriate when issued by the Department of Environment and Heritage.

3.6 The Runoff Control Strategy will be operated generally in accordance with the proposals detailed in design documents produced by McIntyre and Associates, specifically, "Surface Water and Runoff Control Definitive Scheme". McIntyre and Associates, October 1991.

3.7 All Water Resource Commission licence conditions for the runoff dams will be complied with.

3.8 Modification or expansion of the runoff control system will be carried out when required, in order to meet the design objectives. These alterations will be documented a variation to the EMOS.

3.9 Dams will be operated in accordance with Water Resources Commission licence

conditions. These are shown in Appendix 2. In particular, the dams will be operated to comply with the "Guidelines on Prevention of Water Pollution from Cyanide Use in Gold Ore Processing" ("High" hazard category).

3.10 The tailings dams will be operated under conditions that encourage beach consolidation and minimise seepage. If required, additional seepage control works will be implemented.

3.11 Unless otherwise determined, the water management strategy for the pit will be to minimise entry of runoff water and to exclude access by stock, the public and native fauna. A water balance study for the pit and final decommissioning plan will be completed by June 1995. This will be followed by a variation to the EMOS if there is a change in the strategy outlined here.

4. Noise

The mine will respond to assist the resolution of any conflict resulting from a change in the status of noise impacts. The mine will review annually whether the implementation of a formal noise monitoring programme is required, and whether any special noise control provisions should be implemented.

5. Air quality

The mine will respond to assist the resolution of any conflict resulting from a change in the status of air quality impacts. The mine will review annually whether the implementation of a formal noise monitoring programme is required, and whether any additional dust control measures should be implemented.

6. Conservation values

The mine will respond to assist the resolution of any conflict resulting from a change in the status of conservation values. Unnecessary disturbance to fauna and flora will be minimised.

7. Heritage and cultural values

The mine will respond to assist the resolution of any conflict resulting from a change in the status of heritage or cultural values on-site.

8. Monitoring

8.1 No alteration to the monitoring programme described in Table 11 will occur without being preceded by a variation to the EMOS.

8.2 The mine will modify the water sampling regime in response to changes in site activity, so that any additional potential sources of contaminants are adequately covered by sampling sites.

8.3 Water sampling additional to that described in Section 6.2 will be carried out from time to time to provide additional information when required.

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FIGURES

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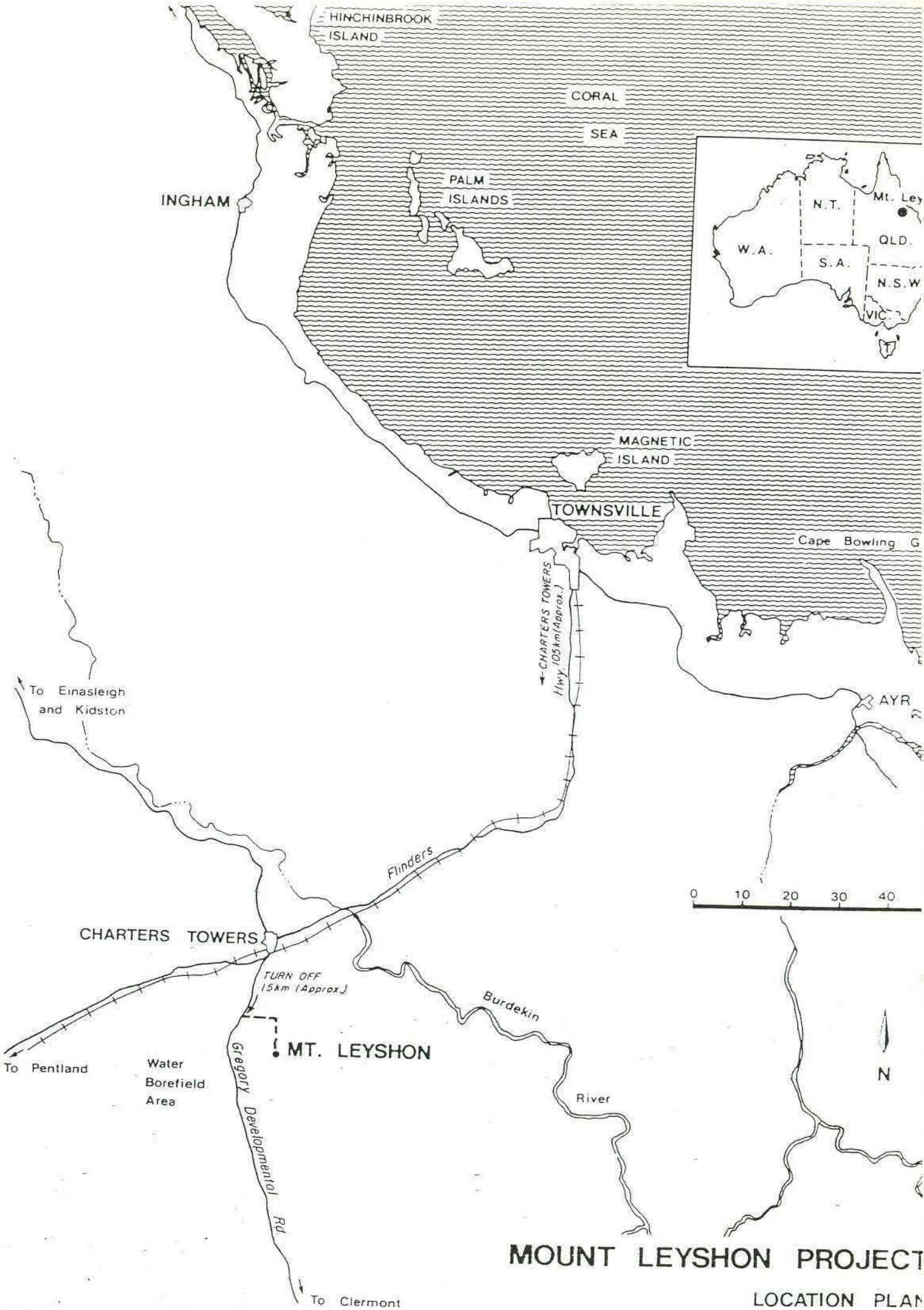
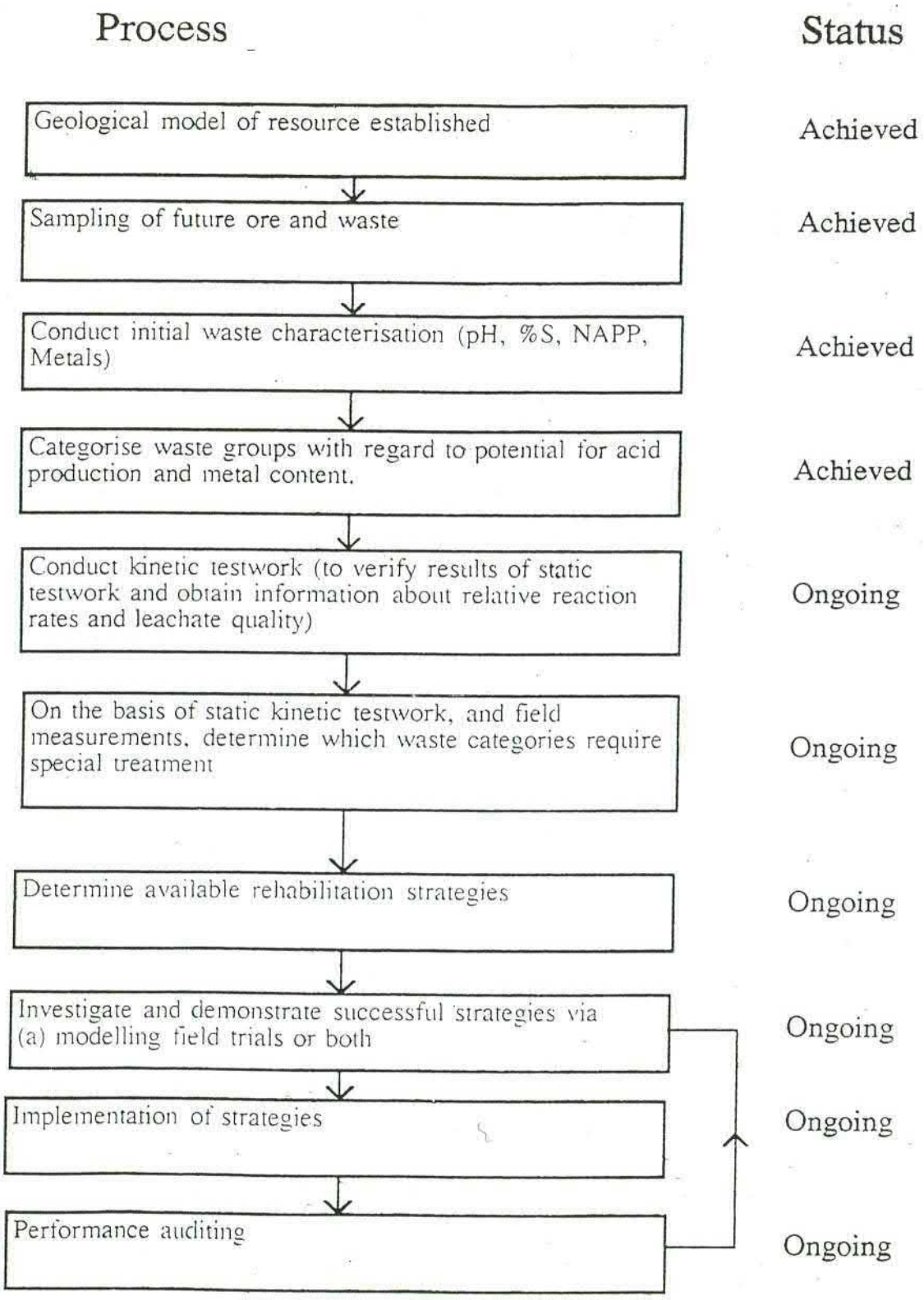


MOUNT LEYSHON PROJECT

LOCATION PLAN

FIG. 1

FIGURE 4 METHOLOGY BEING FOLLOWED FOR THE LONG-TERM CONTROL OF ACID MINE DRAINAGE AT MT LEYSHON GOLD MINE.



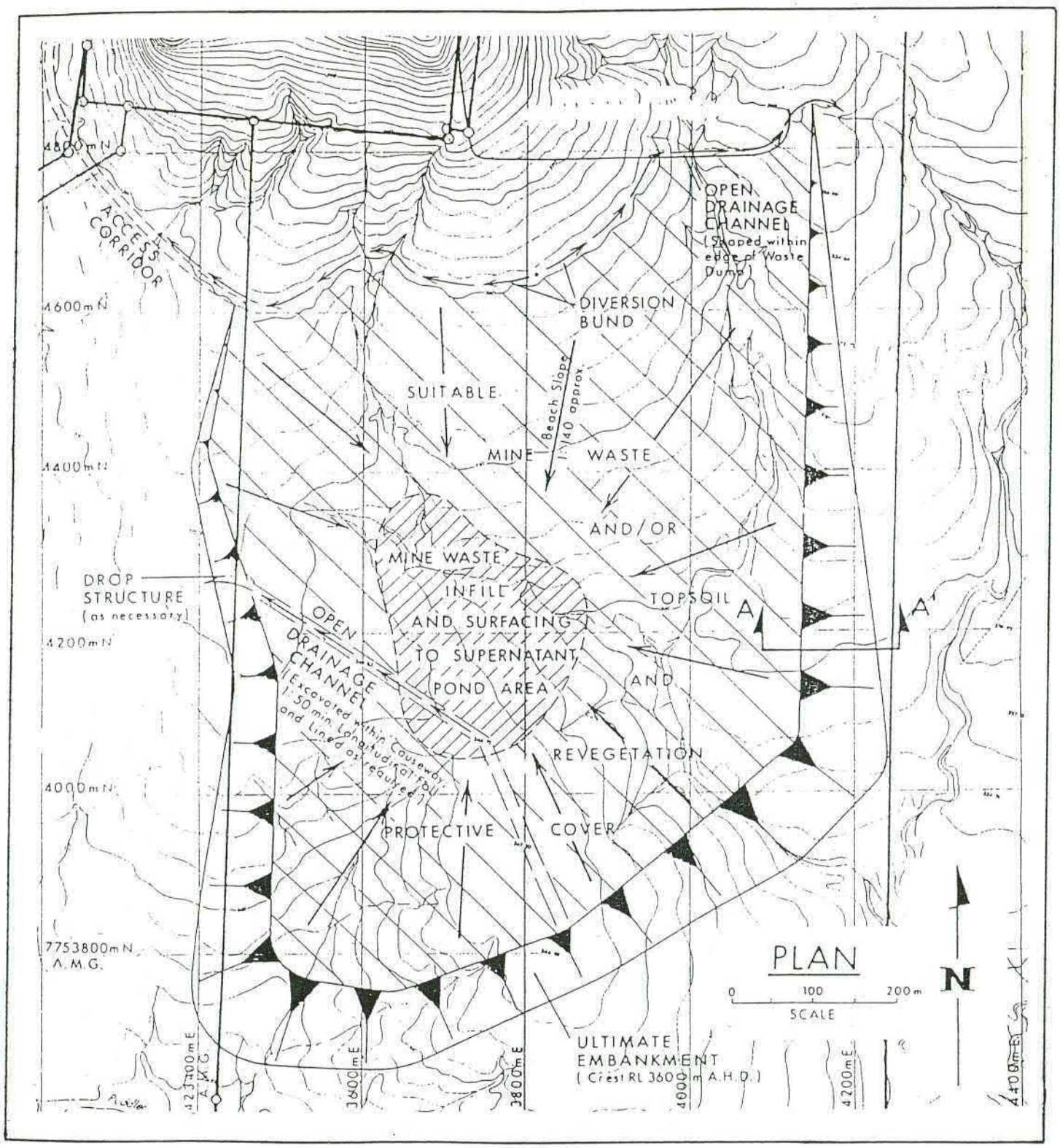


Figure 5. Provisional final landform for the Southern Tailings Dam

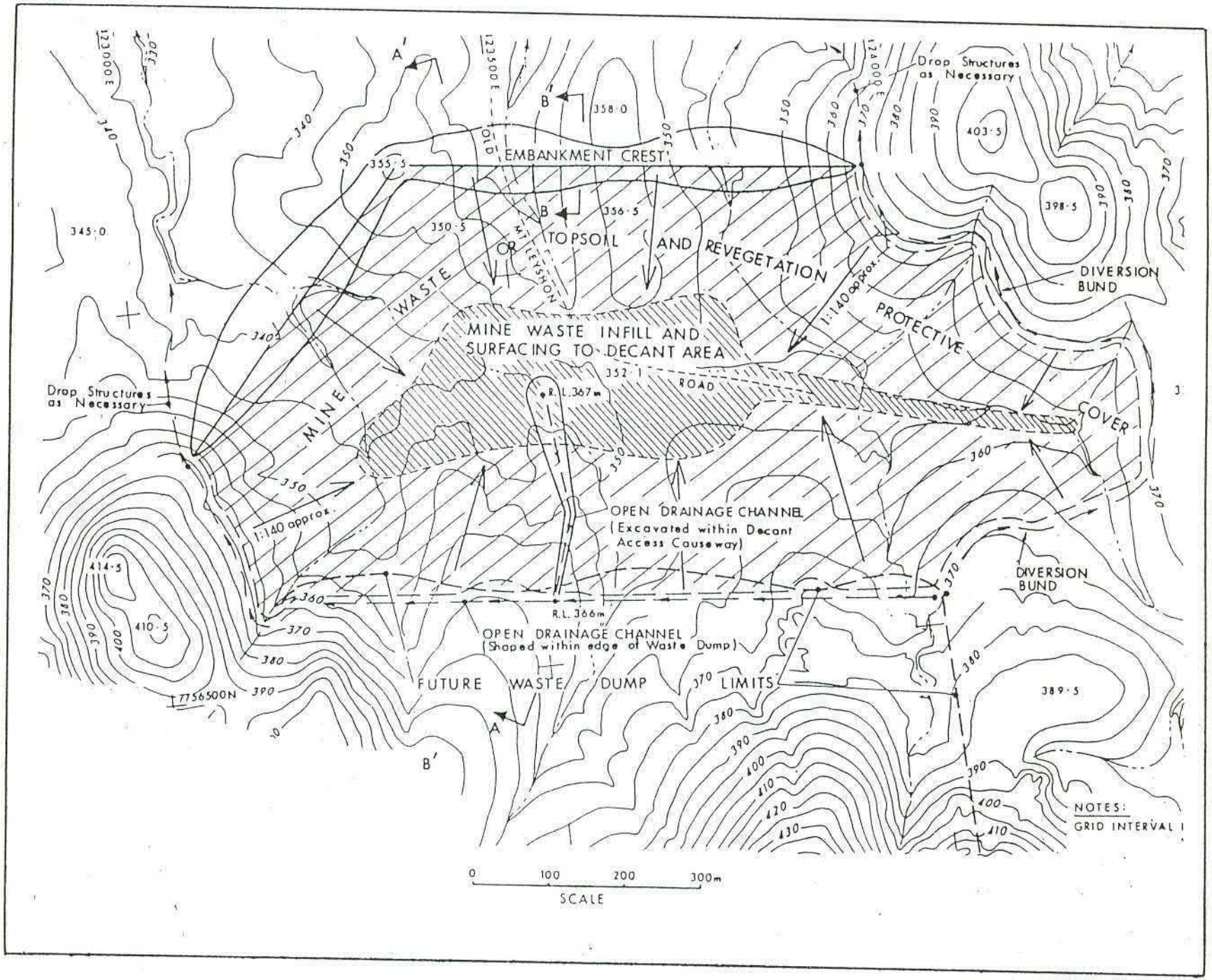


Figure 6. Provisional final land form for the Northern Tailings Dam

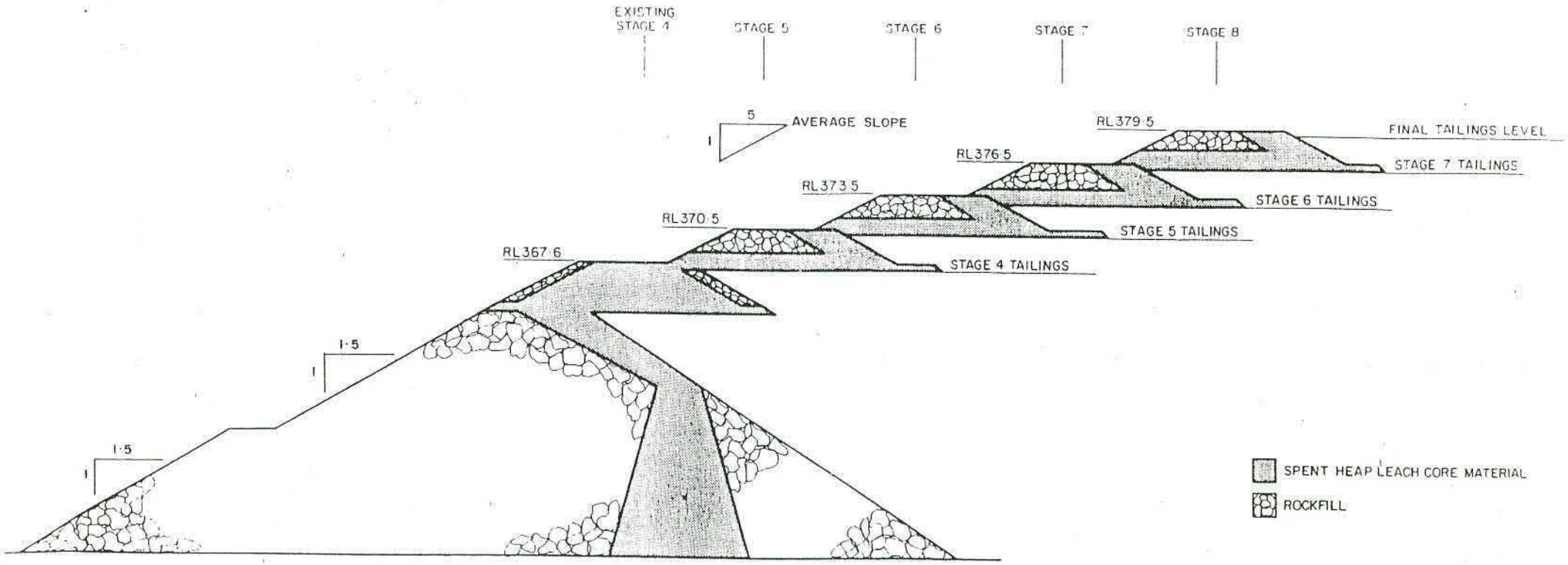


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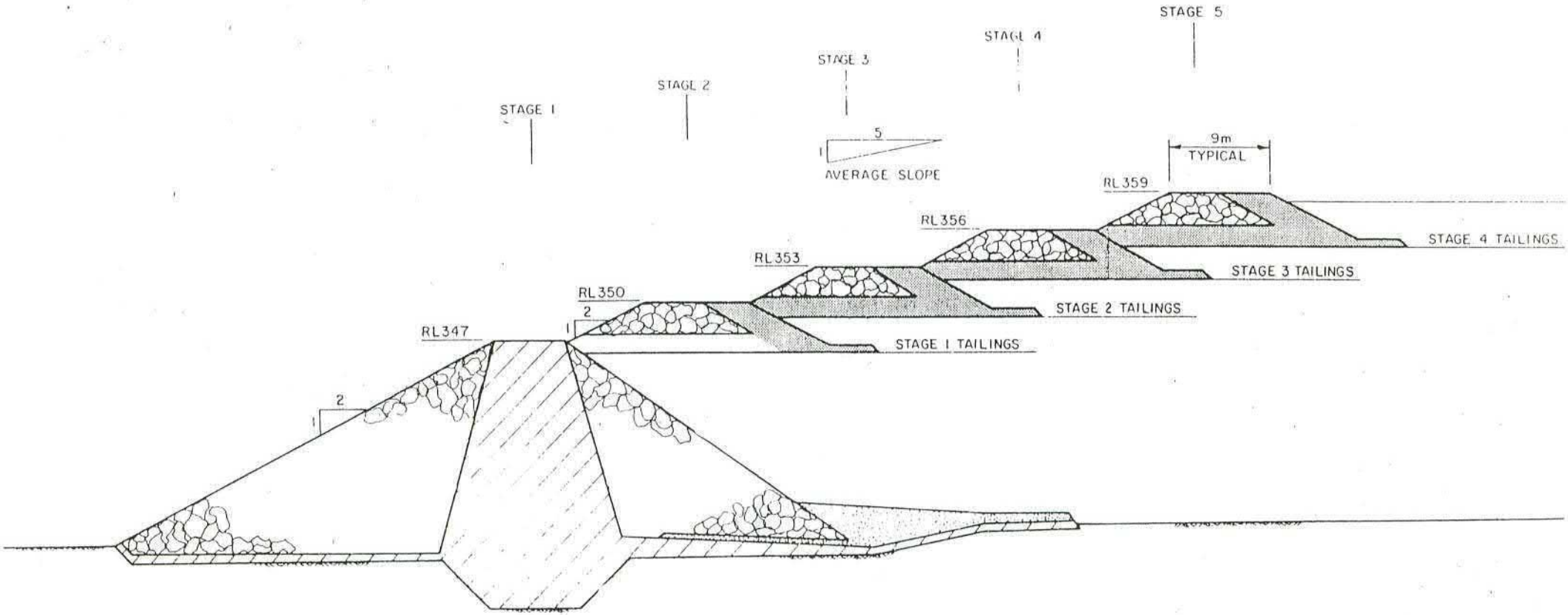
Figure 7 Representative final bank profile, Northern Tailings dam



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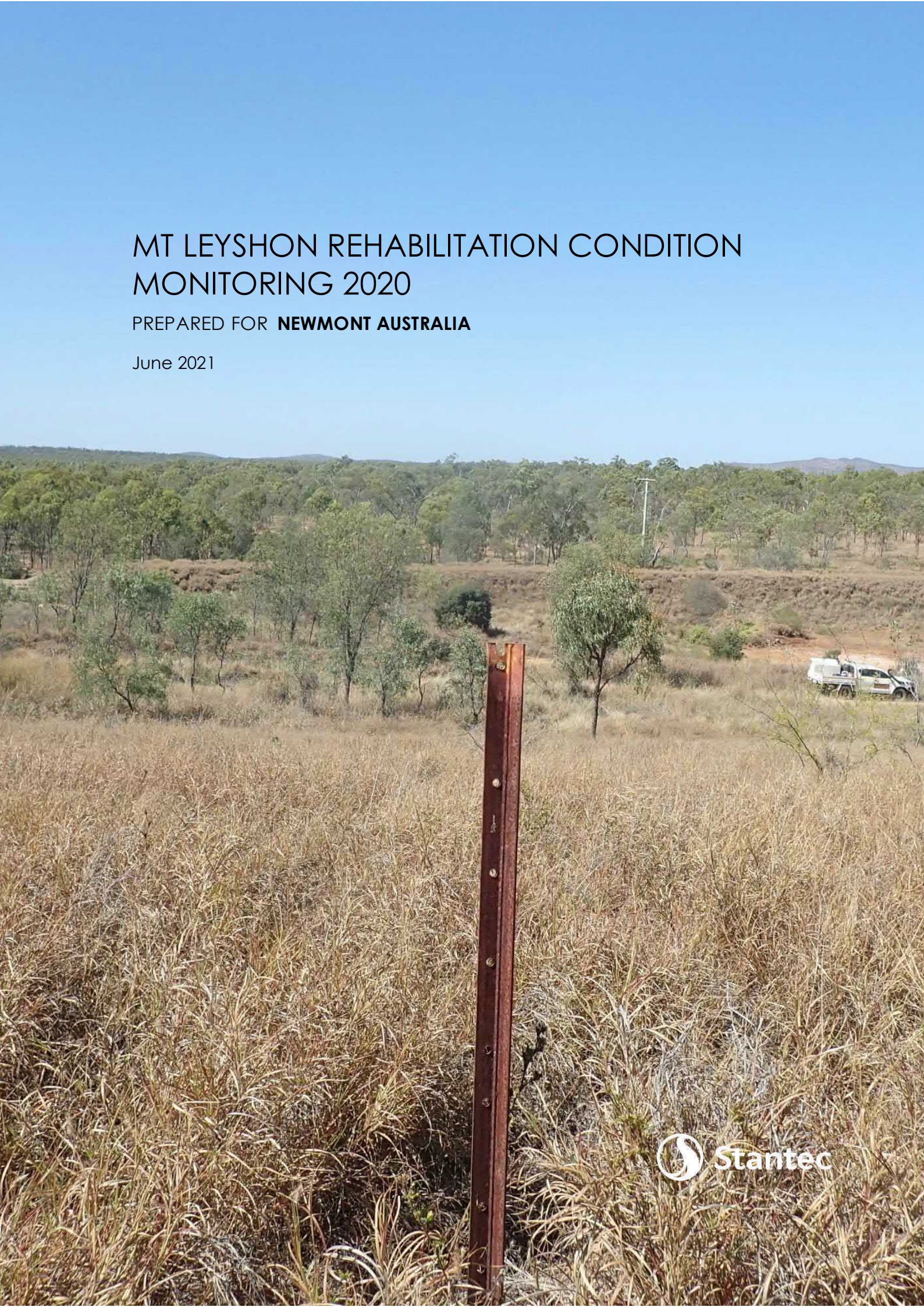
Appendix D:
Mt Leyshon Rehabilitation and Pastoral Lease Condition Monitoring 2021

MT LEYSHON REHABILITATION CONDITION MONITORING 2020

PREPARED FOR **NEWMONT AUSTRALIA**

June 2021



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Executive Summary

In October 2020, Stantec Australia undertook annual rehabilitation monitoring of the legacy Mt Leyshon Gold Mine (Mt Leyshon) in northern Queensland for Newmont Australia (Newmont). The 2020 monitoring was the eighth annual assessment utilising a monitoring method designed by Outback Ecology, to provide a 'rapid assessment' approach that satisfied monitoring requirements under the site's Environmental Authority (EA). Rehabilitation was assessed on 31 sub-domains across 11 landforms. In addition, three analogue areas were assessed for comparison to rehabilitation areas. The Rapid Assessment method, detailed in a 'handbook' provided in 2013, uses a scaled-based scoring system to calculate a rehabilitation performance score (condition score) for each landform.

Mt Leyshon landform rehabilitation performance achieved a 'good' overall condition rating at most areas in 2020. There was no change in average condition scores for the analogues or the rehabilitation areas, except for an increase at the Southern Tailings Dam and a decrease at the Processing Area, by one point at both. The New North Tailings Dam had the highest average condition score of the rehabilitated landforms and was equivalent to the analogue average, while the Northern waste rock landform (WRL) had the lowest average condition score and was performing relatively poorly compared to analogue sites, due to the bare East face which consisted of exposed waste rock with little to no soil. The main issues influencing long term rehabilitation success are the presence of Category 3 restricted flora species and erosion on some batters. As of 1st July 2016, Queensland Biosecurity Laws stipulate that all reasonable and practical measures need to be taken to minimise the risks to 'restricted' species (DAF 2016).

The soil surface of most rehabilitated areas at Mt Leyshon was stable, attributed to widespread, high grass cover and a high degree of rock incorporation into the topsoil. Most rehabilitation areas were covered in introduced and native grasses, with the most abundant being *Cenchrus ciliaris* (Buffel Grass). Overall, grasses were the dominant vegetation type, but with sparse woody shrubs also present across the landforms. The introduced herbaceous legume, *Stylosanthes* sp., was the most common non-grass species and was present on most landforms. Woody shrubs and trees were present on most landforms with *Acacia* and *Eucalyptus* as the dominant genera.

In 2020, four species, classed as restricted invasive Category 3 plants under Queensland legislation, were identified at Mt Leyshon; *Cryptostegia grandiflora* (Rubber Vine), *Parkinsonia aculeata* (Parkinsonia), *Ziziphus mauritiana* (Chinee Apple), and *Opuntia stricta* (Prickly Pear). At least one of these was recorded at all analogue and all rehabilitation sites, except Old North Tailings Dam West Flat sub-domain and New North Tailings Dam Central Flat sub-domain. No prohibited restricted invasive plants were found at Mt Leyshon. Several other 'environmental weeds' were recorded at Mt Leyshon, two of which were considered a priority for eradication by the Charters Towers Regional Council (CTRC 2019); *Calotropis procera* (Calotrope) and *Vachellia farnesiana* (Mimosa Bush).

While the populations of restricted invasive species at Mt Leyshon had not grown substantially since 2019, it is recommended that control measures continue to be employed, where practicable, to minimise the risk of existing species spreading and outcompeting native vegetation. Control of Calotrope, Mimosa Bush, and *Aerva javanica* (Kapok bush) was also recommended.

Sub-domains with dominant to abundant populations of restricted and priority weed species on the corridors or edges included:

- three sub-domains on the Eastern WRL (South West Flat, East Batters and South Batters); mainly *Cryptostegia grandiflora* (Rubber Vine) which was not confined to the edges and was potentially outcompeting native vegetation, and *Calotropis procera* (Calotrope);
- both sub-domains on the Roche Hill rehabilitation; where an increase in weed species and abundance was recorded at the Batters sub-domain, with Calotrope and Prickly Pear newly recorded. Rubber Vine was restricted to drainage lines and no impacts from weeds were noted; and
- the processing area which still had abundant weeds on corridors and edges, however, spraying had reduced their prevalence since 2019, with 2020 monitoring indicating the Rubber Vine was no longer a dominant species in the drains and was not increasing in numbers.

Overall, erosion was not a major issue at most sites, with minimal gullies present in 2020. Most gullies were not actively expanding based on visual comparison between the 2019 and 2020 assessments. Erosion management is an ongoing issue on the batters of the Southern WRL, where erosion gullies remain mostly active on the Batters sub-domain. Furthermore, some gullies on the Eastern WRL Central North Flat and

Batters sub-domains were not yet considered stable or mostly stable. Ongoing monitoring of erosion prone Batters sub-domains at Mt Leyshon should continue.

Remote sensing analysis of ground cover types and bare ground was conducted at Mt Leyshon in 2020 for both rehabilitation domains and the four analogues assessed on-ground. The objective of the assessment was to gather more quantitative and comprehensive data to support on-ground monitoring. The rehabilitation domains analysis aligned with on-ground results, which showed grass was the dominant ground cover type on both rehabilitation domains and the analogues. There was usually considerably less shrub cover on the rehabilitation then there was at the analogues. In addition, the rehabilitation generally had more ground considered bare than the analogues, however, all landforms, except the Northern WRL, had less than 20% bare ground. There was no trend in ground cover between the 2017 and 2020 imagery, however, the imagery was taken in different seasons, therefore, change detection between them was quite limited due to the seasonality of vegetation in the dry tropics.

A remote sensing analysis was also conducted on the pastoral leases surrounding Mt Leyshon. The objective of the assessment was to better understand potential risk and magnitude of sediment from the leases being eroded into the Burdekin Catchment, and ultimately out to the Coral Sea where it impacts the Great Barrier Reef. The analysis of the pastoral lease indicated five areas which had large areas of low levels of organic ground cover (<30%) in proximity to water courses. The low organic ground cover was often associated with what appeared to be cattle watering points, pastoral infrastructure, and vehicle or cattle tracks. The five areas identified may warrant further investigation on-ground to determine whether they are, or are at risk of, contributing sediment into the watercourses around Mt Leyshon. There were no trends relating to ground cover between the 2019 and 2020 imagery.

Ongoing monitoring at Mt Leyshon using the methods within this report is recommended, including the use of remote sensing to gain a more comprehensive representation of ground cover types and bare areas across the landforms and pastoral leases.

Newmont Australia

Mt Leyshon Rehabilitation Condition Monitoring 2020

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1. Introduction

The Mt Leyshon Gold Mine (Mt Leyshon) is located 30 km south of Charters Towers and 125 km southwest of Townsville, in Northern Queensland. Newmont Australia (Newmont) currently have approximately2,500 hectares (ha) of mining lease for Mt Leyshon, as well as approximately22,000 ha of pastoral leases surrounding the site. Large-scale open-cut mining operations occurred at the site between 1986 and 2001, and rehabilitation works occurred over much of the site between 1995 and 2007. Stantec has carried out rehabilitation monitoring at Mt Leyshon between 2007 and 2011 using the CSIRO-developed Ecosystem Function Analysis (EFA) framework. In 2013, Newmont commissioned Outback Ecology to design and implement a less-intense monitoring program (Outback Ecology 2013), that could be undertaken by site personnel and would still satisfy requirements under the site's newly issued Environmental Authority (EA). These requirements state:

- a rehabilitation monitoring program must be developed and be implemented by a person possessing appropriate qualifications and experience in the field of mine site rehabilitation;
- rehabilitation monitoring must be conducted on at least a yearly basis, and must include sufficient spatial and temporal replication to enable scientifically justifiable conclusions, to the satisfaction of the administering authority; and
- verification of rehabilitation success is to be carried out for each domain. Monitoring must be carried out for each domain at a minimum sampling intensity of 1:15,000 and must include sufficient replication to enable statistical analysis of results.

It is Stantec's understanding that prior to implementation of the revised monitoring approach ('Rapid Assessment'), as described in this report, the approach was discussed with Newmont personnel and submitted to the administering agency in 2013, although no comment was received.

This report presents the results of the October 2020 monitoring as well as results from the previous seven assessments using this methodology. The main objectives of the monitoring were to:

- describe the current condition of rehabilitation areas in relation to analogue sites;
- identify areas of rehabilitation where constraints to performance may require remedial actions;
- support on-ground monitoring with a remotely-sensed ground cover analysis;
- identify areas at risk of eroding sediment into waterways in the surrounding pastoral leases; and
- recommend future monitoring strategies, based on the outcomes of this assessment.

1.1 Vegetation and land use

Mt Leyshon is located within the Einasleigh Uplands bioregion (Interim Biogeographic Regionalisation for Australia; IBRA v7), an area dominated by *Eucalyptus crebra* (Narrow-leaf Ironbark) and *Corymbia erythrophloia* (Red Bloodwood) woodlands on shallow-soiled hills and slopes (Outback Ecology 2012). The mine is also within the Burdekin River Drainage Basin, with the Burdekin River discharging into the Coral Sea near Ayr (DES 2013). The major land uses in the area are cattle and goat grazing, and general agriculture (NRM 2008). The surrounding land has experienced continuous periods of disturbance since European settlement, with vegetation communities dominated by introduced flora, inclusive of intentionally-sown pasture grasses and legumes (NRM 2008). The dominant vegetation components at Mt Leyshon are the introduced *Cenchrus ciliaris* (Buffel Grass) and the nitrogen-fixing legume *Stylosanthes* spp. (Stylo), both of which occur in analogue and rehabilitation areas (Outback Ecology 2012).

Under Queensland legislation, potentially harmful introduced plant species are classified as either 'prohibited' or 'restricted' under the *Biosecurity Act 2014* (effective July 2016), and all reasonable and practical measures need to be taken to minimise the risks of restricted and prohibited species as part of a general biosecurity obligation (DAF 2016). These invasive plants are having significant adverse impacts in Queensland and it is desirable to manage them and prevent their spread, thereby protecting uninfested parts of the State (DAF 2020).

A major issue associated with grazing in the Burdekin River Drainage Basin is the loss of sediment and associated particulate nutrients through erosion into water courses. Low vegetation cover (less than 30%) is associated with an increased risk of soil erosion (Queensland Government 2020). The Great Barrier Reef receives runoff from six major drainage basins, of which the Burdekin River Drainage Basin is a major

contributor (Reef Plan 2020). The Burdekin River Drainage Basin is included within the Reef 2050 Water Quality Improvement Plan and has associated water quality targets. As part of this study, we conducted a remote sensing analysis on the pastoral leases surrounding Mt Leyshon. The objective of the assessment was to better understand potential risk and magnitude of sediment from the leases being mobilised into the Burdekin River drainage system.

1.2 Climate

Mt Leyshon is located in the dry tropical region of Northern Queensland. The closest weather station is Charters Towers Airport (station number 034084), approximately 27 km north of Mt Leyshon. It receives an annual average rainfall of 644 millimetres (mm), and mean maximum temperatures ranging from 25°C in June (winter) to 35°C in December (summer) (BOM 2020). In the 12 months prior to the 2020 monitoring, 490 mm of rain was recorded at Charters Towers, 154 mm below the long-term annual average. In contrast, above-average rainfall was received prior to the 2019 assessment, however, this was a result of above-average rainfall mostly received in February 2019. Dryer than average conditions were experienced in the two months prior to the 2020 assessment (**Figure 1-1**).

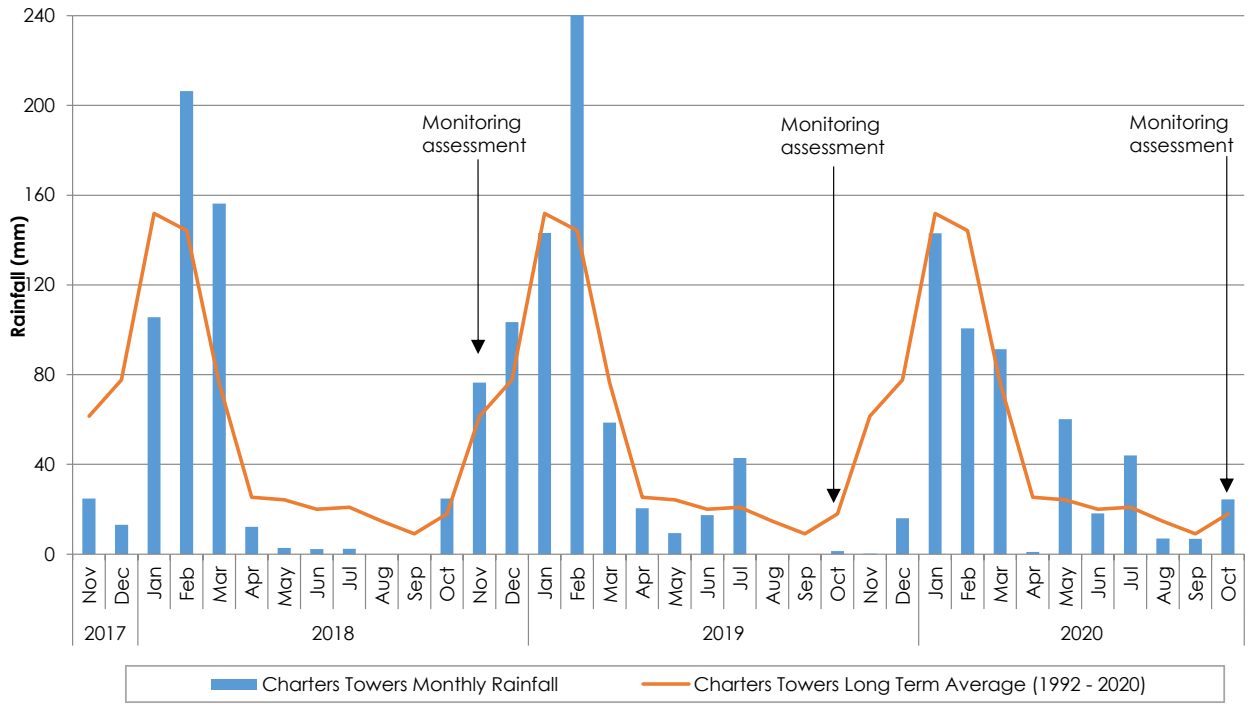

Figure 1-1: Monthly rainfall at Charters Towers Airport (station number 034084) from November 2017 to October 2020, in comparison with the long-term average (1992-2020)

2. Methods

2.1 On-ground monitoring methods

Detailed methods for the Rapid Assessment are available in the field monitoring handbook (**Appendix A**). A summary of these methods is as follows:

- each landform was separated into sub-domains, each comprising a particular age of rehabilitation, lift, and/or aspect. Areas which were homogenous and small were not sub-divided.
- a Rapid Assessment of each sub-domain was conducted, which involved assigning a scale-based score to a range of parameters relating to landform and soil surface characteristics, vegetation condition and structure, weeds and erosion (Appendix A.2.2). Each parameter score ranged from one to five, with one representing the lowest score possible and five representing the highest score possible. An aggregate numerical score from 20 parameters (maximum possible score of 100) was assigned to each sub-domain so changes in rehabilitation condition could be detected over time. All parameters were treated equally, with no numerical weighting applied. Each rehabilitation area was compared to a set of analogues. Note that a perfect score of 100 is extremely unlikely to be achieved by any site, including analogues.

In addition to the scale-based scoring, the Rapid Assessment also included:

- photo-point monitoring of existing EFA transects and installation of additional representative photograph locations;
- way-pointing (GDA94) and photographing erosion features (gullies and rills);
- way-pointing (GDA94) of restricted invasive species (such as *Opuntia stricta* (Prickly pear)), and observations of other environmental weeds;
- documenting other potential factors affecting condition (i.e. tree death); and,
- incidental notes relating to vegetation and landform condition including the observation of fauna or surface expression of potentially hostile materials.

2.1.1 Introduced species

Introduced flora species were monitored as part of the 2020 assessment, although, not all introduced species at Mt Leyshon were considered weeds, as some are considered valuable fodder for grazing (e.g. Buffel Grass or *Stylosanthes*. sp.) or are not invasive. For the purposes of this report, the term "weed" refers to species that were considered invasive under Queensland (QLD) legislation (DAF 2016) or were considered a priority for eradication by the Charters Towers Regional Council, such as *Calotropis procera* (Calotrope) (CTRC 2019).

Four introduced species identified at Mt Leyshon in 2020 were classified as restricted invasive Category 3 plants (Category 3 weed; Cat 3): *Cryptostegia grandiflora* (Rubber Vine), *Parkinsonia aculeata* (Parkinsonia), *Ziziphus mauritiana* (Chinee Apple), and *Opuntia stricta* (Prickly Pear) (DAF 2020). Other weeds that were invasive, but not classified as 'restricted invasive species', were noted and are referred to as 'environmental weeds' throughout this report. The environmental weed, *Calotropis procera* (Calotrope) was considered a priority for eradication by the Charters Towers Regional Council (CTRC 2019), while *Vachellia farnesiana* (Mimosa Bush) was considered a priority for eradication or containment. *Aerva javanica* (Kapok Bush), was considered a serious environmental weed by the QLD Government (2016).

2.1.2 Statistical analysis

Descriptive statistics (mean ± standard error) were used to compare the condition of each rehabilitation area (including all sub-domains) to the analogues over time. Small areas (e.g. ≤ 4 hectares) were not divided into more than one sub-domain when the Rapid Assessment monitoring method was initiated, therefore, their relative performance cannot be statistically assessed. These smaller areas were represented by one transect each.

2.1.3 Areas monitored

Rehabilitation across eleven landforms (domains) and 31 sub-domains, were monitored using the Rapid Assessment by two Stantec rehabilitation specialists between 12-16 October 2020 (**Table 2-1**, **Figure 2-1**). In addition, three analogue areas (with four analogue transects) were monitored for comparison with rehabilitation. Analogue sites were representative of areas undisturbed by mining activities. Analogue transects T21 and T23, were installed in 2007, while analogue transects T28 and T32, were installed in 2008.

Table 2-1: Mt Leyshon analogues, rehabilitation sites (domains) and sub-domains monitored annually from 2013 to 2020, using the Rapid Assessment method

Site	Sub-domain	Year of rehabilitation	Area (hectares)	Number of monitoring points	Transect/photo-point names
Analogues	N/A	N/A	N/A	4	T21, T28
				2	T23
				2	T32
Old North Tailings Dam	West Flat	2001	22	8	T14
	East Flat	2001	32	2	PP10, PP11
	North Face (West)	2001 (est.)	4	1	PP06
	North face (East)	2001 (est.)	2	2	PP08, PP09
New North Tailings Dam	East Flat	2005	11	2	PP03, PP04
	West Flat	2005	28	9	T15, PP07
	North Flat	2005	30	8	T16
	Central Flat	2005	25	1	PP05
	North Batters	2005 (est.)	12	2	PP01, PP02
Northern Waste Rock Landform (WRL)	Top (Flat)	1996	9	3	PP12, PP14, PP15
	East Face	1996	4	1	PP13
	South and West Faces	1996	16	1	PP16
	North Face	1996	9	2	T12
Roche Hill	Flat	2004	4	1	PP17
	Batters	2004 (re-worked 2017)	3	1	PP18, PP18b, PP18c, PP18d, PP18e
Non-Acid Forming Oxide Stockpile	N/A	2006	4	4	T30, T31
Southern Waste Rock Landform (WRL)	Flat	1995	3	1	PP19
	Batters	1995	17	2	T11
Southern Tailings Dam	Flat	1995	50	9	T10, PP20
	Batters	1995	13	5	T26, T27, PP23
Eastern Waste Rock Landform (WRL)	Southwest Flat	1995	27	16	T07, T09
	North Flat	1995	13	8	T02
	Central South Flat	1998 (est.)	22	1	PP22
	Central North Flat	1998 (est.)	34	1	PP21
	South East Batters	1998	8	2	T20
	North East Batters	2001	19	6	T01, T24
	East Batters	2000	17	6	T04, T19, T22
	South Batters	2000 (est.)	25	2	T25
Pregnant Pond	N/A	2004	1	2	T34
Processing Area	N/A	2009	2	8	T35

Site	Sub-domain	Year of rehabilitation	Area (hectares)	Number of monitoring points	Transect/photo-point names
Water Treatment Pond	N/A	2007	4	2	T33

2.2 Remote sensing

In 2020, Stantec were commissioned by Newmont to undertake a remote sensing analysis of the Mt Leyshon landforms and Newmont's surrounding pastoral leases. The aim of the analyses was to determine trends in live vegetation cover and the extent of bare areas. Specifically, the aim of the mine site landforms analysis was to supplement the on-ground assessment and determine compliance with the site's Environmental Authority (EA). The aim of the pastoral lease analysis was to assess rangeland condition surrounding the mine site, specifically to identify areas that were potential zones of resource loss into watercourses that feed into the Burdekin River.

2.2.1 Aerial imagery and spatial data

2.2.1.1 Rehabilitation domains and analogues

Stantec had previously procured an image of the Mt Leyshon landforms taken from the Worldview 3 satellite. The imagery was comprised of red, green and blue (RGB), and near-infrared (NIR) bands and was in a raster file format at a 50 centimetre (cm) resolution. The image was captured in December 2017.

In 2020, Stantec procured another archived multispectral image of the Mt Leyshon landforms. This image was captured by the Pleiades 1 Satellite on the 30th of June 2020. This image also contained RGB and NIR bands and was captured at 50 cm resolution.

2.2.1.2 Pastoral leases

Satellite imagery from the Sentinel 2 satellite provides a cost-effective means of analysing large areas such as pastoral leases. The Sentinel 2 satellite provides multispectral imagery comprised of 13 spectral bands across the RGB, red-edge, NIR and shortwave infrared (SWIR) wavelengths, ranging from 10 m to 60 m resolution. RGB and NIR bands are available at 10 m resolution and were used for this study.

A shapefile containing polygon data of Newmont pastoral lease boundaries was provided by Newmont to Stantec. The pastoral lease shapefile was used to select archived imagery of the pastoral leases captured by the Sentinel 2 satellite. Images captured in October 2019 and October 2020 were selected for analysis. The timing of image capture coincided with the 2019 and 2020 on-ground assessments.

2.2.2 Survey Areas

The rehabilitation domain demarcations displayed in **Figure 2-1** were utilised for the remote sensing analysis. The target size of the analogue areas (polygons) analysed was determined by using the average size of a rehabilitation domain, which was 6 ha. The shape of the polygons was drawn to avoid disturbance. All analogue polygons were 6 ha in size, except T2, whose size was limited to 3.4 ha by visibly altered or cleared land, and the Eastern WRL.

The pastoral lease boundaries provided by Newmont were used for analysis of the larger area.

2.2.3 Analysis

Images were assessed for cover categories using object-based image analysis (OBIA) and ground cover analyses detailed below. The results were compared to detect changes between 2017 and 2020 for the rehabilitation domains and analogues areas, and for 2019 and 2020 imagery for the pastoral leases.

2.2.3.1 Object-Based Image Analysis (OBIA)

ESRI ArcGIS Pro software was used to segment image pixels into larger 'objects' based on spectral and spatial similarities, before the Normalised Difference Vegetation Index (NDVI) was used to measure vegetation 'greenness' and therefore, condition. The index is calculated using the NIR and red bands, using the following equation:

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

The software was then 'trained' to recognise cover classes in the imagery, using a supervised OBIA classification method. Parameters were adjusted to best suit the target features, to enable creation of the most unique object statistics for each feature, using all spectral reflectance attributes (RGB, NIR, NDVI), along with size and shape properties. The result is an image classified into 'Bare ground', 'Grass', 'Litter', 'Shrub', 'Shadow' and 'Water' cover classes.

Ground-truthing data would ideally be collected to train the OBIA model to differentiate between cover classes as accurately as possible, based on real-world observations. In the absence of available ground-truthing, training data was created by inspecting the imagery closely, in conjunction with photos taken in the field, to best guess which areas most likely represented the target cover classes. For this reason, misclassification errors will exist, especially between similar classes such as grass and shrub. Testing the model outputs for accuracy would also require ground-truthing data.

It should also be noted that any classification is subject to error, depending on how unique the properties of the target features are compared to their neighbours. The size of the features also makes a difference, in relation to the resolution of the imagery, as well as the number of spectral bands available for use.

In the pastoral lease analyses, the coarser nature of the Sentinel 2 imagery (10 m vs. 50 cm), means that natural 'averaging' of the underlying cover exists. For example, small areas of bare ground and live vegetation within a single 10 m pixel may be 'averaged' into one class or the other, reducing overall accuracy. This is a limitation of using coarser resolution imagery, but also the reason it is suitable for regional analyses rather than detailed local analysis.

2.2.3.2 Ground Cover Analysis

To help pick out 'hotspots' of low vegetation cover or bare ground, a moving average approach was employed, whereby a search window is passed over the classified image to calculate an average cover value for each pixel, based on the proportion of cover (shrub, grass or litter) against bare ground, within the target pixel and its neighbouring pixels. The result of this moving average is a surface that smooths out local fluctuations in cover but highlights significant concentrations of low (or high) cover.

The search window was set at 30 m x 30 m for the mine area (seen as a reasonable measure similar to on-ground monitoring quadrats), and 50 m x 50 m for the pastoral lease area (to account for the larger pixel size). The results were then classed into cover categories based on these average values: <30% cover, 30-50% cover, and >50% cover.

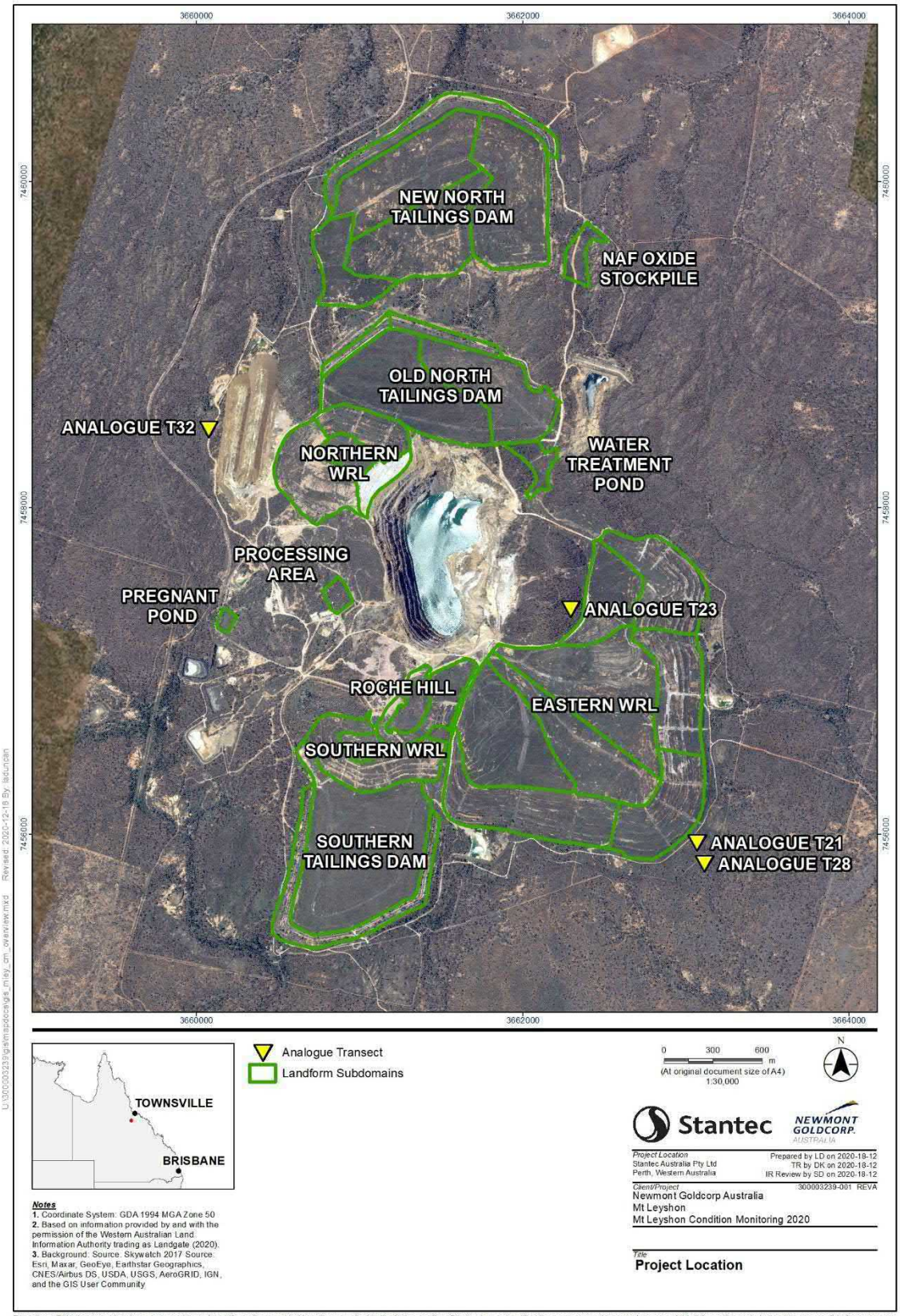

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Figure 2-1: Landforms (domains) and analogues monitored in 2020 at Mt Leyshon

3. Results and discussion

Site description summaries and Rapid Assessment results are presented below. Raw Rapid Assessment monitoring data with photos from photo-points are provided in **Appendix B**. Transect photos from all available monitoring years are presented in **Appendix C**. Current and historical (2013 to 2020) condition score averages (and standard errors) for each landform and analogues are presented in **Appendix D**. Weed species, weed ratings/severity and locations (sub-domains) are summarised in **Appendix E.** Maps associated with the OBIA analyses in (**Appendix F**).

3.1 Analogues

Transect T21 (grassland analogue) was located on a gently-sloping, grassy area near the south-eastern tip of the Eastern WRL. As detailed in previous monitoring reports (Outback Ecology 2012), this site was dominated by introduced Buffel Grass, and legume species *Stylosanthes* spp., with sparse mid and upper storey vegetation strata present (**Figure 3-1**). The gentle slope of the grassland analogue area and surrounding area was most comparable to flat rehabilitation areas.

Figure 3-1: Grassland analogue transect T21 start in 2019 (left) and 2020 (right)

Transect T23 (*Eucalyptus/Acacia* grassland analogue) was located on a sloping wooded area between the Mt Leyshon pit and the Eastern WRL. Vegetation was described as dense grassy understorey dominated by Buffel Grass covered by a moderately dense upper storey of *Eucalyptus crebra* (Narrow-leaf Ironbark), tall *Acacia* species and other *Eucalyptus* species (**Figure 3-2**). T23 was the steepest of the analogue areas monitored and was an appropriate reference for most sloping rehabilitation areas.

Figure 3-2: *Eucalyptus/Acacia* grassland analogue transect T23 start in 2019 (left) and 2020 (right)

Transect T28 (*Eucalyptus/Corymbia* grassland analogue) was in a sparse woodland southeast of the Eastern WRL. It had an open upper storey comprised mostly of *Eucalyptus crebra* (Narrow-leaf Ironbark), and a lower storey dominated by native grass species (Outback Ecology 2012). It was selected to

compliment analogue transect T21, with the transects being adjacent to one another, although on opposing sides of the mine lease boundary. Transect T28 and the surrounding area were gently sloping and considered an appropriate reference site for flat rehabilitation areas (**Figure 3-3**).

Figure 3-3: *Eucalyptus/Corymbia* grassland analogue transect T28 in 2019 (left) and 2020 (right)

Transect T32 (mixed *Acacia/Eucalyptus* analogue) was composed of an upper storey dominated by *Acacia* and *Eucalyptus* species, and a lower storey dominated by the introduced *Melinis repens* (Red Natal Grass) (Outback Ecology 2012). The transect and surrounding area was moderately sloped, and was comparable to sloping rehabilitation areas, in particular those that support grasses other than Buffel Grass (**Figure 3-4**).

Figure 3-4: Mixed *Acacia/Eucalyptus* analogue transect T32 start in 2019 (left) and 2020 (right)

In 2020, the analogue areas achieved an average condition score of 76, with no change since 2019 (**Table 3-1**). The analogues had the highest average score compared with the rehabilitation; a trend observed since 2013 (**Appendix D**). The consistently high scores of the analogue sites reflect the stable soil characteristics, thick lower storey vegetation, well-developed upper storey vegetation, and a lack of erosion features. The scores calculated for the analogue sites represent a benchmark for the rehabilitation areas.

Table 3-1: Condition scores achieved by analogue sites in 2020

Analogues	Condition Score (2020)	Difference from 2019
T21 and T28	79	0
T23	73	0
T32	77	0
Average	76	0

3.1.1 Soil

Overall, the analogue sites had very stable soil surfaces, with no evidence of erosion or loss of material. The presence of high vegetation cover, primarily comprised of dense grasses, stabilised the soil surface by the introduction of organic material such as roots and litter which bind the soil particles together, as well as promoting infiltration and nutrient cycling. Large rocks and aggregated stony soil also assisted in stabilising the soil, limiting sheeting erosion.

3.1.2 Vegetation

All analogue areas were dominated by high grass cover with some form of upper storey dominated primarily by *Eucalyptus crebra* (Narrow-leaf Ironbark) or *Acacia* species. Buffel Grass was the most prevalent species across the analogue areas, dominating all analogues sites. Other species present at the analogue sites included *Stylosanthes* sp., *Acacia* spp., and *Eucalyptus* spp., all of which contributed to the overall high vegetation cover. Upper storey canopy cover was dominated by *Eucalyptus* spp. and *Corymbia* spp. Mid-storey strata was the least dense and the least diverse stratum across all analogue sites, most likely a result of the mature upper storey canopy outcompeting mid-storey species, such as smaller *Acacia* spp. Similarly, herb cover was limited across the analogue areas due to dense grass cover outcompeting herbaceous species.

3.1.3 Weeds

Three Category 3 weeds, Rubber Vine, Prickly Pear, and Chinee Apple were identified at the analogue areas in 2020. Rubber Vine was not recorded on the analogues in 2019 and it was only noted at analogue transect T23. *Opuntia stricta* was scattered in the area surrounding transect T23 and one individual was found near transect T32, while Chinee Apple was at all analogues except T32. The environmental weeds, Mimosa Bush and Red Natal Grass were also recorded at T23, and weeds at this analogue appeared to be outcompeting native shrubs. Red Natal Grass was also found at T21 and T28, with the potential to colonise a large area.

3.1.4 Habitat

All the analogue sites had very high terrestrial and arboreal habitat value. Numerous faunal niches were available in the form of dense grass cover, large rocks, litter, logs, mostly moderate to high woody species cover, including tall trees. Evidence of utilisation by kangaroos and birds were noted at all analogue sites, while rabbits, ants, grasshoppers, skinks, and spiders were also recorded on one or more analogue site. Cattle grazing and scats were observed at analogue T28.

3.1.5 OBIA classification

All analogue areas assessed in 2017 and 2020 had few bare areas and were dominated by grass and shrub cover (**Figure 3-5**; **Appendix F**). All analogue sites comprised of high grass and high shrub cover, however, the proportions of each varied between analogues sites and between years. The proportion of the analogues that were assessed as litter also varied substantially between areas and years. The variation between 2017 and 2020 values was most likely due to the different time of year the imagery was captured: December ("wet-season") for 2017 and June ("dry-season") for 2020.

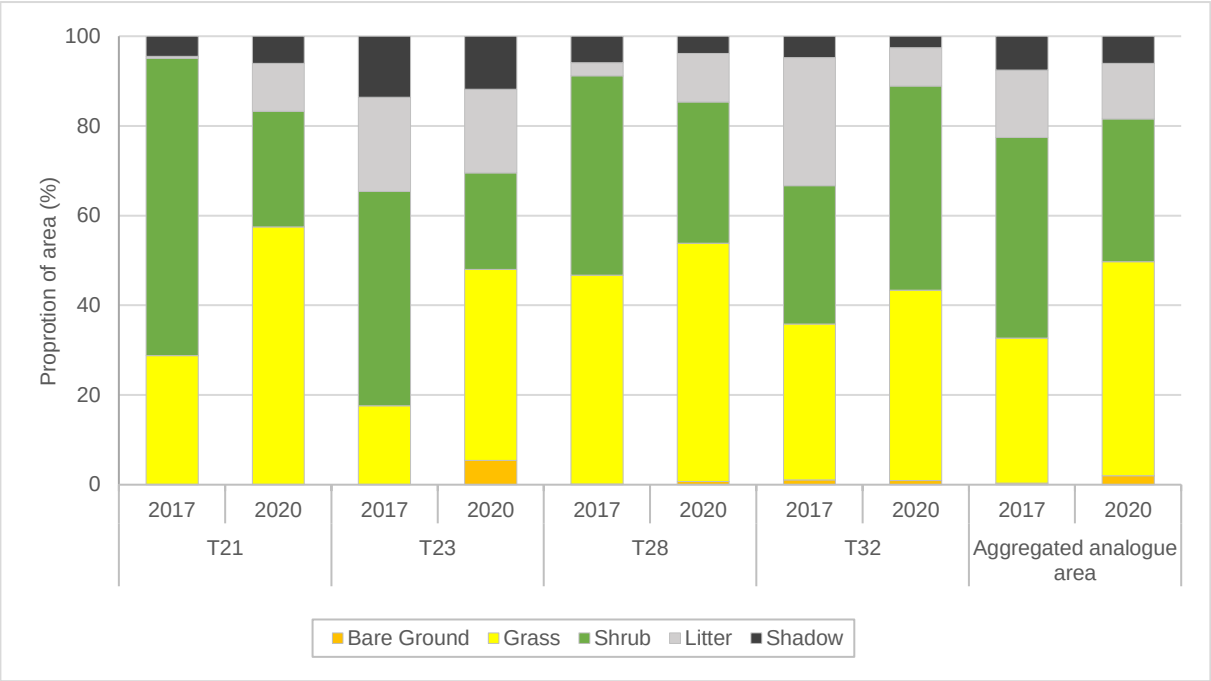

Figure 3-5: Proportion of ground cover types on analogues areas in 2017 and 2020 based on analysis of satellite imagery

3.2 Rehabilitation

3.2.1 Old North Tailings Dam

Old North Tailings Dam rehabilitation works were completed in 2001 and the area was divided into four sub-domains; East Flat, West Flat, North Face (East) Batters, and North Face (West) Batters (**Figure 3-7**). One transect, T14 consisting of four sub-transects (A-D) (**Figure 3-6**), was established on the West Flat sub-domain in 2007 and five photo-points were established on the remaining sub-domains in 2013.

Figure 3-6: Old North Tailings Dam West Flat sub-domain transect T14A end in 2019 (left) and 2020 (right)

In 2020, the average condition score for the Old North Tailings Dam rehabilitation was 69, which was the same as the previous assessment in 2019 and was seven points lower than the average analogue score (**Table 3-2**). This score was also lower than all assessments prior to 2019 (**Appendix D**). The condition scores for the flat sub-domains were greater than the batters sub-domains.

Table 3-2: Condition scores achieved by the Old North Tailings Dam rehabilitation, in comparison with the analogue average in 2020

Sub-domain	Condition Score (2020)	Difference from 2019
East Flat	77	-1
West Flat	76	0
North Face (East) - Batters	60	+2
North Face (West) – Batters	63	0
Rehabilitation average	69	0
Analogue average	76	0

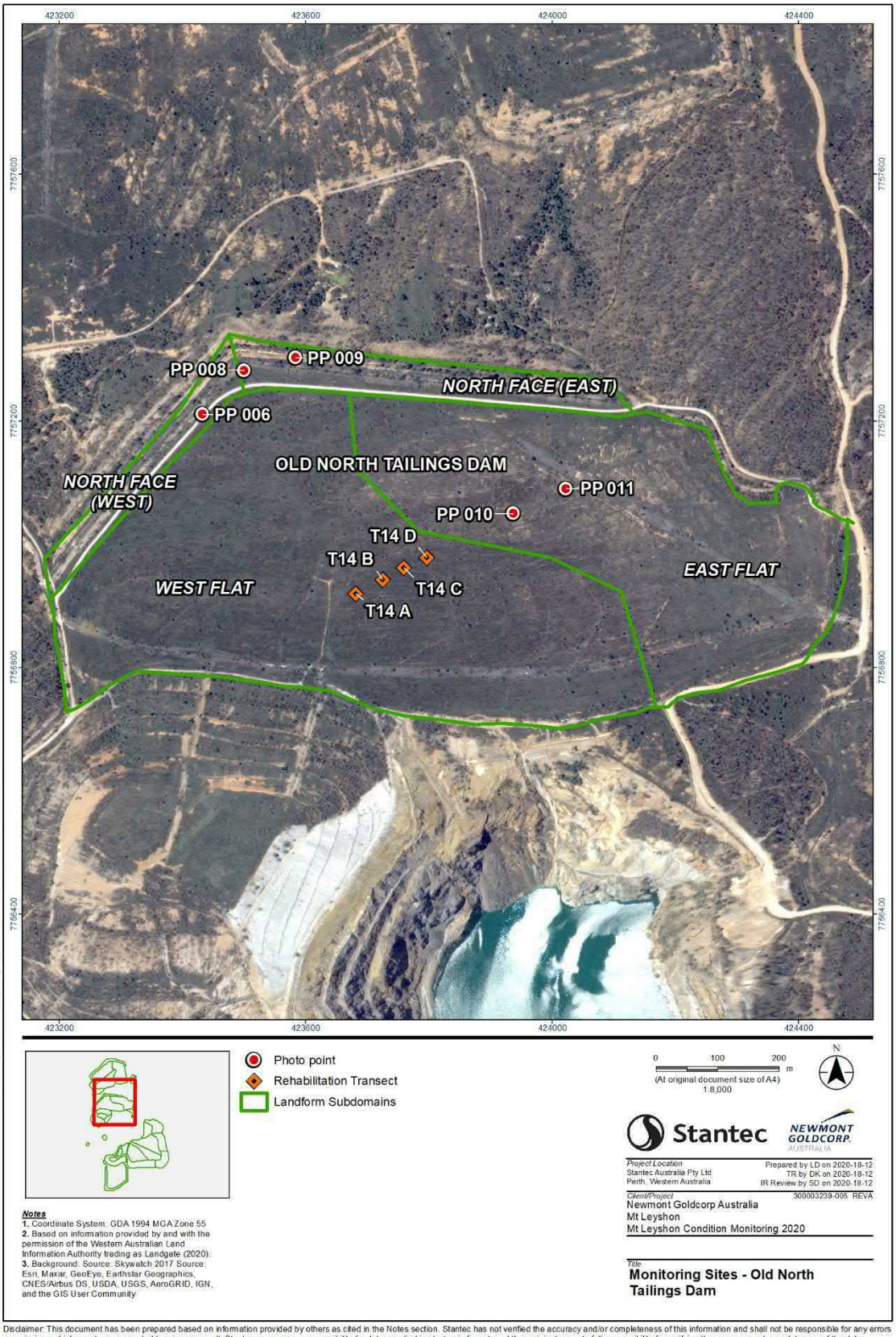

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Figure 3-7: Old North Tailings Dam with sub-domains and 2020 monitoring locations

3.2.1.1 Soil

The soil surface stability of the flat sub-domains was high due to the flat topography, dense grass cover and a high degree of rock incorporation into the topsoil. The soil condition for the batters sub-domains was lower, mostly due to the steeper slopes and lower grass cover on these areas compared to the flat sub-domains.

3.2.1.2 Vegetation

Vegetation on the rehabilitation was mostly dominated by native and introduced grasses, with Buffel Grass contributing most of the cover. Grass cover was high on the flat sub-domains and ranged from low to moderate on the batters sub-domains. Herbaceous species had low to moderate cover on the flat sub-domains, while woody species had low to patchy cover (for plants <1.5 m tall) to patchy cover (for plants >1.5 m tall) and consisted mainly of *Acacia* spp. In comparison, herbaceous cover was low on the batters sub-domains, while woody species for both height classes provided patchy cover, consisting of a mixture of *Acacia* and *Eucalyptus* species. Species richness for all vegetation classes were generally low across the Old North Tailings Dam locations.

3.2.1.3 Weeds

Restricted Category 3 weed Rubber Vine, and environmental weed Red Natal Grass, were present in scattered clusters on the batters sub-domains, with a minor impact on native vegetation noted. In addition, Rubber Vine was also recorded on the East Flat sub-domain in 2020 and was absent in the previous assessment. Environmental weeds such as Mimosa Bush and Kapok Bush were recorded on the East Flat and North Face (East) Batters sub-domains.

3.2.1.4 Erosion

Gullies and rills were recorded on the batters, although these were mostly stable or becoming stable. No erosion was present on the flat sub-domains.

3.2.1.5 Habitat

The flat sub-domains had high terrestrial habitat value, while the batters sub-domains had moderate terrestrial habitat value. Arboreal habitat was patchy on all sub-domains, except the North Face (East) batters where it was high. There was evidence of kangaroos, birds, rabbits, across the rehabilitation areas. Skinks and grasshoppers were also recorded on the batters sub-domains, while there was evidence of wallabies and dingos on the flat sub-domains.

3.2.1.6 OBIA classification

The remote sensing OBIA analysis showed the Old North Tailings Dam was dominated by grass, with sparse shrubs (**Figure 3-8; Appendix F**), supporting on-ground observations in 2020. Compared to the aggregated analogue ground cover values, the rehabilitation had more grass cover and notably less shrub cover, however, there was a similar amount of bare ground between the two. Grass cover on the rehabilitation did not change substantially between 2017 and 2020, despite the 2017 imagery capture occurring in the "wet-season", and 2020 in the "dry-season".

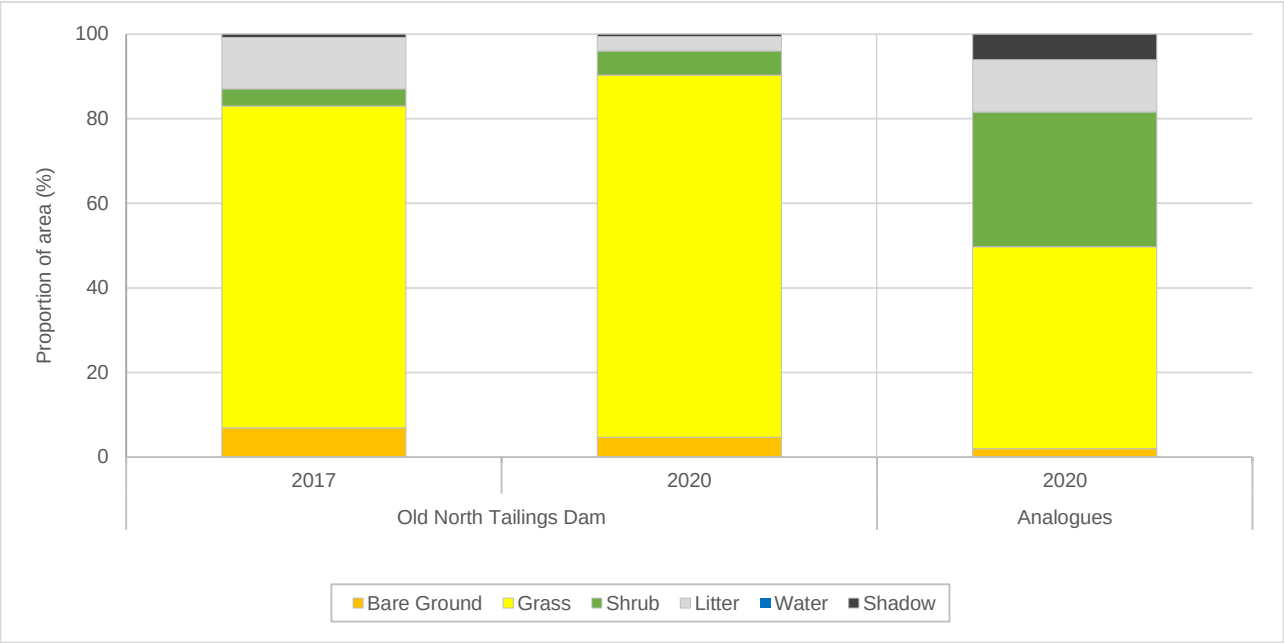

Figure 3-8: Proportion of ground cover types of the Old North Tailings Dam rehabilitation in 2017 and 2020, based on image analysis, compared to the analogue areas in 2020.

3.2.2 New North Tailings Dam

Rehabilitation works on the New North Tailings Dam landform occurred in 2005. The New North Tailings Dam was divided into five sub-domains, four on the flat areas and one on the north batters (**Figure 3-10**). In 2007, two transects, T15 and T16, were established on the West Flat and North Flat sub-domains (**Figure 3-9**). Photo-points established in 2013 were present on all sub-domains. Some areas on the batters do not appear to be rehabilitated as they consisted of only loose rock, especially on the lower lift.

Figure 3-9: New North Tailings Dam West Flat sub-domain transect T15a end in 2019 (left) and 2020 (right)

The average condition score for the New North Tailings Dam was 76, equivalent to the analogue average and the 2019 assessment (**Table 3-3**). The West Flat, East Flat and Central Flat sub-domains had the highest condition scores, all of which were higher than the average analogue score. Although the condition score for the North Batters sub-domain increased since 2016, it remained below the average analogue score (**Appendix D**). In contrast, the condition score for the North Flat sub-domain has decreased since 2016.

Table 3-3: Condition scores achieved by the New North Tailings Dam rehabilitation, in comparison with the analogue average in 2020

Sub-domain	Condition Score (2020)	Difference from 2019
West Flat	81	0
North Flat	73	0
East Flat	80	0
Central Flat	81	0
North Batters	67	0
Rehabilitation average	76	0
Analogue average	76	0

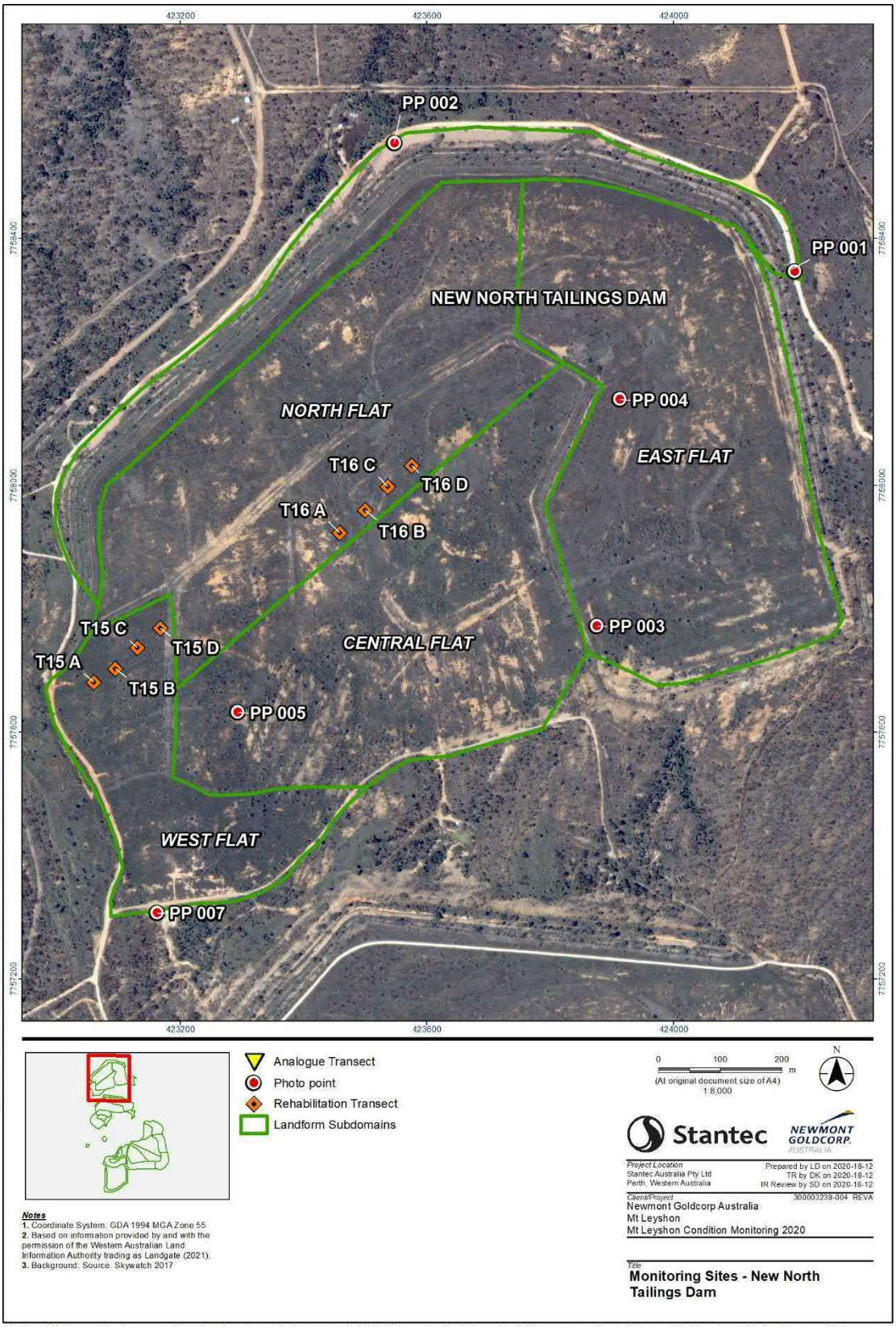

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Figure 3-10: New North Tailings Dam with sub-domains and 2020 monitoring locations

3.2.2.1 Soil

The soil surface on the New North Tailings Dam flat sub-domains was very stable, attributed to a high degree of rock incorporation into the topsoil, and high vegetation cover. Although the North Batters sub-domain also had a high degree of rock incorporation into the topsoil, the steep slope angle allowed for the formation of minor rills, resulting in slightly lower soil surface stability.

3.2.2.2 Vegetation

Vegetation on the New North Tailings Dam consisted mostly of native and introduced grasses, varying in cover from moderate on the North Batters sub-domain to high across the flat sub-domains. Grass cover consisted almost entirely of Buffel Grass. The cover of herbaceous plants ranged from low to moderate across the rehabilitation. Woody species (< 1.5 m and > 1.5 m tall; mainly *Acacia* spp.) were present on all sub-domains and generally provided patchy to moderate cover. *Eucalyptus* spp. were also present on the North batters.

3.2.2.3 Weeds

Rubber Vine (Category 3 plant) was recorded at all the New North Tailings Dam sub-domains, except for the Central Flat sub-domain. Restricted species, Chinee Apple and Parkinsonia, were present on the North Flat and East Flat sub-domains, with the Parkinsonia outcompeting native vegetation in some areas, particularly at the North Flat sub-domain. In 2020, the environmental weed Kapok Bush, was no longer present across the North Batters sub-domain, however, Red Natal Grass and Stinking Passionflower were newly recorded, mostly found on edges.

3.2.2.4 Erosion

Some rills were present on the North Batters sub-domain, appearing to have increased since the previous assessment. No erosion features were recorded on the remaining New North Tailings Dam sub-domains.

3.2.2.5 Habitat

There was a high degree of terrestrial habitat on the flat sub-domains of the New North Tailings Dam rehabilitation, while the North Batters sub-domain provided a moderate level of terrestrial habitat. Arboreal habitat ranged from patchy to high across the flat sub-domains, with it was high at the North Batters sub-domain. Kangaroos were found across all sub-domains, with feral pigs, dogs, rabbits, lizards, snakes, and birds recorded at multiple sub-domains. Birds were abundant on the North Batters sub-domain where arboreal habitat value was high.

3.2.2.6 OBIA classification

Similar to the analogues, the New North Tailings Dam rehabilitation area was mostly composed of living vegetation cover, with notably smaller areas covered by litter or bare (**Figure 3-11; Appendix F**). However, the rehabilitation was notably different to the analogues in 2020 because it comprised of substantially more grass and substantially less shrub cover.

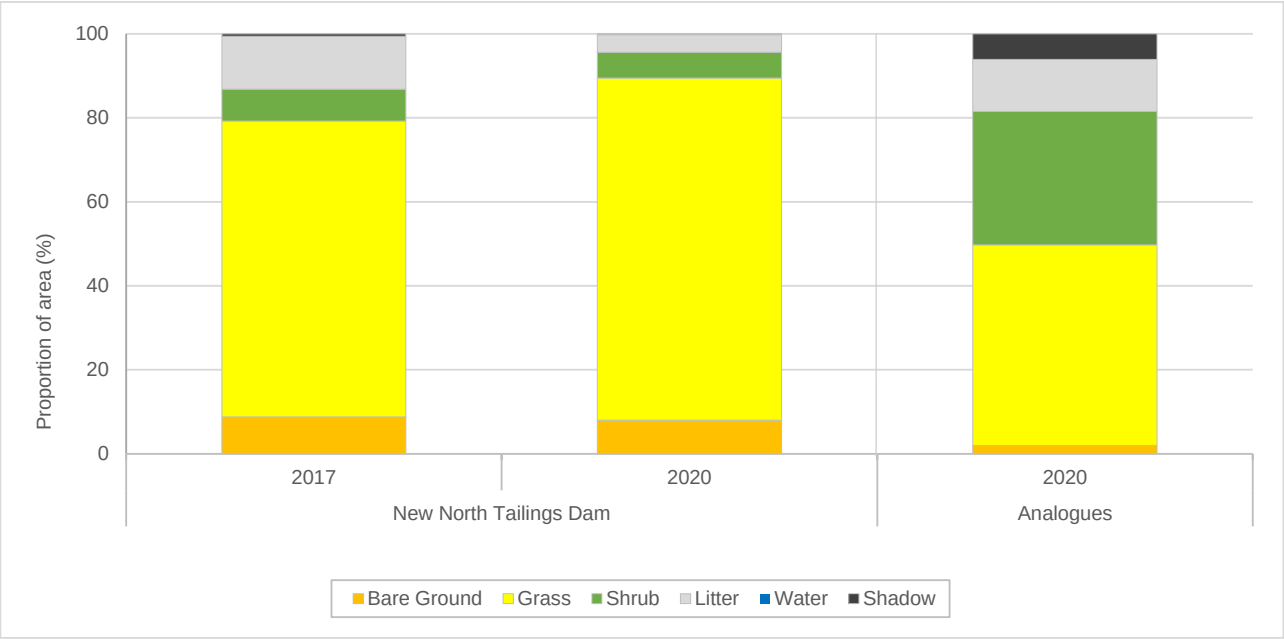

Figure 3-11: Proportion of ground cover types of the New North Tailings Dam rehabilitation in 2017 and 2020, based on image analysis, compared to the analogue areas in 2020.

3.2.3 Northern WRL

Rehabilitation of the Northern WRL was completed in 1997, with a surface profile described as topsoil spread over heap leach material. In 2007, transect T12 was established on the North Face sub-domain, with sub-transect A located on the steep upper batter (**Figure 3-12**) and sub-transect B on the lower batter. Photo-points were established on the Southwest Face, East Face, and Top (Flat) sub-domains in 2013. The landform was divided into four sub-domains; North Face, South and West Face, East Face, and Top (Flat) (**Figure 3-13**) for the purposes of this assessment.

Figure 3-12: Northern WRL North Face sub-domain transect T12A end in 2019 (left) and 2020 (right)

The average condition score for the Northern WRL rehabilitation was 56 in 2020, the same as the previous assessment and below the analogue average (**Table 3-4**). This was the lowest average score of all the rehabilitation areas monitored. Condition scores for individual sub-domains did not change, with the East Face sub-domain scoring the lowest (lowest score on the landform and across all Mt Leyshon rehabilitation areas), with a condition score of 35, due to unfavourable soil characteristics for plant growth. In contrast, the Top (Flat) sub-domain was the best performing area on the landform, with a score of 70, although the condition score had decreased by six since 2018 (**Appendix D**).

Table 3-4: Condition scores achieved by the Northern WRL rehabilitation, in comparison with the analogue average in 2020

Sub-domain	Condition Score (2020)	Difference from 2019
North Face	59	0
East Face	35	0
South and West Face	59	0
Top (Flat)	70	0
Rehabilitation average	56	0
Analogue average	76	0

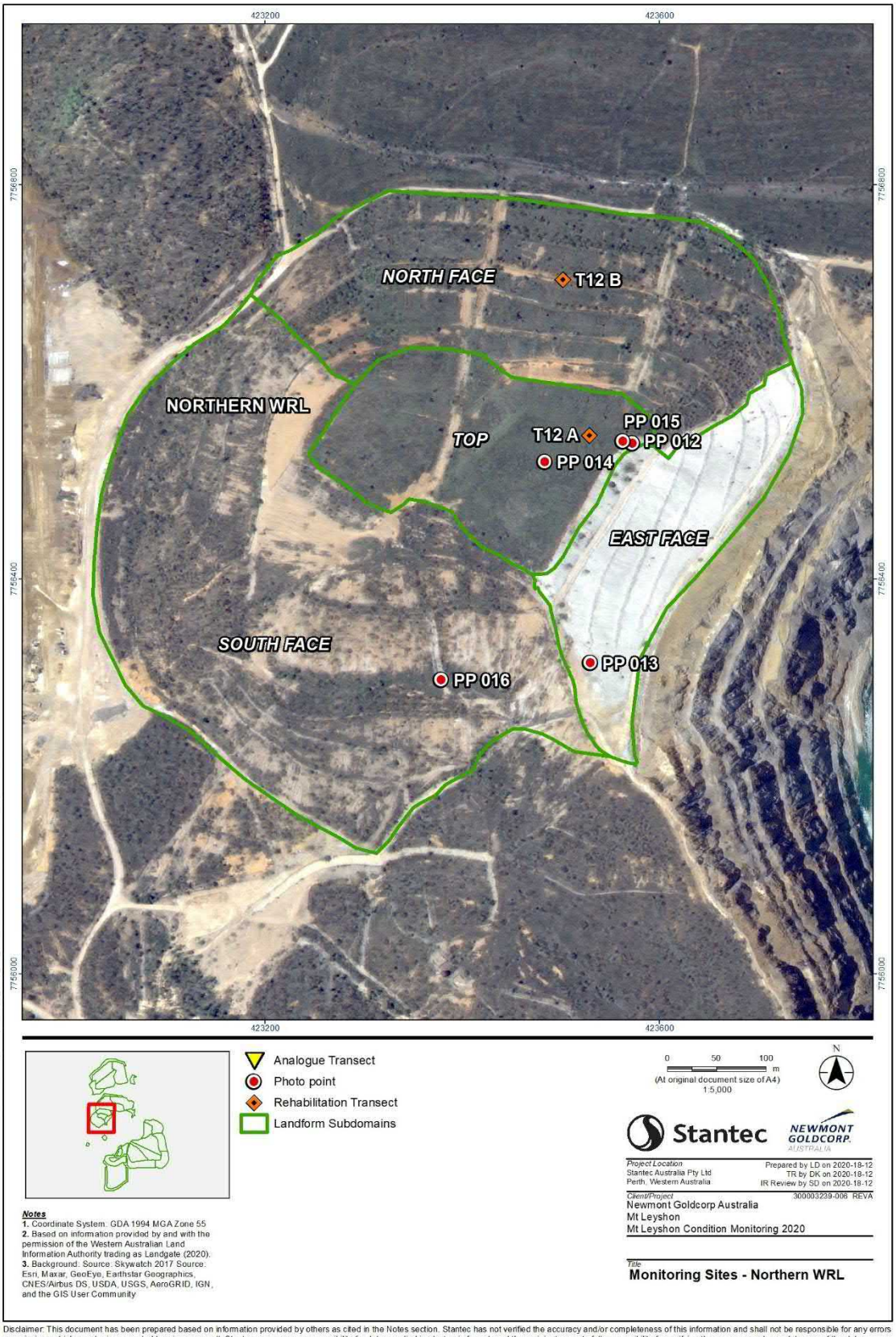

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Figure 3-13: Northern WRL with sub-domains and 2020 monitoring locations

3.2.3.1 Soil

The Top (Flat) sub-domain had the highest soil characteristic scores on the Northern WRL, which was mostly attributed to dense grass cover, a high degree of rock incorporation into the topsoil, and the flat topography. The soil surface on the batters (sloped) sub-domains were less stable than the flat area, most considered stable, with the East Face sub-domain considered unstable. The North Face and South and West Faces had moderate soil condition overall, mostly due to a reasonably high grass cover, which aided soil stability. Investigation into possible remedial actions for the East Face is recommended.

3.2.3.2 Vegetation

Vegetation on the Northern WRL consisted mostly of native and introduced grasses, with Buffel Grass being the dominant species. The Top (Flat) sub-domain had the highest overall vegetation species richness and cover, while the East Face had the lowest species richness and the lowest grass and herbaceous cover. Herbaceous and woody species were uncommon across all sub-domains in 2020, although woody species (*Acacia* and *Eucalyptus* species) were more common on the North Face and South and West Faces, providing low to moderate cover. There was no change in the vegetation scores between the 2019 and 2020 assessments.

3.2.3.3 Weeds

In 2020, Rubber Vine, a Category 3 weed, was present in varying abundance across all Northern WRL sub-domains, including the Top (Flat) area where it was absent in 2019. It was confined to, and dominant in the corridors or edges at the East Face and North Face sub-domains. Environmental weed Mimosa Bush was present on all sub-domains, ranging from frequent on the South-West batters sub-domain to small, isolated populations on the Top (Flat) sub-domain. Another environmental weed of concern, Kapok Bush, was recorded on Top (Flat) (confined to edges) and North Face sub-domains, patchy.

3.2.3.4 Erosion

Numerous small rills were identified on all Northern WRL sub-domains, except the Top (Flat) sub-domain which only recorded a few rills. The stability of the erosion features ranged from active on the East Face sub-domain to stable on the Top (Flat) sub-domain.

3.2.3.5 Habitat

Availability of terrestrial habitat was moderate to high, resulting from dense grass cover across all Northern WRL sub-domains, except the East Face sub-domain which was almost completely bare. The vegetation present provided low arboreal habitat value. Faunal utilisation of the Northern WRL included kangaroos, wild dogs/dingoes, rabbits, snakes, spiders, grasshoppers, and ants. There was no evidence of fauna on the East Face sub-domain.

3.2.3.6 OBIA classification

The remote sensing OBIA analysis showed the Northern WRL was dominated by grass cover, with substantially less shrub cover (**Figure 3-14; Appendix F**), supporting on-ground observations in 2020. Compared to the analogues, the rehabilitation had similar grass cover but notably less shrub cover. However, compared to the analogues there was substantially more bare area, which was mainly contributed by the east face of the landform. In 2020, there was slightly more grass and shrub cover, and slightly less litter cover and bare ground than in 2017, which likely represented typical seasonal fluctuations in ground cover.

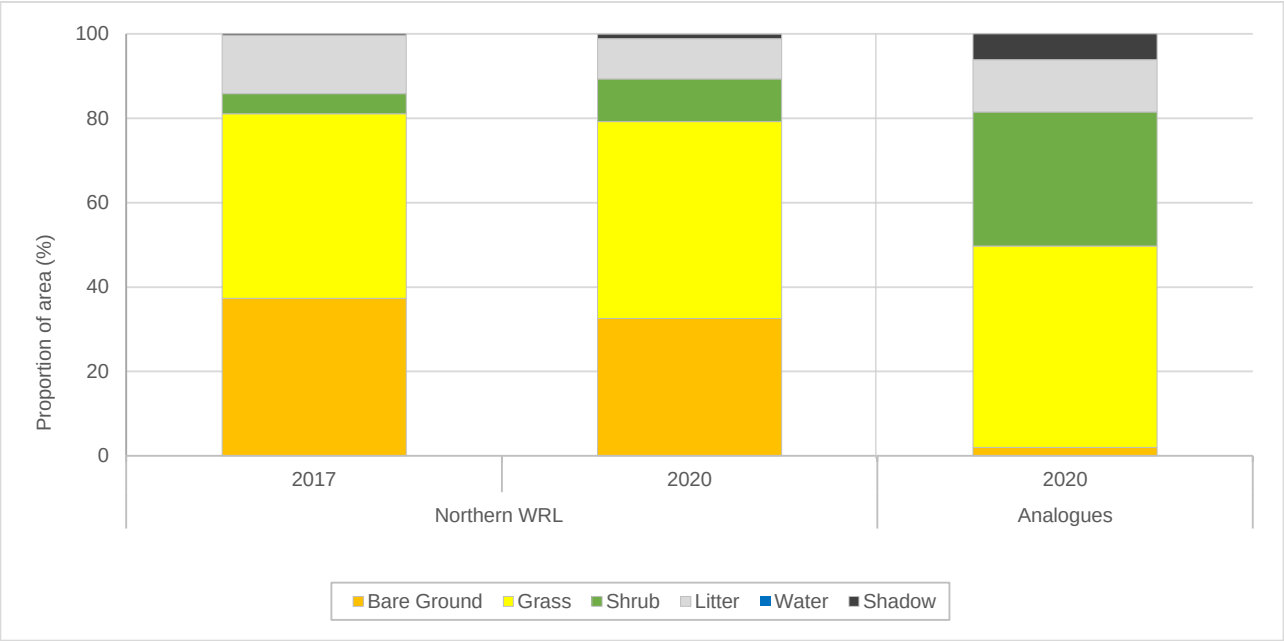

Figure 3-14: Proportion of ground cover types of the Northern WRL rehabilitation in 2017 and 2020, based on image analysis, compared to the analogue areas in 2020.

3.2.4 Roche Hill

The surface profile of the Roche Hill landform consisted of topsoil spread over porphyry rock. Rehabilitation works were completed around 2004, with rework of the Batters sub-domain (western side) completed in 2017. It was split into two sub-domains, the Flat and surrounding Batters (**Figure 3-15**, **Figure 3-16**). Photo-points were established in 2013 on both sub-domains, however, re-work of the Batters sub-domain in 2017 resulted in the removal of the photo-point monitoring post PP18. This photo-point was re-established in 2019. Additional photo-points, PP18b, PP18c, PP18d and PP18e were established in 2020 (**Figure 3-16**).

Figure 3-15: Re-worked Roche Hill Batters sub-domain in 2019 (left) and in 2020 (right) from PP18

In 2020, the average condition score for the Roche Hill rehabilitation was 62, with no change since 2019 (**Table 3-5**). Condition scores for individual sub-domains and the combined landform average were below the analogue average in 2020. The Flat sub-domain had a higher condition score than the Batters sub-domain due to flat topography, greater stability and slightly more vegetation (cover and species richness).

Table 3-5: Condition scores achieved by the Roche Hill rehabilitation, in comparison with the analogue average in 2020

Sub-domain	Condition Score (2020)	Difference from 2019
Flat	67	0
Batters	56	0
Rehabilitation average	62	0
Analogue average	76	0

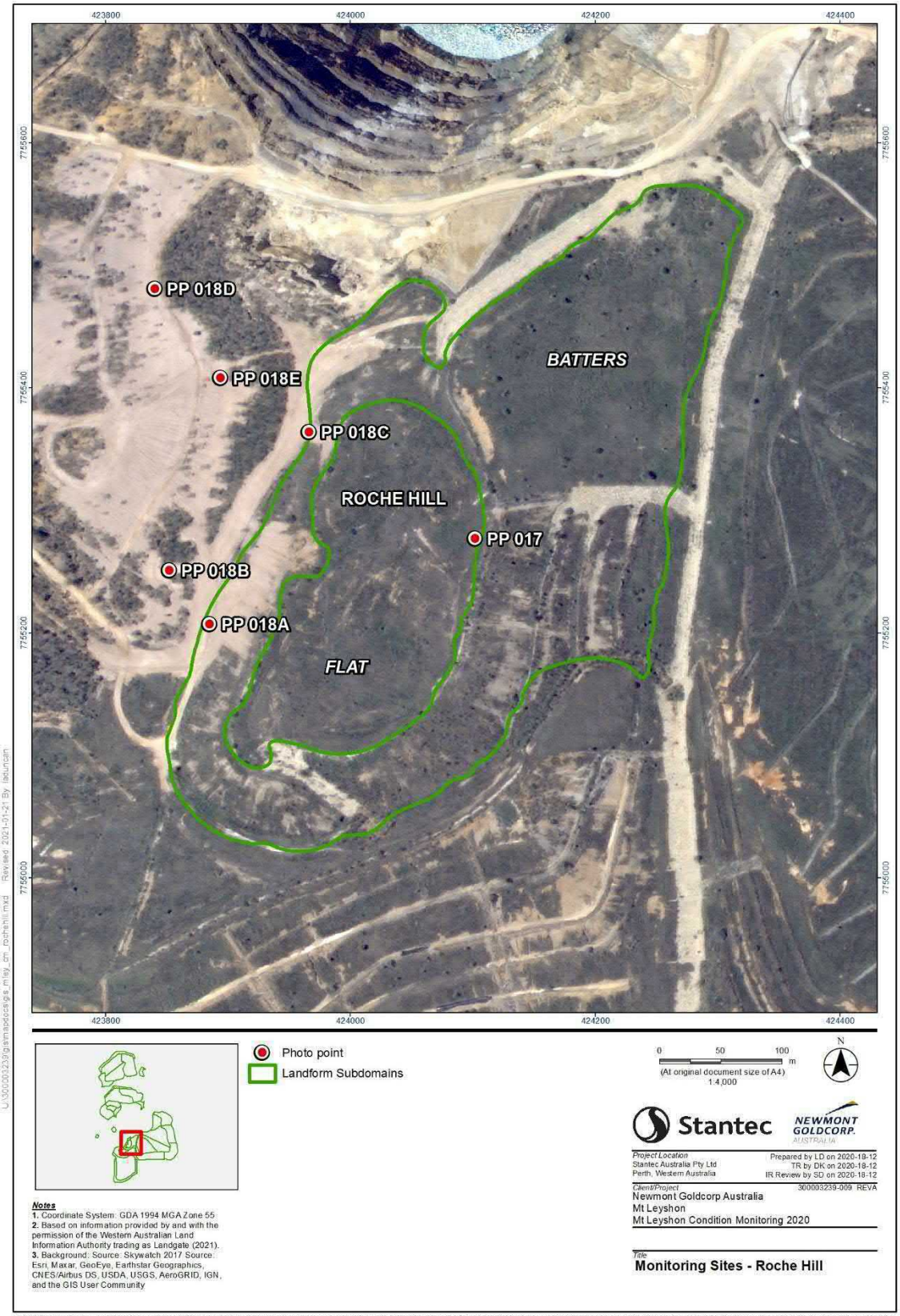

Figure 3-16: Roche Hill with sub-domains and 2020 monitoring locations

3.2.4.1 Soil

Overall, both sub-domains achieved good soil condition ratings in 2020, although soil stability was slightly lower on the Batters sub-domain due to steeper slopes and less vegetation cover compared with the Flat sub-domain. A high degree of rock incorporation into the topsoil and high vegetation cover contributed to a stable soil surface of the Flat sub-domain.

3.2.4.2 Vegetation

Vegetation on the Roche Hill rehabilitation consisted mostly of native and introduced grasses Grass cover was high on the Flat sub-domain and moderate on the Batters sub-domain, which was an improvement since 2019. Herbaceous species were only recorded on the Flat sub-domain, providing low cover. Woody species (<1.5 m tall) richness was also low and provided low cover at both sub-domains, while woody species (>1.5 m tall) were only recorded at the Batters sub-domain. Although there was limited middle and upper storey vegetation, some *Acacia* sp. were developing, and juvenile *Eucalyptus* sp. were also recorded on the Batters sub-domain, indicating potential for development of the upper storey. Large but patchy *Stylosanthes* sp. were recorded on the Flat sub-domain.

3.2.4.3 Weeds

Two restricted weed species (Category three) were recorded on the Roche Hill rehabilitation in 2020; Rubber Vine along drainage lines and corridors within the Flat sub-domain and Prickly Pear near two photo points (PP18d and PP18e) on the Batters sub-domain. The environmental weed Red Natal Grass, was scattered throughout both sub-domains, growing with Buffel Grass, and not considered to be a threat to native vegetation.

3.2.4.4 Erosion

In 2020, a small number of rills were recorded on the Batters sub-domain, which were classed as mostly stable. It was likely these rills formed following works in the area in 2017 when vegetation cover was low. A few established gullies, considered mostly stable, were newly recorded in 2020. No erosion features were recorded on the Flat sub-domain.

3.2.4.5 Habitat

The Flat sub-domain was of high terrestrial habitat value and patchy arboreal habitat value, whilst the Batters sub-domain had patchy terrestrial habitat and low arboreal habitat value. There was evidence of kangaroos, wild dogs/dingos, rabbits, and snakes across both sub-domains, with birds also sighted on the Flat sub-domain.

3.2.4.6 OBIA classification

Based on image analysis, Roche Hill rehabilitation was dominated by grass cover (**Figure 3-17; Appendix F**) with less than 1% shrub cover. Compared to the analogues, the rehabilitation had more grass cover and notably less shrub cover. In 2019, there was substantially more litter cover and substantially less grass cover than in 2020, likely due to seasonal fluctuations between grass and litter.

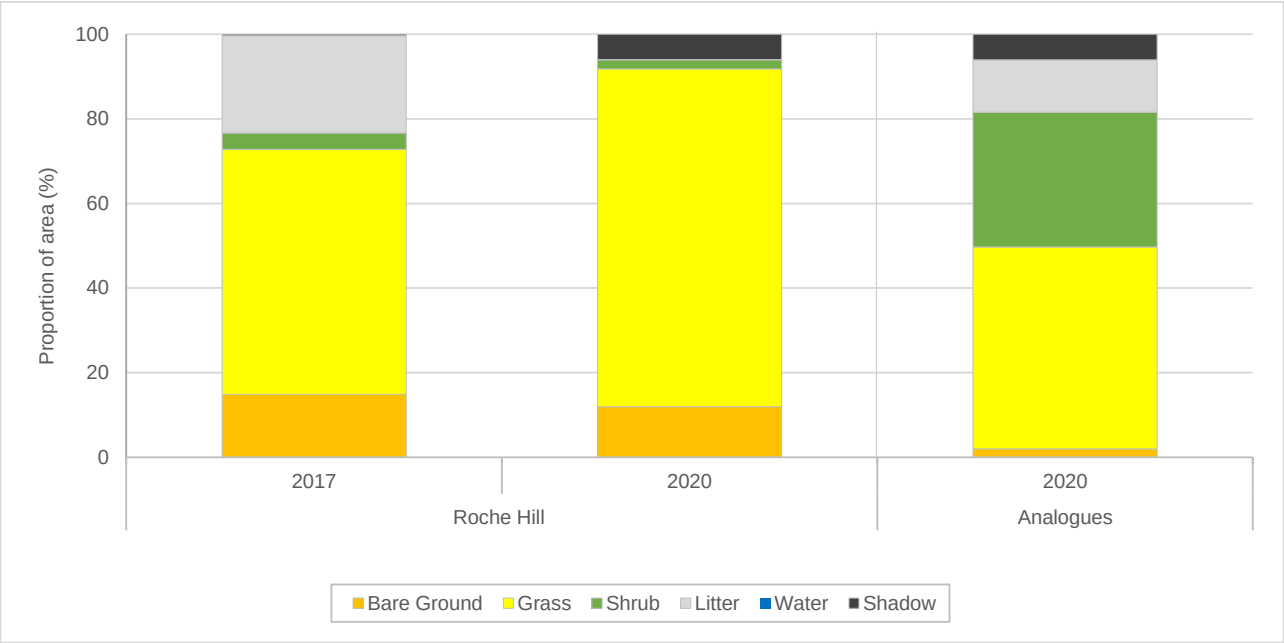

Figure 3-17: Proportion of ground cover types of the Roche Hill rehabilitation in 2017 and 2020, based on image analysis, compared to the analogue areas in 2020.

3.2.5 Non-acid Forming (NAF) Oxide Stockpile

Rehabilitation works on the Non-Acid Forming (NAF) Oxide Stockpile landform were completed in 2006, with two transects, T30 and T31, installed in 2008 (**Figure 3-18** and **Figure 3-19**). Due to the homogenous nature of the landform and its small size, it was not divided into sub-domains (**Figure 3-20**).

Figure 3-18: NAF Oxide Stockpile transect T30 end in 2019 (left) and 2020 (right)

Figure 3-19: NAF Oxide Stockpile transect T31 end in 2019 (left) and 2020 (right)

The NAF Oxide Stockpile condition score was 64 and below the analogue average in 2020, with no change since 2019 (**Table 3-6**). The site had a stable soil surface, high grass cover and grass species richness, no erosion and differed from the analogues by having less herbaceous and woody vegetation, and lower arboreal habitat value.

Table 3-6: Condition scores achieved by the NAF Oxide Stockpile rehabilitation, in comparison with the analogue average in 2020

Sub-domain	Condition Score (2020)	Difference from 2019
NAF Oxide Stockpile	64	0
Analogue average	76	0

Figure 3-20: NAF Oxide Stockpile rehabilitation area and 2020 monitoring locations

3.2.5.1 Soil

The overall soil condition of the NAF Oxide Stockpile rehabilitation was very stable. There was a high degree of rock incorporation into the topsoil along with a high degree of vegetation cover, contributing to good soil stability.

3.2.5.2 Vegetation

Vegetation on the landform consisted almost entirely of native and introduced grasses. Buffel Grass was dominant and had very high cover. Herbaceous species contributed a low amount of cover and no woody species were present on the landform.

3.2.5.3 Weeds

Two restricted invasive species, Chinee Apple and Rubber Vine were recorded on the NAF Oxide Stockpile rehabilitation in 2020, with the former confined to the edge and the latter present in patches. These weeds appeared to be in minor competition with native species for resources. The environmental weed Red Natal Grass was present in scattered populations on the rehabilitation and may have also been competing with native species.

3.2.5.4 Erosion

No erosion features were recorded on the NAF Oxide Stockpile rehabilitation in 2020.

3.2.5.5 Habitat

There was a high degree of terrestrial habitat on the rehabilitation, provided by the extensive grass cover, whilst there was little arboreal habitat. Evidence of feral pigs, kangaroos, birds, grasshoppers, and snakes was recorded across the rehabilitation, either through direct sightings or observations of scats and tracks. There were many kangaroo and pig tracks seen throughout the grass.

3.2.5.6 OBIA classification

Based on image analysis, the dominant cover of the NAF stockpile rehabilitation was overwhelmingly grass cover (**Figure 3-21; Appendix F**). There was substantially less cover contributed by the other ground cover types, with bare ground followed by shrub cover the next highest covers in 2020. Compared to the analogues, the rehabilitation had more grass cover but notably less shrub cover in 2020. In 2020, there was more grass cover, and slightly less shrub and litter cover than in 2017, which likely represented typical seasonal fluctuations in ground cover types.

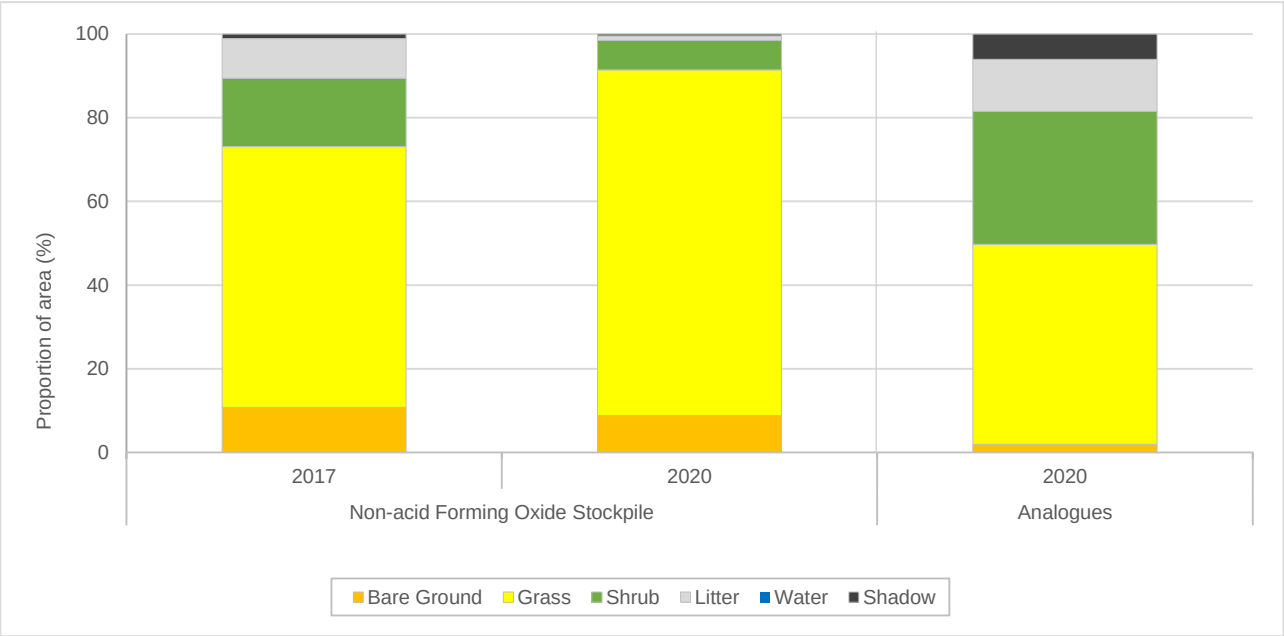

Figure 3-21: Proportion of ground cover types of the Non-acid Forming Oxide Stockpile rehabilitation in 2017 and 2020, based on image analysis, compared to the analogue areas in 2020.

3.2.6 Southern WRL

The Southern WRL was rehabilitated in 1995 and divided into two sub-domains (Flat and Batters). In 2007, two transects were installed on the Batters sub-domain (**Figure 3-22, Figure 3-23**) and a photo-point was installed on the Flat sub-domain in 2008 (**Figure 3-24**).

Figure 3-22: Southern WRL Batters sub-domain transect T11a end in 2019 (left) and 2020 (right)

Figure 3-23: Southern WRL Batters sub-domain transect T11b start in 2019 (left) and 2020 (right)

The average condition score achieved by the Southern WRL rehabilitation was 61, which was below the analogue average in 2020 (**Table 3-7**). Unlike the declining trend in average condition score since 2015, there was no change between the 2019 and 2020 assessments (**Appendix D**). The previous decline was a result of significant erosion features forming and decreased herbaceous species cover and diversity on the Batters sub-domain.

Table 3-7: Condition scores achieved by the Southern WRL rehabilitation, in comparison with the analogue average in 2020

Site	Condition score (2020)	Difference from 2019
Flat sub-domain	72	0
Batters sub-domain	50	0
Rehabilitation average	61	0
Analogue average	76	0

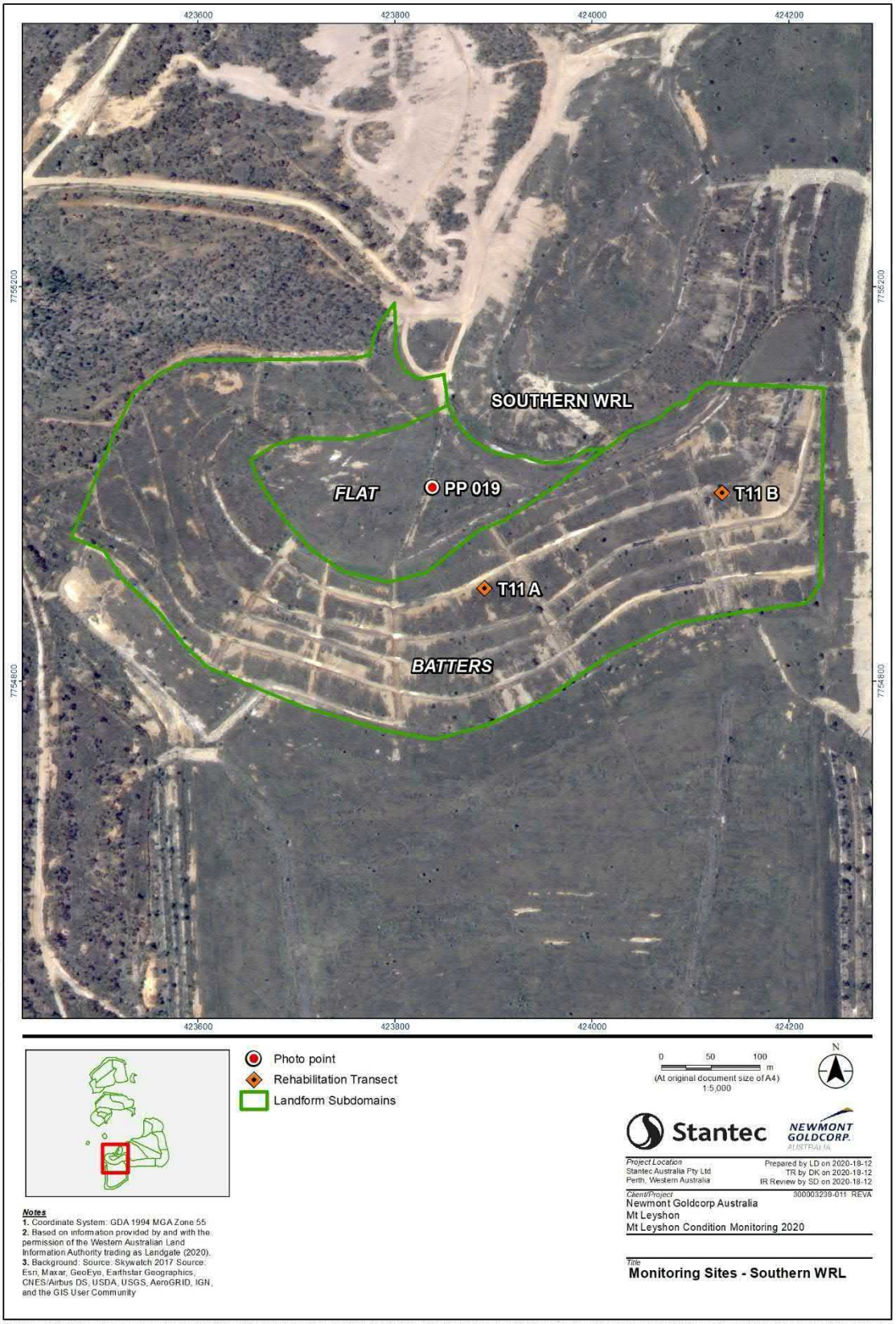

Figure 3-24: Southern WRL with sub-domains and 2020 monitoring locations

3.2.6.1 Soil

The topsoil of the Southern WRL Flat sub-domain was very stable, whilst the topsoil of the Batters sub-domain was mostly intact, with some major erosion features removing topsoil in certain areas. The Flat sub-domain retained high soil characteristic scores, because of high vegetation (grass) cover binding the soil surface and introducing litter, which promotes infiltration and nutrient cycling. The Batters sub-domain achieved lower scores than the Flat sub-domain, a result of more topsoil loss/erosion and less vegetation to bind the soil surface. The steeper slope of the Batters sub-domain further promotes erosion and topsoil loss.

3.2.6.2 Vegetation

Introduced species dominated the vegetation cover of both the Southern WRL sub-domains, with Buffel Grass as the dominant species. Grass cover ranged from moderate on the Batters to high on the Flat sub-domains. Herbaceous species provided low to patchy cover on the Batters and Flat sub-domains, respectively. Woody species consisted mostly of *Acacia holosericea* and *Eucalyptus* spp., and provided low cover on the sub-domains, except for those plants above 1.5 m tall which provided patchy cover on the Batters sub-domain.

3.2.6.3 Weeds

One restricted species, Rubber Vine, was present on both Southern WRL sub-domains. Although weed cover was low overall, the rock armoured drains and major erosion features were hotspots for weed infestation, and are areas recommended for targeted weed removal. On the flats it was confined to corridors and edges and present predominantly in rocky drains, with frequent abundance. It had been sprayed previously, however, re-growth was evident. Although it was not confined to edges or corridors on the Batters sub-domain, it was scattered and primarily located within rock drains and erosion gullies, Calotrope was also recorded on the Flat sub-domain while Red Natal Grass was recorded on the Batters sub-domains.

3.2.6.4 Erosion

Significant erosion features were present on the Batters sub-domain, many of which have worsened since 2018 (**Figure 3-25**). Localised erosion may have increased since 2019, although erosion features were considered mostly active in 2020 as they had been in 2019, hence, no change to condition score. Some major erosion features were active with vegetation growth in the gullies, although not considered enough to stabilize the features.

Figure 3-25: An erosion gully on the Southern WRL Batters in 2019 (left) and 2020 (right)

3.2.6.5 Habitat

Numerous faunal habitats were available at the Southern WRL, including dense grass cover, litter, rocks, and some shrubs and trees. The terrestrial habitat value was high, and the arboreal habitat value was patchy. Evidence of kangaroos, rabbits, wild dogs/dingos utilising the area was recorded and birds were observed using the arboreal habitats. An abandoned water sump on a benched section of the Batters sub-domain also provided faunal habitat.

3.2.6.6 OBIA classification

The remote sensing OBIA analysis showed the Southern WRL was dominated by grass cover (**Figure 3-26; Appendix F**). The rehabilitation had more grass cover and bare ground than the analogues, and substantially less shrub cover. In 2020, there was slightly more grass and shrub cover, slightly less bare ground, and notably less litter cover than in 2017, however, this still likely represented typical seasonal fluctuations in ground cover.

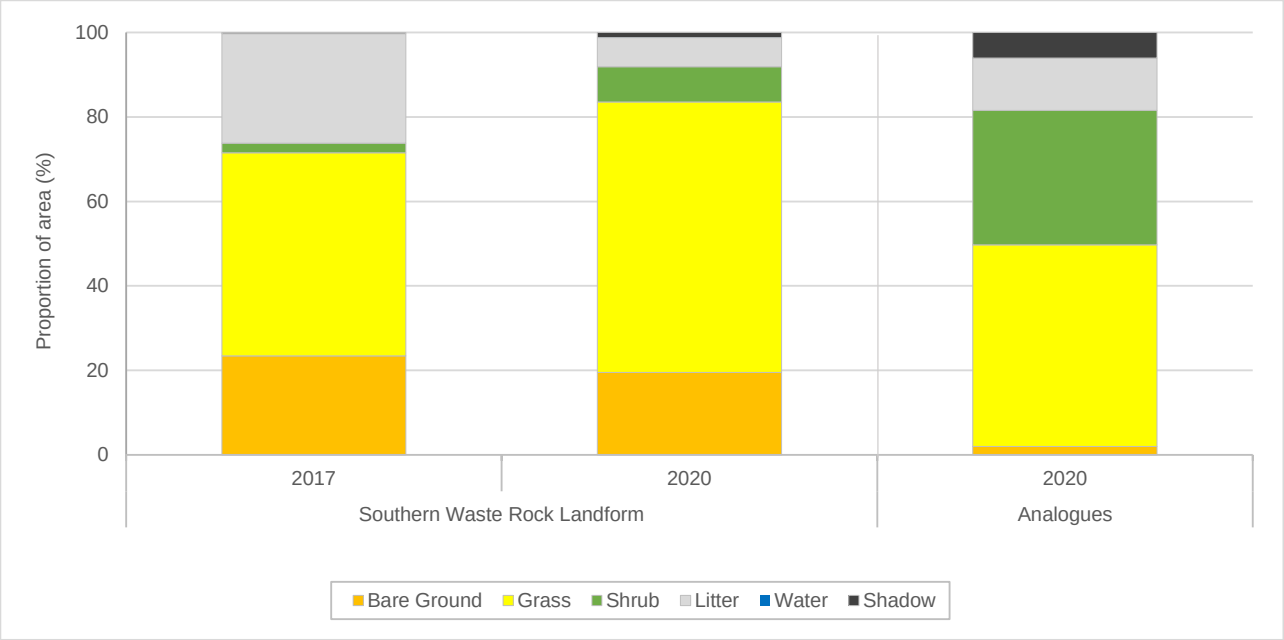

Figure 3-26: Proportion of ground cover types of the Southern WRL rehabilitation in 2017 and 2020, based on image analysis, compared to the analogue areas in 2020.

3.2.7 Southern Tailings Dam

The cover profile of the Southern Tailings Dam consisted of topsoil over heap-leach material and was rehabilitated in 1995. The area was divided into Flat and Batters sub-domains (**Figure 3-29**). On the Flat sub-domain, one transect (T10) was installed in 2007, consisting of four sub-transects (A-D) (**Figure 3-27**). On the Batters sub-domain, two transects (T26 and T27) were installed in 2008 (**Figure 3-28**). Photo-points were installed in 2013; PP20 on the Flat sub-domain and PP23 on the Batters sub-domains (**Figure 3-29**).

Figure 3-27: Southern Tailings Dam Flat sub-domain transect T10a end in 2019 (left) and 2020 (right)

Figure 3-28: Southern Tailings Dam Batters sub-domain transect T26 start in 2019 (left) and 2020 (right)

In 2020, the average condition score for the Southern TSF rehabilitation was 71, an increase since the 2019 assessment, although it remained below the analogue average (**Table 3-8**). Condition scores increased at the Flat sub-domain and declined at the Batters sub-domain. These changes were mostly due to decreased weed cover on the Flat, and increased erosion and weed cover on the Batters.

Table 3-8: Condition Scores achieved by the Southern Tailings Dam rehabilitation, in comparison with the analogue average in 2020

Site	Condition score (2020)	Difference from 2019
Flat sub-domain	73	+3
Batters sub-domain	68	-2
Rehabilitation average	71	+1
Analogue average	76	0

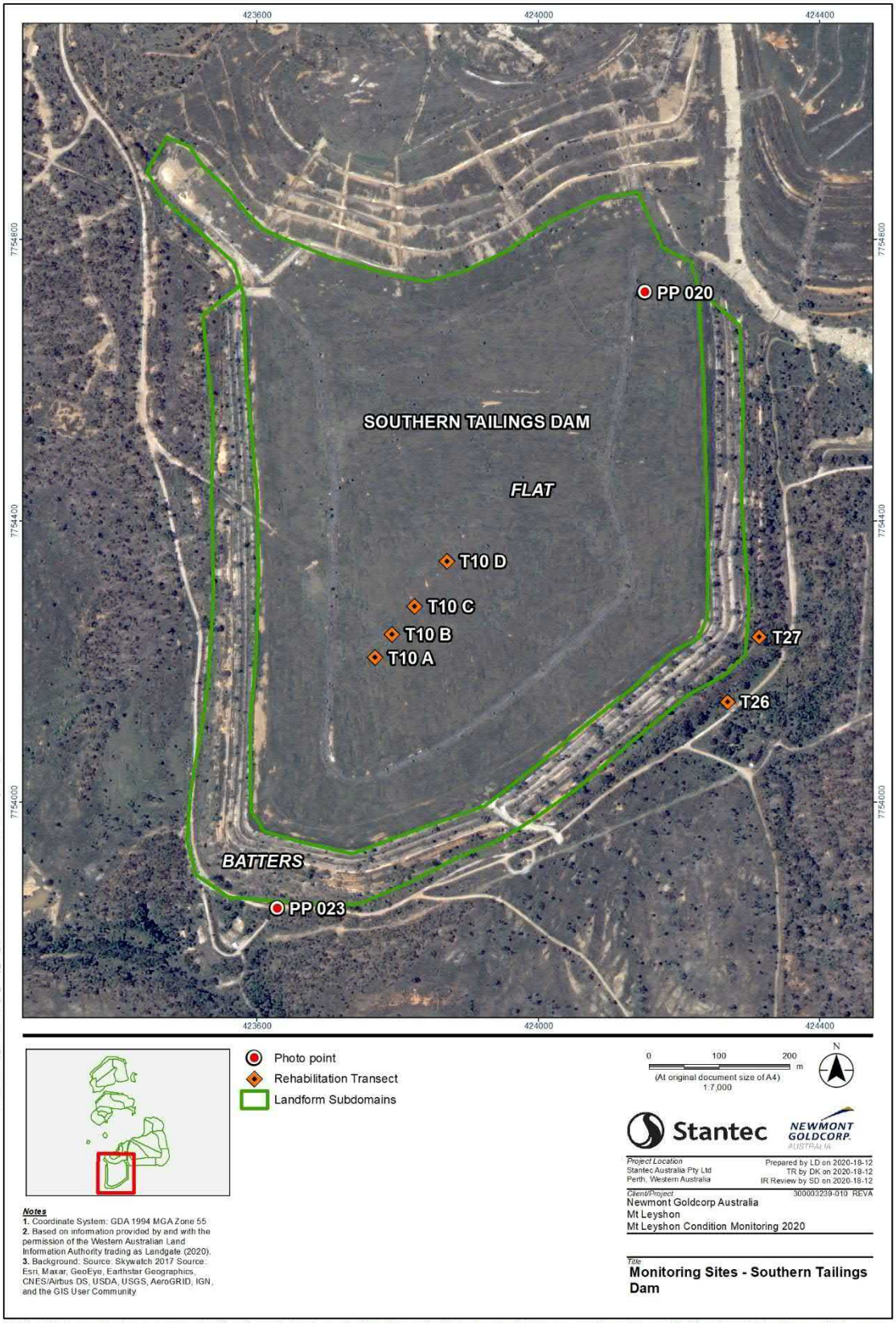

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Figure 3-29: Southern Tailings Dam with sub-domains and 2020 monitoring locations

3.2.7.1 Soil

In 2020, the soil surface of the Flat sub-domain remained high (very stable), with dense grass cover and high rock incorporation into the topsoil, aiding in the formation of a solid soil surface crust. The Batters sub-domain had a mostly intact soil surface with no change in the soil stability and overall vegetation cover since 2019 assessment.

3.2.7.2 Vegetation

Vegetation cover on the Batters and Flat sub-domains was dominated by moderate to high grass cover, predominantly Buffel Grass. Herbaceous and woody native species were limited in their diversity and cover on the Flat sub-domain, whilst woody species cover was higher on the Batters sub-domain. On the Batters sub-domain, woody species below 1.5 m provided patchy cover, while species above1.5 m provided high cover, and were primarily composed of *Corymbia* and *Acacia* species.

3.2.7.3 Weeds

Two restricted species, Rubber Vine and Chinee Apple were recorded on the Southern Tailings Dam rehabilitation in 2020. On the Flat sub-domain, Rubber Vine had been extensively sprayed and was mostly dead, with some regrowth and juveniles. Hence, drainage lines remained hotspots also due to numerous Chinee Apple individuals observed on the low-lying areas. The Batters sub-domain had no Chinee Apple observed and only scattered Rubber Vine, a result of previous weed control. Both sub-domains recorded Red Natal Grass throughout the area and patchy *Chloris gayana* (Rhodes grass).

3.2.7.4 Erosion

In 2020, the Batters sub-domain had some minor erosion features in the form of small gullies (few establishing) in a few areas. This was a slight increase in erosion since 2019, which had a few established gullies, hence, the lower condition score in 2020. No erosion features (rills/gullies) were observed on the Flats sub-domain in 2020.

3.2.7.5 Habitat

Multiple habitat niches were identified at the Southern Tailings Dam sub-domains, including dense grasslands and high litter cover at the Flat sub-domain and well-developed arboreal habitat on the Batters sub-domain. There was evidence of faunal visitation; kangaroos and birds at both sub-domains, as well as feral pigs and snakes at the Flat sub-domain.

3.2.7.6 OBIA classification

The remote sensing OBIA analysis showed the Southern Tailings Dam, like most other rehabilitation areas assessed, was dominated by grass cover (**Figure 3-30; Appendix F**). The rehabilitation had notably more grass cover than the analogues, and substantially less shrub cover. In 2017 and 2020 there was similar coverage of the different ground cover types.

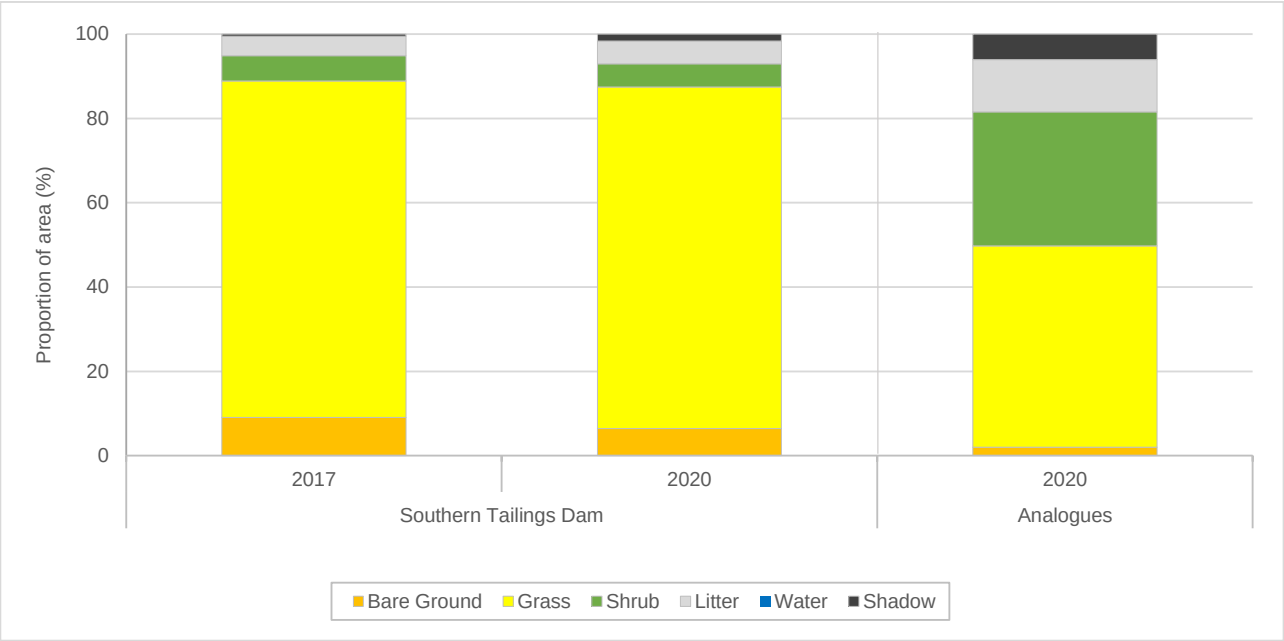


Figure 3-30: Proportion of ground cover types of the Southern Tailings Dam rehabilitation in 2017 and 2020, based on image analysis, compared to the analogue areas in 2020.

3.2.8 Eastern WRL

The Eastern WRL is the largest landform rehabilitated at Mt Leyshon and was divided into eight sub-domains; four flat areas and four sloping areas (**Figure 3-31** to **Figure 3-33**). It had a cover profile of topsoil spread over a porphyry rock layer. Five different ages of rehabilitation were estimated from the assessment of historic aerial imagery: 1995, 1996, 1998, 2000, and 2001.

Figure 3-31: Eastern WRL North Flat sub-domain transect T02A end in 2019 (left) and 2020 (right)

Figure 3-32: Eastern WRL South East Batters sub-domain transect T20 end in 2019 (left) and 2020 (right)

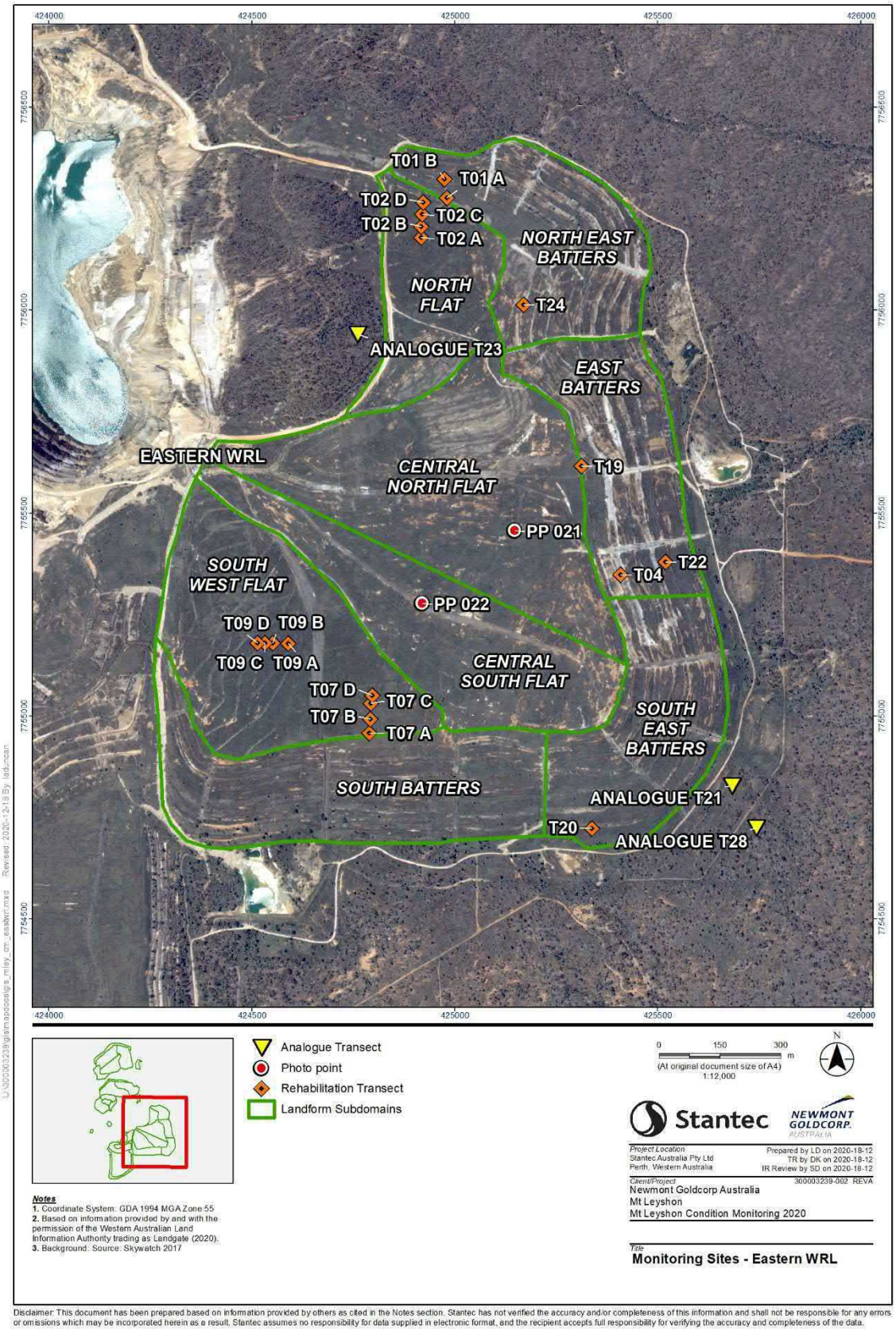


Figure 3-33: Eastern WRL with sub-domains and 2020 monitoring locations

In 2020, the average condition score for the Eastern WRL rehabilitation was 66, with no change since 2019 (**Table 3-9**). Condition scores for the individual sub-domains were also below the analogue average. North Flat sub-domain recorded an improved condition score in 2020, which was a result of increased herbaceous and woody vegetation (>1.5 m tall).

Table 3-9: Condition scores achieved by the Eastern WRL rehabilitation, in comparison with the analogue average in 2020

Sub-domain	Condition Score (2020)	Difference from 2019
South-West Flat	67	0
North Flat	74	+4
Central South Flat	74	0
Central North Flat	69	0
South East Batters	66	0
North East Batters	66	0
East Batters	55	0
South Batters	56	0
Rehabilitation average	66	0
Analogue average	76	0

3.2.8.1 Soil

Soil characteristics were generally stable on the Eastern WRL rehabilitation in 2020. Each sub-domain had a high degree of rock incorporation into the topsoil and high grass cover, contributing to the stable soil surface. The Batters sub-domains received lower overall soil characteristic scores compared with the flat sub-domains, mainly due to the steeper, longer slopes and slightly less rock incorporation into the topsoil of the batters.

3.2.8.2 Vegetation

Vegetation on the Eastern WRL rehabilitation consisted mostly of native and introduced grasses, with Buffel Grass the most dominant species. Herbaceous plants, such as *Stylosanthes* sp., generally contributed a low amount of cover, while woody species were uncommon, particularly woody species above 1.5 m tall. Although vegetation cover was generally high, it was noted that some areas of the landform were bare, including sections of the Central North Flat, Central South Flat, and East Batters sub-domains, potentially due to sub-optimal soil conditions.

3.2.8.3 Weeds

Three, category-three restricted weed species (Queensland Government Biosecurity Act 2014), present across the Eastern WRL rehabilitation in 2020: Rubber Vine and Prickly Pear, and Chinee Apple. The dominant weed was Rubber Vine, which was competing with native vegetation on three sub-domains (Southwest Flat, East Batters and South Batters). Calotrope and Mimosa Bush were also recorded at numerous Eastern WRL sub-domains. Other environmental weeds recorded were, Red Natal Grass at all sub-domains, Stinking Passionflower at five sub-domains, and patchy Kapok Bush at Southwest Flat and South Batters.

3.2.8.4 Erosion

Rills and gullies were not recorded on the flat Eastern WRL sub-domains in 2020, except for a few established gullies at the Central North Flat sub-domain which were actively expanding. Rills and gullies were present across the Batters sub-domains and were classified as either stabilising or mostly active.

3.2.8.5 Habitat

The terrestrial habitat value of the Eastern WRL rehabilitation was high to very high, attributed to extensive grass cover, patches of good herbaceous cover, and good rock habitat in areas across the landform. In contrast, there was little to no arboreal habitat value provided by the existing vegetation. Evidence of kangaroos, rabbits, skinks, and birds was observed across all sub-domains, while feral pigs, wallabies and grasshoppers were also recorded on the batters sub-domains.

3.2.8.6 OBIA classification

The Eastern WRL rehabilitation, was dominated by grass cover (**Figure 3-34; Appendix F**), with substantially less contribution from the other ground cover types. Compared to the analogues, the rehabilitation had notably more grass cover, but substantially less shrub cover. Between 2017 and 2020 there was a slight increase in grass cover and decrease in litter cover, which was likely part of normal seasonal variations in cover types.

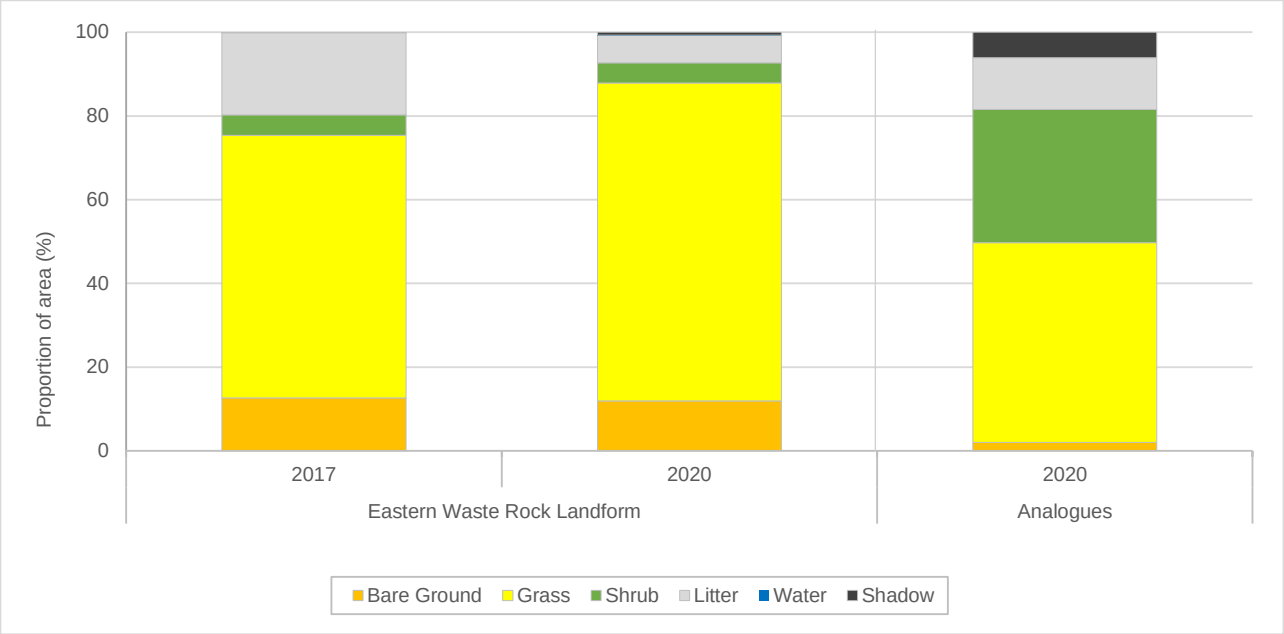


Figure 3-34: Proportion of ground cover types of the Eastern WRL rehabilitation in 2017 and 2020, based on image analysis, compared to the analogue areas in 2020.

3.2.9 Pregnant Pond

The Pregnant Pond landform rehabilitation works, which involved topsoil application, ripping, and seeding with a Buffel Grass and *Stylosanthes* spp. mix, were completed in 2004. Due to the small footprint and homogenous nature of the vegetation at the site, this site was not sub-divided and one monitoring transect was sufficient. Transect T34 was installed in 2010 to monitor rehabilitation (**Figure 3-35, Figure 3-36**).

Figure 3-35: Pregnant Pond transect T34 end in 2019 (left) and 2020 (right)

In 2020, the condition score for the Pregnant Pond rehabilitation was 72, with no change since 2019 (**Table 3-10**). Although the condition score remained below the analogue average in 2020, it was the closest to the analogue average since monitoring began, with only four points difference.

Table 3-10: Condition score achieved by the Pregnant Pond rehabilitation, in comparison with the analogue average in 2020

Site	Condition score (2020)	Difference from 2019
Pregnant Pond	72	0
Analogue average	76	0

Figure 3-36: Pregnant Pond rehabilitation area and 2020 monitoring location

3.2.9.1 Soil

The Pregnant Pond rehabilitation had a soil surface crust that was mostly intact with a moderate degree of rock incorporation into the topsoil. In areas where there was a high degree of grass and litter cover, the soil was stable and cohesive, and in bare areas the soil was only slightly less stable.

3.2.9.2 Vegetation

Pregnant Pond rehabilitation was covered almost entirely in Buffel Grass, providing high cover, with herbaceous species contributing low cover. Woody plants have developed in the area, consisting of *Acacia* species (including *Acacia holosericea*). Woody species under 1.5 m tall had patchy cover, while woody species over 1.5 m tall contributed low cover.

3.2.9.3 Weeds

The only restricted weed species recorded on the Pregnant Pond rehabilitation in 2020 was juvenile Rubber Vine. The environmental weed, Mimosa Bush was also recorded. Currently, both species were not widespread on the rehabilitation and, therefore, may have had just a minor impact on native vegetation. However, if weeds are not controlled at this domain, they have the potential to spread.

3.2.9.4 Erosion

No erosion features were evident on the Pregnant Pond rehabilitation in 2020, consistent with previous monitoring.

3.2.9.5 Habitat

The Pregnant Pond rehabilitation had a very high terrestrial habitat value, with a large proportion of the area covered in dense grass. Patchy trees also provided some arboreal habitat. Kangaroos and rabbits were observed during the assessment.

3.2.9.6 OBIA classification

The Pregnant Pond rehabilitation was dominated by grass cover (**Figure 3-37; Appendix F**), with notably less cover contributed by the other ground cover types. The rehabilitation had notably more grass cover, but substantially less shrub cover, than the analogues. Between 2017 and 2020 there was a slight decrease in grass cover and an increase in shrub cover, which was likely part of normal seasonal variations in cover types.

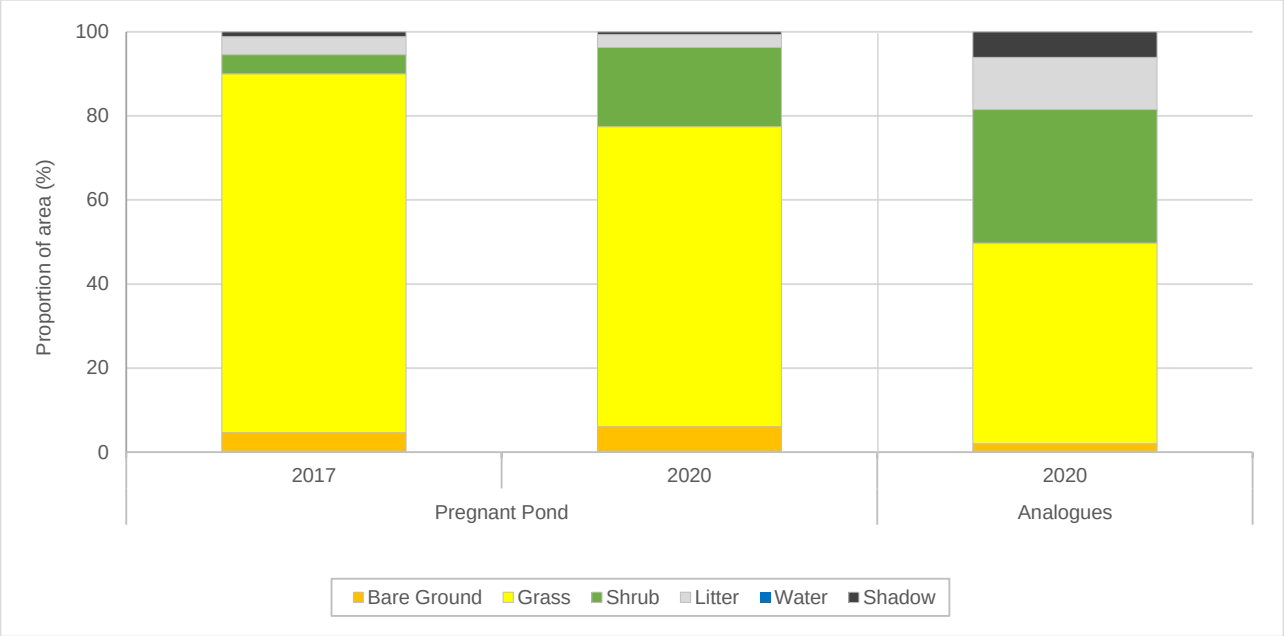


Figure 3-37: Proportion of ground cover types of the Pregnant Pond rehabilitation in 2017 and 2020, based on image analysis, compared to the analogue areas in 2020.

3.2.10 Processing Area

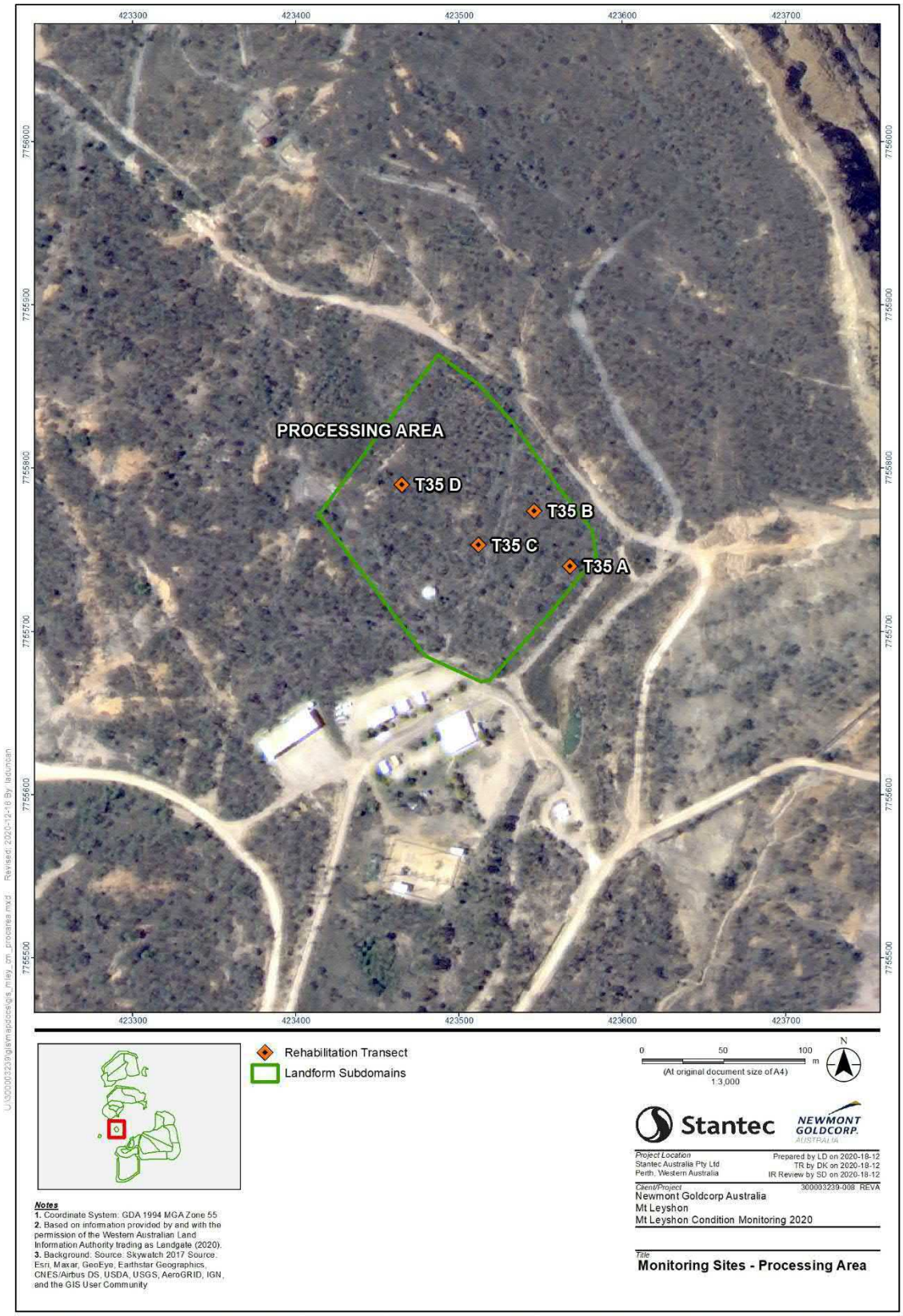
The Processing Area rehabilitation works were completed in 2009. Although two transects, T35 and T36, were installed in 2009, T36 has not been located since 2011. Transect T35 consisted of four sub-transects (A-D) spread across the rehabilitation (**Figure 3-38** and **Figure 3-39**). Due to the small size of the rehabilitation area, it was not divided into sub-domains.

Figure 3-38: Processing Area transect T35A end in 2019 (left) and 2020 (right)

The Processing Area rehabilitation achieved a condition score of 62 in 2020, which was slightly lower than the previous assessment and lower than the analogue average (**Table 3-11**). The condition score declined due to one notable established gully (erosion feature) observed in 2020, which had not been recorded in 2019 (**Appendix C**). This was an improvement to the previous assessment which recorded a large decline between 2018 and 2019 (**Appendix D**), mostly due to changes in weeds, vegetation, and habitat values. These parameters did not change in 2020.

Table 3-11: Condition score achieved by the Processing Area rehabilitation, in comparison with the analogue average in 2020

Site	Condition score (2020)	Difference from 2019
Processing Area	62	-1
Analogue average	76	0



Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

Figure 3-39: Processing Area and 2020 monitoring locations

3.2.10.1 Soil

Overall, the soil on the Processing Area rehabilitation was in good condition, with a very stable surface crust and high degree of rock incorporation into the topsoil. Cover of organic matter on the rehabilitation was high, which contributed to the high stability of the soil surface. The stability of the landform was also aided by the low slope angle.

3.2.10.2 Vegetation

Grass cover on the rehabilitation was moderate and mostly consisted of Buffel Grass, while herbaceous species were uncommon. Woody species contributed a low proportion of cover and consisted primarily of *Acacia holosericea* and *Eucalyptus* spp.

3.2.10.3 Weeds

As a result of targeted weed removal following the 2019 assessment Rubber Vine was no longer as prevalent in 2020. Continued targeted removal is recommended for remaining individuals. A second restricted weed, Chinee Apple, was recorded infrequently across the rehabilitation in 2020 and this should also receive targeted weed control. Two environmental weeds, Mimosa bush and Stinking Passionflower, were observed infrequently across the rehabilitation. Weeds remained abundant on corridors or edges.

3.2.10.4 Erosion

One established and stable gully (erosion feature) was observed on the Processing Area rehabilitation in 2020, missed in previous assessment due to vegetation cover. Hence, condition score decreased by one.

3.2.10.5 Habitat

Processing Area rehabilitation had moderate terrestrial habitat value and patchy arboreal habitat. There was evidence of birds, spiders, kangaroos, wallaby, and rabbits on the rehabilitation, either through direct sightings or scats, tracks, and burrows.

3.2.10.6 OBIA classification

The Processing Area rehabilitation was dominated by grass cover, closely followed by shrubs in 2020 (**Figure 3-40; Appendix F**). The rehabilitation had roughly similar grass and shrub coverage to the analogues. Between 2017 and 2020 there was a slight decrease in grass and litter cover and an increase in shrub cover, which was likely part of normal seasonal variations in cover types.

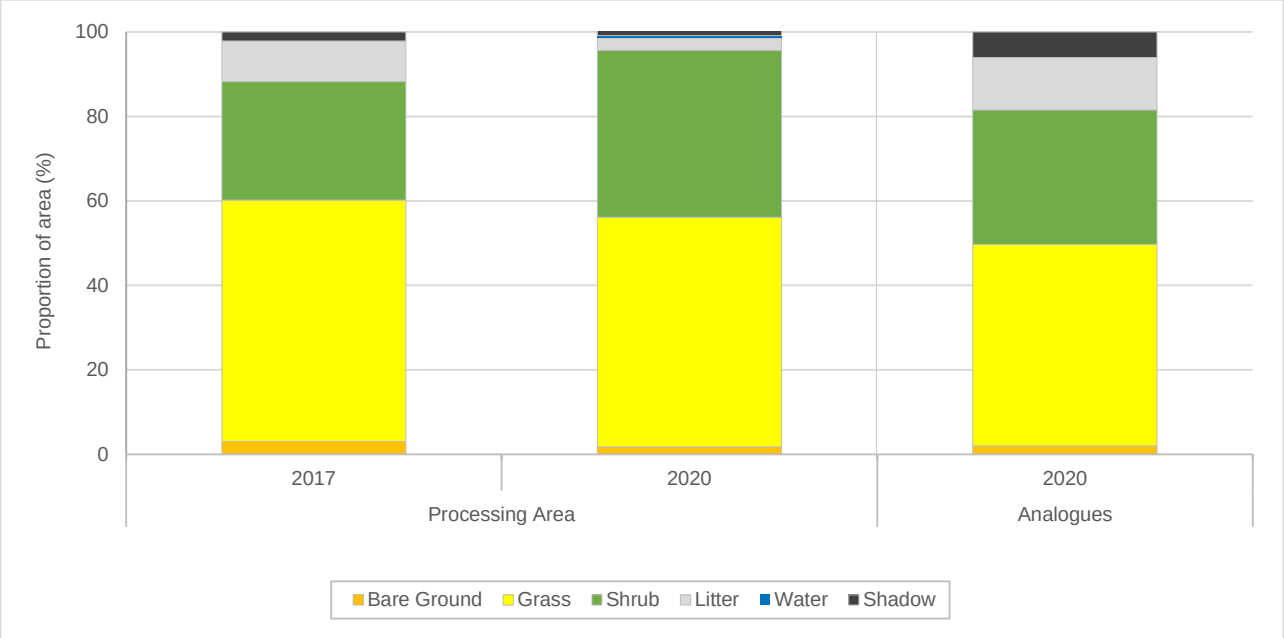


Figure 3-40: Proportion of ground cover types of the Processing Area rehabilitation in 2017 and 2020, based on image analysis, compared to the analogue areas in 2020.

3.2.11 Water Treatment Pond

The Water Treatment Pond was located northeast of the Mt Leyshon Pit and covered approximately one hectare. Rehabilitation of the Water Treatment Pond occurred in 2007, involving the application of topsoil which had been collected from around the mine, and seeding the area, predominantly with Buffel Grass and *Stylosanthes* spp. In 2010, transect T33, was installed on a low sloping section of the site (**Figure 3-41**). A drain was located at the base of the transect, and a raw water dam was located to the northeast. Due the small size of the rehabilitation area, it was not divided into sub-domains (**Figure 3-42**).

Figure 3-41: Water Treatment Pond transect T33 end in 2019 (left) and 2020 (right)

In 2020, the Water Treatment Pond achieved a condition score of 74, with no change since 2019 (**Table 3-12**). It was only two points below the analogue average, a result of limited mid storey and upper storey vegetation cover. In the monitoring years 2016 – 2018, this site achieved condition scores above the analogue average (**Appendix D**).

Table 3-12: Condition score achevied by the Water Treatment Pond rehabilitation, in comparison with the analogue average in 2020

Site	Condition score (2020)	Difference from 2019
Water Treatment Pond	74	0
Analogue average	76	0

Figure 3-42: Water Treatment Pond rehabilitation area and 2020 monitoring location

3.2.11.1 Soil

The soil surface at the Water Treatment Pond rehabilitation area was very stable, with a strong intact soil crust. Additionally, topsoil was well incorporated with rock and organic matter due to the dense grass cover. The dense grass cover further strengthened the soil surface and provided protection from erosion.

3.2.11.2 Vegetation

Vegetation at the Water Treatment Pond was dominated by high grass cover consisting of various native and introduced species, mainly Buffel Grass. There was patchy herbaceous cover which consisted mostly of *Stylosanthes* sp.. Woody plants contributed low cover to the rehabilitation site and were predominantly mature *Acacia* species and *Corymbia* sp..

3.2.11.3 Weeds

Two restricted species, Rubber Vine and Prickly Pear, were observed at the Water Treatment Pond in 2020. Rubber Vine individuals were mostly in low lying areas and drainage lines. There were also patches of environmental weeds, including Stinking Passionflower, Mimosa Bush, and Rhodes Grass.

3.2.11.4 Erosion

Due to the topography and stability of the rehabilitation, no erosion features were observed.

3.2.11.5 Habitat

Terrestrial and arboreal habitat value at the Water Treatment Pond rehabilitation was considered high. Multiple faunal niches were available, including dense grasses, some trees, litter, and rocks. Rabbits, kangaroos, ants, and bird sightings were made at the site.

3.2.11.6 OBIA classification

The Water Treatment Pond rehabilitation was dominated by grass cover, with far less cover contributed by the other ground cover types (**Figure 3-43; Appendix F**). The rehabilitation had notably more grass and substantially less shrub cover than the analogues. Between 2017 and 2020 there was a slight increase in grass cover and shrub cover, with a decrease in litter cover, which was likely part of normal seasonal variations in cover types.

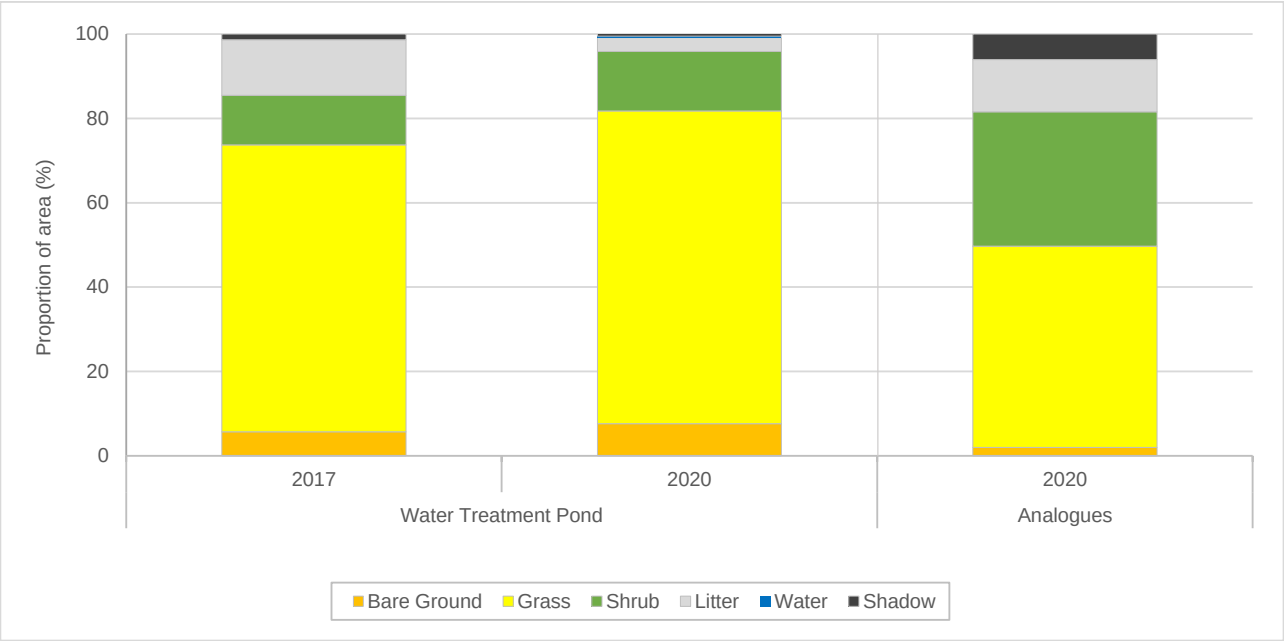


Figure 3-43: Proportion of ground cover types of Water Treatment Pond rehabilitation in 2017 and 2020, based on image analysis, compared to the analogue areas in 2020.

3.3 Pastoral lease ground cover analysis

Remotely-sensed ground cover data of the study area at Mt Leyshon revealed that 8% of the 20,960 ha had <30% organic ground cover, which included living and dead plants, and plant litter (**Figure 3-44**). This was similar in 2019 where 7% of the pastoral lease that had <30% organic cover. Areas with organic ground cover of <30% are considered at a higher risk of eroding soil then areas with higher organic ground cover (Queensland Government 2020). This is because plants help stabilise the soil surface, help it resist disturbance, and ultimately reduce erosion of the soil surface.

Five areas were visually assessed as being of particular interest because they had larger patches of <30% cover in proximity to water courses (**Figure 3-45** to **Figure 3-49**). Vegetation generally improves the stability of the soil surface because plants, especially those in the lower to mid storey, shelters the soil surface from disturbance, plant roots exude chemicals which bind soil particles together and encourage soil microbial activity, and plant litter incorporation into the soil improves its water moisture content and also binds soil particles together. At Mt Leyshon, large bare areas near water courses were at potential risk of soil eroding into tributaries of the Burdekin River.

Each of the five areas identified had large sections of <30% vegetation cover along one or more water courses. Area two (**Figure 3-46**) was of particular interest because it showed at least three locations where it appeared stream banks were unstable and eroding (Queensland Government 2020). An on-ground assessment would be required to ground truth the remote sensing and confirm sediment was, or was at risk of, eroding into watercourses. Many of the areas with low vegetation cover were apparent in both the 2019 (**Appendix F**)and 2020 imagery and appeared to be related to cattle watering points, pastoral infrastructure, and vehicle and cattle tracks.

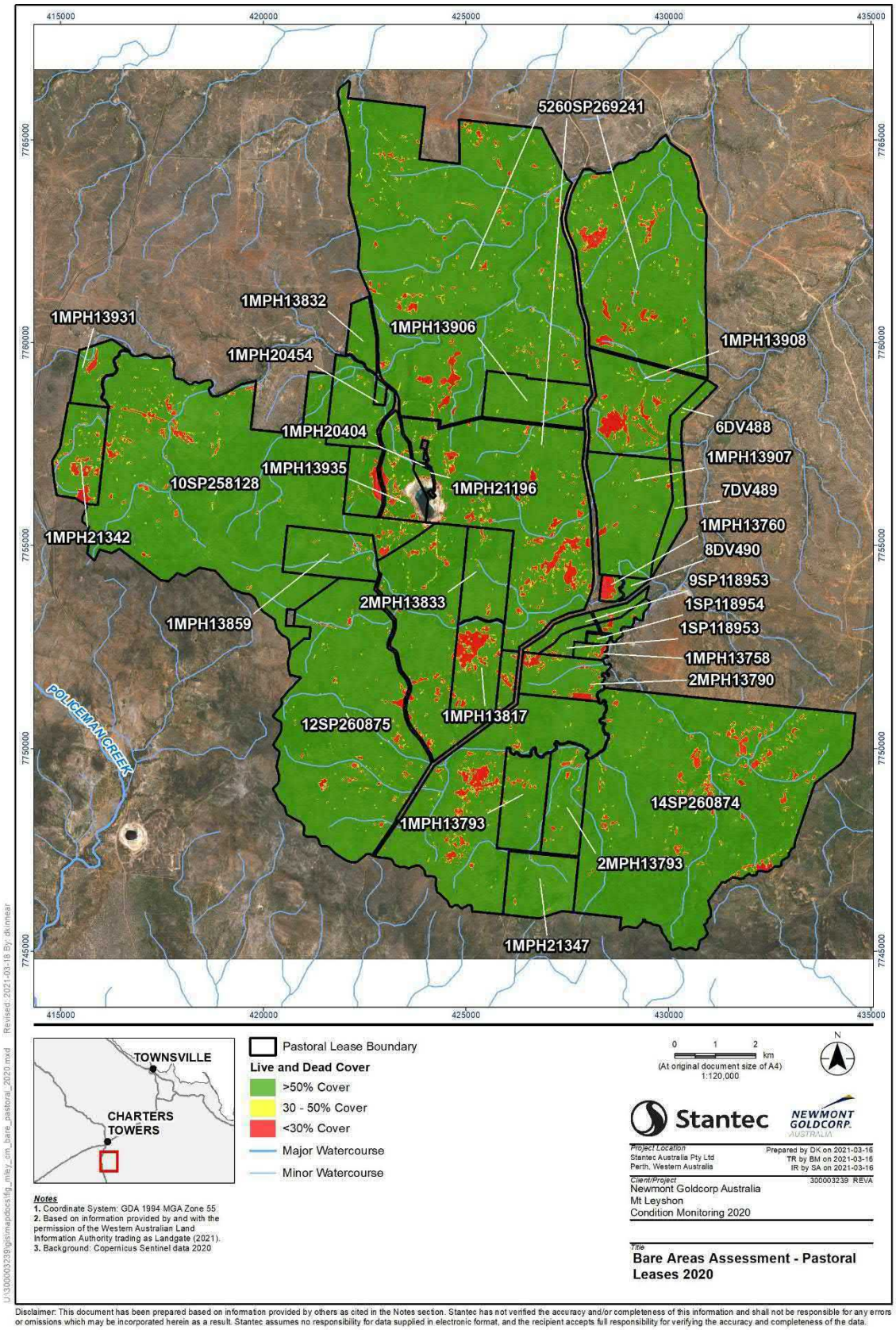


Figure 3-44: Organic ground cover classes over the Mt Leyshon pastoral leases in 2020

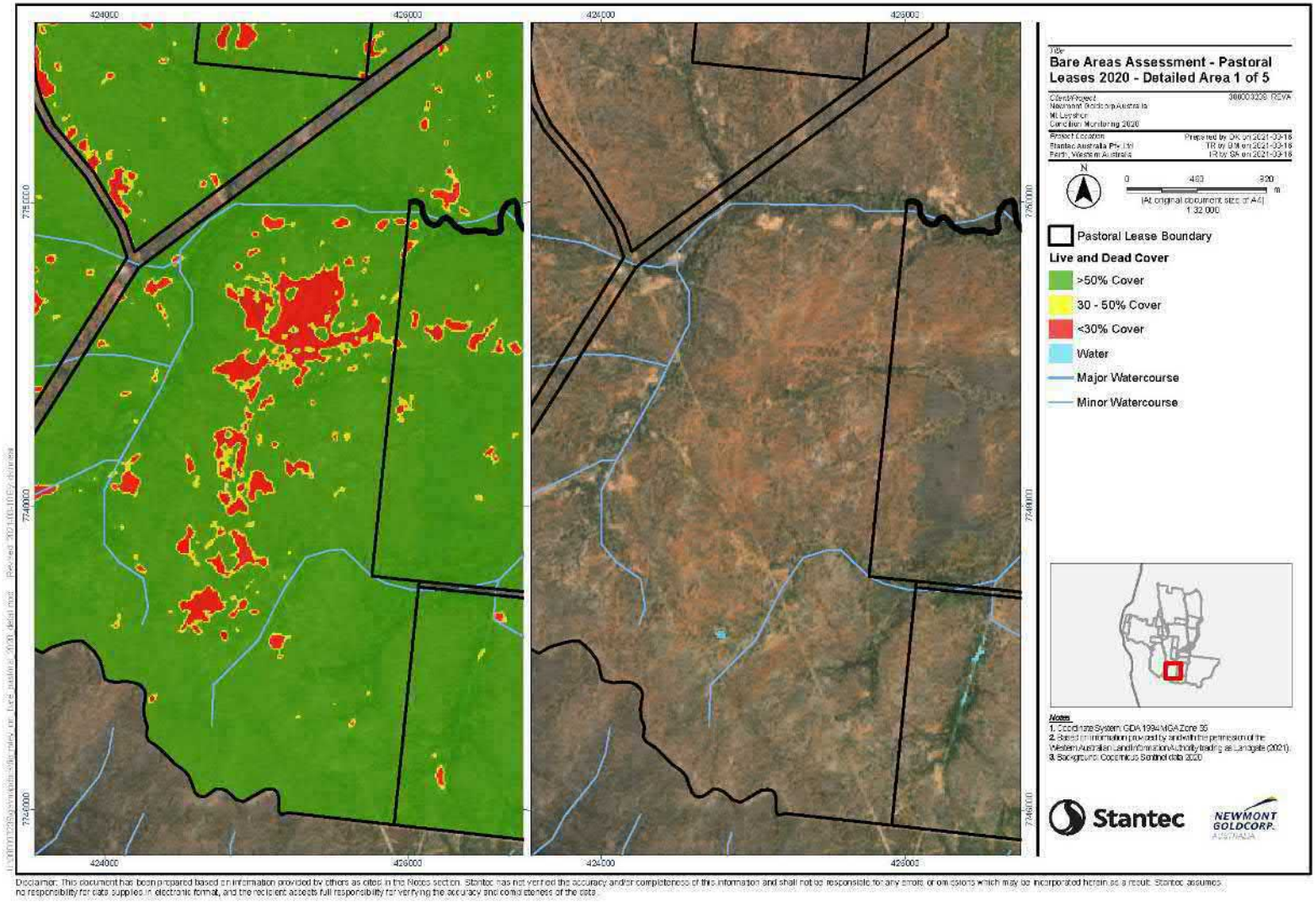


Figure 3-45: Organic ground cover classes in Area 1 at Mt Leyshon in 2020

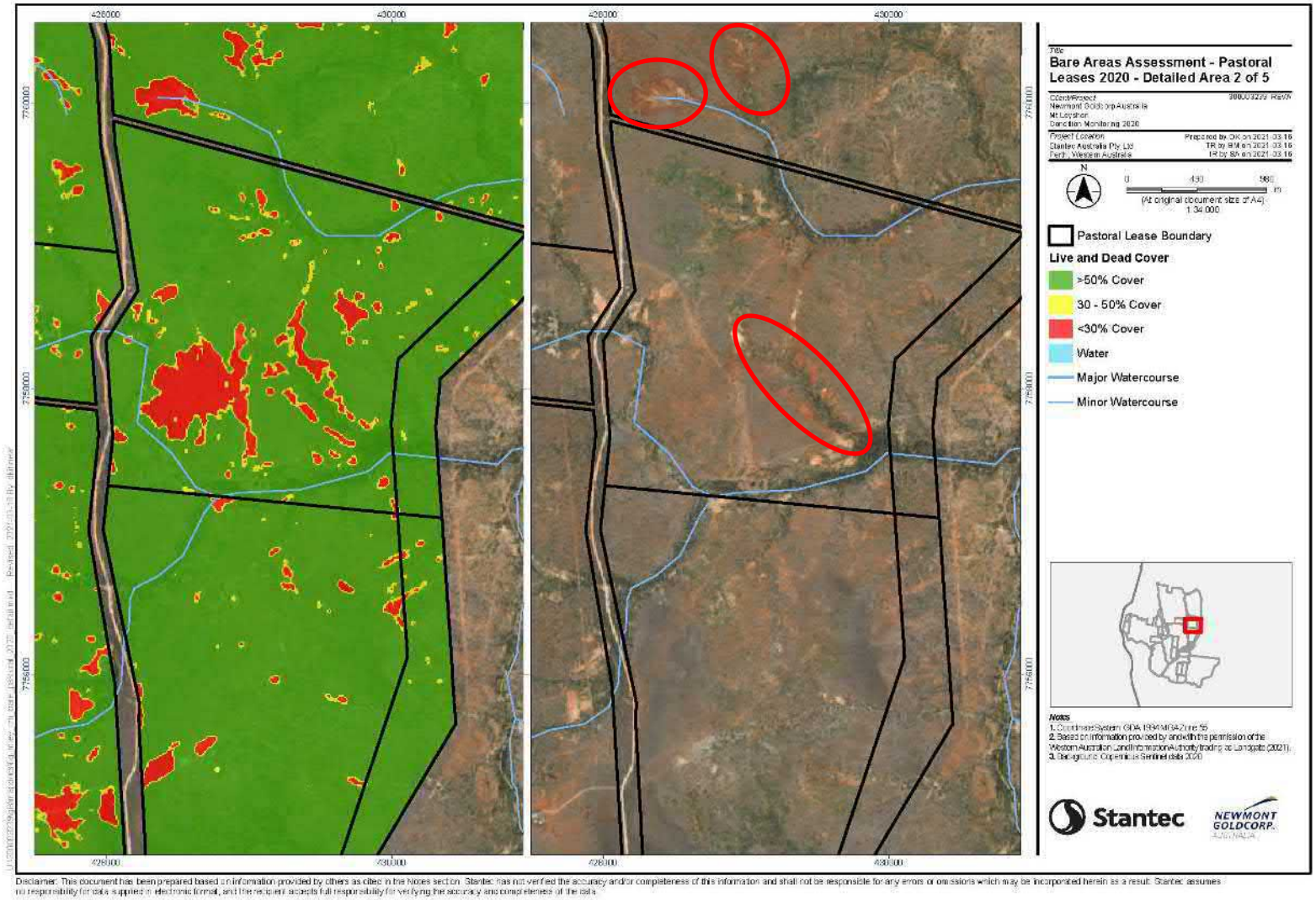


Figure 3-46: Organic ground cover classes in Area 2 at Mt Leyshon in 2020, with the encircled red areas of the right image showing what appeared to be stream bank erosion

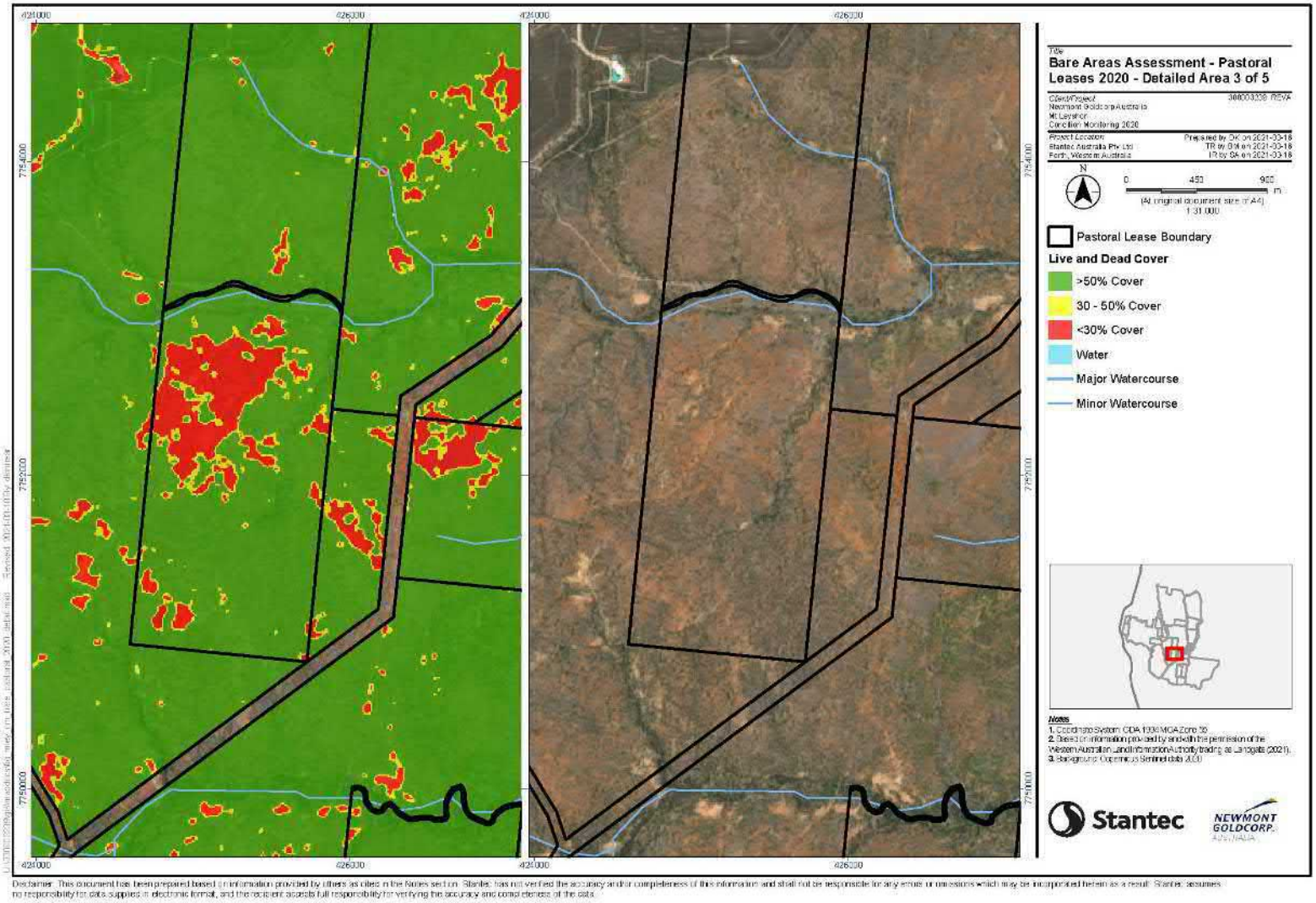


Figure 3-47: Organic ground cover classes in Area 3 at Mt Leyshon in 2020

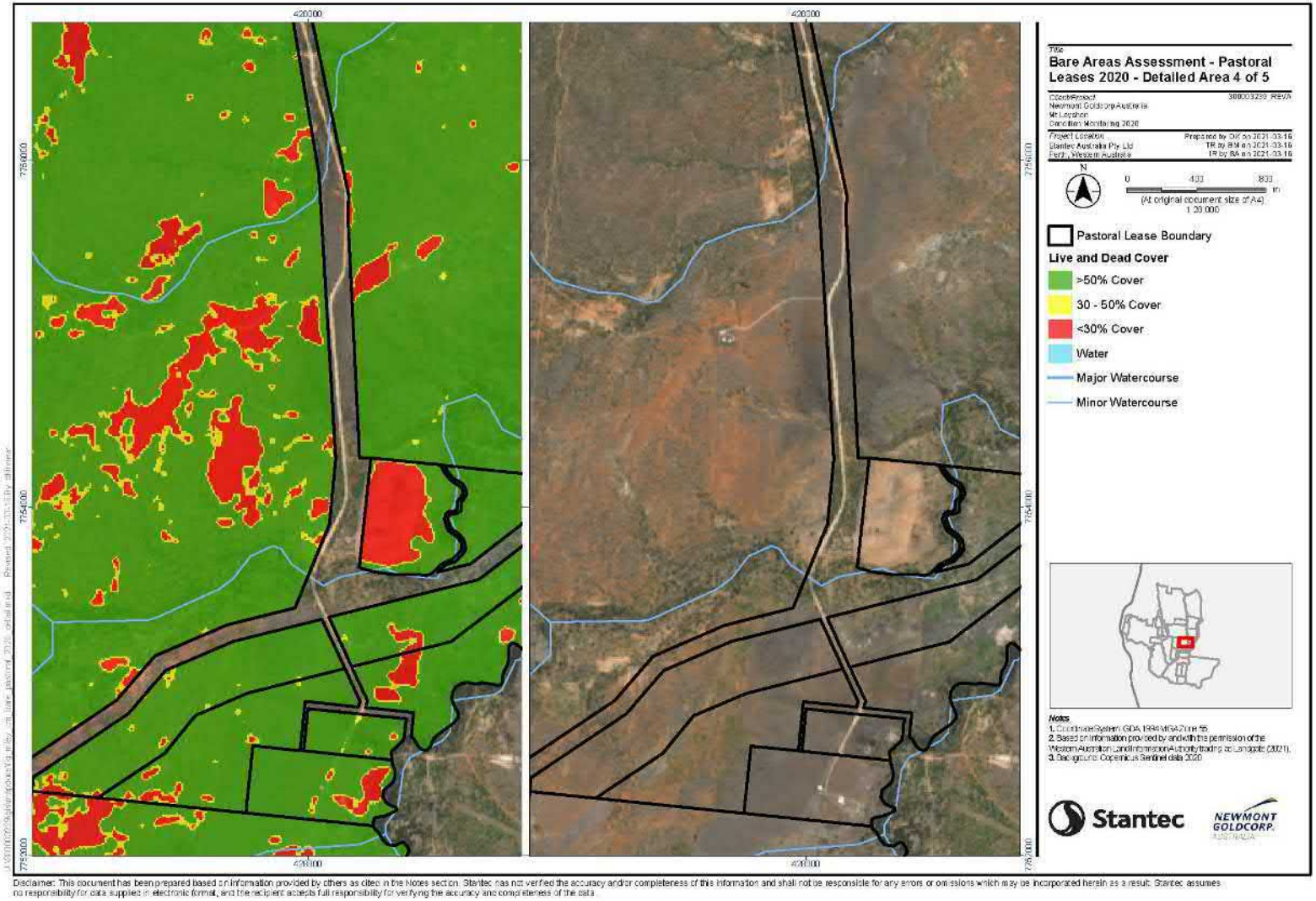


Figure 3-48: Organic ground cover classes in Area 4 of interest at Mt Leyshon in 2020

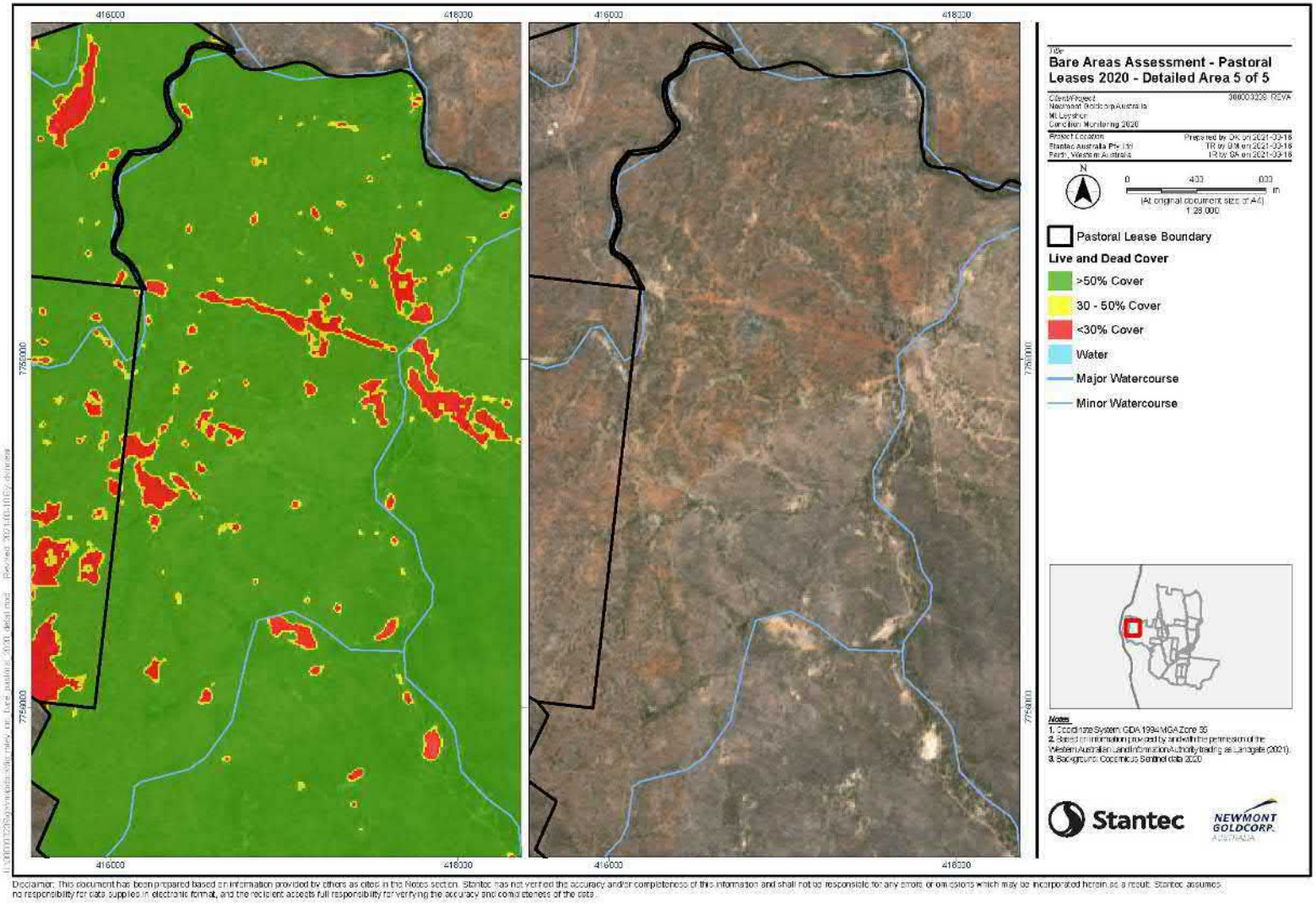


Figure 3-49: Organic ground cover classes in Area 5 at Mt Leyshon in 2020

4. Summary and recommendations

Mt Leyshon mined landform rehabilitation achieved a 'good' overall condition rating at most areas in 2020 and was supporting mature ecosystems. There was no change in average condition scores for the analogues or the rehabilitation areas, except for a decline at the Processing Area and an increase at the Southern Tailings Dam area (**Table 4-1**). Average condition scores of the rehabilitated landforms were below the average analogue score, except for the New North Tailings Dam which achieved the same score as the analogue average. Only six out of 31 rehabilitation sub-domains recorded change in condition score between the last two assessments. As with previous assessments, there was high variability between sub-domains; in most cases the flat sub-domains had higher condition scores that were generally more like the analogues, compared to the batters. The primary issue affecting closure at Mt Leyshon was the presence of restricted invasive species. Two rehabilitated areas, Northern WRL East Face and Southern WRL Batters, were identified as requiring significant resources to address widespread issue or isolated high severity.

4.1 Soil

Overall, the soil surface across the rehabilitated landforms at Mt Leyshon was very stable, mostly attributed to the high degree of rock incorporation into the topsoil and high grass cover as noted in previous years. Areas which had slightly lower soil surface stability (mostly intact), had less grass cover or were located on steeper slopes. The Northern WRL East Face sub-domain was the only area considered unstable, and the only area with no grass cover. Investigation into possible remedial actions for the East Face is recommended.

4.2 Vegetation

Grasses were present at all landforms, providing high cover at most sites, mostly attributed to the presence of *Cenchrus ciliaris* (Buffel Grass). The only area where grasses were absent was on the Northern WRL East Face sub-domain. Native herbaceous species were commonly observed across the landforms, mostly providing low or patchy cover. Woody species (mid and upper storey) generally provided low to moderate cover across the landforms. *Acacia holosericea* was the most common woody species in both height classes. Woody species were absent from the NAF Oxide Stockpile rehabilitation. Due to the high grass cover and relatively low cover of woody species over 1.5 m (upper storey), most areas had a high terrestrial habitat value with minimal arboreal habitat.

4.3 Weeds

In 2020, four restricted invasive species were recorded at the Mt Leyshon rehabilitation: *Cryptostegia grandiflora* (Rubber Vine), *Ziziphus mauritiana* (Chinee Apple), *Opuntia stricta* (Prickly Pear), and *Parkinsonia aculeata* (Parkinsonia). At least one of these species was recorded on all landforms and all but two sub-domains (Old North Tailings Dam West Flat and New North Tailings Dam Central Flat sub-domain).

Calotropis procera (Calotrope) and *Vachellia farnesiana* (Mimosa bush) were also present in some areas across Mt Leyshon, and both observed to be outcompeting native vegetation. These species were considered a priority for eradication and control by the Charters Towers Regional Council and it is recommended that removal of these species be conducted where practicable. There were also three landforms (six sub-domains) with the environmental weed *Aerva javanica* (Kapok Bush), and targeted weed control is also recommended as it is considered a serious environmental weed (QLD Government 2016). No prohibited restricted invasive species were recorded on the rehabilitated landforms at Mt Leyshon.

In 2020, weed control appeared to be successful for reducing numbers and coverage of Rubber Vine and Chinee Apple at the Sothern Tailings Dam. It is recommended that targeted weed control is continued to reduce the spread of these species, however, given the limited access to some areas this may not be possible. Weed control in easily accessible areas is encouraged, and yearly monitoring indicates that effective control measures encourage native vegetation establishment.

4.4 Erosion

Erosion was not a major issue at most sites, with minimal gullies present in 2020. Most gullies were not actively expanding based on visual comparison between the 2019 and 2020 assessments. Erosion features

were more common on areas that had lower vegetation cover compared to areas which had higher vegetation cover. Erosion severity was also higher on batters with steeper slopes. Erosion was most prevalent on batters' subdomains due to their sloping nature. Southern WRL Batters sub-domain had the most numerous and severe active erosion features, and significant resources would be required to address this issue.

Table 4-1: Average Condition Scores achieved by Mt Leyshon landforms from 2013 to 2020 and the main factors negatively affecting rehabilitation condition

Landform	Average Condition Score								Factors negatively affecting condition
	2013	2014	2015	2016	2017	2018	2019	2020	
Analogues (n=3)	78	78	78	78	77	77	76	76	Restricted invasive species present
Old North Tailings Dam (n=4)	74	74	74	75	71	72	69	69	Restricted invasive species present
New North Tailings Dam (n=5)	77	77	77	76	75	75	76	76	Restricted invasive species present
Northern WRL (n=4)	62	62	62	63	58	60	56	56	Restricted invasive species present, East Face not rehabilitated and not suitable for vegetation growth
Roche Hill (n=2)	66	NM*	NM*	66	NA**	61	62	62	Restricted invasive species present
Non-Acid Forming Oxide Stockpile (n=1)	72	72	72	68	72	72	64	64	Restricted invasive species present
Southern WRL (n=2)	74	74	74	69	67	67	61	61	Restricted invasive species present, major erosion features on batters
Southern Tailings Dam (n=2)	75	75	75	78	71	70	70	71	Restricted invasive species present, minor erosion
Eastern WRL (n=8)	71	71	71	68	68	69	66	66	Restricted invasive species present, erosion features on the batters
Pregnant Pond (n=1)	71	71	71	71	70	71	72	72	Restricted invasive species present
Processing Area (n=1)	74	74	74	83	73	73	63	62	Restricted invasive species present
Water Treatment Pond (n=1)	72	76	76	78	79	79	74	74	Restricted invasive species present

*nm = not monitored, **na = not applicable, partially monitored

4.5 OBIA classification

Based on image analysis, grass cover was the dominant cover at all rehabilitation areas assessed at Mt Leyshon in 2020 and grass contributed substantially more cover than shrubs at most domains (**Figure 4-1**). All rehabilitation areas had substantially more grass and substantially less shrub cover than the analogues, except for the Processing Area which had a similar vegetation structure to the analogues. In general, the rehabilitation areas had more ground considered bare than the analogues, however, except for the Northern WRL, all had bare cover of less than 20%. The Northern WRL was noted for a higher proportion of bare areas than the analogues and other domains, however, this was largely due to the bare east batter which consisted of exposed waste rock with little to no soil on the surface.

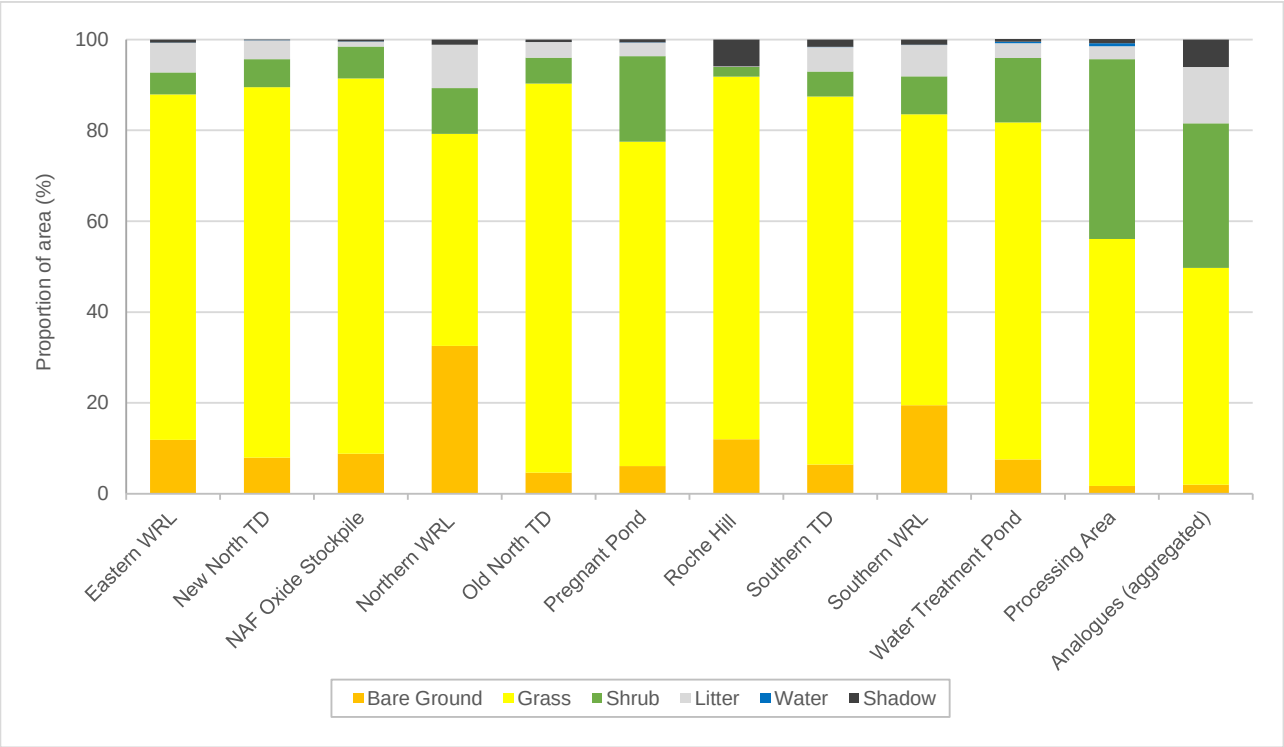


Figure 4-1: Proportions of ground cover types on the Mt Leyshon rehabilitation areas in 2020

4.6 Pastoral lease ground cover analysis

The analysis of organic ground cover across the pastoral leases over Mt Leyshon identified five broad areas suggested for on-ground investigation based on the 2020 imagery. Those five areas had a concentration of ground with <30% cover that were near one or more water courses. One of those areas, Area 2, was of particular interest because there appeared to be unstable and eroding creek banks that were visible in the imagery.

4.7 Monitoring recommendations

It is recommended that remote sensing approaches are continued to be incorporated into rehabilitation monitoring at Mt Leyshon, in combination with the Rapid Assessment method. Remote sensing provided a more quantitative assessment of an entire landform for parameters related to ground cover types, including bare area detection, but could also be used in relation to plant health, erosion, and detection of some weed species. Continued monitoring of Mt Leyshon rehabilitation is recommended, with adjustments made to the Rapid Assessment Field datasheets, to better assess and record the weeds and their potential impacts across the landform.

It is also recommended that the five areas identified in the pastoral lease ground cover analysis are visited during the next on-ground assessment to confirm conclusions from current image analysis. It is also recommended that the remote-sensing analysis is repeated for continued detection of change over time.

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Appendices

Appendix A Rapid Assessment Field Monitoring Handbook

A.1 Introduction

In 2013, Newmont Australia commissioned Outback Ecology (now Stantec) to design and implement a monitoring program less intensive than annual Ecosystem Function Analysis (EFA) (Outback Ecology 2013). In addition, the method had to chart the progress of rehabilitation over time and address new guidelines governing Mt Leyshon.

The method developed to assess the condition of rehabilitation at Mt Leyshon was a Rapid Assessment. This method can be completed relatively quickly in the field and also requires minimal training. The method assessed numerous factors relating to rehabilitation performance, mainly using visual criteria. These factors assessed are used to produce a rehabilitation performance 'score' for each area assessed. The limitations of the Rapid Assessment approach include results being prone to observer bias or interpretation and the lack of replication on smaller landforms.

Each rehabilitated landform has been separated into sub-domains for the purpose of the Rapid Assessment. Each sub-domain represents an area comprising of different ages of rehabilitation, topography, vegetation communities or aspect. Small, homogenous areas ≤ 4 ha have not been sub-divided. In total, 31 rehabilitation sub-domains on eleven landforms were identified during the first assessment in 2013, in addition to three analogue areas that were used as reference sites. The Rapid Assessment method has been used for annual monitoring assessments at Mt Leyshon since 2013.

A.2 Monitoring procedure

The Rapid Assessment comprises of three assessment types; photo-monitoring, rehabilitation condition assessment and supplementary rehabilitation condition notes. These three assessments are combined into one field-sheet provided (**Section A.2.3**).

Step 1 – Equipment (pre-field)

- print previous years field assessment sheets and use a pen to update information for the current assessment
- print blank field assessment sheets to record any additional information
- print aerial imagery of sub-domains with previous years waypoints labelled and sub-domain boundaries
- other equipment required:
  - Clip board
  - Hand-held measuring tape
  - Digital camera
  - Compass
  - GPS with previous years waypoints loaded and sub-domain shape-files loaded

Step 2 - Locate Domain

- determine boundaries of chosen sub-domain using previous maps

Step 3 – Photo Monitoring

- locate an existing photo monitoring point in your sub-domain using GPS waypoints (GDA94)
- using photos taken in previous year, re-take photographs. Capture the same field of view as previous photos;
- take photos of additional areas of interest (e.g. large bare areas);

- where possible, include a post or other feature within the frame of new photos in order to facilitate replication for future assessments
- complete 'Photo Monitoring' sections of field sheet; record all photo numbers in field sheet
- way-point any new photo-point locations and record orientation and photo number in field sheet (**Table A-2**)
- repeat these steps for each photo-point in sub-domain (if more than one)

Table A-1: Example photo-point monitoring

Photo-Points			
Location	Direction	Waypoint	Photo number/s
T21 Start	SSE	55 K 425684 7754827	281
T21 End	NNW`	55 K 425704 7754778	282, 283

Step 3 – Complete Field Sheet

- Complete the field sheet (**Section A.2.1**) at the photo-point.
- When there are multiple photo monitoring points:
  - complete the field sheet at the last photo monitoring point visited.
  - scoring for field sheets will be an average of photo monitoring points.
  - Note: not all photo-point locations will be suitable for the Rapid Assessment i.e. when the photo-point location is located on an adjacent landform. Field sheets must be filled in at a photo-point location within the sub-domain being assessed.
- Using the field sheet (printed with the previous year's data), score each of the 20 parameters using standard descriptions (**Section A.2.2**). There are five descriptions per parameter.
- Each parameter should be scored according to **Table A-2**.
- Provide supplementary notes in spaces provided throughout the field sheet.
- The field-team is encouraged to make additional notes to those suggested in the field sheet.
- Landform characteristics and rehabilitation performance are assessed by using site knowledge or traversing the area around the sub-domain.
- Weeds and erosion features should be located using a combination of way-points from previous assessments, opportunistic sightings and site knowledge.
- Way-point new declared weed populations.
- It is not necessary to re-monitor all erosion photo-points; however, re-assessment is recommended for substantial features that are active. This will also help determine trends over time.
- All new gully photo-monitoring locations should be way-pointed.
- Record all way-points (if new) and photo numbers on field sheet.

Table A-2: Scoring categories and area parameters

Scored Categories	Area of Assessment
Landform Characteristics	Representative of sub-domain
Rehabilitation Performance	Representative of sub-domain
Soil Surface	Representative of approx. 1 ha area surrounding photo-point locations
Erosion	Representative of sub-domain
Habitat	Representative of approx. 1 ha area surrounding photo-point locations
Vegetation	Representative of approx. 1 ha area surrounding photo-point locations
Weeds	Representative of sub-domain

A.2.1 Field sheet

Name of Area:		Date/Time:	

Landform characteristics (Triennial)

Slope Angle:	Very Steep	Steep	Medium	Low	Flat
Slope Length	Very Long (>50m)	Long (30-50m)	Medium (10-30m)	Short (<10m)	NA

Rehabilitation Performance

Overall Condition:	Very Poor	Poor	Fair	Good	Excellent
Factors affecting closure:					
Investment needed	Major	Significant	Strategic	Low	None

Photo-Monitoring

Photo-points:			
Location:	WP:	Photo:	Notes:

Soil Surface

Soil Surface					
Surface Stability:	Unstable	Unstable Patches	Fair	Mostly intact	Very Stable
Surface Cover					
Bare:	%	Plants:	%	Litter:	%
Topsoil:	No topsoil	Low (applied)	Low (transported)	Moderate	High

Erosion

Erosion:					
Rill Frequency:	Numerous (Severe)	Numerous (Small)	Many	Few	None
Gullies:	Many (Large)	Many (Small)	Few (Establishing)	Few (Established)	None
Gully waypoints and photos:					

Feature Stability:	Active	Mostly active	Becoming Stable	Mostly Stable	Stable
Other Erosion:					
Action required:					

Habitat

Habitat					
Habitat Value (Terrestrial):	Low	Patchy	Moderate	High	Very High
Habitat Value (Arboreal):	Low	Patchy	Moderate	High	Very High
Habitat Features:					
Fauna:					

Vegetation

Grasses:					
Grass Cover:	None	Low	Patchy	Moderate	High
Species Richness:	None	Low	Medium	High	Very High
Species of note:					
Notes:					
Herbs:					
Herb Cover:	None	Low	Patchy	Moderate	High
Species Richness:	None	Low	Medium	High	Very High
Species of note:					
Notes:					
Woody Species (<1.5m):					
Woody Cover:	None	Low	Patchy	Moderate	High
Species Richness:	None	Low	Medium	High	Very High
Species of note:					
Notes:					
Upper storey (>1.5m):					
Cover:	None	Low	Patchy	Moderate	High
Species Richness:	None	Low	Medium	High	Very High
Species of note:					
Notes:					

Vegetation Condition:	
Notes e.g. death, excessive grazing:	

Introduced Species

Introduced Species:					
Corridors and edges:	Dominant	Abundant	Frequent	Scattered	Exotics Absent
Species confined to edges:					
Other Introduced Species:					
Declared Species Waypoints:					
Impact of Weed Species:					
Weed control required:					

A.2.2 Rehabilitation condition assessment and notes

A.2.2.1 Landform characteristics (triennial monitoring)

Several factors that were used in the Rapid Assessment are permanent features of the landform design i.e. slope angle and length. While the angle of a slope has been quantified in the table below the values stated are not absolute. The angle of a slope can be variable across a landform and the description selected should also consider surface material characteristics and landform design. Similarly, the descriptions for the slope length have been quantified, however, slope length can also be variable. It is up to the field-team's discretion to select the most appropriate description from the five options provided for each factor.

Slope Angle	Score	Description
Very steep	1	A slope that is approximately >25 degrees
Steep	2	A slope that is approximately 20 - 25 degrees
Medium	3	A slope that is approximately 15 - 19 degrees
Low	4	A slope that is approximately 5 – 14 degrees
Flat	5	A slope that is approximately >5 degrees

Slope Length	Score	Description
Very long	1	Longer than 50 m
Long	2	30 - 50 m long
Medium	3	10 - 29 m long
Short	4	Shorter than10 m
N/A	5	No slope exists

A.2.2.2 Landform rehabilitation performance

Two scored factors are recorded relating to landform rehabilitation performance; 'overall condition' and 'investment needed'. Any factor that potentially affects the closure of an area should be noted. Factors affecting closure would include declared weeds or erosion. The field-team should comment on frequency and severity of any factors that are substantially affecting the condition of the rehabilitation.

Overall Condition	Score	Description
Very Poor	1	Many or widespread factors affecting condition that will require remediation before closure.
Poor	2	Landform unlikely to achieve relinquishment unless certain factors are addressed.
Fair	3	Factors developing which could impact closure.
Good	4	Only isolated occurrences of low impact factors affecting condition.
Excellent	5	No factors where integrity of landform is compromised. Comparable qualities to analogue areas.

Investment Needed	Score	Description
Major	1	Major investment over a large area of resources to address issues (or potential issues).
Significant	2	Significant resources required to address widespread issue or isolated high severity issue.
Strategic	3	Targeted spending of resources to address small scale developing issue.
Low	4	Low investment to improve factors that would benefit progression towards closure.
None	5	No investment of resources required to achieve closure.

A.2.2.3 Soil surface

Soil surface characteristics are integral to the performance of rehabilitation. The stability of the soil surface indicates its vulnerability to disturbance while the amount and integration of topsoil indicates the suitability of the growth medium. The proportion of the area covered by plants and or litter represents the amount of organic matter present. All three factors should be assessed in a representative area of approximately one ha near to photo-points locations. If multiple photo-point locations exist, then an average should be calculated.

Surface Stability	Score	Description
Unstable	1	High levels of disturbance. Low integrity of surface crust.
Unstable Patches	2	Little or no crusting, with moderate occurrence of or high potential for disturbance.
Fair	3	Establishing surface crust integrity with few occurrences of instability.
Mostly Intact	4	Disturbance limited to isolated occurrences. Mostly well resistant to disturbance.
Very Stable	5	No crust brokenness, high levels of cryptogam cover and good resistance to disturbance.

Surface Cover					
Bare:	%	Plants:	%	Litter:	%

Surface Cover: Percent assigned to proportional contribution of components. Proportions should be rounded to the nearest 10% but the sum of cover values should equal 100%.

Topsoil	Score	Description
No Topsoil	1	No topsoil or evidence of topsoil application.
Low (applied)	2	Low levels of topsoil applied (high integration of rock). Most topsoil retained on slope.
Low (transported)	3	Originally higher levels of topsoil but transported to lower parts of slope or into sediment fans.
Moderate	4	Moderate amount of topsoil integrated with surface. Up to 50% of surface occupied by stony material.
High	5	High amount of topsoil integration and cover.

No Topsoil

High

A.2.2.4 Erosion

The presence of excessive erosion can be very detrimental to the performance of the rehabilitation. Erosion can transport resources such as topsoil and soil seed-banks off the rehabilitation. In addition to scoring the features, other types of erosion, sediment fanning and other issue related to erosion should be commented upon, and if required photographs and way-points documented.

Rills	Score	Description
Numerous (severe)	1	High number of rills. Corrugated appearance of large width and depths approaching 30 cm
Numerous (small)	2	High number of rills up but low severity and depth
Many	3	Many rills (up to 20 per 50m) but low severity and no major impact or loss of material
Few	4	Few rills (up to 10 per 50m) with low impact and severity
None	5	No significant or discernible rilling (could be obscured by grasses)

Gullies	Score	Description
Many (large)	1	Many gullies (over 10 per 50 m) with depths exceeding 50 cm and/or widths exceeding 1m.
Many (small)	2	Many gullies (over 10 per 50 m) but low depth (under 50 cm) and widths under 1m.
Few (established)	3	Few gullies (less than 10 per 50 m) though active features with potential for further increase in dimension
Few (establishing)	4	Few gullies (less than 10 per 50 m) but mostly stable and non-active
None	5	No gullies present (or obscured by grasses)

Feature Stability	Score	Description
Active	1	Features large and active with unstable edges and significant sediment fanning. No colonising plants
Mostly Active	2	Low levels of stabilisation and self-armouring on some features only, with majority expected to increase
Becoming Stable	3	Only few features with recent activity. Many self-armoured or with establishing plants
Mostly Stable	4	Most features appearing stable, with little recent sediment deposition or with high grass cover
Stable	5	Features not recently active and low potential for reactivating and/or with high grass cover

Unstable

Stable

A.2.2.5 Habitat

The habitat factors pertain to the availability of faunal habitat. The factors were categorised into terrestrial habitat (plants, litter and rocks) and arboreal habitat (abundance and stratification of shrubs or trees). Additional faunal habitat and evidence of fauna utilising the rehabilitation should be noted (scats, tracks, or direct sighting).

Habitat Value (Terrestrial)	Score	Description
Low	1	Low plant and litter cover, with few habitable rocks
Patchy	2	Only isolated occurrences of habitat including rocks, litter or large plants
Moderate	3	Developing lower storey niches and moderate cover of rocky material.
High	4	Moderate lower storey cover and rocky cover with interspersing litter
Very High	5	Numerous rocks, high lower storey plant cover (e.g. grass, herbs) and abundant litter

Low

Very High

Habitat Value (Arboreal)	Score	Description
Low	1	No trees or upper storey
Patchy	2	Low upper storey cover, isolated to several individuals with few habitable niches
Moderate	3	Developing upper storey stratification across area with some habitable niches
High	4	Moderate upper-storey cover. Mixed age with developing stratification and habitable niches
Very High	5	High upper-storey cover. Mixed aged, well stratified and with numerous nesting hollows.

Low

Very High

A.2.2.6 Vegetation

Vegetation is an integral component of rehabilitation performance. Only perennial vegetation is considered in this Rapid Assessment. Cover (estimate guide is provided below) and perennial species richness (number of species) is to be estimated for grasses, herbs, woody shrubs <1.5 m in height and woody shrubs or trees >1.5 m in height. Any species that the field-team consider noteworthy should be recorded. Additional notes relating to juveniles, reproduction, plant health, or grazing should also be documented.

Perennial Vegetation Cover	Score	Description
None	1	Not represented, or with less than 1% cover
Low	2	Low cover (1-10%)
Patchy	3	Moderate cover over small proportion of area (11-25%)
Moderate	4	Moderate cover (25-50%)
High	5	High cover (over 50%)

Cover estimate guide				
Size of Plot	1% Cover	10% Cover	20% Cover	50% Cover
5x5 m	50 cm x 50 cm	1.5 m x 1.5 m	2 m x 2 m	3.5 m x 3.5 m
10x10 m	1 m x 1 m	3 m x 3 m	4.5 m x 4.5 m	7 m x 7 m
20x20 m	2 m x 2 m	6 m x 6 m	9 m x 9 m	14 m x 14 m
50x50 m	5 m x 5 m	15 m x 15 m	23 m x 23 m	35 m x 35 m
100x100 m (1ha)	10 m x 10 m	30 m x 30 m	45 m x 45 m	70 m x 70 m

Low

High

Perennial Species Richness	Score	Description (estimated over 1ha area at photo-points)
None	1	No species (0)
Low	2	Low number of species (1-2)
Medium	3	Moderate number of species (3-5)
High	4	High number of species (6-10)
Very High	5	Very high number of species (over 10)

A.2.2.7 Weeds

Not all introduced species are considered weeds because some are considered valuable cattle fodder (*Cenchrus ciliaris* or *Stylosanthes* sp.) or are not invasive. Any species that are on the Declared Pest species list provided by the Queensland Government or are considered invasive should be included and are referred to as weeds within this document. The majority of weeds at Mt Leyshon are confined to the edge of rehabilitation or along drains and roads (corridors) and consequently the descriptions relate only to weeds observed in these areas. Additional information such as weed species, declared species way-points and the impact of weeds on the rehabilitation should be recorded. The field-team is encouraged to also comment on weeds not located along corridors (drains) or edges.

Corridors and Edges (Weeds)	Score	Description
Dominant	1	Weeds dominate corridor edges (more than 50% cover)
Abundant	2	Multiple species and high cover of weeds (20-50% cover)
Frequent	3	Frequent occurrence of weeds (up to 20%) and multiple species represented
Scattered	4	Scattered occurrences of one or more weeds along edges
Absent	5	No weed species on edges (or less than 1% cover)

Cryptostegia grandiflora in drain on rehabilitated landform

A.2.3 Data entry

Once the data has been collected the field-team should electronically record data for each sub-domain using an approach that records all factors (see **Section A.2.3.1** for an example). As shown in **Section A.2.2** each description has an associated numerical score ranging from one to five. Using these numerical scores an aggregated score for each sub-domain can be calculated. This is then averaged for each domain.

A.2.3.1 Data Entry Example

Landform Assessment										
Area:	New North Tailings Dam North Batters						Date:		30/09/2013	
Landform characteristics:										
Slope Angle:	Very Steep		Steep	X	Medium		Low		Flat	
Slope Length:	Very Long		Long		Medium	X	Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate	X	High	
Slake Test	1-2 bare, 4 litter				Texture	3				
Overall condition:	Very Poor		Poor		Fair	X	Good		Excellent	
Investment required:	Major		Significant		Strategic	X	Low		None	
Factor affecting closure:	Erosion									
Soil:										
Surface stability:	Unstable		Unstable Patches	X	Fair		Mostly Intact		Very stable	
Surface cover:										
Bare:	60%		Plant :	30%			Litter:	10%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy	X	Moderate		High	
Grass species richness:	None		Low		Medium	X	High		Very high	
Herbs:										
Herb cover:	None		Low		Patchy	X	Moderate		High	
Herb species richness:	None		Low		Medium	X	High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy	X	Moderate		High	

Woody species richness:	None		Low		Medium	X	High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Stylosanthes* sp., *Cenchrus ciliaris, Chloris* sp., *Melinis repens, Acacia* spp., *Eucalyptus* spp., *Melaleuca* sp., *Acacia farnesiana, Acacia salicina, Corymbia* sp., *Pterocaulon* sp., *Passiflora foetida*									
Introduced species: Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	*Hyptis suaveolens, Tridax procumbens*									
Introduced species of note:	*Hyptis suaveolens, Tridax procumbens, Parkinsonia aculeata, Cryptostegia grandiflora,* Verbenaceae sp.									
Impact of weed species:	Nil									
Weed control required:	Not essential at time of assessment but might need to be considered									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many	X	Few		None	
Gullies:	Many (large)		Many (small)		Few (establishing)	X	Few (established)		None	
Feature stability:	Active		Mostly active	X	Becoming stable		Mostly stable		Stable	
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High		Very high	X
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroo (euro)									
Faunal Habitat:	Rocks, litter, grass									
	Expression of salt on bench but not excessive (WP: 55 K 424178 7758316)									

Additional notes: (e.g. excessive grazing, poor vegetation health)	
Landform Total Score:	**58**
Landform Maximum Score	**100**

Photo-points:

Location:	Waypoint:	Photos:	Notes:
photo-point 1	55 K 424164 7758352	155	
photo-point 2	55 K 423607 7758565	153	

PP1 (155)

PP2 (153)

Gullies:

Waypoint:	Photos:	Notes:
55 K 423612 7758572	152	
55 K 423607 7758565	153	
55 K 424164 7758352	154	

(152)

(153)

(154)

Weeds:

Species:	Waypoint:	Notes:
Parkinsonia aculeata	55 K 423601 7758512 - 55 K 423803 7758496	
Cryptostegia grandiflora	55 K 423600 7758501	
Cryptostegia grandiflora	55 K 423551 7758561	
Cryptostegia grandiflora	55 K 424170 7758339 - 55 K 424192 7758255	

Appendix B Rapid Assessment monitoring data 2020

B.1 Analogues

Landform Assessment										
Area:	Analogues T21 and T28						Date:		15-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low	X	Flat	
Slope Length:	Very Long	X	Long		Medium		Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good		Excellent	X
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	NA									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	15%		Plant:	75%			Litter:		10%	
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low		Medium	X	High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low		Medium	X	High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy		Moderate	X	High	
Woody species richness:	None		Low		Medium	X	High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Achyranthes aspera*, *Eucalyptus* spp., *Acacia* spp., *Stylosanthes* sp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	*Melinis repens* (Red Natal Grass)									
Introduced species of note:	*Ziziphus mauritiana* (Chinee Apple)									
Impact of weed species:	Potential for Red Natal Grass to colonise larger area of analogue site									
Weed control required:	Targeted *Ziziphus mauritiana* (Chinee Apple), *Melinis ripens* (Red Natal Grass)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High		Very high	X
Habitat value (arboreal):	Low		Patchy		Moderate		High		Very high	X
Fauna:	Kangaroos, birds, ants, cattle									
Faunal Habitat:	Tall trees, logs, dense grass									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Some grazing observed near T28. Analogue sites in excellent conditions overall. Cattle grazing and scats evident.									

Landform Total Score:	**79**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T21 Start	SSE	55 K 425684 7754827
T21 End	NE	55 K 425704 7754778
T21 End	NNE	55 K 425704 7754778
T21 End	NNW	55 K 425704 7754778
T28 Start	SSE	55 K 425744 7754724
T28 End	SW	55 K 425761 7754683
T28 End	NNW	55 K 425761 7754683
T28 End	NE	55 K 425761 7754683

T21 Start - SSE - 2020

T21 End - NE - 2020

T21 End - NNE - 2020

T21 End - NNW - 2020

T28 Start - SSE - 2020

T28 End - SW - 2020

T28 End - NNW - 2020

T28 End - NE - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Ziziphus mauritiana	55 K 425687 7754807	

Ziziphus mauritiana - 2020

Landform Assessment										
Area:	Analogue T23						Date:		14-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep	X	Medium		Low		Flat	
Slope Length:	Very Long	X	Long		Medium		Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good		Excellent	X
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	NA									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	5%		Plant:	85%			Litter:	5%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None	X	Low		Patchy		Moderate		High	
Herb species richness:	None	X	Low		Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy		Moderate	X	High	
Woody species richness:	None		Low		Medium	X	High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Eucalyptus* sp., *Acacia* sp., *Atalaya* sp., *Grevillea* sp.									
Introduced species:										

Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered		Absent	X
Introduced species confined to edges:	Introduced species are not confined to edges and are spread sporadically throughout the area									
Introduced species of note:	*Ziziphus mauritiana* (Chinee Apple), *Opuntia stricta* (Prickly pear), *Cryptostegia grandiflora* (Rubber Vine), *Acacia farnesiana* (Mimosa Bush), *Melinis repens* (Red Natal Grass)									
Impact of weed species:	Competition with native shrubs									
Weed control required:	Targeted control of *Opuntia stricta* (Prickly pear), *Cryptostegia grandiflora* (Rubber Vine), *Ziziphus mauritiana* (Chinee Apple)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High		Very high	X
Habitat value (arboreal):	Low		Patchy		Moderate		High		Very high	X
Fauna:	Birds, kangaroos									
Faunal Habitat:	Trees, logs, dense grass, litter									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Some weeds present in area. The canopy cover may help to reduce invasive grass cover. Vegetation was dry to due lack of rainfall in recent months.									
Landform Total Score:					**73**					
Landform Maximum Score					**100**					

Photo Points / Transects		
Location:	Direction:	Waypoint:
T23 Start	NE	55 K 424761 7755941
T23 End	W	55 K 424800 7755963
T23 End	S	55 K 424800 7755963
T23 End	N	55 K 424800 7755963
T23 End	E	55 K 424800 7755963

T23 Start - NE - 2020

T23 End - W - 2020

T23 End - S – 2020

T23 End - N - 2020

T23 End - E - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Opuntia stricta	55 K 424800 7755963	

Opuntia stricta - 2020

Landform Assessment										
Area:	Analogue T32						Date:		14-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium	X	Low		Flat	
Slope Length:	Very Long	X	Long		Medium		Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good		Excellent	X
Investment required:	Major		Significant		Strategic		Low	X	None	
Factor affecting closure:	NA									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	5%		Plant:	70%			Litter:		25%	
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate	X	High	
Grass species richness:	None		Low		Medium	X	High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low		Medium	X	High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy		Moderate		High	X
Woody species richness:	None		Low		Medium		High	X	Very high	
Species of note:	*Eucalyptus* spp., *Acacia* spp., *Stylosanthes* sp.									
Introduced species:										

Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	Nil									
Introduced species of note:	*Opuntia stricta* (Prickly pear)									
Impact of weed species:	Nil									
Weed control required:	Targeted control of *Opuntia stricta* (Prickly pear)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High		Very high	X
Habitat value (arboreal):	Low		Patchy		Moderate		High		Very high	X
Fauna:	Kangaroos, rabbits, spiders, grasshoppers, skinks									
Faunal Habitat:	Dense grass, logs, rocks, tall trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	One *Opuntia stricta* (Prickly pear) found near transect. A possible weed (unidentified) at 55 K 422601 7756547. Grasses dry due to lack of rainfall.									
Landform Total Score:					**77**					
Landform Maximum Score					**100**					

Photo Points / Transects		
Location:	Direction:	Waypoint:
T32 Start	NW	55 K 422636 7756517
T32 End	SE	55 K 422601 7756547

T32 Start – NW – 2020

T32 End – SE – 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Opuntia stricta	55 K 422615 7756569	
Unidentified weed	55 K 422601 7756547	

Opuntia stricta - 2020

Unidentified weed - 2020

B.2 Old North Tailings Dam

Landform Assessment										
Area:	Old North Tailings Dam East Flat						Date:		14-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Weeds									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	1%		Plant:	94%			Litter:	5%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low		Patchy		Moderate	X	High	
Herb species richness:	None		Low		Medium	X	High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris, Acacia* spp., ?*Eucalyptus/Corymbia* sp. (juvenile) present – very low abundance. *Stylosanthes* sp. (legume) well established									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	*Aerva javanica* (Kapok bush) (track) in low abundance. *Chloris gayana* (Rhodes grass) at edges, *Passiflora foetida* (Stinking Passionflower) in drainage line									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber Vine) in drainage line. Juvenile *Acacia farnesiana* (Mimosa Bush) scattered throughout area									
Impact of weed species:	Nil									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine), *Aerva javanica* (Kapok bush) and *Acacia farnesiana* (Mimosa Bush)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroos, rabbits, birds, wallabies									
Faunal Habitat:	Dense grass, rocks, litter, logs, some trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Vegetation very dry due to lack of rainfall									

Landform Total Score:	**77**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP10	ENE	55 K 423937 7757050
PP10	NW	55 K 423937 7757050
PP10	SW	55 K 423937 7757050
PP10	SE	55 K 423937 7757050
PP11	N	55 K 424022 7757090
PP11	S	55 K 424022 7757090
PP11	E	55 K 424022 7757090
PP11	W	55 K 424022 7757090

PP10 - ENE - 2020

PP10 - NW - 2020

PP10 - SW - 2020

PP10 - SE - 2020

PP11 - N - 2020

PP11 - S - 2020

PP11 - E - 2020

PP11 - W - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Cryptostegia grandiflora	55 K 424022 7757090	in drainage line next to PP11

Cryptostegia grandiflora - 2020

Landform Assessment										
Area:	Old North Tailings Dam West Flat						Date:		14-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	3				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Nil									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	1%		Plant:	96%			Litter:	4%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low		Medium	X	High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris, Acacia* spp., *Stylosanthes* sp. (legume) was abundant									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	*Passiflora foetida* (Stinking Passionflower), *Tridax procumbens*									
Introduced species of note:	Nil									
Impact of weed species:	Nil									
Weed control required:	Nil									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroos, rabbits, birds, dingo									
Faunal Habitat:	Dense grass, rocks, litter, logs, some trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Vegetation very dry due to lack of rainfall									

Landform Total Score:	**76**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T14a Start	NE	55 K 423681 7756920
T14a End	SW	55 K 423693 7756926
T14b Start	NE	55 K 423725 7756943
T14b End	SW	55 K 423739 7756950
T14c Start	NE	55 K 423759 7756962
T14c End	SW	55 K 423773 7756966
T14d Start	NE	55 K 423796 7756979
T14d End	SW	55 K 423806 7756985

T14a Start - NE - 2020

T14a End - SW - 2020

T14b Start - NE - 2020

T14b End - SW - 2020

T14c Start - NE - 2020

T14c End - SW - 2020

T14d Start - NE - 2020

T14d End - SW - 2020

Landform Assessment										
Area:	Old North Tailings Dam North Face (East) Batters						Date:		14-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep	X	Medium		Low		Flat	
Slope Length:	Very Long		Long		Medium	X	Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate	X	High	
Slake Test	3				Texture	4				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Some localised populations of introduced flora - *Cryptostegia grandiflora* (Rubber Vine)									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair	X	Mostly Intact		Very stable	
Surface cover										
Bare:	40%		Plant:	30%			Litter:	30%		
Vegetation:										
Grasses:										
Grass cover:	None		Low	X	Patchy		Moderate		High	
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris, Acacia* spp., *Eucalyptus* spp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	*Aerva javanica* (Kapok bush) on road, *Acacia farnesiana* (Mimosa Bush) on road/edge (not on the batters)									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber Vine) and environmental weeds; *Melinis repens* (Red Natal Grass) (isolated patches) and *Passiflora foetida* (Stinking Passionflower), *Chloris gayana* (Rhodes grass)									
Impact of weed species:	Minor competition with natives									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine) and *Aerva javanica* (Kapok bush)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few	X	None	
Gullies:	Many (large)		Many (small)		Few (establishing)	X	Few (established)		None	
Feature stability:	Active		Mostly active		Becoming stable	X	Mostly stable		Stable	
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate	X	High		Very high	
Habitat value (arboreal):	Low		Patchy		Moderate		High	X	Very high	
Fauna:	Birds, skinks, kangaroos, grasshoppers									
Faunal Habitat:	Some grass, litter, rocks, tall trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Steep slope angle likely to have contributed to historical erosion. Batters near PP9 showing very little vegetation growth/bare and unstable surface.									

Landform Total Score:	**60**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP8	E	55 K 423500 7757282
PP8	N	55 K 423500 7757282
PP8	W	55 K 423500 7757282
PP9	E	55 K 423583 7757303
PP9	N	55 K 423583 7757303
PP9	W	56 K 423583 7757303

PP8 - E - 2020

PP8 - N - 2020

PP8 - W - 2020

PP9 - E - 2020

PP9 - N - 2020

PP9 - W - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Cryptostegia grandiflora	55 K 423504 7757284	

Cryptostegia grandiflora - 2020

Landform Assessment										
Area:	Old North Tailings Dam North Face (West)						Date:		14-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep	X	Medium		Low		Flat	
Slope Length:	Very Long		Long		Medium	X	Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate	X	High	
Slake Test	3				Texture	4				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Nil									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact	X	Very stable	
Surface cover										
Bare:	20%		Plant:	70%			Litter:		10%	
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate	X	High	
Grass species richness:	None		Low		Medium	X	High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris, Acacia* spp., *Eucalyptus* spp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	Nil									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber Vine) found in low lying areas, *Tridax procumbens* (Tridax daisy) patchy, *Melinis repens* (Red Natal Grass)									
Impact of weed species:	Minor									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few	X	None	
Gullies:	Many (large)		Many (small)		Few (establishing)	X	Few (established)		None	
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable	X	Stable	
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate	X	High		Very high	
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Birds, kangaroos, rabbits, grasshoppers									
Faunal Habitat:	Grass, rocks, logs, trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Steep slope likely contributing to historical erosion									

Landform Total Score:	**63**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP6	E	55 K 423432 7757211
PP6	NE	55 K 423432 7757211
PP6	NW	55 K 423432 7757211
PP6	SW	55 K 423432 7757211

PP6 - E - 2020

PP6 - NE - 2020

PP6 - NW- 2020

PP6 - SW - 2020

B.3 New North Tailings Dam

Landform Assessment										
Area:	New North Tailings Dam West Flat						Date:		13-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good		Excellent	X
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Nil									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	5%		Plant:	90%			Litter:		5%	
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low		Medium		High	X	Very high	
Herbs:										
Herb cover:	None		Low		Patchy		Moderate	X	High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low		Medium	X	High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Acacia* spp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	*Cryptostegia grandiflora* (Rubber Vine) populating drains and low lying areas									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber Vine), *Melinis repens* (Red Natal Grass)									
Impact of weed species:	Minor competition with native shrubs									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low		Patchy		Moderate	X	High		Very high	
Fauna:	Kangaroos, feral pigs, rabbits, birds, skinks, snakes									
Faunal Habitat:	Dense grass, litter, rocks, logs, some small trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Windrow has greater Buffel grass cover than last year. High grass cover providing good habitat for fauna. Very dry vegetation due to lack of rainfall.									

Landform Total Score:	**81**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T15a Start	NE	55 K 423059 7757681
T15a End	SW	55 K 423072 7757689
T15b Start	NE	55 K 423094 7757703
T15b End	SW	55 K 423103 7757715
T15c Start	NE	55 K 423130 7757737
T15c End	SW	55 K 423139 7757747
T15d Start	NE	55 K 423167 7757769
T15d End	SW	55 K 423177 7757780
PP7	S	55 K 423162 7757307
PP7	W	55 K 423162 7757307
PP7	E	55 K 423162 7757307

T15a Start - NE - 2020

T15a End - SW - 2020

T15b Start - NE - 2020

T15b End - SW - 2020

T15c Start - NE - 2020

T15c End - SW - 2020

T15d Start - NE - 2020

T15d End - SW – 2020

PP7 - S - 2020

PP7 - W - 2020

PP7 - E - 2020

Landform Assessment										
Area:	New North Tailings Dam North Flat						Date:		14-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test					Texture					
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic	X	Low		None	
Factor affecting closure:	Some weed cover									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	5%		Plant:	90%		Litter:		5%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low		Medium	X	High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Acacia* spp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	*Parkinsonia aculeata*									
Introduced species of note:	*Acacia farnesiana* (Mimosa Bush), *Ziziphus mauritiana* (Chinee Apple) (low abundance) *Passiflora* sp., *Cryptostegia grandiflora* (Rubber Vine)									
Impact of weed species:	Displacement of native vegetation									
Weed control required:	Targeted control of Category 3 weeds; *Cryptostegia grandiflora, Parkinsonia aculeata* and *Ziziphus mauritiana*									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroos, feral pigs, insects									
Faunal Habitat:	Dense grass, litter, rocks, trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Area dominated by dense grass. Many varieties of kangaroo present.									

Landform Total Score:	**73**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T16a Start	NE	55 K 423458 7757923
T16a End	SW	55 K 423467 7757934
T16b Start	NE	55 K 423500 7757960
T16b End	SW	55 K 423514 7757973
T16c Start	NE	55 K 423527 7757990
T16c End	SW	55 K 423533 7757994
T16d Start	NE	55 K 423575 7758032
T16d End	SW	55 K 423584 7758041

T16a Start - NE - 2020

T16a End - SW - 2020

T16b Start - NE - 2020

T16b End - SW - 2020

T16c Start - NE - 2020

T16c End - SW - 2020

T16d Start - NE - 2020

T16d End - SW - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Parkinsonia aculeata	55 K 423584 7758041	
Cryptostegia grandiflora	55 K 423527 7757990	
Ziziphus mauritiana	55 K 423552 7758019	

Parkinsonia aculeata - 2020

Cryptostegia grandiflora - 2020

Ziziphus mauritiana - 2020

Landform Assessment										
Area:	New North Tailings Dam East Flat						Date:		13-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair	X	Good		Excellent	
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	*Parkinsonia aculeata* spread sporadically throughout the area									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	5%		Plant:	90%			Litter:	5%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low		Medium	X	High		Very high	
Herbs:										
Herb cover:	None		Low		Patchy	X	Moderate		High	
Herb species richness:	None		Low		Medium	X	High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy		Moderate	X	High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy		Moderate	X	High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris, Acacia* spp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent	X	Scattered		Absent	
Introduced species confined to edges:	*Cryptostegia grandiflora* (Rubber Vine) and *Acacia farnesiana* (Mimosa Bush) confined to drainage lines and low-lying areas									
Introduced species of note:	*Parkinsonia aculeata* and *Ziziphus mauritiana* (Chinee apple)									
Impact of weed species:	*Parkinsonia aculeata* has potential to increase in cover and displace native vegetation									
Weed control required:	Targeted control of *Cryptostegia grandiflora, Ziziphus mauritiana* and *Parkinsonia aculeata*									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low		Patchy		Moderate		High	X	Very high	
Fauna:	Kangaroos, birds, pigs, lizards, snakes, dogs/dingoes									
Faunal Habitat:	Dense grass, good tree cover, littler, logs, rocks									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Grassed very dry due to lack of rainfall. *Parkinsonia aculeata* seeding heavily. Many fauna tracks and diggings throughout grasses.									

Landform Total Score:	**80**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP3	N	55 K 423876 7757772
PP3	S	55 K 423876 7757772
PP3	E	55 K 423876 7757772
PP3	W	55 K 423876 7757772
PP4	N	55 K 423913 7758139
PP4	S	55 K 423913 7758139
PP4	E	55 K 423913 7758139
PP4	W	55 K 423913 7758139

PP3 - N - 2020

PP3 - S - 2020

PP3 - E - 2020

PP3 - W - 2020

PP4 - N - 2020

PP4 - S - 2020

PP4 - E - 2020

PP4 - W - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Parkinsonia aculeata	55 K 423549 7758111	>10 individuals
Parkinsonia aculeata	55 K 423545 7758086	
Ziziphus mauritiana	55 K 423944 7758143	

Parkinsonia aculeata - 2020

Parkinsonia aculeata - 2020

Ziziphus mauritiana - 2020

Landform Assessment										
Area:	New North Tailings Dam Central Flat						Date:		13-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Nil									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	10%		Plant:	87%			Litter:	3%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low		Medium	X	High		Very high	
Herbs:										
Herb cover:	None		Low		Patchy	X	Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy		Moderate	X	High	
Woody species richness:	None		Low		Medium	X	High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low		Medium	X	High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Acacia* spp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	Nil									
Introduced species of note:	*Melinis repens* (Red Natal Grass), and occasional *Passiflora foetida* (Stinking Passionflower)									
Impact of weed species:	Nil									
Weed control required:	Nil									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low		Patchy		Moderate	X	High		Very high	
Fauna:	Kangaroos, dogs/dingoes, pigs, rabbits									
Faunal Habitat:	Dense grass, rock, litter, logs, trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Vegetation very dry due to lack of rainfall. *Cryptostegia grandiflora* (Rubber vine) was not observed this year.									

Landform Total Score:	**81**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP5	N	55 K 423293 7757632
PP5	S	55 K 423293 7757632
PP5	E	55 K 423293 7757632
PP5	W	55 K 423293 7757632

PP5 - N - 2020

PP5 - S - 2020

PP5 - E - 2020

PP5 - W - 2020

Landform Assessment										
Area:	New North Tailings Dam North Batters						Date:		14-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep	X	Medium		Low		Flat	
Slope Length:	Very Long		Long		Medium	X	Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	3				Texture	3				
Overall condition:	Very Poor		Poor		Fair	X	Good		Excellent	
Investment required:	Major		Significant		Strategic		Low	X	None	
Factor affecting closure:	Some minor rilling (erosion) has increased									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact	X	Very stable	
Surface cover										
Bare:	20%		Plant:	70%			Litter:	10%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate	X	High	
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy		Moderate	X	High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy		Moderate	X	High	
Woody species richness:	None		Low		Medium	X	High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Eucalyptus* spp., *Acacia* spp.. *Acacia* has grown at site P2 and slightly higher grass cover (although has not increased overall score).									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	Nil									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber Vine), *Melinis repens* (Red Natal Grass) and *Passiflora foetida* (Stinking Passionflower) mostly on edges									
Impact of weed species:	Minor competition									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine).									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few	X	None	
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable	X	Mostly stable		Stable	
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate	X	High		Very high	
Habitat value (arboreal):	Low		Patchy		Moderate		High	X	Very high	
Fauna:	Birds, including an abundant red tailed black cockatoos, kangaroos									
Faunal Habitat:	Some grass cover, shrubs and mature trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Erosion (rilling) found at PP02 getting slightly worse. *Aerva javanica* (Kapok) absent this year, while *Cryptostegia grandiflora* (Rubber Vine) was newly recorded.									

Landform Total Score:	**67**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP1	E	55 K 424197 7758347
PP2	ESE	55 K 423548 7758555
PP2	S	55 K 423548 7758555
PP2	SE	55 K 423548 7758555

PP1 - E - 2020

PP2 - ESE - 2020

PP2 - S - 2020

PP2 - SE - 2020

Erosion		
Feature:	Waypoint:	Notes:
Erosion	55 K 423548 7758555	erosion found at PP02

Erosion - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Cryptostegia grandiflora	55 K 423548 7758555 (?)	found near PP2?

Cryptostegia grandiflora - 2020

B.4 Northern WRL

Landform Assessment										
Area:	Northern WRL East Face						Date:		13-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium	X	Low		Flat	
Slope Length:	Very Long		Long	X	Medium		Short		NA	
Topsoil:	No topsoil	X	Low (applied)		Low (transported)		Moderate		High	
Slake Test	1				Texture	No Soil (0)				
Overall condition:	Very Poor	X	Poor		Fair		Good		Excellent	
Investment required:	Major	X	Significant		Strategic		Low		None	
Factor affecting closure:	Area is yet to be rehabilitated with topsoil – reinforced aggregate comprises the surface of the east face.									
Soil:										
Surface stability:	Unstable	X	Unstable Patches		Fair		Mostly Intact		Very stable	
Surface cover										
Bare:	95%		Plant:	4%			Litter:		1%	
Vegetation:										
Grasses:										
Grass cover:	None	X	Low		Patchy		Moderate		High	
Grass species richness:	None	X	Low		Medium		High		Very high	
Herbs:										
Herb cover:	None	X	Low		Patchy		Moderate		High	
Herb species richness:	None	X	Low		Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Acacia* spp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	*Cryptostegia grandiflora* (Rubber vine), *Opuntia stricta* (Prickly pear)									
Introduced species of note:	*Tridax procumbens* (Tridax daisy)									
Impact of weed species:	Nil									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine) and *Opuntia stricta* (Prickly pear)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)	X	Many		Few		None	
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)	X	None	
Feature stability:	Active		Mostly active	x	Becoming stable		Mostly stable		Stable	
Habitat & Fauna:										
Habitat value (terrestrial):	Low	X	Patchy		Moderate		High		Very high	
Habitat value (arboreal):	Low	X	Patchy		Moderate		High		Very high	
Fauna:	Nil									
Faunal Habitat:	Rocks									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Area is almost completely bare due to lack of topsoil. PP12 post does not show the face, consider relocation of post onto a lift on the face.									

Landform Total Score:	**35**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP12	N	55 K 423573 7756538
PP12	S	55 K 423573 7756538
PP12	E	55 K 423573 7756538
PP12	W	55 K 423573 7756538
PP13	N	55 K 423530 7756315
PP13	S	55 K 423530 7756315
PP13	E	55 K 423530 7756315
PP13	W	55 K 423530 7756315

PP12 - N - 2020

PP12 - S - 2020

PP12 - E - 2020

PP12 - W - 2020

PP13 - N - 2020

PP13 - S - 2020

PP13 - E - 2020

PP13 - W - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Opuntia stricta	55 K 423573 7756538	at base of PP12 post

Opuntia stricta - 2020

Landform Assessment										
Area:	Northern WRL South and West Face						Date:		13-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium	X	Low		Flat	
Slope Length:	Very Long	X	Long		Medium		Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate	X	High	
Slake Test	3				Texture	4				
Overall condition:	Very Poor		Poor		Fair	X	Good		Excellent	
Investment required:	Major		Significant		Strategic	X	Low		None	
Factor affecting closure:	Some areas lacking vegetative cover (bare). Some old established erosion gullies.									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact	X	Very stable	
Surface cover										
Bare:	30%		Plant:	40%			Litter:		30%	
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate	X	High	
Grass species richness:	None		Low		Medium	X	High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy		Moderate	X	High	
Woody species richness:	None		Low		Medium	X	High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy		Moderate	X	High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris, Acacia* spp., *Eucalyptus* spp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent	X	Scattered		Absent	
Introduced species confined to edges:	Nil									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber vine), *Acacia farnesiana* (Mimosa bush), small occurrence of *Passiflora foetida* (Stinking Passionflower), *Melinis repens* (Red Natal Grass)									
Impact of weed species:	Minor competition with native vegetation									
Weed control required:	Targeted control of *Cryptostegia grandiflora*									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)	X	Many		Few		None	
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)	X	None	
Feature stability:	Active		Mostly active		Becoming stable	X	Mostly stable		Stable	
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate	X	High		Very high	
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroos, dogs/dingoes, spiders, rabbits, snakes									
Faunal Habitat:	Trees, dense grass, rocks, logs									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Some large bare areas with old erosion gullies. Some hidden rills in dense grass. Dense grass is very dry due to lack of rainfall.									

Landform Total Score:	**59**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP16	N	55 K 423379 7756298
PP16	S	55 K 423379 7756298
PP16	E	55 K 423379 7756298
PP16	WNW	55 K 423379 7756298

PP16 - N - 2020

PP16 - S - 2020

PP16 - E - 2020

PP16 - WNW - 2020

Erosion		
Feature:	Waypoint:	Notes:
Erosion 26	55 K 423256 7756116	

Erosion 26 - 2020

Landform Assessment										
Area:	Northern WRL North Face						Date:		13-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep	X	Medium		Low		Flat	
Slope Length:	Very Long	X	Long		Medium		Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair	X	Good		Excellent	
Investment required:	Major		Significant		Strategic		Low	X	None	
Factor affecting closure:	Some historical erosion. Some bare areas lacking vegetative cover.									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact	X	Very stable	
Surface cover										
Bare:	8%		Plant:	82%			Litter:	10%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate	X	High	
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low		Patchy	X	Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris, Acacia* spp., *Eucalyptus* spp., *Cenchrus setigerus*									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	*Cryptostegia grandiflora* (Rubber Vine), *Aerva javanica* (Kapok bush) patchy									
Introduced species of note:	*Melinis repens* (Red Natal Grass), ?*Cascabela* sp.									
Impact of weed species:	*Cryptostegia grandiflora* (Rubber Vine) dominating drains									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many	X	Few		None	
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)	X	None	
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable	X	Stable	
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate	X	High		Very high	
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroos, dogs/dingos, rabbits									
Faunal Habitat:	Grass cover, rocks, logs and trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Major drainage – meshing attempted recently? Seeding not taken?, Erosion deep halfway along transect? Further identify ?*Cascabela* sp. next assessment to confirm it's not a restricted species									

Landform Total Score:	**59**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T12 A Start	N	55 K 423529 7756546
T12 A End	S	55 K 423532 7756590
T12 B Start	N	55 K 423502 7756704
T12 B End	S	55 K 423507 7756730

T12 A Start - N - 2020

T12 A End - S - 2020

T12 B Start - N - 2020

T12 B End - S - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
?*Cascabela* sp.	55 K 423501 7756735	check and id next assessment
Cryptostegia grandiflora	55 K 423529 7756546	new weed

?*Cascabela* sp - 2020

Cryptostegia grandiflora - 2020

Erosion		
Feature:	Waypoint:	Notes:
Erosion	55 K 423534 7756579	> 1 m deep, 10 m long

Erosion - 2020

Landform Assessment										
Area:	Northern WRL Top (Flat)						Date:		13-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Weeds									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	0%		Plant:	95%			Litter:	5%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None	X	Low		Patchy		Moderate		High	
Woody species richness:	None	X	Low		Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass) dense and knee high									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered		Absent	X
Introduced species confined to edges:	Nil									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber Vine) and *Aerva javanica* (Kapok bush) patchy, *Melinis repens* (Red Natal Grass)									
Impact of weed species:	Nil									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few	X	None	
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low	X	Patchy		Moderate		High		Very high	
Fauna:	Kangaroos, dogs/dingoes, rabbits, snakes, grasshoppers, ants									
Faunal Habitat:	Dense grass									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Grasses are very dry due to lack of rainfall									

Landform Total Score:	**70**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP14	NE	55 K 423484 7756519
PP14	NW	55 K 423484 7756519
PP14	SE	55 K 423484 7756519
PP14	SW	55 K 423484 7756519
PP15	N	55 K 423525 7756545
PP15	S	55 K 423525 7756545
PP15	E	55 K 423525 7756545
PP15	W	55 K 423525 7756545

PP14 - NE - 2020

PP14 - NW - 2020

PP14 - SE - 2020

PP14 - SW - 2020

PP15 - N - 2020

PP15 - S - 2020

PP15 - E - 2020

PP15 - W - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Cryptostegia grandiflora	55 K 423484 7756519	

Cryptostegia grandiflora - 2020

B.5 Roche Hill

Landform Assessment										
Area:	Roche Hill Flat						Date:		13-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	3				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic	X	Low		None	
Factor affecting closure:	Weed presence in drain lines and near windrows. *Cryptostegia grandiflora* (Rubber Vine) was actively sprayed – evidence of regrowth but some dead. Limited upper storey – some *Acacia* sp. present, low in density.									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	10%		Plant:	70%		Litter:	20%			
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None	X	Low		Patchy		Moderate		High	
Woody species richness:	None	X	Low		Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Acacia holosericea*, *Eucalyptus* spp. (juvenile), some large legumes but patchy									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant	X	Frequent		Scattered		Absent	
Introduced species confined to edges:	*Cryptostegia grandiflora* (Rubber Vine), *Acacia farnesiana* (Mimosa Bush) patchy, both restricted to drains									
Introduced species of note:	*Melinis repens* (Red Natal Grass) scattered within grassland									
Impact of weed species:	No impacts									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroos, rabbits, dogs, birds									
Faunal Habitat:	Dense grass, rocks, litter, some patchy tree cover									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Grass cover is thick and very dry. Weed control is recommended in drainage lines. Dense *Cenchrus ciliaris* (Buffel Grass) is knee/waist high PP17 vicinity									

Landform Total Score:	**67**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP17	NNE	55 K 424102 7755277
PP17	NW	55 K 424102 7755277
PP17	SE	55 K 424102 7755277
PP17	SW	55 K 424102 7755277

PP17 - NNE - 2020

PP17 - NW – 2020

PP17 - SE - 2020

PP17 - SW - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Cryptostegia grandiflora	55 K 424058 7755277	healthy weed
Cryptostegia grandiflora	55 K 424056 7755308	sprayed – dead/slight regrowth
Cryptostegia grandiflora	55 K 424058 7755325	sprayed – dead/slight regrowth

Cryptostegia grandiflora - 2020

Cryptostegia grandiflora - 2020

Cryptostegia grandiflora - 2020

Landform Assessment										
Area:	Roche Hill Batters						Date:		13-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium	X	Low		Flat	
Slope Length:	Very Long		Long	X	Medium		Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	2				Texture	3				
Overall condition:	Very Poor		Poor		Fair	X	Good		Excellent	
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Weeds									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	15%		Plant:	80%			Litter:	5%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate	X	High	
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None	X	Low		Patchy		Moderate		High	
Herb species richness:	None	X	Low		Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Acacia* sp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant	X	Frequent		Scattered		Absent	
Introduced species confined to edges:	No species confined to edges									
Introduced species of note:	*Calotropis procera* (Calotrope), *Opuntia stricta* (Prickly pear) was found near PP18d/PP18e. *Passiflora foetida* (Stinking Passionflower), *Melinis repens* (Red Natal Grass) growing with *Cenchrus ciliaris*									
Impact of weed species:	No negative impacts									
Weed control required:	Targeted control of *Opuntia stricta* (Prickly pear) and *Calotropis procera* (Calotrope)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few	X	None	
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)	X	None	
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable	X	Stable	
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy	X	Moderate		High		Very high	
Habitat value (arboreal):	Low	X	Patchy		Moderate		High		Very high	
Fauna:	Kangaroos, dogs/dingos, rabbits, snakes									
Faunal Habitat:	Some grass cover, however, not as dense as most other sites. Some mid-story developing									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Erosion was a result of works in the area in 2017, with minimal ground cover to bind soil together. The area is beginning to blend well into the surrounding landscape, and a monitoring post was re-installed in 2019 to define the photo point. A new PP was added in 2020 as requested by Newmont.									

Landform Total Score:	**56**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP18	N	55 K 423885 7755207
PP18	E	55 K 423885 7755207
PP18	S	55 K 423885 7755207
PP18	W	55 K 423885 7755207
PP18b	N	55 K 423852 7755251
PP18b	NW	55 K 423852 7755251
PP18c	SW	55 K 423966 7755364
PP18d	W	55 K 423840 7755481
PP18e	NW	55 K 423894 7755408

PP18 - N - 2020

PP18 - E - 2020

PP18 - S - 2020

PP1 - W - 2020

PP18b - N - 2020

PP18b - NW - 2020

PP18c - SW - 2020

PP18d - W - 2020

PP18e - NW - 2020

Erosion		
Feature:	Waypoint:	Notes:
Erosion gully	55 K 423938 7755403	

Erosion gully - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Opuntia stricta (Prickly pear)	55 K 423851 7755461	
Calotropis procera	55 K 423938 7755403	

Opuntia stricta- 2020

Calotropis procera - 2020

B.6 Non-Acid Forming Oxide Stockpile

Landform Assessment										
Area:	Non-Acid Forming Oxide Stockpile						Date:		13-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low	X	Flat	
Slope Length:	Very Long		Long	X	Medium		Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic		Low	X	None	
Factor affecting closure:	Some localised populations of introduced flora									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	1%		Plant:	98%			Litter:	1%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None	X	Low		Patchy		Moderate		High	
Woody species richness:	None	X	Low		Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None	X	Low		Patchy		Moderate		High	
Woody species richness:	None	X	Low		Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass)									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	*Ziziphus mauritiana* (Chinee apple)									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber Vine) patchy, *Melinis repens* (Red Natal Grass)									
Impact of weed species:	Minor competition with natives									
Weed control required:	Targeted control of *Ziziphus mauritiana* (Chinee apple) and *Cryptostegia grandiflora* (Rubber Vine)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High		Very high	X
Habitat value (arboreal):	Low	X	Patchy		Moderate		High		Very high	
Fauna:	Feral pigs, kangaroos, birds, grasshoppers, snakes									
Faunal Habitat:	Dense grassland									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Very dry grass due to lack of rainfall. Many kangaroo and pig tracks throughout grass. Grass knee to waist high.									

Landform Total Score:	**64**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T30 Start	E	55 K 424443 7757707
T30 End	W	55 K 424490 7757703
T30 End	N	55 K 424490 7757703
T31 Start	N	55 K 424388 7757723
T31 End	S	55 K 424375 7757775

T30 Start - E - 2020

T30 End - W - 2020

T30 End - N - 2020

T31 Start - N - 2020

T31 End - S - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Ziziphus mauritiana	55 K 424500 7757702	

Ziziphus mauritiana - 2020

B.7 Southern WRL

Landform Assessment										
Area:	Southern WRL Batters						Date:		14-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium	X	Low		Flat	
Slope Length:	Very Long	X	Long		Medium		Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate	X	High	
Slake Test	3				Texture	3				
Overall condition:	Very Poor		Poor		Fair	X	Good		Excellent	
Investment required:	Major		Significant	X	Strategic		Low		None	
Factor affecting closure:	Major active erosion features are present on the batters. Some erosion features are beginning to stabilize with vegetation growth in the rills and gullies, however, some are bare and uncapped waste is visible. Localised erosion may have increased since 2019.									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact	X	Very stable	
Surface cover										
Bare:	20%		Plant:		70%		Litter:		10%	
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate	X	High	
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris, Acacia holosericea, Eucalyptus melanophloia, E. platyphylla*									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	Nil									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber Vine) is primarily located within rock drains and erosion gullies, patchy, *Melinis repens* (Red Natal Grass)									
Impact of weed species:	No significant impacts. *Cryptostegia grandiflora* (Rubber vine) dominant species in rock drains									
Weed control required:	Targeted spraying of *Cryptostegia grandiflora* (Rubber Vine), although some hard to access.									
Erosion:										
Rill frequency:	Numerous (severe)	X	Numerous (small)		Many		Few		None	
Gullies:	Many (large)	X	Many (small)		Few (establishing)		Few (established)		None	
Feature stability:	Active		Mostly active	X	Becoming stable		Mostly stable		Stable	
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroos, rabbits, dingos/dogs, birds									
Faunal Habitat:	Dense grass, logs, litter, rocks, water sump present on batters' lift, patchy trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Major active erosion features are present, some vegetation growth in the gullies, however, not enough to stabilize. Erosion points mostly active, new erosion point added #36									

Landform Total Score:	**50**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T11a Start	SE	55 K 423891 7754894
T11a End	NW	55 K 423915 7754859
T11b Start	S	55 K 424132 7754991
T11b End	N	55 K 424142 7754955

T11a Start - SE - 2020

T11a End - NW - 2020

T11b Start - S - 2020

T11b End - N - 2020

Erosion		
Feature:	Waypoint:	Notes:
Erosion 13	55 K 424142 7754928	
Erosion 25	55 K 423901 7754861	
Erosion 27	55 K 424124 7754953	
Erosion 28	55 K 424190 7754965	
Erosion 29	55 K 424193 7754962	looks much deeper than 2019
Erosion 30	55 K 423976 7754940	fine white sediment deposited at base of erosion
Gully 18	55 K 423980 7754902	
Erosion 31	55 K 423965 7754934	

Erosion 13 - 2020

Erosion 25 - 2020

Erosion 27 - 2020

Erosion 28 - 2020

Erosion 29 - 2020

Erosion 30 - 2020

Gully 18 - 2020

Erosion 31 - 2020

Landform Assessment										
Area:	Southern WRL Flat						Date:		14-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	2				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic		Low	X	None	
Factor affecting closure:	*Cryptostegia grandiflora* (Rubber Vine) present in rock drains, has been sprayed but there is re-growth in places.									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	2%		Plant:	95%		Litter:	3%			
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low		Patchy	X	Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris, Acacia holosericea, Eucalyptus* sp.									
Introduced species:										

Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent	X	Scattered		Absent	
Introduced species confined to edges:	*Cryptostegia grandiflora* (Rubber Vine) and *Acacia farnesiana* (Mimosa Bush) are present, predominantly in rocky drains									
Introduced species of note:	*Calotropis procera* (Calotrope) and minor *Passiflora foetida* (Stinking Passionflower)									
Impact of weed species:	Dominant species edging drains									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine) and *Calotropis procera* (Calotrope)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroos, dogs, rabbits, birds									
Faunal Habitat:	Dense grass, rocks, some sparse trees, litter									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Majority of the area is covered in dense dry grass (Buffel Grass). Good habitat, however, native species are sparse.									

Landform Total Score:	**72**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP19	N	55 K 423838 7754996
PP19	S	55 K 423838 7754996
PP19	E	55 K 423838 7754996
PP19	W	55 K 423838 7754996

PP19 - N - 2020

PP19 - S - 2020

PP19 - E - 2020

PP19 - W - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Cryptostegia grandiflora	55 K 423847 7755020	sprayed, looks dead
Calotropis procera	55 K 423842 7755077	

Cryptostegia grandiflora - 2020

Calotropis procera - 2020

B.8 Southern Tailings Dam

Landform Assessment										
Area:	Southern Tailings Dam Batters						Date:		14-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep	X	Medium		Low		Flat	
Slope Length:	Very Long		Long		Medium	X	Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	3				Texture	3				
Overall condition:	Very Poor		Poor		Fair	X	Good		Excellent	
Investment required:	Major		Significant		Strategic		Low	X	None	
Factor affecting closure:	Some historical erosion present									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact	X	Very stable	
Surface cover										
Bare:	10%		Plant:		70%		Litter:		20%	
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate	X	High	
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low		Medium	X	High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy		Moderate		High	X
Woody species richness:	None		Low		Medium		High	X	Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Corymbia* spp., *Acacia* spp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	Nil									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber Vine), *Melinis repens* (Red Natal Grass), *Acacia farnesiana* (Mimosa Bush), *Chloris gayana* (Rhodes grass) patchy									
Impact of weed species:	Nil									
Weed control required:	Ongoing targeted control of invasive species, *Cryptostegia grandiflora* (Rubber Vine)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few	X	None	
Gullies:	Many (large)		Many (small)		Few (establishing)	X	Few (established)		None	
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable	X	Stable	
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate	X	High		Very high	
Habitat value (arboreal):	Low		Patchy		Moderate		High	X	Very high	
Fauna:	Birds, kangaroos									
Faunal Habitat:	Trees, rocks, logs									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Steep batters may have contributed to old erosion rills and gullies. Grasses and small shrubs have colonised the batter. *Cryptostegia grandiflora* (Rubber Vine) on batters (patchy) at T26. Fire at T27 – recent/2019?									

Landform Total Score:	**68**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T26 Start	SE	55 K 424269 7754143
T26 End	SW	55 K 424243 7754167
T26 End	SE	55 K 424243 7754167
T26 End	NW	55 K 424243 7754167
T26 End	NE	55 K 424243 7754167
T27 Start	E	55 K 424314 7754235
T27 End	W	55 K 424340 7754235
PP23	N	55 K 423629 7753849
PP23	NE	55 K 423629 7753849
PP23	NW	55 K 423629 7753849

T26 Start - SE - 2020

T26 End - SW - 2020

T26 End - SE - 2020

T26 End - NW - 2020

T26 End - NE - 2020

T27 Start - E - 2020

T27 End - W - 2020

PP23 - N - 2020

PP23 - NE - 2020

PP23 - NW - 2020

Erosion		
Feature:	Waypoint:	Notes:
Erosion 10	55 K 423508 7753938	Reinforced in 2018 – discontinue monitoring
Erosion 11	55 K 423778 7753845	
Erosion 12 (new)	55 K 423875 7753883	

Erosion 10 - 2020

Erosion 11 - 2020

Erosion 12 - 2020

Landform Assessment										
Area:	Southern Tailings Dam Flat						Date:		14-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic	X	Low		None	
Factor affecting closure:	Re-growth of weeds - *Cryptostegia grandiflora* (Rubber Vine) and *Ziziphus mauritiana* (Chinee Apple) were the dominant species in drains and low lying areas until extensive spraying									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	5%		Plant:	90%		Litter:	5%			
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low		Medium	X	High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), patchy legume									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	*Cryptostegia grandiflora* (Rubber Vine) and *Ziziphus mauritiana* (Chinee Apple) – evidence of regrowth or seeding on new juveniles, in drains and low lying areas									
Introduced species of note:	*Melinis repens* (Red Natal Grass), *Chloris gayana* (Rhodes grass) patchy,									
Impact of weed species:	Displacement of native vegetation									
Weed control required:	Continue targeted control in drains and low lying areas (re-growth)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High		Very high	X
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroos, feral pigs, birds, snakes, rabbits									
Faunal Habitat:	Dense grass, rocky drains, some small trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Grasses very dry due to lack of rainfall in recent months. Extensive spraying of Rubber Vine and Chinee Apple was carried out by Newmont and most weeds were dead, resulting in an improved landform score. Targeted control of *Cryptostegia grandiflora* (Rubber Vine) and *Ziziphus mauritiana* (Chinee Apple) regrowth may assist native shrub establishment. A few unknown weeds were recorded. Many varieties of kangaroo observed.									

Landform Total Score:	**73**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T10a Start	NE	55 K 423768 7754206
T10a End	SW	55 K 423777 7754218
T10b Start	NE	55 K 423792 7754239
T10b End	SW	55 K 423800 7754248
T10c Start	NE	55 K 423824 7754279
T10c End	SW	55 K 423831 7754289
T10d Start	NE	55 K 423870 7754343
T10d End	SW	55 K 423878 7754352
PP20	N	55 K 424152 7754725
PP20	S	55 K 424152 7754725
PP20	E	55 K 424152 7754725
PP20	W	55 K 424152 7754725

T10a Start - NE - 2020

T10a End - SW - 2020

T10b Start - NE - 2020

T10b End - SW - 2020

T10c Start - NE - 2020

T10c End - SW - 2020

T10d Start - NE - 2020

T10d End - SW – 2020

PP20 - N - 2020

PP20 - S - 2020

PP20 - E - 2020

PP20 - W - 2020

B.9 Eastern WRL

Landform Assessment										
Area:	Eastern WRL South West Flat						Date:		15-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair	X	Good		Excellent	
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Nil									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	8%		Plant:	85%			Litter:	7%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low		Patchy	X	Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None	X	Low		Patchy		Moderate		High	
Woody species richness:	None	X	Low		Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Pterocaulon sphacelatum, Acacia holosericea, Tephrosia supina*									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant	X	Abundant		Frequent		Scattered		Absent	
Introduced species confined to edges:	*Tridax* sp.									
Introduced species of note:	*Calotropis procera* (Calotrope), *Cryptostegia grandiflora* (Rubber Vine), *Melinis repens* (Red Natal Grass), patchy *Aerva javanica* (Kapok bush), *Sida* sp.									
Impact of weed species:	Minor									
Weed control required:	Targeted control of *Calotropis procera* and *Cryptostegia grandiflora* (Rubber Vine)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low	X	Patchy		Moderate		High		Very high	
Fauna:	Kangaroos, rabbits									
Faunal Habitat:	Dominated by dense grass									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Dense grassland with sparse tree canopy. *Acacia* individuals have grown since previous assessment. *Calotropis procera* (Calotrope), *Cryptostegia grandiflora* (Rubber Vine) now evident and no *Opuntia stricta* (Prickly pear) found in 2020.									

Landform Total Score:	**67**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T07a Start	N	55 K 424789 7754958
T07a End	S	55 K 424789 7754974
T07b Start	N	55 K 424791 7754992
T07b End	S	55 K 424791 7755001
T07c Start	N	55 K 424793 7755031
T07c End	S	55 K 424794 7755041
T07d Start	N	55 K 424796 7755051
T07d End	S	55 K 424794 7755057
T09a Start	W	55 K 424589 7755178
T09a End	E	55 K 424577 7755179
T09b Start	W	55 K 424551 7755180
T09b End	E	55 K 424542 7755179
T09c Start	W	55 K 424532 7755180
T09c End	E	55 K 424522 7755180
T09d Start	W	55 K 424513 7755180
T09d End	N	55 K 424502 7755179
T09d End	E	55 K 424502 7755179
T09d End	S	55 K 424502 7755179

T07A Start – N -2020

T07A End – S - 2020

T07B Start – N -2020

T07B End – S - 2020

T07C Start – N -2020

T07C End – S - 2020

T07D Start – N -2020

T07D End – S - 2020

T09A Start – W -2020

T09A End – E - 2020

T09B Start – W -2020

T09B End – E - 2020

T09C Start – W -2020

T09C End – E - 2020

T09D Start – W -2020

T09D End – N - 2020

T09D End – E - 2020

T09D End – S - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Calotropis procera	55 K 424492 7755244	
Cryptostegia grandiflora	55 K 424474 7755170	
Cryptostegia grandiflora	55 K 424496 7755224	
Cryptostegia grandiflora	55 K 424503 7755249	new, in drain

Calotropis procera - 2020

Cryptostegia grandiflora - 2020

Cryptostegia grandiflora - 2020

Cryptostegia grandiflora - 2020

Landform Assessment										
Area:	Eastern WRL North Flat						Date:		15-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	4				
Overall condition:	Very Poor		Poor		Fair		Good		Excellent	X
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Nil									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	1%		Plant:	90%			Litter:	9%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Acacia* sp.									
Introduced species:										

Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered		Absent	X
Introduced species confined to edges:	Nil, however, some weeds present throughout body of area									
Introduced species of note:	*Opuntia stricta* (Prickly Pear), *Cryptostegia grandiflora* (Rubber Vine), *Acacia farnesiana* (Mimosa Bush), patchy *Passiflora foetida* (Stinking Passionflower), *Melinis repens* (Red Natal Grass)									
Impact of weed species:	If weed species continue to spread, they may outcompete native shrubs in the area.									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine) and *Opuntia stricta* (Prickly Pear)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low	X	Patchy		Moderate		High		Very high	
Fauna:	Kangaroos, birds									
Faunal Habitat:	Dense grass, sparse *Acacia* shrubs									
Additional notes: (e.g. excessive grazing, poor vegetation health)	*Opuntia stricta* (Prickly Pear) and *Cryptostegia grandiflora* (Rubber Vine), found at T02b, *Acacia farnesiana* (Mimosa Bush) found at T02a. *Cenchrus ciliaris* (Buffel Grass) remains the dominant species in the area, knee to waist high.									

Landform Total Score:	**74**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T02a Start	S	55 K 424917 7756180
T02a End	W	55 K 424917 7756168
T02a End	N	55 K 424920 7756256
T02a End	E	55 K 424920 7756256
T02b Start	S	55 K 424917 7756206
T02b End	N	55 K 424917 7756196
T02c Start	S	55 K 424920 7756237
T02c End	N	55 K 424922 7756222
T02d Start	S	55 K 424922 7756266
T02d End	N	55 K 424920 7756256

T02a Start - S - 2020

T02a End - W - 2020

T02a End - N - 2020

T02a End - E - 2020

T02b Start - S - 2020

T02b End - N - 2020

T02c Start - S - 2020

T02c End - N - 2020

T02d Start - S - 2020

T02d End - N - 2020

Landform Assessment										
Area:	Eastern WRL Central South Flat						Date:		15-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate	X	High	
Slake Test	4				Texture	2				
Overall condition:	Very Poor		Poor		Fair		Good		Excellent	X
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Nil									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	10%		Plant:	70%			Litter:	20%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris, Acacia holosericea*									
Introduced species:										

Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	Nil									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber vine), *Melinis repens* (Red Natal Grass), *Bidens pilosa*									
Impact of weed species:	Minor									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber vine)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High		Very high	X
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroos, birds, skinks, rabbits									
Faunal Habitat:	Dense grass, shrubs, trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Some bare areas near PP22. Minor washout near drain. Grasses very dry due to lack of rainfall in recent months.									
Landform Total Score:					**74**					
Landform Maximum Score					**100**					

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP22	NE	55 K 424920 7755277
PP22	NW	55 K 424920 7755277
PP22	SE	55 K 424920 7755277
PP22	SW	55 K 424920 7755277

PP22 – NE - 2020

PP22 –NW - 2020

PP22 – SE - 2020

PP22 – SW - 2020

Landform Assessment										
Area:	Eastern WRL Central North Flat						Date:		15-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low		Flat	X
Slope Length:	Very Long		Long		Medium		Short		NA	X
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic		Low	X	None	
Factor affecting closure:	Some areas dominated by weeds. Some areas lacking vegetative cover.									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	2%		Plant:	90%			Litter:	8%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low		Medium	X	High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Stylosanthes* sp., *Acacia* spp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered		Absent	X
Introduced species confined to edges:	Nil, however, introduced species are spread throughout the area.									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber Vine), *Melinis repens* (Red Natal Grass), *Calotropis procera* (Calotrope), *Passiflora foetida* (Stinking Passionflower)									
Impact of weed species:	Grasses dominating area causing possible displacement to native vegetation.									
Weed control required:	*Cryptostegia grandiflora* (Rubber Vine), *Calotropis procera* (Calotrope), *Melinis repens* (Red Natal Grass)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)	X	None	
Feature stability:	Active	X	Mostly active		Becoming stable		Mostly stable		Stable	
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroos, Birds, Skinks									
Faunal Habitat:	Grass, rocks, trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Some areas of the landform are lacking vegetative cover, potentially due to soil condition. Introduced grasses are dominating the area. Grasses are very dry due to lack of rainfall in recent months.									

Landform Total Score:	**69**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
PP21	N	55 K 425148 7755456
PP21	E	55 K 425148 7755456
PP21	S	55 K 425148 7755456
PP21	W	55 K 425148 7755456

PP21 - N – 2020

PP21 - E – 2020

PP21 - S – 2020

PP21 - W – 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Cryptostegia grandiflora	55 K 425177 7755575	
Calotropis procera	55 K 425228 7755464	
Cryptostegia grandiflora	55 K 425179 7750574	

Cryptostegia grandiflora - 2020

Calotropis procera - 2020

Cryptostegia grandiflora - 2020

Erosion		
Feature:	Waypoint	Notes:
Erosion new	55 K 425265 7755461	
Erosion 20		no GPS
Erosion 22	55 K 425183 7755566	
Erosion 23	55 K 425190 7755636	bare patch - no veg

Erosion NEW – 2020

Erosion 20 – 2020

Erosion 22 – 2020

Erosion 23 – 2020

Landform Assessment										
Area:	Eastern WRL South East Batters						Date:		16-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep	X	Medium		Low		Flat	
Slope Length:	Very Long		Long	X	Medium		Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate	X	High	
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Nil									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	8%		Plant:	82%			Litter:	10%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low		Medium		High	X	Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel grass), *Acacia* spp., *Eucalyptus* spp., *Corymbia* sp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent	X	Scattered		Absent	
Introduced species confined to edges:	*Clitoria* sp., *Sida cordifolia*									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber Vine), *Melinis repens* (Red Natal Grass), *Chloris gayana* (Rhodes grass)									
Impact of weed species:	Minor competition with native grasses									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few	X	None	
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)	X	None	
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroos, feral pigs, wallabies, rabbits, birds									
Faunal Habitat:	Dense grass, trees, rocks									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Grasses very dry due to lack of rain in months leading to monitoring. Some old erosion (rilling and gullies) around corner of WRL, many of which are populated by grasses. *Cryptostegia grandiflora* (Rubber Vine) near erosion 4.									

Landform Total Score:	**66**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T20 Start	S	55 K 425338 7754723
T20 End	NW	55 K 425326 7754681
T20 End	N	55 K 425326 7754681
T20 End	NE	55 K 425326 7754681

T20 Start - S - 2020

T20 End - NW - 2020

T20 End - N - 2020

T20 End - NE - 2020

Erosion		
Feature:	Waypoint:	Notes:
Erosion 4	55 K 425535 7755128	

Erosion 4 - 2020

Landform Assessment										
Area:	Eastern WRL North East Batters						Date:		15-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium	X	Low		Flat	
Slope Length:	Very Long		Long		Medium	X	Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic		Low	X	None	
Factor affecting closure:	Nil									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact	X	Very stable	
Surface cover										
Bare:	30%		Plant:	60%			Litter:		10%	
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low		Medium		High	X	Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Stylosanthes* sp., *Cassytha* sp., *Acacia holosericea*									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered		Absent	X
Introduced species confined to edges:	Nil									
Introduced species of note:	*Opuntia stricta* (Prickly Pear) at T01b, patchy *Cryptostegia grandiflora* (Rubber Vine) at T24, *Acacia farnesiana* (Mimosa bush), *Passiflora foetida* (Stinking Passionflower), *Melinis repens* (Red Natal Grass)									
Impact of weed species:	Nil									
Weed control required:	Targeted control of *Opuntia stricta* (Prickly Pear) and *Cryptostegia grandiflora* (Rubber Vine)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few	X	None	
Gullies:	Many (large)		Many (small)		Few (establishing)	X	Few (established)		None	
Feature stability:	Active		Mostly active		Becoming stable	X	Mostly stable		Stable	
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High		Very high	X
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Grasshoppers, birds, kangaroos									
Faunal Habitat:	Grass, rocks, some trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Area dominated by grass (Buffel Grass) knee/waist high. Patches of bare soil evident. Unidentified weed also recorded.									

Landform Total Score:	**66**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T01a Start	N	55 K 424980 7756277
T01a End	S	55 K 424983 7756301
T01b Start	N	55 K 424975 7756323
T01b End	S	55 K 424978 7756351
T24 Start	E	55 K 425169 7756014
T24 End	WNW	55 K 425200 7756003
T24 End	W	55 K 425200 7756003
T24 End	SW	55 K 425200 7756003
T24 End	NW	55 K 425200 7756003
T24 End	N	55 K 425200 7756003

T01a Start - N - 2020

T01a End - S - 2020

T01b Start - N - 2020

T01b End - S - 2020

T24 Start - E - 2020

T24 End - WNW - 2020

T24 End - W - 2020

T24 End - SW - 2020

T24 End - NW - 2020

T24 End - N - 2020

Erosion		
Feature:	Waypoint:	Notes:
Erosion 1	55 K 424982 7756314	washed out more
Erosion 2	55 K 424879 7756386	more legumes/Buffel grass
Erosion 3	55 K 425117 7755968	
Erosion 5	55 K 425214 7756037	
Erosion 6	55 K 425122 7756020	
Gully 9	55 K 425213 7756116	
Erosion 7	55 K 424979 7756298	
Erosion New	55 K 425140 7755979	minor

Erosion 1 - 2020

Erosion 2 - 2020

Erosion 3 - 2020

Erosion 5 - 2020

Erosion 6 - 2020

Gully 9 - 2020

Erosion 7 - 2020

Erosion New - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Opuntia stricta	55 K 424975 7756323	at T01b start

Opuntia stricta - 2020

Landform Assessment										
Area:	Eastern WRL South Batters						Date:		15-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium	X	Low		Flat	
Slope Length:	Very Long		Long		Medium	X	Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate	X	High	
Slake Test	4				Texture	2				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic	X	Low		None	
Factor affecting closure:	Weeds, such as *Cryptostegia grandiflora* (Rubber Vine) and *Calotropis procera* (Calotrope) located within the area.									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact	X	Very stable	
Surface cover										
Bare:	5%		Plant:	85%		Litter:	10%			
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low		Medium	X	High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None	X	Low		Patchy		Moderate		High	
Woody species richness:	None	X	Low		Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Acacia holosericea*, *Hibiscus* sp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant	X	Abundant		Frequent		Scattered		Absent	
Introduced species confined to edges:	Nil									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber Vine), *Calotropis procera* (Calotrope), *Clitoria* sp., *Passiflora foetida* (Stinking Passionflower), *Aerva javanica* (Kapok bush), *Melinis repens* (Red Natal Grass)									
Impact of weed species:	Displacement of native vegetation									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine) and *Calotropis procera* (Calotrope)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few	X	None	
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)	X	None	
Feature stability:	Active		Mostly active		Becoming stable	X	Mostly stable		Stable	
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low	X	Patchy		Moderate		High		Very high	
Fauna:	Kangaroos, birds									
Faunal Habitat:	Grassy plains, trees, litter									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Erosion is low on the landform and confined to the upper lift.									
Landform Total Score:					**56**					
Landform Maximum Score					**100**					

Photo Points / Transects		
Location:	Direction:	Waypoint:
T25 Start	S	55 K 424781 7754923
T25 End	NW	55 K 424779 7754889
T25 End	N	55 K 424779 7754889
T25 End	NE	55 K 424779 7754889

T25 Start - S - 2020

T25 End - NW - 2020

T25 End - N - 2020

T25 End - NE - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Calotropis procera	55 K 424784 7754889	
Cryptostegia grandiflora	55 K 424770 7754888	

Calotropis procera - 2020

Cryptostegia grandiflora - 2020

B.10 Pregnant Pond

Landform Assessment										
Area:	Pregnant pond						Date:		12-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium	X	Low		Flat	
Slope Length:	Very Long		Long		Medium	X	Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate	X	High	
Slake Test	4				Texture	2				
Overall condition:	Very Poor		Poor		Fair		Good		Excellent	X
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Nil									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	2%		Plant:	95%			Litter:	3%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low		Medium	X	High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Acacia holosericea*, *Corymbia* sp. patchy									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	Nil									
Introduced species of note:	*Acacia farnesiana* (Mimosa Bush), juvenile *Cryptostegia grandiflora* (Rubber Vine), *Melinis repens* (Red Natal Grass)									
Impact of weed species:	Minor									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber Vine)									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High		Very high	X
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Kangaroos, rabbits									
Faunal Habitat:	Dense grass, trees									
Additional notes: (e.g. excessive grazing, poor vegetation health)	No erosion features found in assessment. *Acacia holosericea* have grown since previous assessment. Buffel Grass waist high in patches.									

Landform Total Score:	**72**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T34 Start	SW	55 K 422952 7755491
T34 End	NE	55 K 422929 7755476

T34 Start – SW - 2019

T34 End – NE - 2019

B.11 Processing Area

Landform Assessment										
Area:	Processing Area						Date:		12-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low	X	Flat	
Slope Length:	Very Long	X	Long		Medium		Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic	X	Low		None	
Factor affecting closure:	Presence of weed species in rehabilitated area.									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	20%		Plant:	60%			Litter:	20%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate	X	High	
Grass species richness:	None		Low	X	Medium		High		Very high	
Herbs:										
Herb cover:	None		Low	X	Patchy		Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low		Patchy	X	Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (Buffel Grass), *Acacia holosericea*, *Eucalyptus* spp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant	X	Frequent		Scattered		Absent	
Introduced species confined to edges:	Nil									
Introduced species of note:	*Cryptostegia grandiflora* (Rubber Vine), *Acacia farnesiana* (Mimosa Bush) and infrequent observations of *Passiflora foetida* (Stinking Passionflower) and *Ziziphus mauritiana* (Chinee Apple)									
Impact of weed species:	*Cryptostegia grandiflora* (Rubber Vine) not as prevalent as 2019, has died off. Targeted control was carried out.									
Weed control required:	Continue targeted removal of weed species									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)	X	None	
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate	X	High		Very high	
Habitat value (arboreal):	Low		Patchy	X	Moderate		High		Very high	
Fauna:	Birds, spiders, kangaroos, rabbits, wallaby									
Faunal Habitat:	Some grasses, and tall trees sparse in cover									
Additional notes: (e.g. excessive grazing, poor vegetation health)	One notable gully (erosion feature) observed (hence score decreased by one), slight increase in grass cover and two additional weeds recorded.									

Landform Total Score:	**62**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T35a Start	SE	55 K 423568 7755740
T35a End	NW	55 K 423560 7755747
T35b Start	E	55 K 423546 7755774
T35b End	W	55 K 423555 7755770
T35c Start	SE	55 K 423512 7755753
T35c End	NE	55 K 423521 7755750
T35d Start	E	55 K 423465 7755790
T35d End	W	55 K 423471 7755786

T35a Start - SE - 2020

T35a End - NW - 2020

T35b Start - E - 2020

T35b End - W - 2020

T35c Start - SE - 2020

T35c End - NW - 2020

T35d Start - E - 2020

T35d End - W - 2020

Erosion		
Feature:	Waypoint:	Notes:
Erosion scour	55 K 423510 7755803	~ 15 m long, 0.2 m wide, 0.25 m deep

Erosion scour - 2020

Weeds of Significance		
Species:	Waypoint:	Notes:
Cryptostegia grandiflora	55 K 423554 7755762	dead
Cryptostegia grandiflora	55 K 423553 7755815	

Cryptostegia grandiflora - 2020

Cryptostegia grandiflora - 2020

B.12 Water Treatment Pond

Landform Assessment										
Area:	Water Treatment Pond						Date:		14-10-20	
Landform characteristics:										
Slope Angle:	Very Steep		Steep		Medium		Low	X	Flat	
Slope Length:	Very Long		Long	X	Medium		Short		NA	
Topsoil:	No topsoil		Low (applied)		Low (transported)		Moderate		High	X
Slake Test	4				Texture	3				
Overall condition:	Very Poor		Poor		Fair		Good	X	Excellent	
Investment required:	Major		Significant		Strategic		Low		None	X
Factor affecting closure:	Some populations of introduced flora, particularly around drainage channel (high abundance of weeds)									
Soil:										
Surface stability:	Unstable		Unstable Patches		Fair		Mostly Intact		Very stable	X
Surface cover										
Bare:	5%		Plant:	75%		Litter:		20%		
Vegetation:										
Grasses:										
Grass cover:	None		Low		Patchy		Moderate		High	X
Grass species richness:	None		Low		Medium	X	High		Very high	
Herbs:										
Herb cover:	None		Low		Patchy	X	Moderate		High	
Herb species richness:	None		Low	X	Medium		High		Very high	
Woody species (<1.5 m tall):										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low		Medium	X	High		Very high	
Woody species (>1.5 m tall)										
Woody cover:	None		Low	X	Patchy		Moderate		High	
Woody species richness:	None		Low	X	Medium		High		Very high	
Species of note:	*Cenchrus ciliaris* (waist high in places near transect), *Stylosanthes* sp., *Acacia* spp., *Corymbia* sp.									

Introduced species:										
Introduced species on corridors or edges:										
Abundance	Dominant		Abundant		Frequent		Scattered	X	Absent	
Introduced species confined to edges:	*Cryptostegia grandiflora* (Rubber vine) in low lying areas and drain lines									
Introduced species of note:	*Opuntia stricta* (Prickly Pear), *Acacia farnesiana* (Mimosa Bush), *Passiflora foetida* (Stinking Passionflower) and some patches of *Chloris gayana* (Rhodes grass), *Melinis repens* (Red Natal Grass)									
Impact of weed species:	Competition with native shrubs in low lying areas and drain lines									
Weed control required:	Targeted control of *Cryptostegia grandiflora* (Rubber vine), *Opuntia stricta* (Prickly pear) and *Passiflora foetida* (Stinking Passionflower) which is dominant in drain and on top of landform amongst Buffel Grass.									
Erosion:										
Rill frequency:	Numerous (severe)		Numerous (small)		Many		Few		None	X
Gullies:	Many (large)		Many (small)		Few (establishing)		Few (established)		None	X
Feature stability:	Active		Mostly active		Becoming stable		Mostly stable		Stable	X
Habitat & Fauna:										
Habitat value (terrestrial):	Low		Patchy		Moderate		High	X	Very high	
Habitat value (arboreal):	Low		Patchy		Moderate		High	X	Very high	
Fauna:	Kangaroos, rabbits, ants, birds									
Faunal Habitat:	Grass, litter, rocks, trees, logs									
Additional notes: (e.g. excessive grazing, poor vegetation health)	Vegetation in good health. Many varieties of *Acacia* providing high terrestrial and arboreal habitat. Buffel Grass knee to waist high, *Stylosanthes* sp. is quite established. Some minor erosion on slope leading to flat. Unidentified weed near the Rubber Vine pictured below.									

Landform Total Score:	**74**
Landform Maximum Score	**100**

Photo Points / Transects		
Location:	Direction:	Waypoint:
T33 Start	SE	55 K 424399 7756697
T33 End	NW	55 K 424360 7756733

T33 Start - SE - 2020

T33 End - NW - 2020

Erosion		
Feature:	Waypoint:	Notes:
Erosion	55 K 424399 7756697	minor on base of slope SW from T33 start

Erosion - 2020

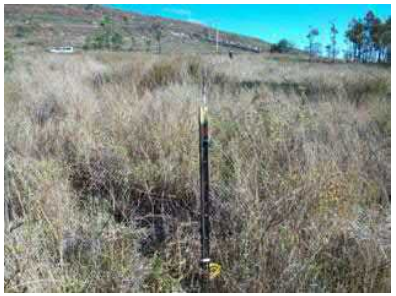
Weeds of Significance		
Species:	Waypoint:	Notes:
Cryptostegia grandiflora	55 K 424398 7756684	Unidentified weed near this plant
Opuntia stricta	55 K 424429 7756696	

Cryptostegia grandiflora - 2020

Opuntia stricta - 2020

Appendix C Transect photos – all available monitoring years

C.1 Analogues

T21			
2007	2008	2009	2010
			
2011	2013	2014	2015
2016	2017	2018	2019

2020 (End NNW)			

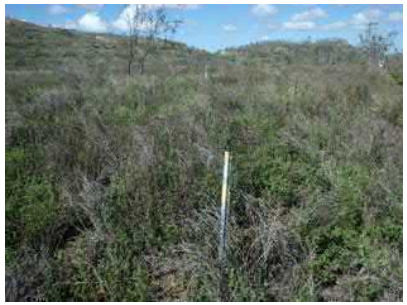
T23			
2007	2008	2009	2010
2011	2013	2014	2015

2016	2017	2018	2019
2020 (End W)			

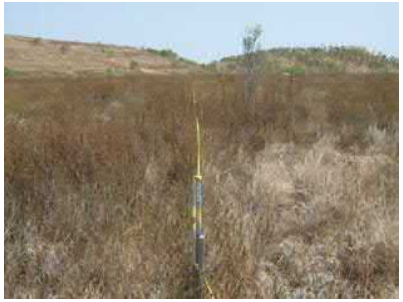
T28			
2008	2009	2010	2011
2013	2014	2015	2016
2017	2018	2019	2020

T32			
2008	2009	2010	2011
2013	2014	2015	2016
2017	2018	2019	2020

C.2 Old North Tailings Dam

Old North Tailings Dam West Flat sub-domain T14A			
2007	2008	2009	2010
2011	2013	2014	2015
2016	2017	2018	2019
			

2020			

Old North Tailings Dam West Flat sub-domain T14B			
2007	2008	2009	2010
2011	2013	2014	2015
			

2016	2017	2018	2019
2020			

Old North Tailings Dam West Flat sub-domain T14C			
2007	2008	2009	2010
2011	2013	2014	2015

2016	2017	2018	2019
2020			

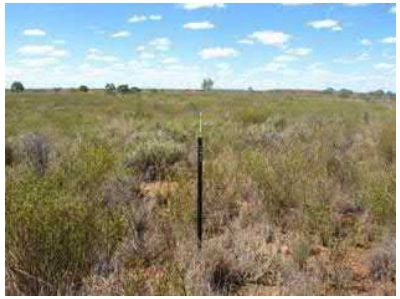
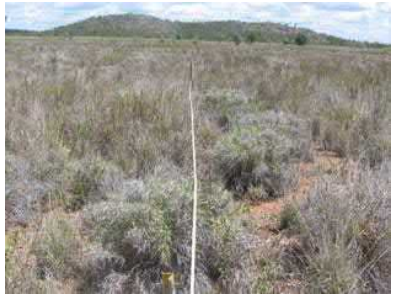
Old North Tailings Dam West Flat sub-domain T14D			
2007	2008	2009	2010
2011	2013	2014	2015
2016	2017	2018	2019

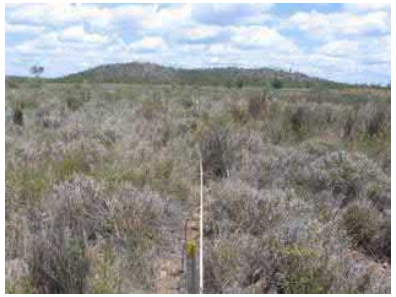
2020			

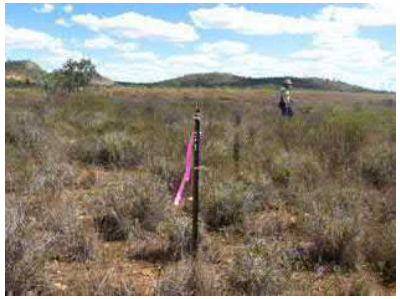
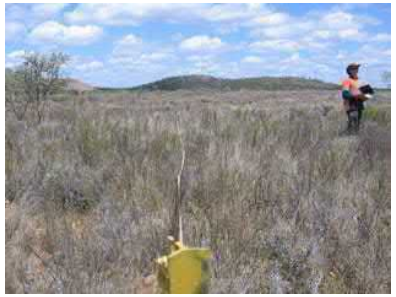
C.3 New North Tailings Dam

New North Tailings Dam West Flat sub-domain T15A			
2007	2008	2009	2013
2014	2015	2016	2017
2018	2019	2020	

New North Tailings Dam West Flat sub-domain T15B			
2007	2008	2009	2013
2014	2015	2016	2017
2018	2019	2020	

New North Tailings Dam West Flat sub-domain T15C			
2007	2008	2009	2013
			
2014	2015	2016	2017
2018	2019	2020	

New North Tailings Dam West Flat sub-domain T15D			
2007	2008	2009	2013
			
2014	2015	2016	2017
2018	2019	2020	

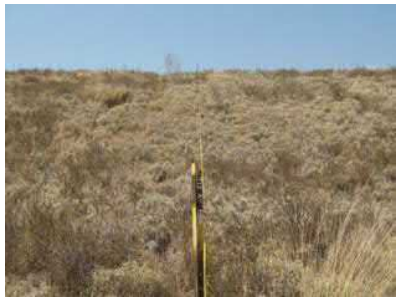
New North Tailings Dam North Flat sub-domain T16A			
2007	2008	2009	2013
			
2014	2015	2016	2017
2018	2019	2020	

New North Tailings Dam North Flat sub-domain T16B			
2007	2008	2009	2013
2014	2015	2016	2017
2018	2019	2020	

New North Tailings Dam North Flat sub-domain T16C			
2007	2008	2009	2013
2014	2015	2016	2017
2018	2019	2020	

New North Tailings Dam North Flat sub-domain T16D			
2007	2008	2009	2013
2014	2015	2016	2017
2018	2019	2020	

C.4 Northern WRL

Northern WRL North Face sub-domain T12A			
2007	2008	2009	2011
			
2013	2014	2015	2016
2017	2018	2019	2020

Northern WRL North Face sub-domain T12B			
2007	2008	2009	2011
2013	2014	2015	2016
2017	2018	2019	2020

C.5 Roche Hill

Roche Hill Flat sub-domain PP17			
2011	2013	2014	2015
2016	2017	2018	2019
2020			

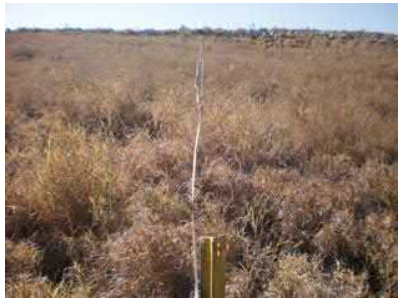
Roche Hill Batters sub-domain PP18			
2013	2014	2016	2017
			not monitored – rework in progress
2018	2019	2020	

C.6 Non-Acid Forming Oxide Stockpile

Non-Acid Forming Oxide Stockpile T30			
2008	2009	2010	2011
2013	2014	2015	2016
2017	2018	2019	2020

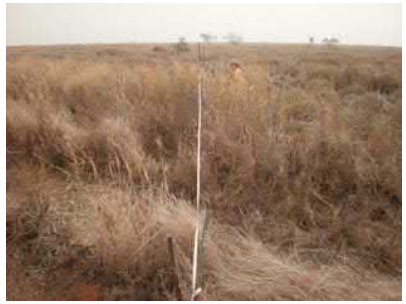
Non-Acid Forming Oxide Stockpile T31			
2011	2013	2014	2015
2016	2017	2018	2019
2020			

C.7 Southern WRL

Southern WRL Batters sub-domain T11A			
2007	2008	2009	2013
			
2014	2015	2016	2017
2018	2019	2020	

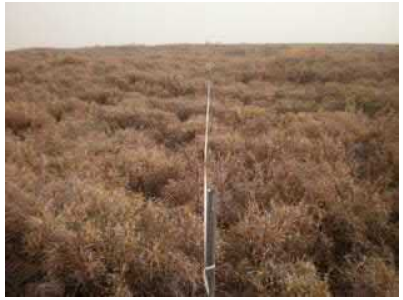
Southern WRL Batters sub-domain T11B			
2007	2008	2009	2013
2014	2015	2016	2017
2018	2019	2020	

C.8 Southern Tailings Dam

Southern Tailings Dam Flat sub-domain T10A			
2007	2008	2009	2010
			
2013	2014	2015	2016
2017	2018	2019	2020

Southern Tailings Dam Flat sub-domain T10B			
2007	2008	2009	2010
2013	2014	2015	2016
2017	2018	2019	2020

Southern Tailings Dam Flat sub-domain T10C			
2007	2008	2009	2010
2013	2014	2015	2016
2017	2018	2019	2020

Southern Tailings Dam Flat sub-domain T10D			
2007	2008	2009	2010
			
2013	2014	2015	2016
2017	2018	2019	2020

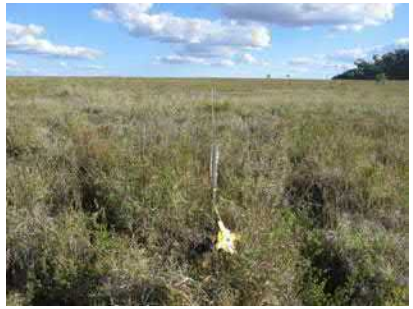
South Tailings Dam Batters sub-domain T26			
2008	2009	2010	2011
2013	2014	2015	2016
2018	2019	2020	

South Tailings Dam Batters sub-domain T27			
2008	2009	2010	2011
2013	2014	2015	2016
2017	2018	2019	2020

C.9 Eastern WRL

Eastern WRL North Flat sub-domain T02A			
2007	2008	2011	2013
2014	2015	2016	2017
2018	2019	2020	

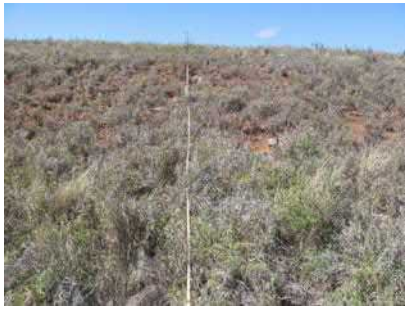
Eastern WRL North Flat sub-domain T02B			
2007	2008	2011	2013
2014	2015	2016	2017
2018	2019	2020	

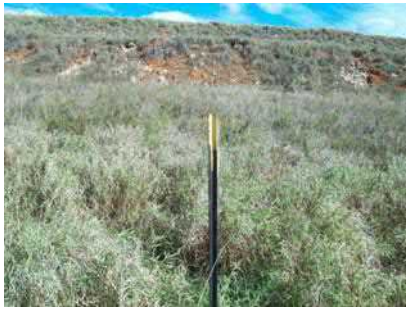
Eastern WRL North Flat sub-domain T02C			
2007	2008	2011	2013
			
2014	2015	2016	2017
2018	2019	2020	

Eastern WRL North Flat sub-domain T02D			
2007	2008	2011	2013
2014	2015	2016	2017
2018	2019	2020	

Eastern WRL South East Batters sub-domain T20			
2007	2008	2009	2010
2011	2013	2014	2015
2016	2017	2018	2019

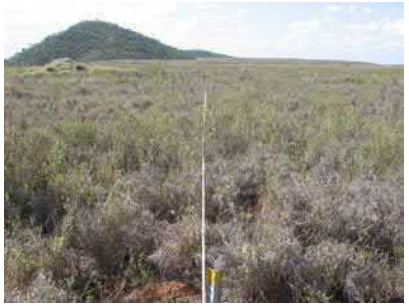
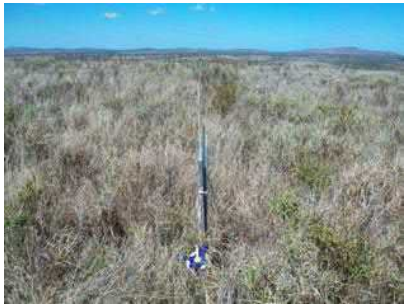
2020 (End NNW)			

Eastern WRL North East Batters sub-domain T01A			
2008	2009	2010	2011
			
2013	2014	2015	2016
2017	2018	2019	2020

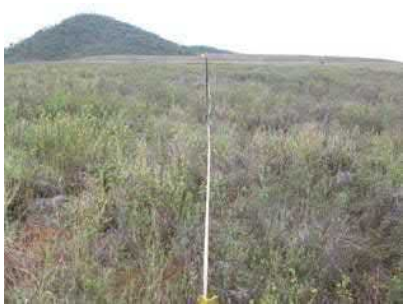
Eastern WRL North East Batters sub-domain T01B			
2008	2009	2010	2011
			
2013	2014	2015	2016
2017	2018	2019	2020

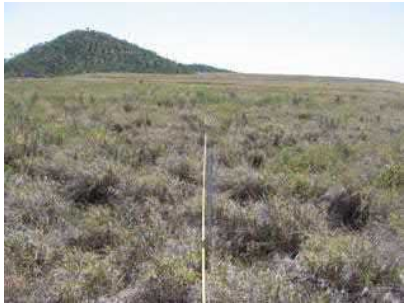
Eastern WRL North East Batters sub-domain T24			
2007	2008	2009	2010
2011	2013	2014	2015
2016	2017	2018	2019

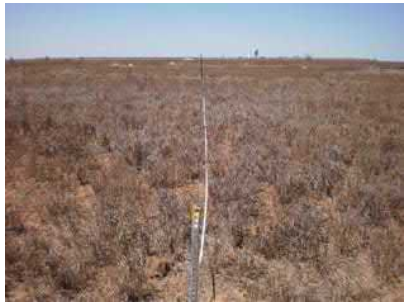
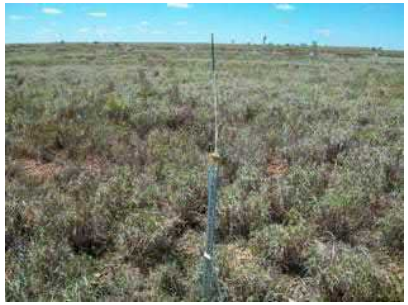
2020			

Eastern WRL South West Flat sub-domain T07A			
2007	2008	2009	2010
			
2013	2014	2015	2016
2017	2018	2019	2020

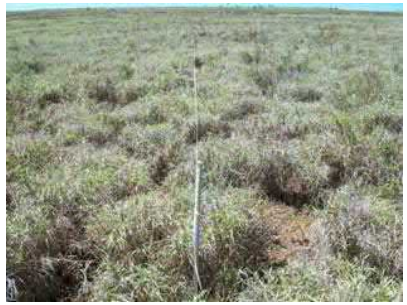
Eastern WRL South West Flat sub-domain T07B			
2007	2008	2009	2010
2013	2014	2015	2016
2017	2018	2019	2020

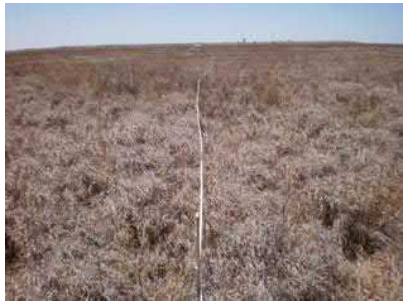
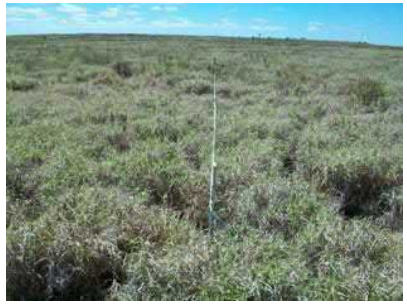
Eastern WRL South West Flat sub-domain T07C			
2007	2008	2009	2010
			
2013	2014	2015	2016
2017	2018	2019	2020

Eastern WRL South West Flat sub-domain T07D			
2007	2008	2009	2010
			
2013	2014	2015	2016
2017	2018	2019	2020

Eastern WRL South West Flat sub-domain T09A			
2008	2009	2010	2013
			
2014	2015	2016	2017
2018	2019	2020	

Eastern WRL South West Flat sub-domain T09B			
2008	2009	2010	2013
2014	2015	2016	2017
2018	2019	2020	

Eastern WRL South West Flat sub-domain T09C			
2008	2009	2010	2013
			
2014	2015	2016	2017
2018	2019	2020	

Eastern WRL South West Flat sub-domain T09D			
2008	2009	2010	2013
			
2014	2015	2016	2017
2018	2019	2020	

Eastern WRL East Batters sub-domain T04			
2007	2008	2009	2010
2011	2013	2014	2015
2016	2017	2018	2019

2020			

Eastern WRL East Batters sub-domain T19			
2007	2008	2009	2010
2011	2013	2014	2015

2016	2017	2018	2019
2020			

Eastern WRL East Batters sub-domain T22			
2007	2008	2009	2010

2011	2013	2014	2015
2016	2017	2018	2019
2020			

Eastern WRL South Batters sub-domain T25			
2007	2008	2009	2013
2014	2015	2016	2017
2018	2019	2020	

C.10 Pregnant Pond

Pregnant Pond T34			
2010	2011	2013	2014
2015	2016	2017	2018
2019	2020		

C.11 Processing Area

Processing Area T35A			
2011	2013	2014	2015
2016	2017	2018	2019
2020			

Processing Area T35B			
2011	2013	2014	2015
2016	2017	2018	2019
2020			

Processing Area T35C			
2011	2013	2014	2015
2016	2017	2018	2019
2020			

Processing Area T35D			
2011	2013	2014	2015
2016	2017	2018	2019
2020			

C.12 Water Treatment Pond

Water Treatment Pond T33			
2010	2011	2013	2014
2015	2016	2017	2018
2019	2020		

Appendix D Descriptive statistics of condition monitoring scores (2013 – 2020)

Figures (**D-1 – D-11**) below present the mean condition scores of the analogue sites (n = 3 sites) compared to each rehabilitation area (n = the number of sub-domains monitored as indicated in each figure legend), between 2013 and 2020. Error bars show standard errors. Where only one rehabilitation domain was monitored (n = 1) there is no associated error.

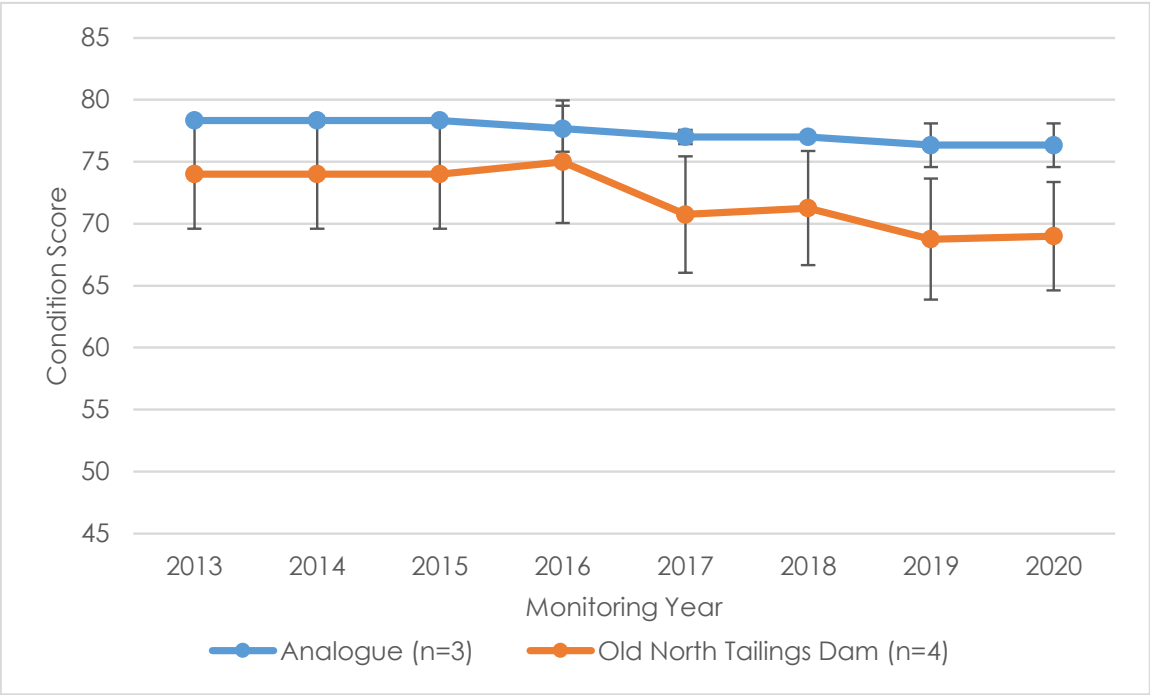


Figure D-1: Old North Tailings Dam

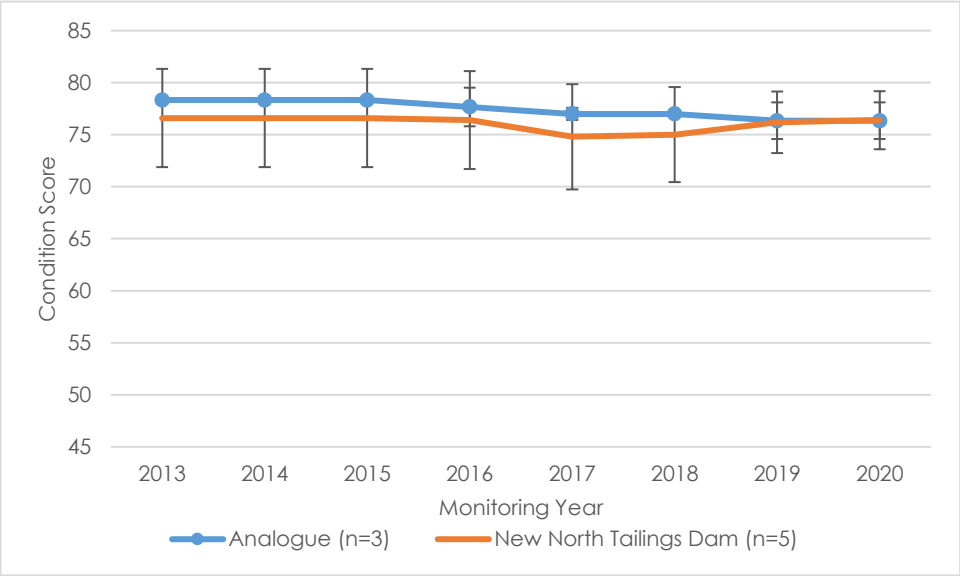


Figure D-2: New North Tailings Dam

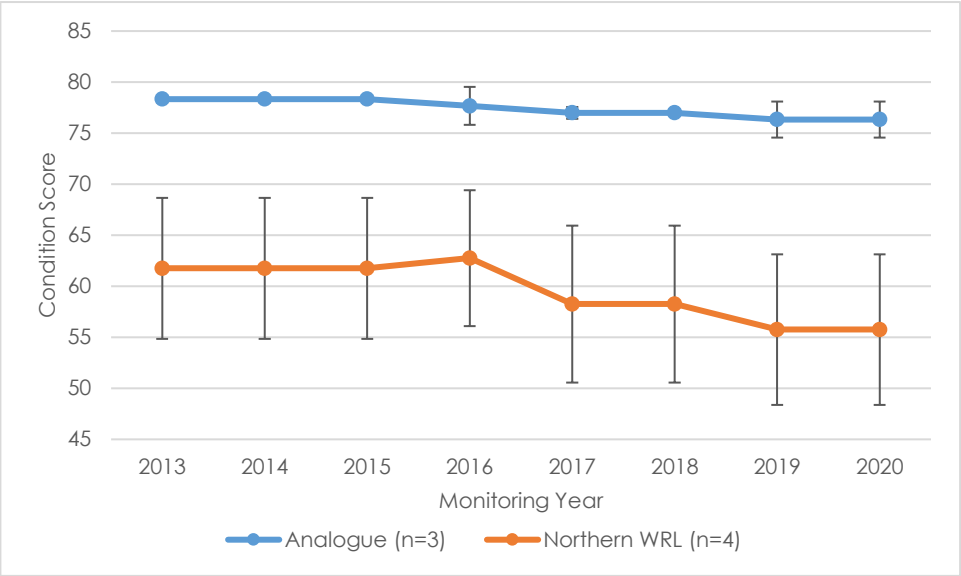


Figure D-3: Northern WRL

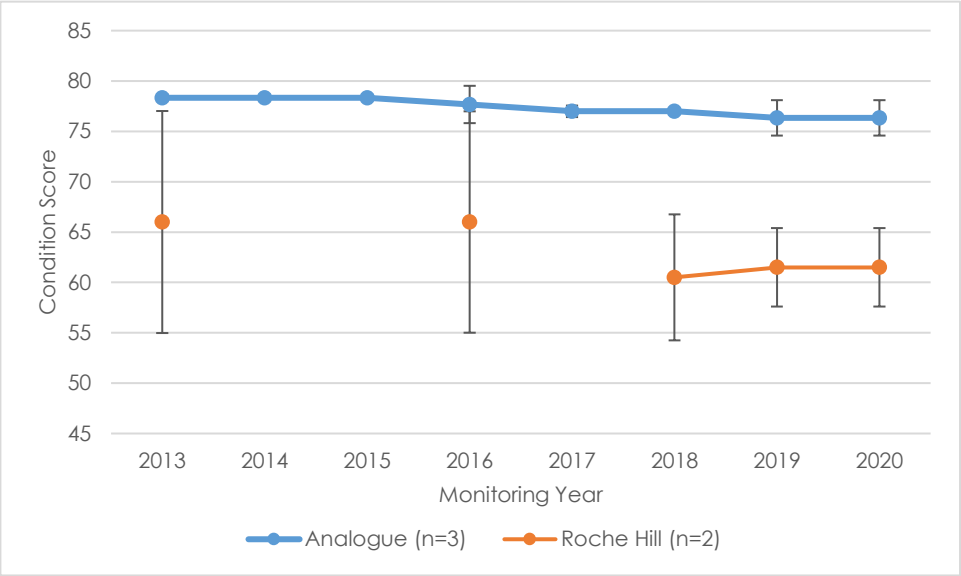


Figure D-4: Roche Hill

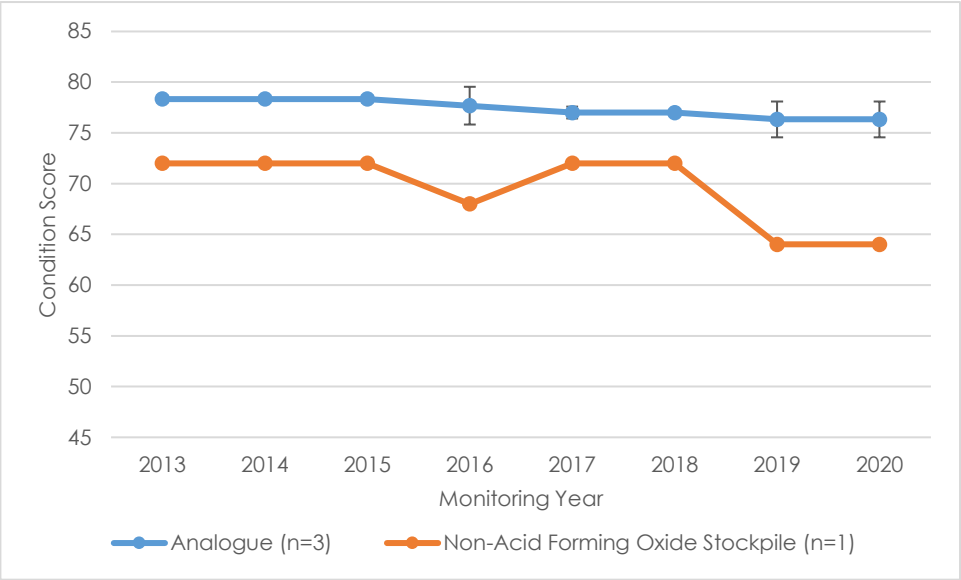


Figure D-5: Non-Acid Forming Oxide Stockpile

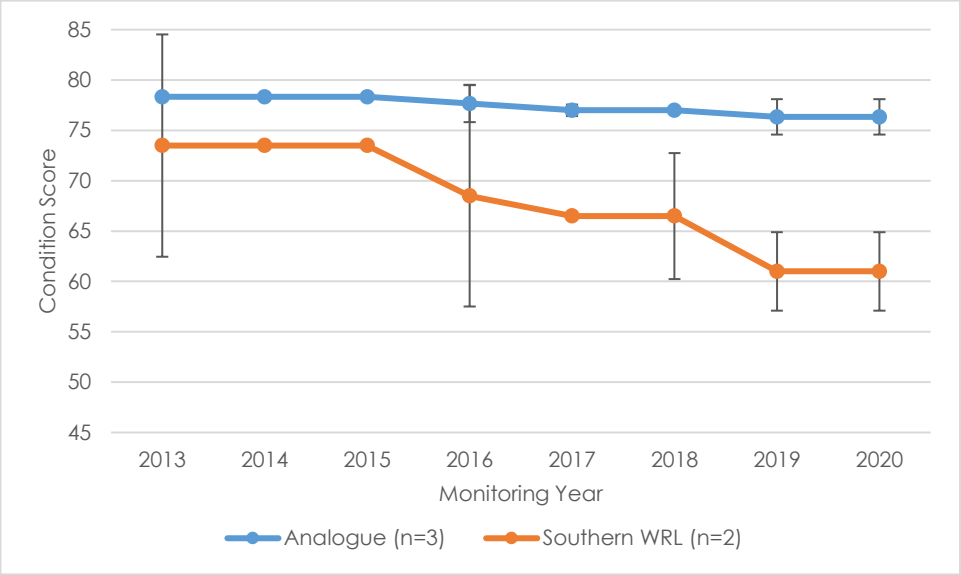


Figure D-6: Southern WRL

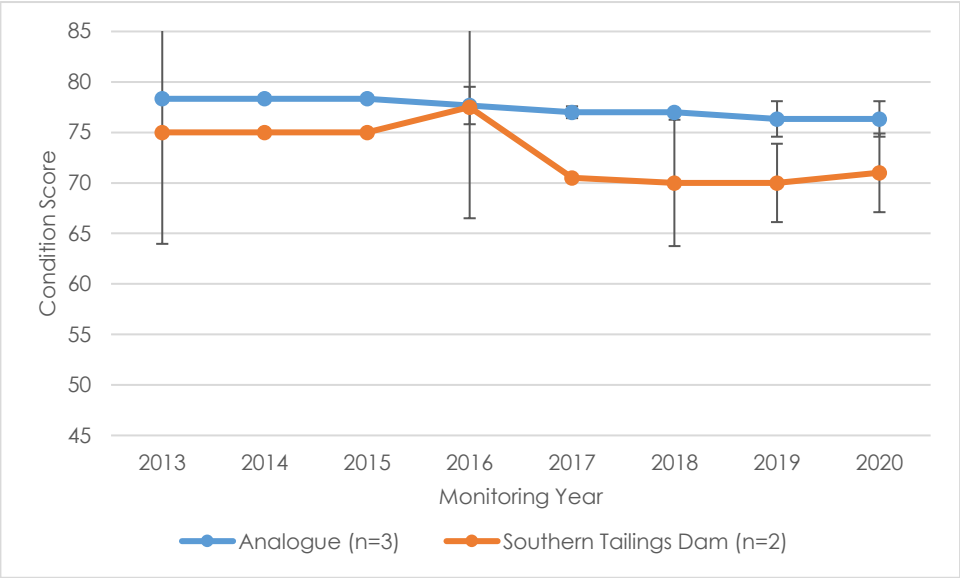


Figure D-7: Southern Tailings Dam

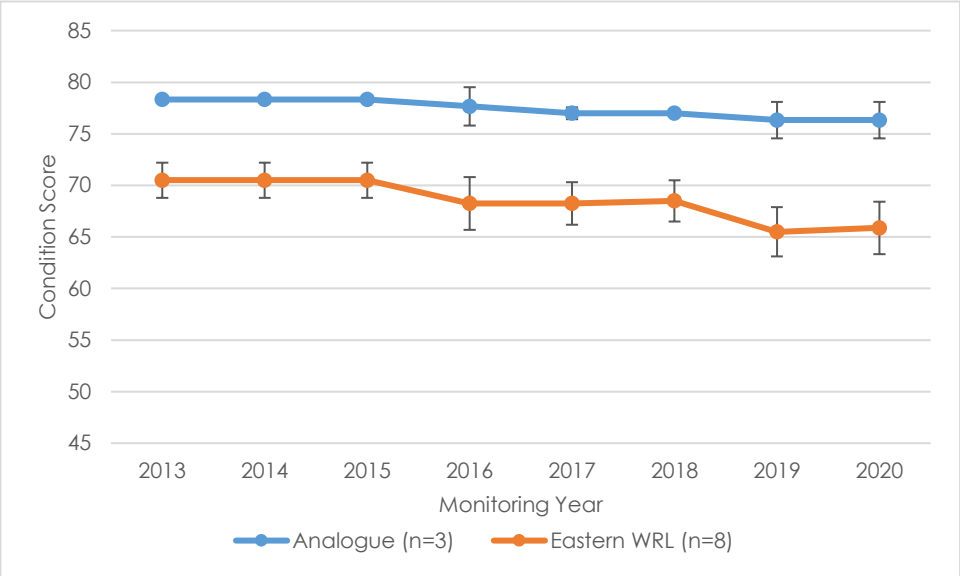


Figure D-8: Eastern WRL

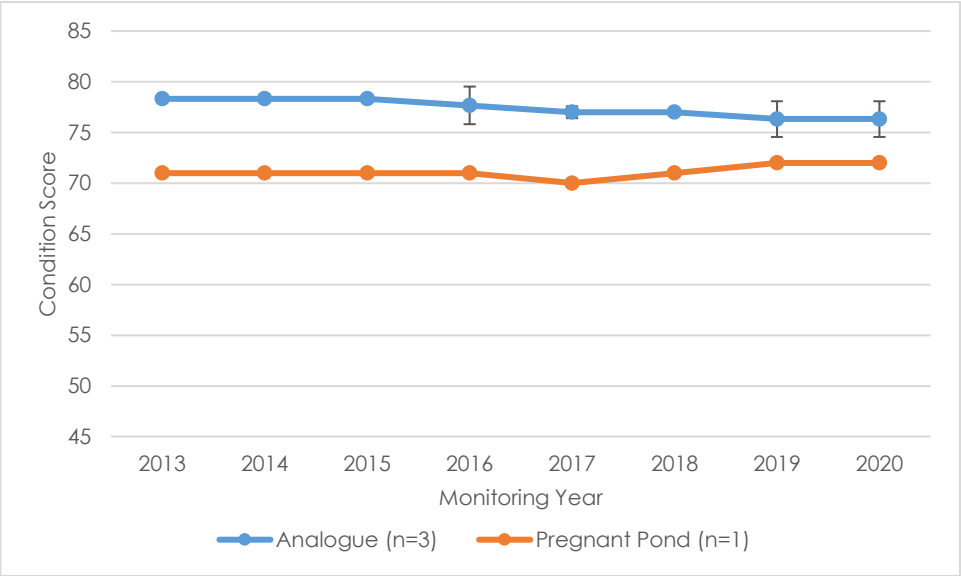


Figure D-9: Pregnant Pond

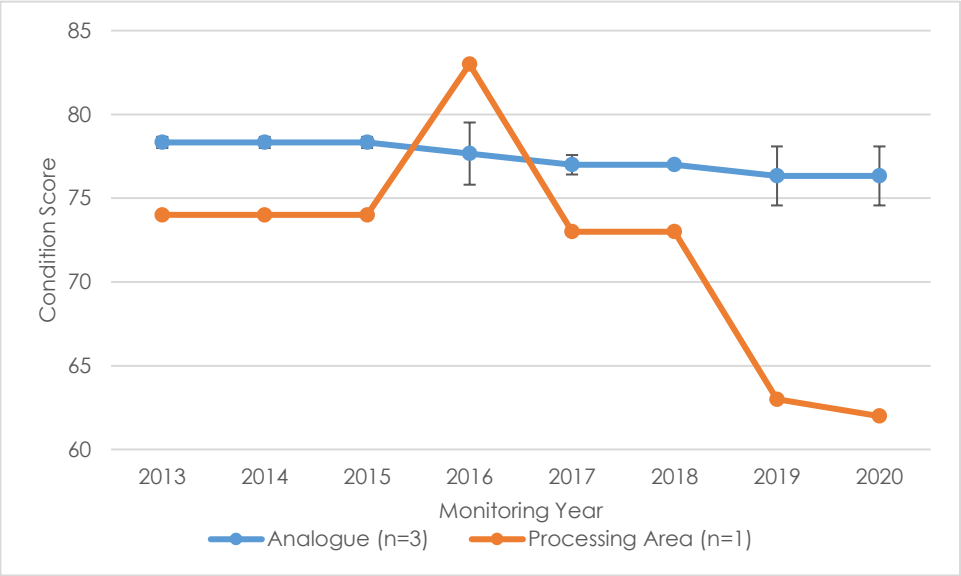


Figure D-10: Processing Area

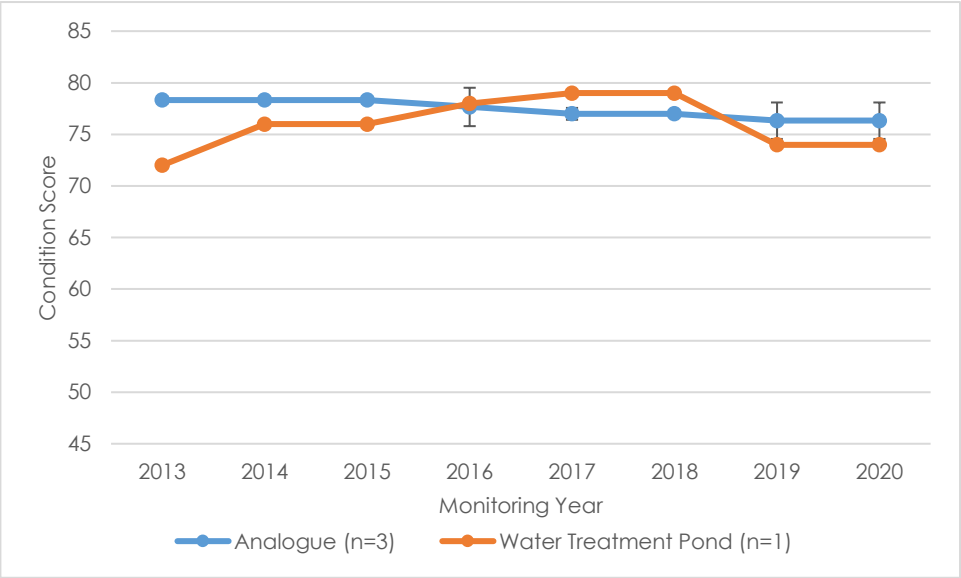


Figure D-11: Water Treatment Pond

Appendix E Weed species present and their locations in 2020

Table E-1: Weed species and locations at Mt Leyshon in 2020

Species (Common Name)	Priority Rating	Location/sub-domain
Cryptostegia grandiflora (Rubber Vine)	restricted invasive Category 3	Analogue T23 Old North Tailings Dam - North Face (East) Batters Old North Tailings Dam - North Face (West) Batters Old North Tailings Dam – East Flat New North Tailings Dam - East Flat New North Tailings Dam - West Flat New North Tailings Dam – North Flat New North Tailings Dam – North Batters Northern WRL - East Face Northern WRL - North Face Northern WRL – Flat Northern WRL - South and West Face Roche Hill – Flat Non-Acid Forming Oxide Stockpile Southern WRL – Batters Southern WRL – Flat Southern Tailings Dam – Batters Southern Tailings Dam – Flat Eastern WRL - North Flat Eastern WRL - Central North Flat Eastern WRL - East Batters Eastern WRL – North East Batters Eastern WRL - South Batter Eastern WRL – Central South Flat Eastern WRL – South East Batters Eastern WRL – South West Flat Pregnant Pond Processing Area Water Treatment Pond
Opuntia stricta (Prickly pear)	restricted invasive Category 3	Analogue site T23 and T32 Northern WRL - East Face Roche Hill - Batters Eastern WRL - East Batters Eastern WRL – North East Batters Eastern WRL - North Flat Water Treatment Pond
Parkinsonia aculeata (Parkinsonia)	restricted invasive Category 3	New North Tailings Dam - East Flat New North Tailings Dam - North Flat
Ziziphus mauritiana (Chinee Apple)	restricted invasive Category 3	Analogue site T23, T21 and T28 New North Tailings Dam - East Flat Non-Acid Forming Oxide Stockpile Southern Tailings Dam – Flat Processing Area Eastern WRL - East Batters

Species (Common Name)	Priority Rating	Location/sub-domain
Acacia farnesiana (Mimosa Bush)	environmental weed/invasive plant (medium priority for eradication by the CTRC)	Analogue site T23 Old North Tailings Dam – East Flat Old North Tailings Dam – North Face (East) Batters New North Tailings Dam - East Flat Northern WRL - South and West Face Roche Hill - Flat Southern WRL – Flat Southern Tailings Dam – Batters Eastern WRL - East Batters Eastern WRL – North East Batters Eastern WRL - North Flat Pregnant Pond Processing Area Water Treatment Pond
Aerva javanica (Kapok bush)	environmental weed	Old North Tailings Dam – East Flat Old North Tailings Dam – North Face (East) Batters Northern WRL - North Face Northern WRL - Flat Eastern WRL – South West Flat Eastern WRL - South Batter
Calotropis procera (Calotrope)	environmental weed (medium priority for eradication by the CTRC)	Roche Hill – Batters Southern WRL - Flat Eastern WRL - Central North Flat Eastern WRL - East Batters Eastern WRL - South Batter Eastern WRL – South West Flat
Melinis repens (Red Natal Grass)	environmental weed	Analogue site T21 and T28, T23 Old North Tailings Dam - North Face (East) Batters Old North Tailings Dam - North Face (West) Batters New North Tailings Dam – North Batters New North Tailings Dam – West Flat Northern WRL - North Face Northern WRL – Flat Northern WRL - South and West Face Roche Hill – Batters Roche Hill – Flat Non-Acid Forming Oxide Stockpile Southern WRL – Batters Southern Tailings Dam – Batters Southern Tailings Dam – Flat Eastern WRL - Central North Flat Eastern WRL – Central South Flat Eastern WRL - East Batters Eastern WRL – North East Batters Eastern WRL - North Flat Eastern WRL - South Batter Eastern WRL - South East Batters Eastern WRL - South West Flat Pregnant Pond Water Treatment Pond

Species (Common Name)	Priority Rating	Location/sub-domain
Passiflora foetida (Stinking Passionflower)	environmental weed (invasive)	Old North Tailings Dam - West Flat Old North Tailings Dam – East Flat Old North Tailings Dam – North Face (East) Batters New North Tailings Dam – North Batters Northern WRL - South and West Face Roche Hill - Batters Roche Hill – Flat Eastern WRL - East Batters Eastern WRL – North East Batters Eastern WRL – North Flat Eastern WRL - Central North Flat Eastern WRL - South Batter Processing Area Water Treatment Pond
Chloris gayana (Rhodes grass)	environmental weed (invasive)	Old North Tailings Dam – East Flat Old North Tailings Dam – North Face (East) Batters Eastern WRL – South East Batters Southern Tailings Dam – Batters Southern Tailings Dam – Flat Water Treatment Pond
Sida cordifolia (Flannelweed)	environmental weed	Eastern WRL - South East Batters Eastern WRL – South West Flat (possible)
Tridax procumbens (Tridax daisy)	environmental weed	Old North Tailings Dam - West Flat Old North Tailings Dam - North Face (West) Batters Northern WRL – East Face

Table E-1: Restricted invasive Category 3 weed species and locations at Mt Leyshon in 2020

Declared weed species (Common Name)	Landform	Sub-domains
Cryptostegia grandiflora (Rubber Vine)	Analogues T23	NA
	Old North Tailings Dam	North Face (East) Batters, North Face (West) Batters, East Flat
	New North Tailings Dam	East Flat, West Flat, North Flat, North Batters
	Northern WRL	East Face, North Face, Flat, South and West Face
	Roche Hill	Flat
	Non-Acid Forming Oxide Stockpile	NA
	Southern WRL	Batters, Flat
	Southern Tailings Dam	Batters, Flat
	Eastern WRL	all sub-domains
	Pregnant Pond	NA
	Processing Area	NA
	Water Treatment Pond	NA

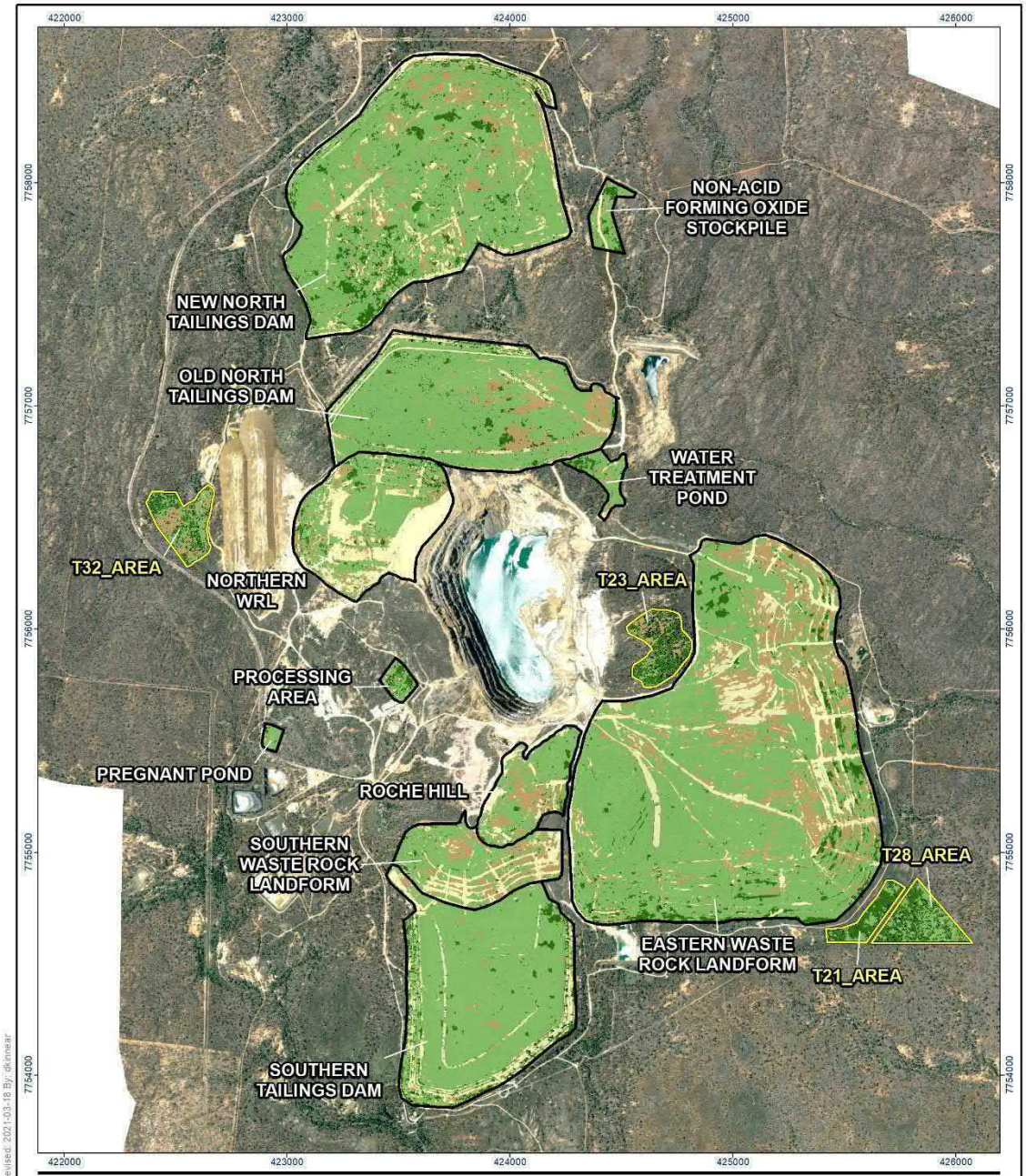
Declared weed species (Common Name)	Landform	Sub-domains
Opuntia stricta (Prickly pear)	Analogues T23 and T32	NA
	Northern WRL	East Face
	Roche Hill	Batters
	Eastern WRL	East Batters, North East Batters, North Flat
	Water Treatment Pond	NA
Parkinsonia aculeata (Parkinsonia)	New North Tailings Dam	East Flat, North Flat
Ziziphus mauritiana (Chinee Apple)	Analogue T23, T21 and T28	
	New North Tailings Dam	East Flat
	Non-Acid Forming Oxide Stockpile	NA
	Southern Tailings Dam	Flat
	Eastern WRL	East Batters
	Processing Area	NA

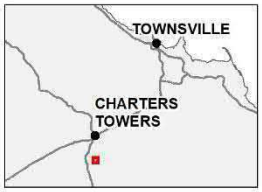
Table E-2: Environmental weed species and locations at Mt Leyshon in 2020

Species (Common Name)	Landform	Sub-domains
Acacia farnesiana (Mimosa Bush)	Analogues T23	NA
	Old North Tailings Dam	East Flat, North Face (East) Batters
	New North Tailings Dam	East Flat
	Northern WRL	South and West Face
	Roche Hill	Flat
	Southern WRL	Flat
	Southern Tailings Dam	Batters
	Eastern WRL	East Batters, North East Batters, North Flat
	Pregnant Pond	NA
	Processing Area	NA
	Water Treatment Pond	NA
Aerva javanica (Kapok bush)	Old North Tailings Dam	East Flat, North Face (East) Batters
	Northern WRL	North Face, Flat
	Eastern WRL	South West Flat, South Batters
	Eastern WRL	East Batters, North East Batters, North Flat
Calotropis procera (Calotrope)	Roche Hill	Batters
	Southern WRL	Flat

Species (Common Name)	Landform	Sub-domains
	Eastern WRL	Central North Flat, East Batters, South Batter, South West Flat
Melinis repens (Red Natal Grass)	Analogue T21 and T28, T23	NA
	Old North Tailings Dam	North Face (East) Batters, North Face (West) Batters
	New North Tailings Dam	North Batters, West Flat
	Northern WRL	North Face, Flat, South and West Face
	Roche Hill	Flat, Batters
	Non-Acid Forming Oxide Stockpile	NA
	Southern WRL	Batters
	Southern Tailings Dam	Batters, Flat
	Eastern WRL	all sub-domains
	Pregnant Pond	NA
	Water Treatment Pond	NA
Passiflora foetida (Stinking Passionflower)	Old North Tailings Dam	West Flat, East Flat, North Face (East) Batters
	New North Tailings Dam	North Batters
	Northern WRL	South and West Face
	Roche Hill	Batters, Flat
	Eastern WRL	East Batters, North East Batters, North Flat, Central North Flat, South Batter
	Processing Area	NA
	Water Treatment Pond	NA
Sida cordifolia (Flannelweed)	Eastern WRL	South East Batters, South West Flat (possible)
Tridax procumbens (Tridax daisy)	Old North Tailings Dam	West Flat, North Face (West) Batters
	Northern WRL	East Face

Appendix F Additional maps





Landform
Analogue Area

OBIA Classification

- Bare Ground
- Grass
- Shrub
- Litter
- Shadow

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1:25,000

N

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NEWMONT GOLDCORP AUSTRALIA

Project Location
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Perth, Western Australia

Prepared by DK on 2021-03-16
TR by BM on 2021-03-16
IR by SA on 2021-03-16

Client/Project
Newmont Goldcorp Australia
Mt Leyshon
Condition Monitoring 2020

300003239 REVA

Title
OBIA Assessment - Mine Area 2017

Notes
1. Coordinate System: GDA 1994 MGA Zone 55
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2021).
3. Background: Source: Skywatch 2017

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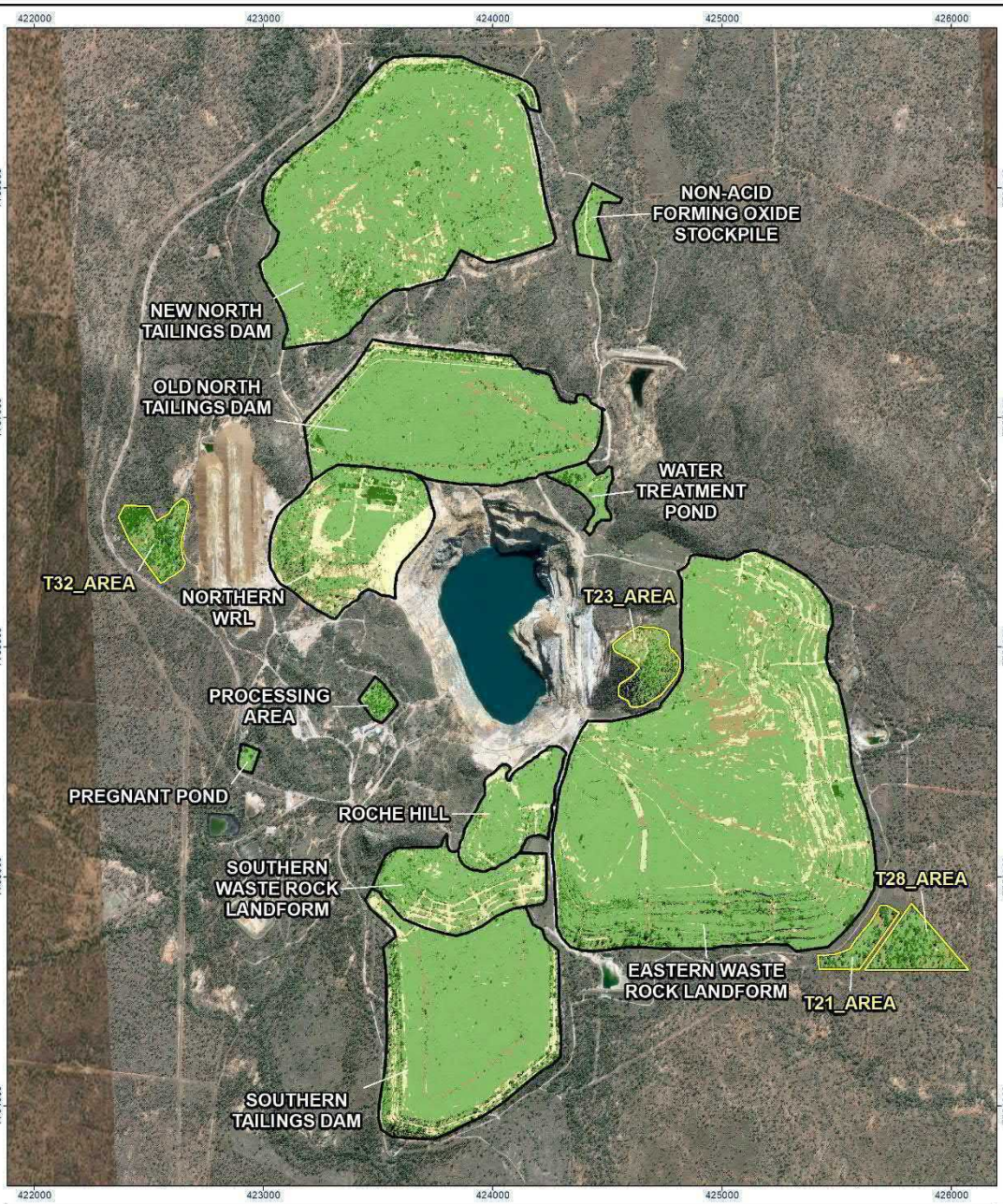

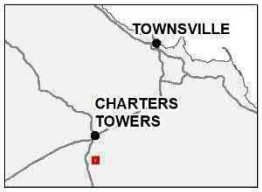

Landform
Analogue Area

OBIA Classification

- Bare Ground
- Grass
- Shrub
- Litter
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0 300 600 m
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N

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Project Location
Stantec Australia Pty Ltd
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TR by BM on 2021-03-16
IR by SA on 2021-03-16

Client/Project
Newmont Goldcorp Australia
Mt Leyshon
Condition Monitoring 2020

300003239 REVA

Title
OBIA Assessment - Mine Area 2020

Notes
1. Coordinate System: GDA 1994 MGA Zone 55
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2021).
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community; Apollo Mapping 2020

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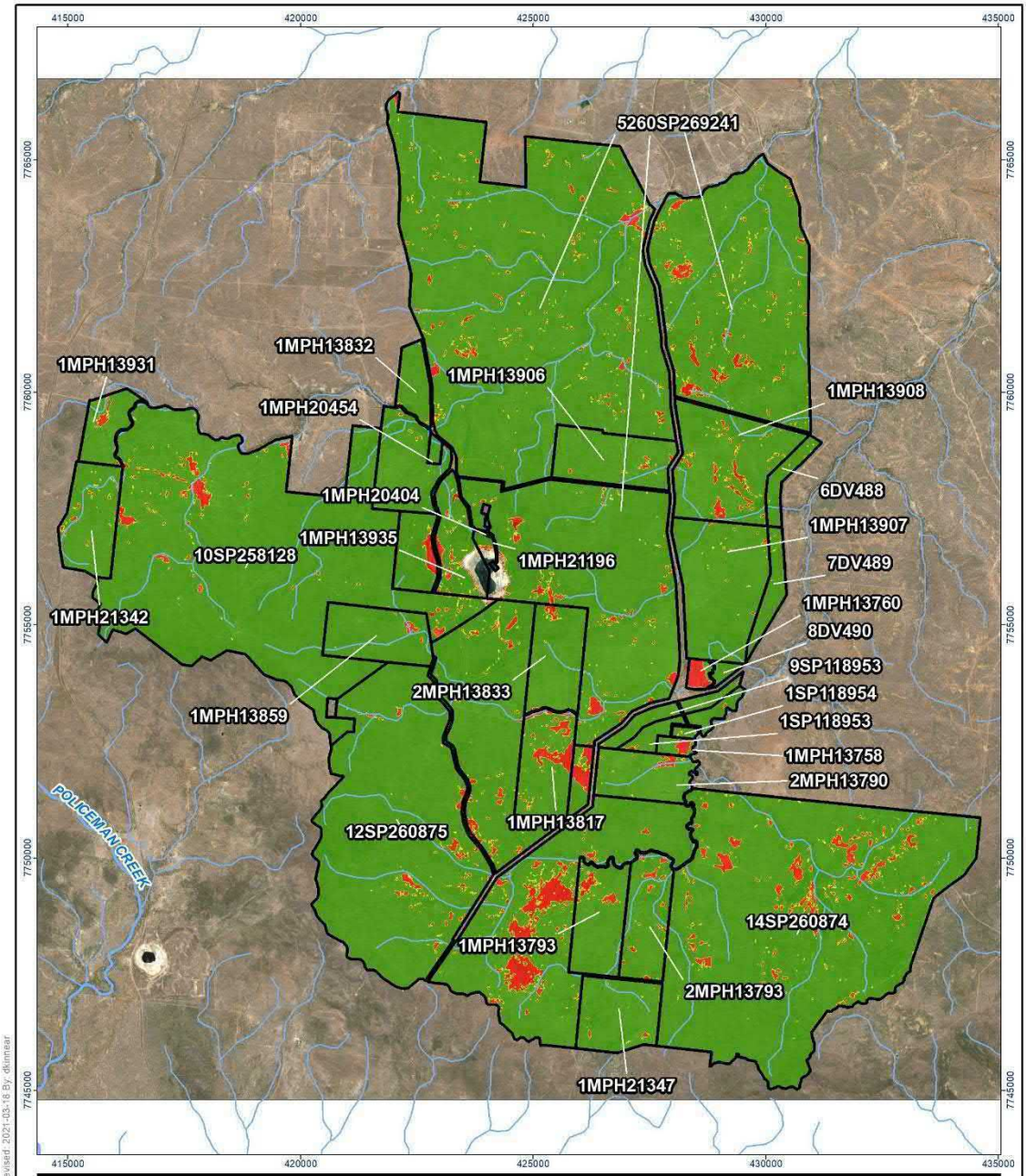

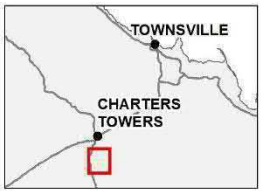

Pastoral Lease Boundary

Live and Dead Cover

- >50% Cover
- 30 - 50% Cover
- <30% Cover
- Major Watercourse
- Minor Watercourse

0 1 2 km
(At original document size of A4)
1:120,000

N

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Project Location
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Perth, Western Australia

Prepared by DK on 2021-03-16
TR by BM on 2021-03-16
IR by SA on 2021-03-16

Client/Project
Newmont Goldcorp Australia
Mt Leyshon
Condition Monitoring 2020

300003239 REVA

Title
Bare Areas Assessment - Pastoral Leases 2019

Notes
1. Coordinate System: GDA 1994 MGA Zone 55
2. Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2021).
3. Background: Copernicus Sentinel data 2019

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Appendix E:
Mt Leyshon Community and Stakeholder Engagement Plan

ENGENY WATER MANAGEMENT

Newmont AUSTRALIA

Newmont Australia

Community Engagement Plan

Mt Leyshon Mine

27 July 2022

M13000_025-REP-001-4

Job no. and Project Name: M13000_025 Mt Leyshon Community Engagement Plan
Doc Path File: \\online.com\files\Management\Projects\M13000_Newmont Asia Pacific\M13000_025 Mt Leyshon SEP\07 Deliv\2. Report\M13000_025-REP-001-4-Mt Leyshon Community Engagement Plan.docx

Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	29/07/2021	Draft for Client Review	Whitney Claxton	Thomas Sheppard	Thomas Sheppard	Samantha Breslin
1	17/08/2021	Client Issue	Whitney Claxton	Thomas Sheppard	Thomas Sheppard	Samantha Breslin
2	2/02/2022	Client Issue	Whitney Claxton	Thomas Sheppard	Thomas Sheppard	Samantha Breslin
3	22/07/2022	Client Issue	Whitney Claxton	Thomas Sheppard	Thomas Sheppard	Samantha Breslin
4	27/07/2022	Client Issue	Whitney Claxton	Thomas Sheppard	Thomas Sheppard	Samantha Breslin
Signatures						

DISCLAIMER

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1 INTRODUCTION

Newmont Australia (Newmont) understand that its activities and operations at the Mt Leyshon Mine can potentially impact the surrounding community and environment. This Community Engagement Plan (CEP) provides a high-level plan and guideline to assist managing the potential impacts of mining activities at Mt Leyshon on the community. Mt Leyshon Mine strongly values its surrounding community of Charters Towers and aims to maintain a strong relationship with all stakeholders.

1.1 SITE BACKGROUND

The Mt Leyshon Mine is an open pit gold mine located ~24 km south of Charters Towers (Figure 1.1), which has been in closure since 2002. The land adjacent of the mine is predominantly used for grazing and extends to include portions of the mining lease which are grazed under agistment agreements. Mt Leyshon Mine commenced operations in September 1986. It produced gold and silver, initially as a heap leach operation of oxide ore, and then via carbon in pulp (CIP) processing of primary un-oxidized ore commencing in 1989. Heap leaching of oxide ore was terminated in 1992, due to the oxide ore being exhausted. Processing of supergene ore via a two-stage leaching process was undertaken during 1992. The CIP plant was originally installed with a capacity of 2 million tonnes per annum (Mtpa) and was upgraded during the mining period to reach a maximum of 5.4 Mtpa. Open pit mining ceased due to depletion of the ore body in early 2001 after which mill feed was sourced from low grade stockpiles which were processed until March 2002.

Final closure designs for nearly all the facilities have been fully implemented and the site is now primarily in a post-closure monitoring and maintenance phase which is being undertaken by Newmont Landco Pty Ltd (Newmont). Activities that are being undertaken during the post-closure monitoring and maintenance phase include:

- Monitoring and reporting to meet the requirements of the Environmental Authority (EA).
- Water management operations to ensure water that is not suitable for release to the environment is intercepted and pumped to the final void pit lake in accordance with the post-closure water management strategy.
- Maintenance of previously rehabilitated areas.
- Additional rehabilitation works.

Exploration of the Mt Leyshon orebody was undertaken from the 1960s to the 1980s by MIM, Marathon Petroleum Australia Ltd, and Noranda Australia Ltd. The mine was developed in the 1980s by Pan Australian Mining Ltd, after purchasing a 50% interest in the operation from Noranda Australia and becoming the sole owners in 1986. In June 1989, Pan Australian Mining Ltd became part of the Normandy Poseidon Group of companies. During the mining period, in June 1991, the holder of the mining leases was changed to Mt Leyshon Gold Mines Ltd. In 1997, the company changed its name to Normandy Mt Leyshon Ltd. In 2002, Newmont outbid Anglogold to acquire all of the Normandy Mining operations, including the Mt Leyshon Mine. Under the conditions of the takeover, the Mt Leyshon mining leases and rights to the resource remained with a company called Leyshon Resources Ltd (LRL). A management agreement was enacted, in which LRL appointed Newmont to manage the low-grade stockpiles, and to implement the remainder of the site closure and rehabilitation plan. In 2016, Newmont acquired all Mt Leyshon mining leases and rights to resources from LRL.

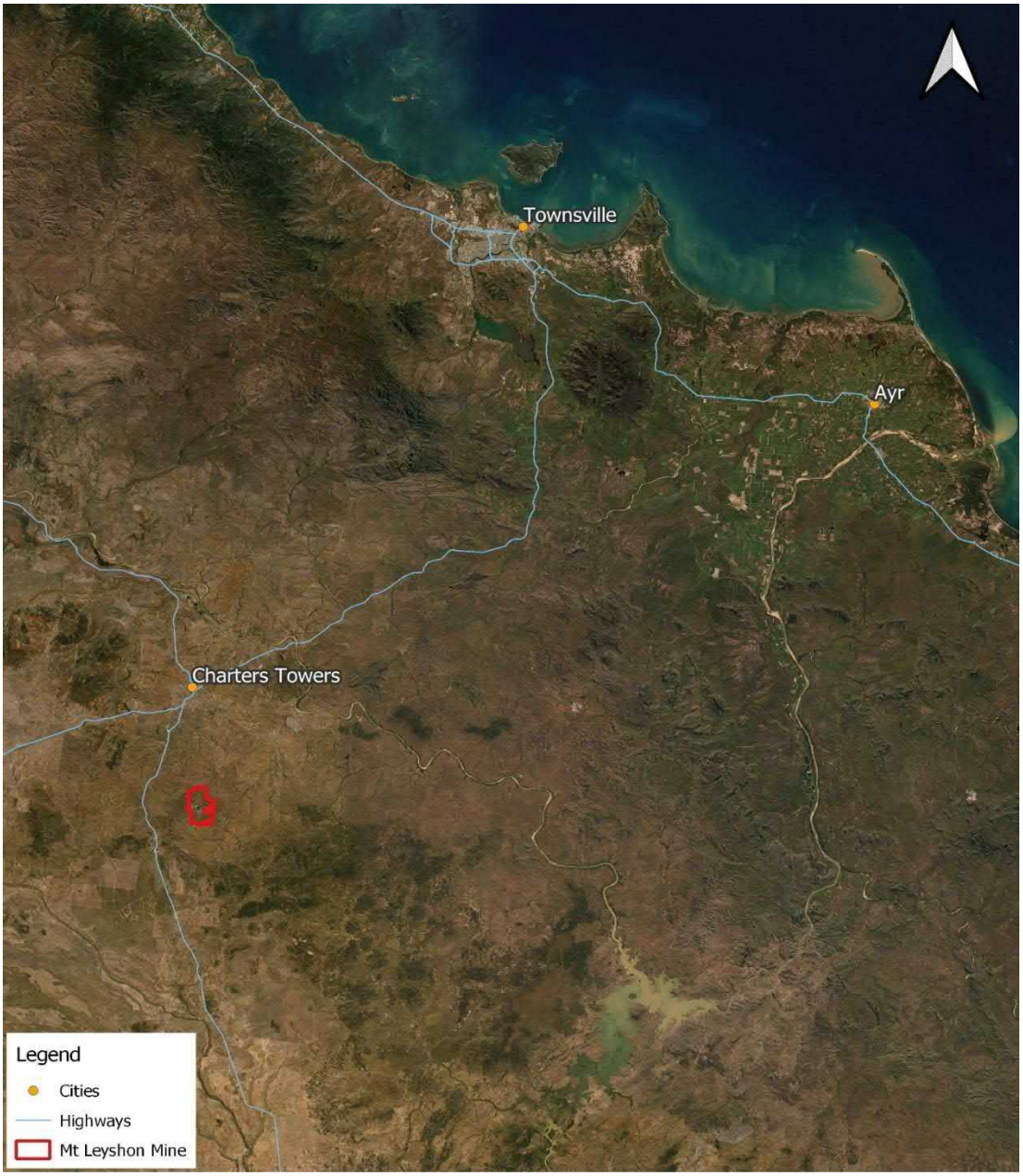


Figure 1.1: Mt Leyshon Mine Location

1.2 PURPOSE AND SCOPE

The purpose of this CEP is to provide an overarching strategy for appropriate, effective, transparent, and open communication with the Mt Leyshon community and all stakeholders. This CEP applies to the Mt Leyshon Mine and will be used to guide engagement with all stakeholders including traditional owner group the Jangga People, local community, government, businesses, and Newmont personnel.

1.3 OBJECTIVES AND PRINCIPLES

Newmont's engagement strategy for the Mt Leyshon Mine is governed by guiding principles to strengthen and maintain the relationship between Newmont and the community. These principles include:

- Effective: Establish communication and engagement that facilitates the desired outcome for the community and Newmont.
- Transparent: Promote open, honest communication to establish a trusting and respectful relationship.

- Respectful: Cultivate respectful communication with community members where their needs are listened to and acknowledged.
- Inclusive: Develop an engagement strategy where all community members are given equal opportunity to communicate with Newmont.
- Responsive: Provide a response to community questions or queries as soon as practically possible.

1.4 REGULATORY FRAMEWORK

Mount Leyshon is subject to the following regulatory frameworks, with respect to community engagement.

- *Queensland Environmental Protection (EP) Act 1994.*

The EP Act authorises certain activities under conditions set by Environmental Authorities (EA). Mount Leyshon operate under EA EPML00863713. EA conditions relevant to stakeholder engagement are:

- Complaint response:
  (G1-1) All complaints received must be recorded including details of complainant, reasons for the complaint, investigations undertaken, conclusions formed, and actions taken. This information must be made available for inspection by the administering authority on request.
- Complaints and Community:
  (G2-1) Records must be kept of all environmental complaints received about the mining activities including the following details:

  a) Name, address and contact number for complainant (if not available record – not identified):
  b) Time and date of complaint.
  c) Reasons for the complaint.
  d) Investigations undertaken.
  e) Conclusions formed.
  f) Actions taken to resolve complaint.
  g) Any abatement measures implemented.
  h) Person responsible for resolving the complaint.

(G2-2) Information required in G2-1 must be available for inspection by the administering authority on request.

(G2-3) When requested by the administering authority, the environmental authority holder must undertake relevant specified monitoring within a timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental harm. The results of the investigation (including an analysis and interpretation of the monitoring results) and abatement measures implemented must be provided to the administering authority within fourteen (14) days of completion of the investigation.

(G2-4) The holder of this environmental authority must establish, promote and maintain easily accessible lines of communication between residents, relevant stakeholders and landowners to ensure that social impacts are identified and managed.

The EP Act also sets requirements for sites that are subject to Progressive Rehabilitation Closure Plans (PRCP) PRC requirements from the EP Act requires Mt Leyshon to comply with section 126C(1)(c)(iv) of the EP Act. Applied to Mount Leyshon, this section of the EP Act requires Mt Leyshon to develop a CEP for ongoing consultation including:

- The objectives for community consultation (Section 1.2 and 1.3 of this plan).
- How the community will be engaged (Section 3.3 of this plan).
- Proposed consultation frequency (Section 3.3 of this plan).
- What information will be released for community consultation (Section 3.3 of this plan).
- How feedback/comments will be considered. (Section 4.2 of this plan).

2 STAKEHOLDER IDENTIFICATION

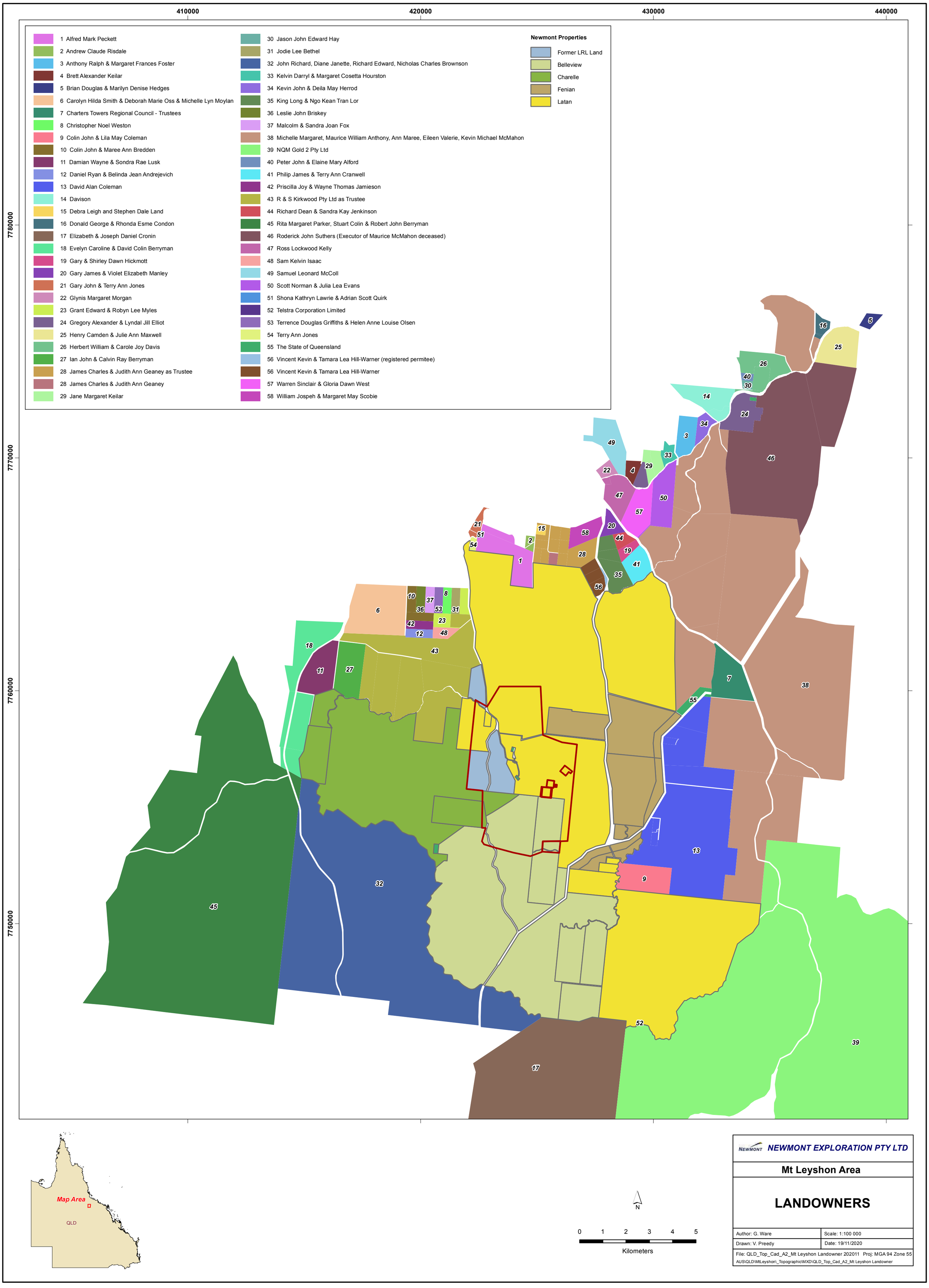
This CEP identifies all stakeholders involved with, or potentially impacted by the Mt Leyshon Mine at the time of writing. In order to determine the type, method, and frequency of engagement required for each stakeholder group, identified stakeholders are assigned an 'identification' which is described in Section 2.1 below. This section also outlines the current known and likely stakeholder issues that have been identified through community consultation in Table 2.2.

2.1 IDENTIFICATION OF STAKEHOLDERS

Stakeholders of Mt Leyshon shown in Appendix A, are identified according to potential impacts the mining activities may have. Table 2.1 outlines the identification categories of stakeholders and the engagement strategy associated to reduce the impacts of mining activities at Mt Leyshon on the respective properties and to maintain a mutually beneficial relationship.

Table 2.1: Stakeholder Classification

Class	Description	Engagement Type
Tier 1	Properties within or immediately adjacent to the mining lease; Newmont owned land and under agistment; safety and environmental regulators, third parties operating on-site; small scale miners and explorers.	Proactive engagement.
Tier 2	Regional landholders adjacent to Newmont owned land.	Reactive engagement.
Tier 3	Special interest groups.	Reactive engagement.



NEWMONT EXPLORATION PTY LTD

Mt Leyshon Area

LANDOWNERS

Author: G. Ware	Scale: 1:100 000
Drawn: V. Preedy	Date: 19/11/2020

File: QLD_Top_Cad_A2_Mt Leyshon Landowner 202011 Proj: MGA 94 Zone 55
AUS\QLD\MtLeyshon_Topographic\MXD\QLD_Top_Cad_A2_Mt Leyshon Landowner

2.2 CURRENT STAKEHOLDER OPPORTUNITIES FOR IMPROVEMENT

Table 2.2 identifies known issues and likely stakeholder concerns identified in Mt Leyshon's previous Mine Closure Stakeholder Engagement Plan. Key concerns outlined in Table 2.2 and consultation with Mt Leyshon have assisted in identifying potential concerns current stakeholders may have and the most appropriate method to engage with stakeholders if these concerns arise.

A risk assessment (Appendix B) has been completed to address relevant potential impacts outlined in Table 2.2 and other potential impacts relevant to Mt Leyshon's current mine activities. The risk assessment has addressed; which stakeholders could be impacted; the likelihood these impacts will occur; and how impacts will be managed.

Table 2.2: Known and Likely Stakeholder Concerns

Stakeholder Group	Known Issues	Likely Stakeholder Concerns
Background Landowners	• Previous land and water contamination. • Future land and water contamination. • Future land tenure and usage. • Breakdown in communication, relationship and trust with Newmont and LRL. • Compensation. • Rehabilitation strategy for the scats stockpile. • Long term behaviour of the final void.	• Remediation of previous contamination. • Inability to remove potential for future events. • Land will not be returned to their control, or that land use will not be as they prefer. • Species introduced for rehabilitation will adversely impact on the stakeholder's land value. • Newmont and LRL are not trustworthy. • Compensation will not be at the level the stakeholders expect. • The scats stockpile has not yet been rehabilitated. • As the pit water level rises, it may have an impact on their land.
Neighbours (nearby and downstream)	• Previous water contamination. • Potential future contamination of water supplies. • Human and animal health. • Past failure of notification processes.	• Remediation of previous contamination. • Inability to remove potential of future water contamination events. • Human or animal health has or will be affected by water or land contamination. • May be delays in notifying landholders regarding any future events.
Community	• Previous land and water contamination. • Future land and water contamination. • Future land tenure and usage. • Breakdown in communication, relationship, and trust with Newmont and LRL. • Investigations are biased by Newmont's desires. • Human and animal health.	• Remediation of previous contamination. • Inability to remove potential for future events. • Land will not be returned to their control, or that land use will not be as they prefer. • Newmont and LRL are not trustworthy. • Greater transparency is required for future investigations. • Human or animal health has or will be affected by water or land contamination.
Statutory / Referral	• Previous land and water contamination. • Future land and water contamination. • Future land tenure and usage. • Breakdown in communication, relationship, and trust with Newmont and LRL. • Human and animal health. • Impact on corporate reputation/transparency of processes. • Fulfilment of statutory responsibility. • Potential for environmental harm and ongoing statutory non compliances.	• Remediation of previous contamination to an acceptable standard. • Potential for Newmont or LRL to avoid future contamination events. • Newmont will not be able to finalise negotiations on land tenure and usage to a satisfactory standard. • Current damaged relationship between Newmont /LRL and the Charters Towers community and others may spread to statutory stakeholders if poorly managed. • Actual or alleged impact on human or animal health triggers continuing public scrutiny. • Management of mine closure has a negative impact on the corporate reputation of the statutory stakeholder. • Statutory obligations may not be met in a complete and timely manner.

3 ENGAGEMENT STRATEGY

Newmont adopts two engagement strategies for Mt Leyshon Mine in order to consider and meet community needs at varying stages of mining activities. The engagement strategies include proactive and reactive engagement.

3.1 PROACTIVE ENGAGEMENT

Proactive engagement involves Newmont ensuring that community needs are understood and fulfilled to strengthen the relationship between Newmont and the community and allow transparent and respectful engagement. Newmont have implemented various proactive engagement processes at Mt Leyshon Mine including:

- Community investment.
- Community updates.
- Community involvement in decision making.

3.1.1 Community Investment

Mt Leyshon is no longer an operational mine site, therefore interest in the mine is less than that of an active mine site. Where possible, Mt Leyshon provides in kind support to local interest groups such as universities and land care parties who express interest in the mine for example, arranging field trips.

3.1.2 Community Updates

Mt Leyshon provides community updates to stakeholders through a variety of methods depending on their level of involvement with Mt Leyshon mine. Regulators are provided with annual technical updates and site inspections along with compliance reporting when required. Stakeholders such as agistees, third parties operating on-site, small scale miners and explorers are provided with updates regarding significant changes or site developments that may impact their activities. Regional landholders are invited to participate in regular meetings through the Dalrymple Landcare Committee or meetings hosted by Mt Leyshon mine. Other community groups such as the Regional Environmental Networking Group are invited to attend biannual meetings.

Frequency and methods of community updates are detailed in Table 3.2.

3.1.3 Community Involvement in Decision Making

Community involvement in decision making assists Mt Leyshon in addressing the communities needs and concerns regarding mine activities. Community involvement in decision making has been a contributing factor in Post Mine Land Use (PMLU) decisions, such as establishing grazing as the preferred PMLU option via early agistee and compensation agreements. Contact between the community and Mt Leyshon will facilitate consultation and engagement on closure and rehabilitation activities.

A key element of proactive engagement with the community is description of former and upcoming rehabilitation efforts as part of progressive rehabilitation in accordance with the publicly available Progressive Rehabilitation Closure Plan (PRCP). Access to the PRCP will be facilitated during proactive engagement sessions. Descriptions of key items relating to upcoming works identified in the PRCP schedule and their timeframes for completion/progression to the next milestone will be incorporated into engagement sessions which provide an opportunity for the community to directly provide feedback which is proposed to be incorporated into PRCP updates as required. It is noted that Newmont own the underlying and adjoining pastoral properties to the mine and community consultation occurs with stakeholders that are beyond the immediate location of the mine which is the reason for the nominated methods and frequencies of engagements.

3.2 REACTIVE ENGAGEMENT

3.2.1 Stakeholder Concern Management

Mt Leyshon understands that despite community engagement efforts, stakeholders may still be impacted by the mine's activities. Through stakeholder concern management, Mt Leyshon aims to resolve individual concerns and identify opportunities to make improvements. Tier 1 impacted stakeholders have been provided with a direct phone number to contact site representatives to register any concerns. Any other persons wishing to contact Mt Leyshon in regard to mine related activities or to register a concern is able to do so by contacting Mt Leyshon on the details provided in Table 3.1.

3.2.2 Emergency Response/Management

In the event of an emergency at Mt Leyshon, stakeholders who may be impacted by the emergency will be informed via the contact details they have provided to the mine. An event that would initiate an emergency response/ management could include, but is not limited to, fire, water release, etc.

Stakeholders who may have identified an emergency at the mine may contact Mt Leyshon on the details provided in Table 3.1.

Table 3.1: Mt Leyshon Contact Details

Contact Details
Website: https://www.newmont.com/
Phone: +618 9423 6100

3.3 ACTION PLAN

An action plan has been created to inform the method and frequency of engagement that Mt Leyshon will provide to stakeholders according to their tier classification specified in Appendix A.

Table 3.2: Method & Frequency of Contact with Stakeholders

Tier	Stakeholder	Method/Content	Frequency
1	Regulators	• Technical updates • Routine site inspections • Compliance reporting • PRCP scheduling and rehabilitation planning	• Annually • Annually • Compliance reporting as required
	Agistees, third parties operating onsite, small scale miners and explorers.	• Updates regarding recent site developments that have the potential to impact stakeholders. • PRCP scheduling and rehabilitation planning	• As required.
2	Regional landholders (open to all community members)	Engagement through the Dalrymple Landcare Committe (DLC): • Meetings • Meeting inclusive of a site update and tour, hosted by Mt Leyshon. • PRCP scheduling and rehabilitation planning	• Quarterly • Annually
3	Regional Environment Networking Group	• Engagement meeting • PRCP scheduling and rehabilitation planning	• Biannual

4 ADMINISTRATION

4.1 RECORD KEEPING AND MANAGEMENT

Record keeping and management at Mt Leyshon is maintained through an existing stakeholder management system called Cintellate. Cintellate can capture stakeholder details, communications, commitments, investments, complaints, and any resulting actions. Cintellate also records relevant information regarding alleged environmental nuisance, studies, and correspondence. A column alerts the user to any outstanding actions they need to close out to confirm matters are attended to in a timely manner. All stakeholder engagements are required to be captured in Cintellate.

4.2 REVIEW AND CONTINUOUS IMPROVEMENT

The community engagement plan and associated administration processes will be reviewed as significant changes occur to assess whether concerns are actively being resolved and responded to in a timely manner. The review process will also take into consideration where improvements can be made based on issues identified from the previous engagement period.

5 QUALIFICATIONS

a) In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to confirm that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

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   ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

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g) This Report does not provide legal advice.

6 REFERENCES

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National Native Title Tribunal. Native Title Determination Details QCD2016/001- Birriah People. Accessed 19th July 2021 via: http://www.nntt.gov.au/searchRegApps/NativeTitleClaims/Pages/Determination_details.aspx?NNTT_Fileno=QCD2014/006.

Mount Leyshon Mine Closure Stakeholder Engagement Plan.

Engeny Water Management.

SAI Global. (2018). Risk Management – Principles and guidelines AS/NZS ISO 31000:2018.

Appendix A:
Mt Leyshon Stakeholder Register 2021

Stakeholder ID	Full Name	Stakeholder Type	Stakeholder Name	Position (if applicable)	Class	Phone	Address	Email
SH-00003783	Paul Murray	**Regulator - Environmental (compliance)**	Department of Environment and Science (DES)	Senior Environmental Officer	Tier 1	(07) 4722 5221	Level 10, 445 Flinders Street Townsville QLD 4810	Paul.Murray@des.qld.gov.au
SH-00003784	Kirstie Treloar		Department of Environment and Science (DES)	Principal Environmental Officer	Tier 1	(07) 4722 5468	Level 3, 5B Sheridan Street , Cairns QLD 4870	Kirstie.Treloar@des.qld.gov.au
SH-00003785	Stephanie Brown		Department of Environment and Science (DES)	Senior Environmental Officer	Tier 1	(07) 4722 5361	Level 10, 445 Flinders Street Townsville QLD 4810	Stephanie.Brown@des.qld.gov.au
SH-00003786	Emergency Contact		Pollution Hotline (Incident Reporting)		Tier 1	1300 130 372 option 2		PollutionHotline@des.qld.gov.au
SH-00003787	Graeme Trevorrow	**Regulator - Safety**	Safety Resources and Health Queensland (SRHQ)	Inspector of Mines (Electrical)	Tier 1	(07) 4447 9255 or 0436 845755	Level 10 Verde Towers, 445 Flinders St, Townsville, QLD 4810	graeme.trevorrow@rshq.qld.gov.au
TBC	Alan Graham		Safety Resources and Health Queensland (SRHQ)	A/Regional Inspector of Mines & Mechanical Inspector	Tier 1	(07) 4447 9250 or 0475 829 786	Level 10 Verde Towers, 445 Flinders St, Townsville, QLD 4811	Alan.Graham@rshq.qld.gov.au
SH-00003788	Trevor Brown		Safety Resources and Health Queensland (SRHQ)	Deputy Chief Inspector of Mineral Mines and Quarries	Tier 1	(07) 4447 9253 or 0412057390	Level 10 Verde Towers, 445 Flinders St, Townsville, QLD 4810	trevor.brown@rshq.qld.gov.au
SH-00003789	Emergency Contact		Safety Hotline (Incident Reporting)		Tier 1	(07) 4447 9282 (diverts to on-call inspector)		
SH-00003790	Frank Beveridge	**Shire Council**	Charters Towers Regional Council	Mayor	Tier 1	0458 754 589	12 Mosman St, Charters Towers, QLD, 4820	Frank.beveridge@charterstowers.qld.gov.au
TBC	Emergency Contact		Charters Towers Regional Council		Tier 1	(07) 4761 5300	12 Mosman St, Charters Towers, QLD, 4820	
SH-00004322	John Brownson	**Agistees on Newmont Land**	John Brownson (Agistee - Belleview)		Tier 1	0428 636 494	PO Box 1227, Charters Towers QLD 4820	brownsonbrahmans@gmail.com

Stakeholder ID	Full Name	Stakeholder Type	Stakeholder Name	Position (if applicable)	Class	Phone	Address	Email
SH-00004323	Dianne Brownson		Dianne Brownson (Agistee - Belleview)		Tier 1	0428 636 494	PO Box 1227, Charters Towers QLD 4820	brownsonbrahmans@gmail.com
TBC	Lesley Stringer		Lesley Stringer (Agistee Charelle)		Tier 1	0439 855 640	8 Kirrima Court, Charters Towers QLD 4820	lesley.stringbean@gmail.com
SH-00004324	Les Stringer		Les Stringer (Agistee - Charelle and Charelle ML Owner)		Tier 1	0415 055 488	8 Kirrima Court, Charters Towers QLD 4820	les.stringer@bigpond.com
SH-00004325	Robert Kirkwood		Robert Kirkwood (Agistee - Latan)		Tier 1		PO Box 959, Charters Towers QLD 4820	sallykirkwood@bigpond.com
SH-00004326	Sally Kirkwood		Sally Kirkwood (Agistee - Latan)		Tier 1		PO Box 959, Charters Towers QLD 4820	sallykirkwood@bigpond.com
SH-00004327	Richard Pugh		Richard Pugh (Agistee - Fenian)		Tier 1	0407 636 861	Springview Station, Mingella QLD 4816	janeenpugh@gmail.com
SH-00004328	Janeen Pugh		Janeen Pugh (Agistee - Fenian)		Tier 1	0407 636 861	Springview Station, Mingella QLD 4816	janeenpugh@gmail.com
SH-00004332	Vincent Hill-Warner		Vincent Hill-Warner (Agistee - Mining Leases)		Tier 1	0447 878 449	O'Reilly Road, Seventy Mile Charters Towers QLD 4820	advantageconstructionco@bigpond.com
SH-00004333	Tamara Hill-Warner		Tamara Hill-Warner (Agistee - Mining Leases)		Tier 1	0447 878 449	O'Reilly Road, Seventy Mile Charters Towers QLD 4820	advantageconstructionco@bigpond.com
SH-00004329	Pip Knuth		Pip Knuth (Occupying Newmont Land Only - Merrilands)		Tier 1	0429 877 852 (Blair)	PO Box 281, Charters Towers QLD 4820	burdekindowns@bigpond.com
TBC	Blair Knuth		Blair Knuth (Administrator and primary contact for Pip Knuth)		Tier 1	0429 877 852	PO Box 281, Charters Towers QLD 4821	burdekindowns@bigpond.com
Property ID 1		**Regional Property Owners (updated 2020)**	Alfred Mark Peckett		Tier 2			

Stakeholder ID	Full Name	Stakeholder Type	Stakeholder Name	Position (if applicable)	Class	Phone	Address	Email
Property ID 2			Andrew Claude Risdale		Tier 2			
Property ID 3			Anthony Ralph & Margaret Frances Foster		Tier 2	0428 872 913	Bonnie Doon (Bus Road) PO Box 597 Charters Towers QLD 4820	tmfoster@bluemaxx.com.au
Property ID 4			Brett Alexander Keilar		Tier 2			
Property ID 5			Brian Douglas & Marilyn Denise Hedges		Tier 2		10121 Bluepet, Broughton Road, PO Box 459 Charters Towers QLD 4820	
Property ID 6			Carolyn Hilda Smith & Deborah Marie Oss & Michelle Lyn Moylan		Tier 2			
Property ID 7			Charters Towers Regional Council - Trustees		Tier 2			
Property ID 8			Christopher Noel Weston		Tier 2			
Property ID 9			Colin John & Lila May Coleman		Tier 2			
Property ID 10			Colin John & Maree Ann Bredden		Tier 2			
Property ID 11			Damian Wayne & Sondra Rae Lusk		Tier 2			
Property ID 12			Daniel Ryan & Belinda Jean Andrejevich		Tier 2			
Property ID 13			David Alan Coleman		Tier 2	0427 077 156		
Property ID 14			Darcy Davison		Tier 2	0427 872 193	Broughton View, PO Box 1030 Charters Towers QLD 4820	

Stakeholder ID	Full Name	Stakeholder Type	Stakeholder Name	Position (if applicable)	Class	Phone	Address	Email
Property ID 15			Debra Leigh and Stephen Dale Land		Tier 2			
Property ID 16			Donald George & Rhonda Esme Condon		Tier 2	0407167 886	Broughton Park PO Box 498 Charters Towers QLD 4820	rhonda.condon@bigpond.com.au
Property ID 17			Elizabeth & Joseph Daniel Cronin		Tier 2			
Property ID 18			Evelyn Caroline & David Colin Berryman		Tier 2			
Property ID 19			Gary & Shirley Dawn Hickmott		Tier 2			
Property ID 20			Gary James & Violet Elizabeth Manley		Tier 2			
Property ID 21			Gary John & Terry Ann Jones		Tier 2			
Property ID 22			Glynis Margaret Morgan		Tier 2			
Property ID 23			Grant Edward & Robyn Lee Myles		Tier 2			
Property ID 24			Gregory Alexander & Lyndal Jill Elliot		Tier 2			
Property ID 25			Henry Camden & Julie Ann Maxwell		Tier 2			
Property ID 26			Herbert William & Carole Joy Davis		Tier 2	0427 169 927	Alfred Road, PO Box 1079 Charters Towers QLD 4820	
Property ID 27			Ian John & Calvin Ray Berryman		Tier 2			
Property ID 28			James Charles & Judith Ann Geaney as Trustee		Tier 2			

Stakeholder ID	Full Name	Stakeholder Type	Stakeholder Name	Position (if applicable)	Class	Phone	Address	Email
Property ID 29			Jane Margaret Keilar		Tier 2			
Property ID 30			Jason John Edward Hay		Tier 2			
Property ID 31			Jodie Lee Bethel		Tier 2			
Property ID 32			John Richard, Diane Janette, Richard Edward, Nicholas Charles Brownson		Tier 1	0428 636 494	PO Box 1227, Charters Towers QLD 4820	brownsonbrahmans@gmail.com
Property ID 33			Kelvin Darryl & Margaret Cosetta Hourston		Tier 2			
Property ID 34			Kevin John & Deila May Herrod		Tier 2			
Property ID 35			King Long & Ngo Kean Tran Lor		Tier 2		503 Narangba Road, Kurwongbah QLD 4503	
Property ID 36			Leslie John Briskey		Tier 2			
Property ID 37			Malcolm & Sandra Joan Fox		Tier 2			
Property ID 38			Michelle Margaret, Maurice William Anthony, Ann Maree, Eileen Valerie, Kevin Michael McMahon		Tier 2			
Property ID 39			NQM Gold 2 Pty Ltd		Tier 2			
Property ID 40			Peter John & Elaine Mary Alford		Tier 2			
Property ID 41			Philip James & Terry Ann Cranwell		Tier 2			
Property ID 42			Priscilla Joy & Wayne Thomas Jamieson		Tier 2			

Stakeholder ID	Full Name	Stakeholder Type	Stakeholder Name	Position (if applicable)	Class	Phone	Address	Email
Property ID 43			R & S Kirkwood Pty Ltd as Trustee		Tier 1		PO Box 959, Charters Towers QLD 4820	sallykirkwood@bigpond.com
Property ID 44			Richard Dean & Sandra Kay Jenkinson		Tier 2			
Property ID 45			Rita Margaret Parker, Stuart Colin & Robert John Berryman		Tier 2			
Property ID 46			Roderick John Suthers (Executor of Maurice McMahon deceased)		Tier 2			
Property ID 47			Ross Lockwood Kelly		Tier 2			
Property ID 48			Sam Kelvin Isaac		Tier 2			
Property ID 49			Samuel Leonard McColl		Tier 2		Bus Road, PO Box 484 Charters Towers QLD 4820	
Property ID 50			Scott Norman & Julia Lea Evans		Tier 2			
Property ID 51			Shona Kathryn Lawrie & Adrian Scott Quirk		Tier 2			
Property ID 52			Telstra Corporation Limited		Tier 2			
Property ID 53			Terrence Douglas Griffiths & Helen Anne Louise Olsen		Tier 2			
Property ID 54			Terry Ann Jones		Tier 2			
Property ID 55			The State of Queensland		Tier 2			
Property ID 56			Vincent Kevin & Tamara Lea Hill-Warner (registered permitee)		Tier 1	0447 878 449	O'Reilly Road, Seventy Mile Charters Towers QLD 4820	

Stakeholder ID	Full Name	Stakeholder Type	Stakeholder Name	Position (if applicable)	Class	Phone	Address	Email
Property ID 57			Warren Sinclair & Gloria Dawn West		Tier 2			
Property ID 58			William Jospeh & Margaret May Scobie		Tier 2			
TBC	Tony Hockings	**Third Parties On-Site**	Townsville Mining (Data Centre and Solar Project)		Tier 1	0402668554	Suite 211, Level 2, 520 Flinders St, Townsville QLD 4820	ajh@lexcode.com.au
TBC	Ian Bridge		CopperString (HV Transmission Line)		Tier 1	0407303770		ibridge@visir.com.au
TBC	Tim Wilks		Marchnet (Comms Tower)		Tier 1	0451209556		tim.wilks@marchnet.com.au
TBC			Ergon Energy		Tier 1	13 22 96 (fault line)		
SH-04510	Gerard Blum	**Small Scale Miners and Explorers on Newmont Properties**	Gerard Blum		Tier 1	0427 011 600		
SH-04511	Gerard Toon		Steve Toon		Tier 1	0488 771 746		basada1955@hotmail.com
SH-04713	Paul Beattie		Paul Beattie		Tier 1	0435 076 086		minexco@mammolaluce.com
TBC	Bob Shepherd	**Dalrymple Landcare Committee Inc.**	Dalrymple Landcare Committee Inc.		Tier 3	0467 802 430		Bob.Shepherd@daf.qld.gov.au
TBC	John Foley	**Regional Environmental Networking Group**	Minjar Gold - Pajingo	Senior Environmental Advisor	Tier 3	0448798264	Gregory Development Road, Charters Towers Qld 4820	Paul.Foley@MinjarGold.com.au
TBC	Alisa Wilkinson		Ravenswood Gold	Group Sustainability Manager	Tier 3	0436602405	Level 10, 445 Flinders Street Townsville QLD 4810	alisa.wilkinson@ravenswoodgold.com

Appendix B:
Risk Assessment

Regional

RISK ASSESSMENT

Health and Safety

Risk Summary						Impacted Areas								Current Risk Level				Risk Treatment	Predicted Risk			
Stakeholder Tier	Risk #	Risk Description (Include Activity, Product, Service description etc.)	Potential Cause(s)	Impact Assumption (Details of the credible scenario a risk rating has been assigned for)	Controls	Health	Safety	Environment	External Relations	Heritage	Land & Tenure	Production	Reputation	Risk Category - Major Impacted Area	Consequence	Likelihood	Risk Level	Risk Rating	Risk Treatment Actions	Consequence	Likelihood	Risk Level	Risk Rating
Tier 1	1	Noise	- Rehabilitation works - Maintenance works	- Nuisance - Sleep Impacts	-Mobile plant only -Day shift only -Proximity to sensitive receptors	✓		✓	✓			✓		External Relations	1	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	2	Air quality	- Rehabilitation works - Maintenance works	- Nuisance	-Dust suppression (water cart) -Proximity to sensitive receptors	✓		✓	✓			✓		External Relations	1	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	3	Lighting	-Night works	- Visual nuisance - Sleep Impacts	- Direct lighting plant away from sensitive receptors - Day shift only -Proximity to sensitive receptors	✓		✓	✓			✓		External Relations	1	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	4	Visual amenity	-Presence of final void -Landform reshaping	- Visual contrast to natural environment	- Designs - Compliance to regulatory requirements -Consistent with surrounding landforms				✓					External Relations	1	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	5	Surface water contamination	-Surface water runoff from landforms potentially exposed to contaminants	- ARD discharged from site	- Interception systems - Pumping strategy -Adequate storage in void	✓	✓	✓	✓		✓			Environment	3	1	6	Medium	Develop and Implement a community engagement plan with engagement method and frequency	3	1	6	Medium
	6	Ground water contamination	-Known contaminated groundwater plume	-Use or interaction with contaminated groundwater plume beyond lease and beyond Newmont owned land	- Modeled interaction of surface and groundwater - Control of access to land and bores - Currently contained to lease -No extraction of groundwater within lease boundary	✓	✓	✓	✓		✓		✓	Environment	2	1	2	Low	Develop and Implement a community engagement plan with engagement method and frequency	2	1	2	Low
	7	Land contamination	-Reactive materials	- Reactive materials exposure to air and water	- Cover systems - void storage of contaminated materials	✓	✓	✓	✓		✓		✓	Environment	1	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	8	Cultural/ Native title	- Heritage sites/ artifacts not protected against unauthorised entry or damage.	- Unintended disturbance to cultural heritage sites/artifacts.	- Controlled access to areas where heritage sites/artifacts are present				✓		✓		✓	External Relations	1	2	2	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	9	Future land and tenure usage	- Statutory stakeholders restrict land use and tenure of future or current lease holders -Post mine land use requirements not met	- Land use restrictions may be unfavorable to lease holders	-Conduct and compensation agreements -Formal lease arrangements				✓					External Relations	1	3	4	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	3	4	Low
	10	Community relations	-Lack of engagement	- Non cohesive relations	- Compliance to regulatory disclosure requirements -Informal stakeholder engagement				✓		✓			External Relations	1	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
Tier 2	11	Noise	- Rehabilitation works - Maintenance works	- Nuisance - Sleep Impacts	-Mobile plant only -Day shift only -Proximity to sensitive receptors	✓		✓	✓			✓		External Relations	1	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	12	Air quality	- Rehabilitation works - Maintenance works	- Nuisance	-Dust suppression (water cart) -Proximity to sensitive receptors	✓		✓	✓			✓		External Relations	1	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	13	Lighting	-Night works	- Visual nuisance - Sleep Impacts	- Direct lighting plant away from sensitive receptors - Day shift only -Proximity to sensitive receptors	✓		✓	✓			✓		External Relations	1	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	14	Visual amenity	-Presence of final void -Landform reshaping	- Visual contrast to natural environment	- Designs - Compliance to regulatory requirements -Consistent with surrounding landforms				✓					External Relations	1	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	15	Surface water contamination	-Surface water runoff from landforms potentially exposed to contaminants	- ARD discharged from site	- Interception systems - Pumping strategy -Adequate storage in void	✓	✓	✓	✓		✓			Environment	3	1	6	Medium	Develop and Implement a community engagement plan with engagement method and frequency	3	1	6	Medium
	16	Ground water contamination	-Known contaminated groundwater plume	-Use or interaction with contaminated groundwater plume beyond lease and beyond Newmont owned land	- Modeled interaction of surface and groundwater - Control of access to land and bores - Currently contained to lease -No extraction of groundwater within lease boundary	✓	✓	✓	✓		✓		✓	Environment	2	1	2	Low	Develop and Implement a community engagement plan with engagement method and frequency	2	1	2	Low
	17	Land contamination	-Reactive materials	- Reactive materials exposure to air and water	- Cover systems - void storage of contaminated materials	✓	✓	✓	✓		✓		✓	Environment	1	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	18	Cultural/ Native title	- Heritage sites/ artifacts not protected against unauthorised entry or damage.	- Unintended disturbance to cultural heritage sites/artifacts.	- Controlled access to areas where heritage sites/artifacts are present				✓		✓		✓	External Relations	1	2	2	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	19	Future land and tenure usage	- Statutory stakeholders restrict land use and tenure of future or current lease holders -Post mine land use requirements not met	- Land use restrictions may be unfavorable to lease holders	-Conduct and compensation agreements -Formal lease arrangements				✓					External Relations	1	3	4	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	20	Community relations	-Lack of engagement	- Non cohesive relations	- Compliance to regulatory disclosure requirements -Informal stakeholder engagement				✓		✓			External Relations	1	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
Tier 3	21	Cultural/ Native title	- Heritage sites/ artifacts not protected against unauthorised entry or damage.	- Unintended disturbance to cultural heritage sites/artifacts.	- Limited access to areas where heritage sites/artifacts are present				✓		✓		✓	External Relations	1	2	2	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	22	Future land and tenure usage	- Statutory stakeholders restrict land use and tenure of future or current lease holders	- Land use restrictions may be unfavorable to lease holders	-Conduct and compensation agreements -Formal lease arrangements				✓					External Relations	1	3	4	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	23	Community relations	-Failure to adhere to notification processes	- Non cohesive relations	- Compliance to regulatory disclosure requirements -Informal stakeholder engagement				✓		✓			External Relations	1	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low
	24	Employment	- Change in employment generated by the mine may have a negative impact on corporate reputation.	- Non cohesive relations -Dependance on operation	Nil				✓					External Relations	2	1	1	Low	Develop and Implement a community engagement plan with engagement method and frequency	1	1	1	Low

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Standard Ref: IMS 02

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ENGENY
WATER MANAGEMENT

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Appendix F:
Mt Leyshon Closure Plan 2019

NEWMONT MINING SERVICES PTY LTD

MT LEYSHON CLOSURE PLAN

Roche Hill Rehabilitation 2017

Document	Issue Date	Authored By	Reviewed By	Approved By
REV 1	JUNE 2014	GLEN WARE	RYNHARD KOK GRAHAM NEVILLE	RYNHARD KOK
REV 2	MARCH 2019	GLEN WARE	DAVID YOUNG	GLEN WARE

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1. Introduction

1.1 Background

The Mt Leyshon mine is an open pit gold mine located 24 km south of Charters Towers, which has been in closure since 2002. Mt Leyshon mine commenced operations in September 1986. It produced gold and silver, initially as a heap leach operation of oxide ore, and then via carbon in pulp (CIP) processing of primary un-oxidised ore commencing in 1989. Heap leaching of oxide ore was terminated in 1992, due to the oxide ore being exhausted. Processing of supergene ore via a two stage leaching process was undertaken during 1992. The CIP plant was originally installed with a capacity of 2 million tons per annum (Mtpa), and was upgraded during the mining period to reach a maximum of 5.4 Mtpa.

Open pit mining ceased due to depletion of the ore body in early 2001 after which mill feed was sourced from low grade stockpiles which were processed until March 2002. Final closure designs for nearly all the facilities have been fully implemented and the site is now primarily in a monitoring and maintenance phase which is being undertaken by Newmont Mining Services Pty Ltd (Newmont).

Ownership of the Mt Leyshon mine has a complicated history. Exploration of the Mt Leyshon orebody was undertaken from the 1960s to the 1980s by MIM, Marathon Petroleum Australia Ltd, and Noranda Australia Ltd. The mine was developed in the 1980s by Pan Australian Mining Ltd, after purchasing a 50% interest in the operation from Noranda Australia and becoming the sole owners in 1986. In June 1989, Pan Australian Mining Ltd became part of the Normandy Poseidon Group of companies. During the mining period, in June 1991, the holder of the mining leases was changed to Mt Leyshon Gold Mines Ltd. In 1997 the company changed its name to Normandy Mt Leyshon Ltd. In 2002, Newmont outbid Anglogold to acquire all of the Normandy Mining operations, including the Mt Leyshon mine. Under the conditions of the takeover, the Mt Leyshon mine leases and rights to the resource remained with a company called Leyshon Resources Ltd (LRL). A management agreement was enacted, in which LRL appointed Newmont to manage the low grade stockpiles, and to implement the remainder of the site closure and rehabilitation plan. In 2016, Newmont acquired all Mt Leyshon mine leases and rights to resources from LRL.

Operations at the Mt Leyshon mine are governed by Environmental Authority (EA) EPML00863713 issued to Newmont. Schedule F of the EA defines operating conditions for land. Condition F4-1 of the EA requires that a Post Mine Land Use Plan (PMLUP) must be developed identifying how rehabilitation objectives for the facilities are achieved. Condition F10-1 of the EA requires that a Post Closure Management Plan (PCMP) must be developed.

The PMLUP and the PCMP have several elements in common, and have therefore been combined for the Mt Leyshon mine, and are both included in this Closure Plan document. This Closure Plan was originally submitted to the Department of Environment and Heritage Protection (DEHP) in 2014 to satisfy the requirements of conditions F4-1 and F10-1 of the EA. This updated version of the Closure Plan will be submitted to the Department of Environment and Science (DES) in March 2019.

1.2 Site specific application of PMLUP

The requirements for the PMLUP defined in the EA are based around the assumption that the plan will be prepared during operations, and will define the closure objectives, the planned designs for closure, the proposed vegetation and erosion control methodologies, and the trials which will be undertaken to refine the proposed approaches. The PMLUP is intended to allow the planned closure designs to be reviewed in advance of implementation, to ensure they are appropriate for the site and consistent with best practice.

Conditions at the Mt Leyshon mine are different to those assumed in the EA conditions for the PMLUP, as the mine has been closed for 17 years. Investigations into cover performance in progressively rehabilitated facilities commenced more than 20 years ago (ACTFR, 1992; ACTFR, 1993; ANSTO, 1996). Facilities were progressively rehabilitated during mining as part of the mining contract with rehabilitation of portions of the waste rock storage facilities commencing 22 years ago in 1992. Most of the final closure designs for the overall site were developed more than 14 years ago (Klohn Crippen Consultants, 1999; SRK Consulting, 2000, Normandy Mt Leyshon Ltd, 2000). Implementation of the closure designs at most of the facilities remaining at the end of open pit mining was completed 17 years ago, in 2002.

All closure works were undertaken in compliance with the legislative requirements in place at those times, including the previous versions of the EA, and were undertaken in a manner consistent with industry best practice at those times. The objectives and closure criteria for the closure works were as described in the relevant planning documents (primarily the Environmental Management Overview Strategy or EMOS, submitted in 1993). The planned closure designs were provided to the relevant department of the Queensland Government prior to implementation, as part of the Plan of Operations which was updated and submitted on a regular basis throughout the mining period (see for example the variation to the Plan of Operations submitted in 1997 to describe the planned decommissioning approach for the Old North Tailings Storage Facility, Mt Leyshon Gold Mines, 1997). Progress reports and completion reports were regularly provided to the relevant department throughout the period of the closure works. Subsequent to completion of the closure works, Newmont has been required under the various versions of the EA governing the site (e.g. EA MIM900117003 issued in September 2003) to report the results of routine monitoring by exception (i.e. Newmont has been required to report exceedances). However, further to this legal obligation, Newmont has provided to the relevant department of the Queensland Government summaries of monitoring data and interpretations of site performance on a regular basis, along with updated land use planning and closure planning documents.

The PMLUP which has been prepared and presented in this Closure Plan has therefore necessarily been adapted in some components, to focus on the actual closure works which have been implemented, rather than providing planned designs and rationale for closure works.

As a result of the chequered ownership history of the Mt Leyshon mine, the changes in staffing associated with the various owners, and the significant period which has elapsed since closure designs were developed for the site, a full record of the rationale and implementation of closure designs is not available for all facilities at the site. In some cases, although a closure design document is known to have existed based on references made in other documentation, hard copy or digital versions of the design documents are no longer available. In some cases, the description of closure works included in this document has been based on anecdotal accounts provided by personnel who were involved in the works and have subsequently been located and interviewed.

During development of this document, every effort has been made to fulfil all of the requirements for the PMLUP defined in the EA, however the resulting PMLUP reflects the specific constraints for the Mt Leyshon mine, which are summarised to include:

1. Most of the closure planning required to be described in the PMLUP was undertaken between 17 and 27 years ago.
2. Some of the closure planning documentation has inevitably been lost in the transition period.
3. Due to the multiple changes in site personnel, the rationale for which closure design was selected has been lost in some cases.

1.3 Components of the closure plan

The current section provides an introduction to the context and background of the Closure Plan document. Section 2 describes the general site setting and describes all of the facilities constructed during mining, including each of the facilities which is prescribed in Table F1 in the EA. The requirements for the PMLUP, in terms of the designs adopted for closure of all facilities are met by the information provided in Section 3. Section 4 summarises the PCMP for the Mt Leyshon mine. The detail of the monitoring which is either undertaken or planned to be undertaken at the Mt Leyshon mine is largely provided in other documents referenced in the EA, including the Receiving Environment Monitoring Plan (REMP), the Water Management Plan, and the Groundwater Management Plan, and Section 4 provides only a summary description of these documents.

Throughout the Closure Plan, for ease of reference, the sections have been structured in a similar way to the specific requirements defined in conditions F4-1 and F10-1 in the EA. For further reference, Table 1 provides a direct reference between the requirement as defined in the conditions in the EA, and the specific section in the Closure Plan where the required information is provided.

Table 1: Requirements in EA and location where addressed in Closure Plan

Condition Reference in EA	Details	Where Addressed
F4-1 a	schematic representation of final land form inclusive of drainage features	Section 2, Figure 1, Figure 2
F4-1 b	slope designs	Section 3.2
F4-1 c	cover design	Section 3.3
F4-1 d	drainage design	Section 3.4
F4-1 e	erosion controls proposed on reformed land	Section 3.5
F4-1 f	description of experimental design for monitoring	Section 3.6
F4-1 g	proposed revegetation criteria	Section 3.7
F4-1 h	proposed revegetation methods	Section 3.8
F4-1 i	materials balance	Section 3.9
F4-1 j	research program	Section 3.10
F4-1 k	geotechnical, geochemical and hydrological studies	Section 2
F4-1 l	chemical, physical and biological properties of soil and water	Section 2
F4-1 m	clear objectives and success criteria	Section 3.11
F4-1 n	measurable completion criteria	Section 3.12
F4-1 o	rehabilitation monitoring program	Section 3.13
F10-2 a i	wastewater collection and reticulation systems	Section 4.2.1
F10-2 a ii	wastewater treatment systems	Section 4.2.2
F10-2 a iii	the groundwater monitoring network	Section 4.2.3
F10-2 a iv	final cover systems	Section 4.2.4
F10-2 v	vegetative cover	Section 4.2.5
F10-2 b i	surface water quality monitoring	Section 4.3.1
F10-2 b ii	groundwater quality monitoring	Section 4.3.2
F10-2 b iii	seepage rates monitoring	Section 4.3.3
F10-2 b iv	erosion rates monitoring	Section 4.3.4
F10-2 b v	cover integrity monitoring	Section 4.3.5
F10-2 b vi	vegetation health monitoring	Section 4.3.6

1.4 Contributors to the Closure Plan

This Closure Plan has been prepared by Newmont using documents available from the Mt Leyshon mine archives, and using various plans which have been recently compiled to satisfy other conditions of the EA. External experts who have contributed to aspects of the plan include:

- Big Dog Hydrogeology – Mr Simon Barrett. Discussions of surface water chemistry, groundwater chemistry, geochemistry and provision of relevant maps.
- Engeny Pty Ltd – Dr Andrew Vitale. Discussions of site drainage and water management.
- Outback Ecology Services (now Stantec) – Mr Harley Lacey. Details of vegetation and erosion criteria and monitoring.
- TropWATER (JCU) – Dr Barry Butler. Receiving Environment Monitoring Program.

2. Summary of site conditions and facilities

2.1 Climate

Most of the rainfall occurs at Mt Leyshon mine in the summer, meaning summers are humid while winters are dry and cool. The mean annual rainfall from 1989 to 2019 is 658 mm, with 65% of rainfall occurring between December and March. The minimum annual total rainfall was 277 mm in 1993 and the maximum annual total rainfall was 1,200 mm in 2010. Intense tropical lows during the summer months result in highly variable rainfall. Long term average pan evaporation at the site is 1,900 mm which significantly exceeds annual rainfall. Mean minimum and maximum temperatures range between 22 ^{0}C and 34 ^{0}C in December and between 11 ^{0}C and 25 ^{0}C in July. These climate conditions result in intermittent flows within the surface water streams draining the general mine area in the summer wet season, which reduce to isolated drying pools in the winter dry season (i.e. ephemeral creeks).

2.2 Topography and surface water drainage

The original topography at the Mt Leyshon mine prior to mining was dominated by rocky outcrop hills including Mt Leyshon and Mt Mawe. These hills formed a regional topographic high and coincided with several catchment boundaries, with natural surface water drainage being generally away from the site to the north, south and east.

The original topography at the Mt Leyshon mine has been significantly altered by the mining activities (Figure 1). The open pit removed much of the original Mt Leyshon, and the waste rock and tailings storage facilities are significant landforms which were constructed extending into all of the original catchments draining the site.

All of the facilities with the exception of the scats stockpile have been rehabilitated by placement of a cover, construction of drainage systems, and development of vegetation. The mine water management system includes the operation of containment dams and sumps to collect any seepage or runoff which is not acceptable for discharge and the contained water is subsequently pumped into the lake developing in the open pit.

Waterways between the mine and the mine lease boundary are identified in Figure 1, and these streams flow intermittently in the wet season. In the limited periods when runoff occurs, the topography within the mine lease area drains to:

- The north towards Clarke Creek;
- The south towards Puddler Creek; and
- The east towards Two Mile Creek and Fenian Creek.

Clarke Creek and Puddler Creek are the two largest waterways in the immediate vicinity of the mine. Clarke Creek and Puddler Creek flow along the northern and southern boundaries of the mine lease area respectively. The upstream catchments of these two waterways extend to the west of the mine, and they include a component of background flow. All other site waterways originate within the mine lease area. All of the local receiving streams eventually discharge into the Broughton River, which flows into the Burdekin River 32 km to the north-east of the mine site.

2.3 Groundwater

An extensive field investigation programme completed during the closure period at Mt Leyshon mine, which has included geophysical surveys, drilling, and hydraulic testing has identified that the primary groundwater transmitting unit at the site, which interacts with the mine facilities, and which allows groundwater flow away from the site, is the shallow groundwater system. The shallow groundwater system has been defined to comprise the upper weathered and fractured surface of the basement rocks, typically occurring between around 5 and 25 m below ground level (mBGL). It takes the form of either sandy and gravely weathered basement material or less weathered material where relict structural features remain (BDH, October 2018a).

Groundwater flow directions in this system generally follows the surface water drainages with groundwater moving to the north, south, and east from the mine facilities. Groundwater flow is driven by natural infiltration of rainfall during the wet season. In some areas contact between rainwater and acid producing material in the waste landforms produced acid mine drainage (ARD) which impact on the quality of the groundwater. The impact at Mt Leyshon is restricted to the shallow groundwater system and relate mostly to sulphate and Cobalt. As a result of the significant natural alkalinity of the shallow groundwater, seepage from the mine facilities has not significantly lowered groundwater pH in most locations.

2.4 Geochemistry

There have been a large number of materials characterisation and behaviour assessments completed during the life of the operation as well as during the closure and reclamation phase. These have included:

- Monitoring, management and classification of porphyry waste rock prior to it being used as a seal layer during capping of various facilities (EGI, 1995);
- Geochemical assessments of the tailings stored in the Old North Tailings Storage Facility (EGI, 1999);
- Materials characterisation of the material remaining in the rehabilitated heap leach pad (CMLR, 2006); and
- Assessment of the scats stockpile and potential disposal options (Onkaparinga, 2006).

These and other studies were reviewed in 2009 resulting in the following conclusions (WMC, 2009):

- Porphyry cover materials are generally likely to be Non-Acid Forming (NAF), as indicated by Acid Base Accounting (ABA) and Net Acid Generation (NAG) testwork.
- Waste rock, not including NAF cover materials, is generally classified as Potentially Acid Forming (PAF), with Net Acid Production Potential (NAPP) values > 20 kg H_2SO_4/t and Acid Neutralisation Capacity / Acidification Potential (ANC/AP) values < 1.
- Spent oxide heap leach material ranges from NAF to PAF, with a greater number of samples classifying as the latter, with NAPP values > 20 kg H_2SO_4/t and ANC/AP values < 1.
- Tailings material generally classifies as PAF, with the majority of samples having NAPP values > 20 kg H_2SO_4/t and ANC/AP values < 1.
- Scats also classify as PAF, with all samples tested having NAG pH values < pH 3, NAPP values > 20 kg H_2SO_4/t and ANC/AP values < 1.

- A combination of ABA and NAG testwork indicates that scats have the greatest potential for acid generation, followed by tailings (in the long term).
- Leach test work to investigate the release of metals under weathering conditions indicated that both scats and tailings have the capacity to generate low pH conditions with elevated concentrations of SO_4, Cd, Cu and Zn.

Contaminated site assessments undertaken following completion of the initial site rehabilitation identified metal concentrations in soils above screening criteria and surface soils classified as PAF in the plant area, Treatment Pond Area, and Raw Water Dam (OTEK 2005, GHD, 2006). The materials identified at the Raw Water Dam and Treatment Pond area were subsequently removed. The materials in the Plant area were identified to relate to either original ground which contained naturally elevated metal concentrations, or PAF materials which had been used for rehabilitation cover works (oxide heap leach and supergene material).

2.5 Properties of surface water and groundwater

The changes in the shallow groundwater system arising from the mine facilities in both the operational and closure periods are defined in the Groundwater Management Plan developed for the Mt Leyshon mine site (BDH, October 2013a). The main changes from background conditions which have been observed in groundwater in this system are increased groundwater elevations near the mine facilities, increased sulphate concentrations down-gradient of all facilities, and increased Co concentrations down-gradient of tailings facilities. These changes are well defined by the available data, and potential future changes in sulphate concentration have been determined using a numerical groundwater flow model. The current extent of sulphate in groundwater reaches up to 2 km from the mine facilities, and falls mostly within the mine lease boundary.

Conclusions presented in studies which are relevant to the influence of the Mt Leyshon mine site on surface water chemistry sampled during the closure period are:

- Contaminants in surface water identified as being potentially of concern to the Environmental Values in the area were TDS, SO_4, Al, Cd, CN, Cu, Co, Mn, Pb, U, and Zn (Hydrobiology, March 2011).
- A review of background and baseline surface water quality identified that concentrations of Al, Cd, Co, Mn and U were elevated in background surface waters (SWS, 2011).
- For the intermittent streams occurring between the mine facilities and the lease boundary, it was concluded that the influence of the mine could be discerned in concentrations of SO_4, TDS, and total Cd, Cu, Co, Mn, U and Zn in surface water flows in Clarke Creek, Puddler Creek and Two Mile Creek (SWS, 2011).

- For the receiving streams down-gradient of the mine facilities, it was concluded (SWS, 2011) that the influence of the mine was evident primarily in concentrations of TDS, SO_4, and total Cu, Co, Mn, U, and Zn in the down-gradient streams, and that this influence appeared to be present:
    - Over the whole of Clarke Creek;
    - over the whole of Two Mile Creek;
    - over the portion of Fenian Creek which is down-gradient of the mine, from the confluence of the Two Mile Creek to the Seventy Mile Creek;
    - over variable portions of Seventy Mile Creek between Fenian Creek and the Broughton River for the different contaminants, with SO_4 elevated over the whole of Seventy Mile Creek; and
    - in the Broughton River from the confluence with Clarke Creek to down-gradient of the confluence with Seventy Mile Creek for some of the contaminants, and SO_4 in particular.
- Sampling of the Broughton and Burdekin Rivers identified that the maximum extent of mining related changes in surface water chemistry was the end of the Broughton River, and that no influence was present in surface water quality in the Burdekin River (SWS, 2012).

2.6 Mine facilities

The locations of the closed facilities which were operated during the mining period at the Mt Leyshon mine are illustrated in Figure 1. A brief discussion of the history of each facility and the current status is provided in the following sections. The facilities have been listed in the same order as Table F1 in the EA for ease of reference. Rehabilitation requirements and completion criteria are detailed in Appendix 1.

2.6.1 New Northern Tailings Storage Facility (NNTSF)

- Operated from 1998 to 2001.
- Fully rehabilitated during closure.
- Minor erosion repairs and a small amount of revegetation on batters has been scheduled to be undertaken over the next 3 years.

2.6.2 NAF Oxide Stockpile

- Used to store oxide waste from the open pit during mining.
- Confirmed by on-site testwork to be Non Acid Forming (NAF).
- Utilised as a cover material during closure.
- Stockpile no longer exists and the footprint area is treated the same as the rest of the site for rehabilitation purposes, this facility is therefore not addressed separately in subsequent sections.

2.6.3 PAF Oxide Stockpile

- Used to store oxide waste from the open pit during mining.
- Confirmed by on-site testwork to be PAF.
- Incorporated into waste rock facilities or disposed of to the open pit during closure.
- Stockpile no longer exists and the footprint area is treated the same as the rest of the site for rehabilitation purposes, this facility is therefore not addressed separately in subsequent sections.

2.6.4 Workshop, Office, Fuel storage, Roads & Tracks

- Refers to ancillary support facilities during the mining operation.
- All facilities not required for rehabilitation maintenance and monitoring have been removed and rehabilitated.
- Single chain hydrocarbon contamination was identified in fuel storage area (OTEK, 2005).
- Subsequently it was concluded (GHD, 2006), "Hydrocarbon impact has generally been removed at the surface of the site leaving residual impact at depth." Double skinned bulk fuel storage tanks are now used at Mt Leyshon.
- The footprints of these facility areas are consistent with other areas of the site and are not addressed separately in subsequent sections.

2.6.5 Plum Tree Creek Dam

- Collected seepage and runoff from the Scats stockpile in operations, continues to fill that role in closure, also acts as a staging pond for the transfer of tailings sump flows.
- Is an essential component of the post closure water management system and will not be removed or rehabilitated in the near future.
- Eventual rehabilitation will follow similar approach to all other dams.
- The dam is currently performing well with no earthworks planned.

2.6.6 Old Northern Tailings Storage Facility (ONTSF)

- Operated from 1988 to 1999.
- Fully rehabilitated during closure.
- Minor erosion repairs and a small amount of revegetation on batters, along with some capping on the cover to prevent ponding has been scheduled to be undertaken within the next 5 years.

2.6.7 Raw Water Dam

- Used to store clean water during operations, largest storage facility on site.
- Flows and sediment from the breached Water Treatment Pond entered the Raw Water Dam during operations, this material was subsequently identified and removed during closure.
- Not in use for the closure water management system.
- Future use/rehabilitation/removal will depend on land use.

2.6.8 Scats Stockpile

- Comprises 9.8 Mt of PAF ore material rejected from the CIP crushing circuit during operations.
- No rehabilitation undertaken to date.
- Planned rehabilitation has been addressed separately in closure planning (Newmont, 2017a). Refer to Scats Remediation Plan submitted to DES (27/06/2017).
- Not discussed further in this document.

2.6.9 Northern Waste Rock Storage Facility (NWRSF)

- Concurrently rehabilitated during mining.
- Rehabilitation of eastern slopes is incomplete due to proximity to pit, a compacted porphyry cover has been installed, but application of growth media and revegetation has not been

completed. Final cover of this small area of the facility is not contemplated as runoff enters the pit lake, and access can not be safely achieved.

2.6.10 Pit

- Mined from 1986 to 2001.
- A perimeter bund has been installed and access has been prevented during closure.
- Currently forms an essential component of the closure water management and treatment system, used to store all impacted flows.
- Management of the pit lake is addressed in other studies and is not discussed in this report.

2.6.11 Water Treatment Pond

- Operated during mining to collect ARD impacted waters and apply lime neutralisation prior to reuse, resulting in generation of precipitated metals sludge.
- Unsuccessfully rehabilitated by applying loose cover materials at closure.
- Subsequently excavated to remove sludge and re-covered.
- No longer exists as a facility, footprint treated in the same manner as other areas, not addressed separately in subsequent sections.

2.6.12 Heap Leach Stockpile

- Spent oxide heap leach was investigated during the mining period and found to be suitable for use as a growth medium, apparently based on nutrient content analyses. Supergene heap leach material was known to be unsuitable for use and was delineated in the stockpile using blue plastic placed before depositing the supergene.
- The plan to use spent heap leach material as a growth medium at the site was communicated to the Queensland Government in the document Mt Leyshon Plan of Operations, January 1992.
- Trials of compacting spent oxide heap leach material found that it could achieve the required geotechnical properties to be used as an infiltration barrier on the tailings storage facilities.
- Accordingly most of the oxide heap leach material has been distributed across the other facilities.
- Subsequent investigations identified some heap leach material to be PAF (CMLR, 2006).
- The remaining stockpile comprises 700,000 m^3 of material.

2.6.13 Low Grade Stockpile

- Low grade ore from open pit mining stockpiled during operations.
- Removed and processed from 2001 to 2002.
- Footprint scaped, ripped, but not covered.
- This stockpile no longer exists. Some relatively minor erosion repairs to the footprint have been scheduled.

2.6.14 Eastern Waste Rock Storage Facility (EWRSF)

- Operated from 1994 to end mining, received primarily hard rock mine waste.
- Fully rehabilitated during closure.
- Filling of low lying areas to prevent ponding and improve drainage, as well as drop structure and erosion repairs have been scheduled to be undertaken over the next 3 years

2.6.15 Southern Waste Rock Storage Facility (SWRSF)

- Operated from the start of open pit mining, received primarily oxide waste, also received scats not directed to the Scats Stockpile (estimated 5 mt), and spent supergene leach material.
- Fully rehabilitated during closure.

2.6.16 Mount Hope Dam

- Collected seepage and runoff from the EWRSF in operations, continues to fill that role in closure.
- Is an essential component of the post closure water management system and will not be removed or rehabilitated in the near future.
- Eventual rehabilitation will follow similar approach to all other dams.

2.6.17 Mount Hope Extension Dam

- Collected seepage and runoff from the EWRSF in operations, receives good quality flows in closure and discharges.
- Eventual rehabilitation will follow similar approach to all other dams.

2.6.18 Supergene Dam

- Was operated to contain process solutions in operation, receives seepage and runoff from the leach pad areas in closure.
- Is an essential component of the post closure water management system and will not be removed or rehabilitated in the near future.
- Eventual rehabilitation will follow similar approach to all other dams.

2.6.19 Mt Mawe Dam

- Collected seepage and runoff from the EWRSF in operations, continues to fill that role in closure.
- Is an essential component of the post closure water management system and will not be removed or rehabilitated in the near future.
- Eventual rehabilitation will follow similar approach to all other dams.

2.6.20 Southern Tailings Storage Facility (STSF)

- Operated from 1995 to 2000.
- Fully rehabilitated during closure.

2.6.21 Settlement Dam

- Collected seepage and runoff from the leach pad areas in operations, continues to fill that role in closure.
- Is an essential component of the post closure water management system and will not be removed or rehabilitated in the near future.
- Eventual rehabilitation will follow similar approach to all other dams.

3 Post Mine Land Use Plan

3.1 Background

This section provides the details of the PMLUP as required under Condition F4-1 of the EA. Rather than providing details of design studies describing slopes and covers planned for closure, the sections below mostly describe the as-built closure works, along with the supporting design documents where they could be located.

For the land use and vegetation components of the PMLUP, it is important to understand the constraints resulting from changes in the ownership structure and responsibilities for the mine leases, which are described as follows:

- The mine leases and the resources within the leases are owned by LRL, while Newmont is undertaking rehabilitation works within those leases under a management agreement with LRL.
- During mine development, rather than purchasing the pastoral leases which underlie the mine leases, Mt Leyshon Gold Mines entered compensation agreements with landholders regarding temporary use of the land during the mining and closure period.
- These compensation agreements, which subsequently became the responsibility of LRL, reportedly committed to returning the mine area to grazing land.
- The final land use was therefore clearly defined in closure planning documents submitted to the Queensland Government through the mining period as pastoral land, e.g. Mt Leyshon Plan of Operations, 1997, Table 6.
- During implementation of the closure plan by Newmont under the management agreement, the primary vegetation species applied across the closed facilities was buffel grass to meet the grazing objective.
- Subsequent to the implementation of the closure plan, DEHP have noted that grazing is unlikely to be an appropriate final land use for rehabilitated mine facilities, while Newmont have purchased the underlying pastoral leases, allowing the commitment to return the site to pasture to be reassessed. The current closure criteria for re-establishment of vegetation at the site therefore differ from those in place at the time of rehabilitation of most of the site facilities.

In the following sections, each aspect of the closure designs is discussed generally for the whole site, rather than individually for each facility listed in Table F1 of the EA, but where facility specific designs differ, they are discussed separately in each case.

3.2 Slope designs

Final slope designs for the external faces of the waste rock storage facilities and tailings storage facilities at the Mt Leyshon mine were developed taking account of the objectives which included:

1. To ensure erosional stability of the covers and near surface materials by considering slope angles, slope lengths between benches, and longitudinal gradients for drainage features.
2. To prevent the risk of deep seated, multiple bench failure of facility outslopes, by considering the geotechnical properties of the stored materials and the overall height and average slope angle for the outslopes.

3. To ensure stability under seismic loading, especially for the tailings facilities prior to dewatering, taking account of the potential for liquefaction.

During re-profiling of the waste rock storage facilities, the objective was to reduce the overall slope angle of the external faces to 14 degrees, and the tailings storage facilities were intended to be constructed at an average embankment slope of 11 degrees (as noted in Table 20 in the 2000 Closure Plan (Normandy Mt Leyshon Ltd, 2000) and as specified in the EMOS). Geotechnical modelling of the stability of the tailings storage facilities identified they would be stable under seismic loading associated with a maximum credible earthquake of magnitude 6.4 occurring on a fault at 40 km distance with focus at 10 km depth causing a maximum ground acceleration of 0.06g (URS, 2000).

Figure 2 provides vertically exaggerated cross sections for the facility outslopes along the sections defined in Figure 1, which have been compiled using the digital terrain model for the site, which is considered accurate to 1 to 2 m in elevation. The as-built slope angles for each facility are discussed below.

3.2.1 Roche Hill

The Roche Hill landform was constructed from mine waste (oxide, supergene, and some primary waste), and scats were then placed on the outer edge to delineate the extent of the low grade stockpile before placing the stockpile material. The low grade material was subsequently removed and reprocessed leaving the scats material behind, on a slope which exceeds the defined targets for the site, and has an average angle of 25 to 30 degrees as indicated in Figure 2. The original reclamation strategy implemented for the area involved the placement of approximately one metre of heap leach material over the scats, however the heap leach material significantly eroded producing acid and metalliferous surface water run-off. In 2017 remediation works at Roche Hill were completed that involved:

- Construction of a crest bund at the top of the landform to prevent significant water flow down the batters and erosion issues during high intensity rain events.
- Removal of any potentially acid forming surface material and the filling of gullies with competent rock material. Topsoil was then applied.
- Hydromulching and seeding along the batters to establish vegetation and further mitigate erosion issues.

3.2.2 Open Pit

The average slopes applied during open pit mining, based on the geotechnical studies, were 40 to 50 degrees in the high strength wall rocks (in the breccia), and 35 degrees in the lower strength wall rocks (porphyry, the northeast zone, and within the influence of the West Mine Fault). These slope angles allowed completion of open pit mining with no deep seated failures of the pit slopes. An assessment completed at the end of the mining period identified that failure of critical structures would occur in long term closure. In particular, failure of the north wall at the West Mine Fault was concluded to be inevitable, but it was predicted this would not encroach further than 70 m from the pit rim (Table 17 in the 2000 Closure Plan, Normandy Mt Leyshon Ltd, 2000). Failure of this structure subsequently occurred in January 2009, with minor slumping evident at the pit rim, but being limited to within around 70 m of the pit, as predicted. The pit wall failures risk assessment predicted that any potential future failures are expected to be confined within the pit.

3.2.3 NNTSF

The natural surface in the area of the NNTSF slopes down to the north, northwest and northeast, and the resulting tailings embankment is highest on the northern margins. Figure 1 shows the location of a section cut through the northeast boundary, and Figure 2 illustrates the profile of the outslope. The overall slope height of the facility in this location is around 15 m and Figure 2 illustrates the significant slope of the natural surface at the toe of the facility. The profile indicates the lowest lift for the NNTSF to be the highest, which would be consistent with the original embankment being an engineered earth and rockfill embankment, and with subsequent smaller upstream lifts being completed using locally sourced materials such as compacted heap leach and waste rock fill.

3.2.4 ONTSF

The natural terrain below the ONTSF predominantly slopes northwest towards Plum Tree Creek. A cross section has been constructed through the northwest slopes as indicated in Figure 1. The topographic data presented in Figure 2 illustrate that the total slope height is around 40 m in this location. The ONTSF was constructed using an initial 21 m embankment comprising a zoned earth and rockfill structure with a core of spent heap leach material. This approach allowed a relatively steep outslope to be constructed, as indicated in Figure 2. Subsequent lifts of the embankment were 2 to 5 m in height, were constructed by a combination of downstream and upstream raises, and utilised heap leach and rockfill material.

3.2.5 NWRSF

Figure 1 illustrates the location of a section through the northern margin of the NWRSF. The profile plotted in Figure 2 illustrates that the facility has a total slope height of around 45 m in this location, and an overall outslope angle of 10 degrees.

3.2.6 SWRSF

The digital terrain model has been employed to generate a section through the SWRSF at the interface with the STSF, as indicated in Figure 1. In this location the SWRSF extends around 40 m above the STSF, and has an average outslope of 11 degrees.

3.2.7 STSF

Natural surface at the STSF slopes south towards Puddler Creek, and the highest embankment occurs on the southern margin of the facility. A section through the southern slopes at the location defined in Figure 1 confirms the significant natural slope below the toe of the facility. An overall slope height of 20 m is indicated at this location, with an overall outslope angle of 14 degrees. The steepest portion of the slope occurs at the toe, consistent with the first lift being an engineered structure, and subsequent smaller lifts being constructed using upstream raise methods.

3.2.8 EWRSF

A section through the EWRSF at the location indicated in Figure 1 identifies a total slope height of 60 m at this location, and an average outslope angle of 13 degrees (Figure 2).

3.3 Cover designs

3.3.1 Waste rock storage facilities

The waste rock storage facilities at Mt Leyshon Mine were progressively rehabilitated during operations as part of the mining contract, with cover placement commencing in 1992. The covers

placed early in the mining period comprised 300 mm of compacted oxide heap leach, overlain by 300 mm of topsoil, in accordance with the original EMOS.

Subsequently the ability of the covers to prevent both oxygen and water infiltration to the facilities was investigated by field and laboratory measurements and modelling undertaken by EGI, ACTFR and ANSTO. These studies concluded that the covers were not effective at reducing oxygen diffusion, and efforts were concentrated on minimising water ingress. The characterisation and modelling studies determined that waste rock facility covers should be modified, and the revised design implemented from around 1995 comprised (Klohn Crippen, 1999, Normandy Mt Leyshon, 2000):

- A minimum thickness of 800 mm of porphyry waste rock.
- Compacted to greater than 100% with a minimum compaction >98% over four adjacent test points.
- Geochemical testwork conducted to confirm that the porphyry has a net acid generation type 1 (NAF) as defined for the site specific conditions.
- Overlain by a minimum thickness of 250 mm of topsoil.

As a result of the changes in cover designs during the operating period for the mine, and the progressive rehabilitation that was undertaken:

1. The NWRSF cover is predominantly compacted heap leach, but also includes compacted porphyry, including on the eastern slopes above the open pit.
2. The cover on the SWRSF is all 300 mm of compacted heap leach.
3. The cover on the EWRSF comprises between 1 and 3 m of compacted porphyry, with compaction testing undertaken, and geochemical testing undertaken, and zones found to be PAF removed and replaced.

3.3.2 Tailings storage facilities

Rehabilitation of the tailings storage facilities at the Mt Leyshon mine commenced with the ONTSF in 1997. The ONTSF was intended to act as a trial and model for the other storage facilities and a range of investigations and tests were undertaken to refine the designs. A mounded surface was achieved on the surface of the ONTSF by the combination of placing run of mine waste rock (including PAF materials, 33 of 49 samples tested were PAF), and strategic tailings deposition (BHP, 1997). Compaction trials were then undertaken on the mounded surface using locally sourced materials to investigate the seals which could be achieved, and these field verified results were used in modelling of potential infiltration (EGI, 2000). The seal methods trialled were:

1. 600 mm oxide heap leach, 4 passes impact roller.
2. 300 mm clay, 4 passes impact roller.
3. 600 mm NAF oxide waste rock, 4 passes impact roller.
4. 600 mm NAF oxide waste rock, 10 passes impact roller.
5. In situ waste rock capping material, 10 passes impact roller.

The resulting cover design for tailings storage facilities comprised:

1. 1.5 to 3 m of run of mine waste rock capping, also acting as a capillary break.

2. Minimum 600 mm of compacted oxide heap leach seal. To be placed at a degree of saturation of more than 90% and compacted to a dry density of 97% in order to achieve a hydraulic conductivity less than 1x 10^{-7} m/s. Placed by scraper and compacted via scraper traffic.
3. 300 mm topsoil growth medium.

Implementation of the cover design at each facility is summarised from the as-built data to be as follows:

ONTSF

- Topsoil
  - Minimum thickness 200 mm.
  - Maximum thickness 400 mm.
  - Average thickness 278 mm.
- Heap leach seal
  - Minimum thickness 655 mm.
  - Maximum thickness 764 mm.
  - Average thickness 755 mm.
  - Minimum compaction (253 samples) 97.1%.

STSF

- Topsoil
  - Average thickness 297 mm.
- Heap leach seal
  - Minimum thickness 551 mm.
  - Maximum thickness 819 mm.
  - Average thickness 615 mm.
  - Minimum compaction (501 samples) 97.1%.

NNTSF

- Design modified to include an additional oxide waste rock seal layer above the heap leach.
- Topsoil
  - Average thickness 300 mm.
- Oxide seal
  - Minimum thickness 1,000 mm.
  - Maximum thickness 2,300 mm.
  - Average thickness 1,330 mm.
  - Minimum compaction (95 samples) 95.5%.
- Heap leach seal
  - Minimum thickness 550 mm.
  - Minimum compaction (176 samples) 97.5%.

3.4 Drainage designs

Drainage designs for the covers installed on the upper surfaces and side slopes of the waste rock and tailings storage facilities were developed with the intention of removing as much runoff as possible from the facilities, and hence minimising potential infiltration.

The primary surface drainage paths within the mine disturbance area are shown in Figure 3. Because the surface topography and landforms within the mine disturbance area have been significantly modified as a result of mining activities, the majority of the surface drainage paths are in the form of constructed open drainage channels. Since many of these drainage channels have a steep longitudinal gradient they are typically lined with rock to prevent flow-induced scouring of the channel base. A number of the larger drop structures on the batters of the major landforms are stabilised with grouted rock.

The larger constructed drainage channels include:

- The Spine Drain – engineered waterway located between the EWRSF and SWRSF comprising a stepped profile with drop structures constructed from rock gabions and rock mattresses. The Spine Drain discharges into the Mt Hope Dam;
- Drains on the top surfaces of the waste rock and tailings storage facilities – drainage on these landforms typically involves smaller feeder drains or contour banks that intercept overland flow and convey these flows into larger drainage channels;
- Main drainage channel that discharges into the Settlement Dam;
- Drop structures that drain the batters of the waste rock dumps and tailings storage facilities – these drains are typically lined with large diameter rock to prevent erosion and dissipate flow energy.

More detail of the installed drainage features is provided in the Water Management Plan (Engeny, 2018).

3.5 Erosion control

The majority of the landforms at Mt Leyshon mine have been capped and revegetated since closure. As a result there are limited areas with exposed soils and the main mechanism for transport of sediment offsite is erosion within existing drainage structures. The Water Management Plan for the Mt Leyshon Mine (Engeny, 2018) outlines the measures and ongoing operational requirements for erosion and sediment control which have been developed in accordance with the Best Practice Erosion and Sediment Control.

The principles on which the erosion plan has been founded are:

- Minimise surface disturbance and restrict access to undisturbed areas;
- Progressively rehabilitate and stabilise disturbed areas with vegetation;
- Separate catchment runoff from disturbed and undisturbed areas where practicable;
- Reduce potential for erosion through velocity controls and reduced runoff volume;
- Use of suitably sized and protected drainage structures to manage surface runoff;
- Use of existing onsite containment structures for the capture of sediment laden surface water runoff; and
- Regular monitoring and maintenance to ensure continual operation of the individual erosion and sediment control elements.

3.6 Design of monitoring

Designs for closure monitoring of surface water, groundwater, vegetation health and landform stability were nominated in various plans of operation and closure plans developed during the mining period. These proposed monitoring regimes are not re-visited here as they have been superseded by the actual monitoring instituted since closure and discussed in Section 4.

3.7 Revegetation criteria

Revegetation objectives, indicators and criteria are detailed in Table 1 (Appendix 1). Recent EFA and condition monitoring of rehabilitated areas on landforms at Mt Leyshon are included in Appendix 2. Stocking rates are detailed below in section 3.8 – revegetation methods .

3.8 Revegetation methods

The revegetation approach which was applied during rehabilitation works undertaken during the operating period at the Mt Leyshon mine was:

1. Topsoil placed to a minimum depth of 250 mm.
2. Seed applied at a rate of 5 to 8 kg/ha of pasture grasses.
3. Prior to 1999, application of fertiliser at a rate of 400 kg/ha.
4. From 1999 onwards, application of fertiliser at a rate of 200 kg/ha.

Current revegetation methods involve:

1. Topsoil placed to a minimum depth of 250 mm.
2. Seed applied at a rate of 5 to 8 kg/ha of grasses (Seca, Rhodes, Cooch, Wynn-Cassia, Buffel). The seed mix varies depending on seed type and terrain. In general:
    a. Seca is added to all mixed as it is a legume (Nitrogen fixation)
    b. Buffel is applied on flat areas

c. Wynn –Cassia is applied mainly to dryer areas and on slopes.
d. Rhodes and Cooch grasses are applied to the wetter areas.
e. Topsoil which has been stockpiled for lengthy times is seeded with Triticale (a hybrid of wheat and rye) initially to add organics and improve soil condition. Normal application and seeding of the soil is then undertaken the following season.

3. Fertiliser is applied at a rate of 80 kg/ha. The seed is mixed with the fertilizer in a 12 volt, 40 litre spreader mounted on the back of a Gator vehicle.

3.9 Materials balance

During the operational and closure period, a materials balance was maintained at the Mt Leyshon mine to track the amount of stockpiled oxide heap leach, NAF oxide waste rock, porphyry waste rock and topsoil. This stockpile balance was regularly compared against estimated requirements for final closure, allowing cover designs to be refined to accommodate the availability of materials. The material in greatest demand was porphyry waste rock classified by site testing to be NAF, as this was the only cover material which could be successfully applied to sloped surfaces. As a result of the materials balance, porphyry waste rock was reserved for capping the waste rock facilities, and the capping strategy for the tailings facilities was developed using compacted oxide heap leach.

3.10 Research program

For the purposes of the PMLUP, research programs are intended to refine the closure approaches, as the site becomes better understood, and as industry best practice evolves. Given that the closure and rehabilitation works have been completed, research programs of this nature are not being undertaken.

3.11 Rehabilitation objectives

Revegetation objectives, indicators and criteria are detailed in Table 1 (Appendix 1).

3.12 Completion criteria

Revegetation objectives, indicators and criteria are detailed in Table 1 (Appendix 1).

3.13 Rehabilitation monitoring program

Proposed rehabilitation monitoring programs were described in the various plans of operations and closure plans developed during the operating period at the Mt Leyshon mine. These programs are not re-visited here in the PMLUP, as they have been superseded by the actual rehabilitation monitoring which is described in Section 4.

4 Post Closure Management Plan

4.1 Background

The aim of the PCMP is to describe the active management activities which will be required in closure, and the monitoring infrastructure and activities which are proposed to quantify the success or otherwise of the closure and rehabilitation regime. As active closure management and monitoring has been underway at the Mt Leyshon mine since 2002, the PCMP provided in this section of the report describes the actual management and monitoring activities being undertaken. Most of the monitoring activities are described within and are driven by the EA, which was issued during the closure period and therefore defines the required frequency and locations of closure monitoring.

The EA driven monitoring activities are not described in detail in this section of the Closure Report, as they have been fully defined in various other plans required under the EA, including:

1. The Groundwater Management Plan (BDH, 2018a).
2. The Water Management Plan (Engeny, 2018).
3. The Sulphate Management Plan (BDH, 2013b).
4. The REMP (Newmont, 2018b).

Typically, closure monitoring comprises detailed and frequent monitoring in the early stages of closure to confirm that conditions are as predicted during mining, which is reduced to less frequent monitoring in late closure as conditions become well understood. Some aspects of monitoring at the Mt Leyshon mine, such as groundwater monitoring, are approaching the reduced frequency period, as the monitoring and investigations completed in the 17 year period of closure have generated an updated and detailed understanding of the system.

Although the Mt Leyshon mine is in the mature stages of closure, the surface water and groundwater monitoring regimes described in the REMP are still evolving and changing. Any changes to the locations and frequency of sampling, or to the analytes applied, are regularly incorporated into the original source document, which is the most recent version of the REMP.

Reproduction of monitoring maps within this closure plan has therefore been avoided where possible, and descriptions instead refer to the REMP. In this way, the Closure Plan document remains accurate, as long as the most recent version of the REMP is referenced.

4.2 Mine management infrastructure

4.2.1 Impacted water collection and reticulation

Observations during the closure period at the Mt Leyshon mine have identified that closure of some of the mine facilities has been less successful than anticipated, and that runoff and seepage generated from portions of the facilities continues to reflect the influence of ARD and is not acceptable for discharge. The water quality reflects a combination of factors which have been interpreted to include:

- The installed covers and drainage systems allowing infiltration to the closed facilities to occur at higher rates than modelled.

- Materials used in some of the covers being PAF.
- Instability of compacted oxide heap leach covers on sloping surfaces.
- The presence of facilities which have not been rehabilitated (primarily the Scats stockpile).
- Discharge of mine influenced groundwater into the surface water systems.

Management of the closed Mt Leyshon mine therefore requires the operation of a segregated water management system, in which acceptable quality runoff is discharged, while poor quality runoff and seepage is routed to sumps and containment dams for subsequent disposal or treatment. A pumping and reticulation system has been constructed to transfer stored volumes out of all the sumps and dams operated in closure, to ensure capacity is available for future large precipitation events. The segregation of runoff areas for all of the site facilities, and the pumping and reticulation system are described in the Water Management Plan (Engeny, 2018), and the segregated runoff areas as defined in 2018 are illustrated in Figure 4.

4.2.2 Impacted water treatment

The current management approach applied to the treatment of the ARD influenced seepage and runoff collected within the containment dams and sumps (i.e. the impacted water) is to pump it into the lake developing in the open pit. The infrastructure which is operated to achieve this, and the potential implications to the elevation of the pit lake, are described in the Water Management Plan (Engeny, 2018).

Newmont use the current monitoring data and regular surveys to update the site water model and improve the understanding of site water balance. The current water model predicts that the total catchment area in Figure 4 which reports to the open pit, either by direct runoff, or by subsequent pumping from sumps and dams, will eventually preclude the ability of the open pit to act as a groundwater sink. The current impacted water treatment approach therefore has a finite life and cannot be continued indefinitely without further intervention (Engeny, 2018).

Alternative management approaches for impacted water treatment which have been investigated and costed within closure planning for the Mt Leyshon mine include:

1. Continued improvement of the covers and drainage systems, to allow the amount of catchment runoff which is direct discharged to be increased, and to reduce the total catchment reporting to the open pit.
2. Options to remove water from the site by enhanced evaporation infrastructure.
3. Operation of a conventional water treatment plant to treat site flows to acceptable quality for discharge.
4. Progressive water treatment technologies, like CSIRO Virtual Curtains will also be considered if deemed suitable at the time.

While the second and third approaches listed above are still in the conceptual phases, Newmont is actively working on the first approach which includes remediation of catchments, redirection of clean water etc.

4.2.3 Groundwater monitoring

Groundwater investigations undertaken during the operating and closure periods at the Mt Leyshon mine have resulted in the installation of over 100 groundwater monitoring points. Data collected from these monitoring points have allowed development of a comprehensive understanding of the

shallow groundwater system and the deep groundwater system which are present at the site, including the areal extent of sulphate in the shallow groundwater system resulting from facility seepage occurring during both the operating and closure periods.

Until recently, the groundwater monitoring infrastructure defined in the EA comprised many bores which were within the impacted groundwater zone, and therefore provided limited definition of changes in the boundary of the impacted zone. A new EA was approved for Mt Leyshon 25th June 2014, with a subset of the available groundwater monitoring points being instituted which are more relevant for long term monitoring. Planned groundwater sampling at these locations is described in detail in the REMP (Newmont 2018b).

4.2.4 Cover monitoring and maintenance

In 2013 Outback Ecology were commissioned to implement a monitoring program to meet conditions F5-1, F5-2 and F5-3 of Environment Authority EPML00863713. The methodology, including cover monitoring consists of the following:

- Each landform is separated into sub-domains, each comprising a particular age of rehabilitation, lift, vegetation community or aspect. In total, rehabilitation sub-domains on eleven landforms have been identified in addition to three analogue areas that are used as reference sites.
- On each sub-domain monitoring involves assigning a scale based score to a range of parameters relating to landform and soil surface characteristics, vegetation condition and structure, declared weeds and erosion. Each parameter score ranges from one to five, with one representing the highest score possible. For example the soil surface stability scores ranged from Unstable (one point) through to Very Stable (five points).
- An aggregated numerical score of 20 parameters (maximum score of 100) is assigned to each sub-domain so changes in rehabilitation condition can be detected over time. All parameters are treated equally with no numerical weighting
- In addition to the scale base assessment, the monitoring consists of:
    - Photo-point monitoring of existing EFA transects
    - Way-pointing and photographing erosion gullies
    - Way-pointing declared weed species
    - Documentation of other potential factors affecting condition (e.g. tree death)
    - Incidental notes relating to vegetation and landform condition including the observation of fauna or surface expression of potentially hostile material.

Appendix 2 provides further detail on the rehabilitation monitoring methodology.

Routine cover monitoring helps identify areas which are under performing and require maintenance. An annual planning session is held on-site at Mt Leyshon for the purpose of updating the works schedule. Cover maintenance typically involves erosion repairs, filling areas with clean material to prevent ponding and seeding of areas that are not meeting revegetation criteria.

4.2.5 Vegetation monitoring

Vegetation monitoring methodology is detailed in section 4.2.4 and Appendix 2.

4.3 Monitoring activities

4.3.1 Surface water quality

Monitoring of surface water quality which is undertaken in the intermittent streams draining the Mt Leyshon mine is described in detail in the REMP (Newmont, 2018b). Surface water sampling is undertaken both for compliance against the conditions defined in the EA, and for strategic purposes to guide the ongoing rehabilitation works. Samples are collected from the streams immediately down-gradient of the closed mine facilities, from the major streams exiting the lease boundary, and in the down-gradient receiving environment as far as the Burdekin River. Sampling is undertaken during any release of water from the mine facilities, and during natural flow periods. Surface water samples are analysed for a range of field parameters, and are despatched to an accredited laboratory (ALS and JCU) for determination of pH, EC, major ion concentrations, total and filterable concentrations of a suite of metals, various forms of cyanide, and a range of nutrients and organic compounds. Trigger levels and contaminant limits are defined for surface water quality in the EA using a combination of background water quality, default values for the protection of aquatic ecosystems, and limits for stock watering.

4.3.2 Groundwater quality

The sampling and analysis regime for groundwater at the Mt Leyshon mine is described in the Groundwater Management Plan (BDH, 2018a) and the REMP (Newmont, 2018b).

Monitoring of pore pressures in the deep groundwater system surrounding the open pit, and definition of potential interactions between the pit lake and the groundwater system is undertaken by continuous recording of vibrating wire piezometer sensors grouted in place.

Definition of the influence of seepage from the closed mine facilities on the shallow groundwater system is planned to be provided by:

- Continuous monitoring of groundwater elevation in three locations.
- Measuring depth to groundwater quarterly at 19 locations.
- Collecting annual groundwater samples at ten interpretation locations within the zone of impacted groundwater.
- Collecting quarterly groundwater samples at two locations inferred to be up-gradient of the influence of the mine facilities.
- Collecting quarterly groundwater samples at seven locations which are outside and down-gradient of the current extent of the zone of impacted groundwater.

Groundwater samples are collected after appropriate purging of the monitoring bores, and are filtered and preserved in the field as necessary. Samples are analysed for field physical parameters, and are despatched to a registered laboratory for determination of pH, EC, major ion concentrations, total and filterable concentrations of a suite of metals, various forms of cyanide, and a range of nutrients and organic compounds. Trigger levels and contaminant limits are defined for groundwater quality in the EA using a combination of background water quality, default values for the protection of aquatic ecosystems, and limits for stock watering.

4.3.3 Seepage rates

Quantification of seepage rates from the closed mine facilities is achieved using monitoring data collected from continuous monitoring equipment installed within the impacted water management system described in Section 4.2.1. Data from pressure sensors installed in each containment dam may be converted to the stored water volume using the surveyed dam geometry. Precipitation entering the containment dams may be defined from four tipping bucket precipitation intensity stations installed across the site. Flow meters included in the pumping systems provide continuous records of volumes removed from the dams. In combination, these datasets allow the total rate of runoff and seepage entering the dams to be quantified.

Seepage rates from the closed mine facilities are therefore measured using the continuous monitoring data for the dams, to define the inflow rates in the early dry season, when flow into the dams is continuing, but direct runoff from the facility surface has ceased. These measured seepage rates are subsequently employed to calibrate and update the site wide water balance model (Engeny, 2013), allowing seepage rates to be estimated for any portion of the site where instrumentation has not been installed.

4.3.4 Erosion rates

The presence of excessive erosion can be detrimental to the performance of the rehabilitation. At Mt Leyshon the scoring system listed below is used in addition to ad hoc monitoring which include photographs, waypoint recording and general site inspections.

Rills	Score	Description
Numerous (severe)	1	High number of rills. Corrugated appearance of large width and depths approaching 30 cm
Numerous (small)	2	High number of rills up but low severity and depth
Many	3	Many rills (up to 20 per 50m) but low severity and no major impact or loss of material
Few	4	Few rills (up to 10 per 50m) with low impact and severity
None	5	No significant or discernible rilling (could be obscured by grasses)

Gullies	Score	Description
Many (large)	1	Many gullies (over 10 per 50 m) with depths exceeding 50 cm and/or widths exceeding 1m.
Many (small)	2	Many gullies (over 10 per 50 m) but low depth (under 50 cm) and widths under 1m.
Few (established)	3	Few gullies (less than 10 per 50 m) though active features with potential for further increase in dimension
Few (establishing)	4	Few gullies (less than 10 per 50 m) but mostly stable and non-active
None	5	No gullies present (or obscured by grasses)

4.3.5 Cover integrity

Cover integrity is monitored directly by physical inspection of the upper surfaces and outslopes of the closed waste rock and tailings storage facilities to look for evidence of erosion, cracking or subsidence. These inspections are incorporated into the routine monitoring and maintenance activities undertaken by the Closure Superintendent, including maintenance of all drainage channels.

Indirect observations of cover integrity are provided by the regular interpretation of other monitoring datasets including:

1. Groundwater elevations in the shallow groundwater system immediately down-gradient of the facilities, and specifically long term mounding of groundwater elevations, and any evidence of unusually large recharge events in the wet season.
2. Groundwater quality in the shallow groundwater system immediately down-gradient of the closed mine facilities, which varies in response to the relative magnitude of the two main competing influences, being a) seepage of poor quality water from the facilities, and b) natural recharge of good quality water in other areas of the mine.
3. The calibrated groundwater flow and sulphate transport numerical model (BDH, 2013a), which has been used to quantify the relative magnitude of seepage from each facility, during calibration to the observed groundwater elevations and groundwater quality.
4. Quantification of seepage flow rates reaching the surface, as described in Section 4.3.3.

4.3.6 Vegetation health

Vegetation is an integral component of rehabilitation performance. Cover (cover estimate guide is provided below) and perennial species richness (number of species) is estimated for grasses, herbs, woody shrubs <1.5 m in height and woody shrubs or trees >1.5 m in height. Additional notes relating to juveniles, reproduction, plant health (e.g. discoloured leaves, presence of parasites and dehydration), or grazing are documented.

Perennial Vegetation Cover	Score	Description
None	1	Not represented, or with less than 1% cover
Low	2	Low cover (1-10%)
Patchy	3	Moderate cover over small proportion of area (11-25%)
Moderate	4	Moderate cover (25-50%)
High	5	High cover (over 50%)

Perennial Species Richness	Score	Description (estimated over 1ha area at photo-points)
None	1	No species (0)
Low	2	Low number of species (1-2)
Medium	3	Moderate number of species (3-5)
High	4	High number of species (6-10)
Very High	5	Very high number of species (over 10)

5. Summary and conclusions

Operations at the Mt Leyshon mine are governed by Environmental Authority (EA) EPML00863713 issued to Newmont. Schedule F of the EA defines operating conditions for land. Condition F4-1 of the EA requires that a Post Mine Land Use Plan (PMLUP) must be developed identifying how rehabilitation objectives for the facilities are achieved. Condition F10-1 of the EA requires that a Post Closure Management Plan (PCMP) must be developed.

The PMLUP and the PCMP have several elements in common, and have therefore been combined for the Mt Leyshon mine, and are both included in this Closure Plan document. This Closure Plan was originally submitted to the Department of Environment and Heritage Protection (DEHP) in 2014 to satisfy the requirements of conditions F4-1 and F10-1 of the EA. This updated version of the Closure Plan will be submitted to the Department of Environment and Science (DES) in March 2019.

During development of this document, every effort has been made to fulfil all of the requirements for the PMLUP defined in the EA, however the resulting PMLUP reflects the specific constraints for the Mt Leyshon mine, which are summarised to include:

1. Most of the closure planning required to be described in the PMLUP was undertaken between 17 and 27 years ago, and the descriptions in this document reflect actual, rather than planned closure works.
2. Some of the closure planning documentation has inevitably been lost in the intervening period.
3. Due to the multiple changes in site personnel, the rationale for which closure design was selected has been lost in some cases.

Most of the materials generated during mining at Mt Leyshon were defined at the time or are now known to be Potentially Acid Forming (PAF). Designs for closure of the mine facilities described in the PMLUP were generated using investigation and modelling studies which reflected industry best practice at that time. Cover designs for the facilities were developed to minimise both oxygen and water ingress, while making maximum use of the inventory of available materials. Drainage designs were intended to maximise runoff from the facilities and minimise infiltration.

In portions of the closed mine facilities, the closure approaches implemented have failed to perform at the level anticipated in the design studies. Runoff and seepage from some portions of the closed facilities demonstrate the influence of Acid Rock Drainage (ARD) and are not acceptable for discharge. A comprehensive mine water management system (impacted water management) has been developed and operated during closure to segregate good quality flows from poor quality flows. Poor quality flows are contained and disposed of to the lake developing in the open pit.

It is accepted that in the long term, continued operation of the impacted water management system may preclude the ability of the pit lake to act as a groundwater sink. Alternative management approaches for impacted water treatment which have been investigated and which have been costed within closure planning for the Mt Leyshon mine include:

1. Continued improvement of the covers and drainage systems, to allow the amount of catchment runoff which is directly discharged to be increased, and to reduce the total catchment reporting to the open pit.

2. Options to remove water from the site by enhanced evaporation infrastructure.
3. Operation of a conventional water treatment plant to treat site flows to acceptable quality for discharge.

The PCMP provided in this document reflects the monitoring regime which has been refined and implemented during the 17 year closure period, rather than a proposed monitoring plan. The primary document which describes the objectives, rationale, locations, frequency and analytes for surface water and groundwater monitoring is the Receiving Environment Monitoring Plan (REMP). Monitoring components described in the PCMP section of this document therefore refer to the most recent version of the REMP in many sections.

The monitoring regime summarised in the PCMP allows a comprehensive assessment of the performance of the closure designs implemented at the Mt Leyshon mine, and will define changes with time, by comparison with the criteria defined in this closure plan and defined in the EA.

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7 Figures

Figure 1: Site layout

Figure 2: Facility outslope sections

Figure 3: Facility drainage designs

Figure 4: Drainage destinations

8 Appendix 1 (Table 1 – Rehabilitation Requirements)

Mt Leyshon - Completion Criteria (2019)

Mine Domain and Tenure	Mine Feature Name	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
Rehabilitated Landforms ML10144	New Northern Tailings Storage Facility Old Northern Tailings Storage Facility Southern Tailings Storage Facility Northern Waste Rock Dump Southern Waste Rock Dump Eastern Waste Rock Dump NAF Oxide Stockpile PAF Oxide Stockpile Heap Leach Stockpile Low Grade Stockpile Scats Stockpile	Stable Landform	Landforms will be structurally stable and surfaces will develop resistance to erosive forces.	Assessment of soil stability and erosion through Landscape Function Analysis (LFA) monitoring. Erosion monitoring conducted in conjunction with Ecosystem Function Analysis (EFA) monitoring.	Soil surface stability greater than or equal to the lower limit of the average regional range for three years of monitoring. Erosion features less than or equal to the upper limit of the average regional range for three monitoring years.
		Sustainable Ecosystems	Disturbed land will be rehabilitated such that it is ecologically stable and reflects the surrounding ecology.	Demonstrate that vegetation establishment trends towards relevant analogue sites, or it is appropriate in terms of plant species composition, diversity, abundance, cover and function. Weed populations do not require specific management above that of the surrounding land. Vegetation monitoring along permanent transects as part of EFA assessment.	70% of analogue median (to be verified through future monitoring) for three years of monitoring, applicable to: • Native grass cover and diversity • Woody species cover and diversity • Perennial grass species cover and diversity The capacity to retain water and nutrient resources is equivalent to target ecosystems. LFA infiltration index and nutrient cycling index are at least 70% of median for target ecosystem for three years of monitoring. All legal requirements are met for declared or noxious weed management (compliance with QLD weed management legislation).
		Contaminants Managed	Constructed landforms will not release contaminants that result in adverse environmental impact to the receiving environment.	Contaminated sites will be managed in accordance with the *Contaminated Sites Act 2003*. Groundwater chemistry monitoring at bores NMLMB29 and NMLMB34. * Surface water indicators will be determined after the Receiving Environment Monitoring Program (REMP) is complete and site specific limits have been determined.	Audit of contaminated sites and compliance with *Contaminated Sites Act 2003* Groundwater chemistry in shallow groundwater system meets criteria for stock watering (ANZECC 2000 guidelines), other than in the stock watering exclusion zone. * Surface water completion criteria will be determined after the Receiving Environment Monitoring Program (REMP) is complete and site specific limits have been determined.
		Safe	Ensure landforms are physically safe and do not pose a risk to human, livestock or wildlife	Access roads not required for post-closure access are rehabilitated. Public access to the site is restricted (fencing and signage).	Evidence in Final Rehabilitation Report (FRR) that redundant roads have been adequately rehabilitated. DEHP approval of FRR.

Mine Domain and Tenure	Mine Feature Name	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
Roads and Administrative Infrastructure ML10144	Workshop Office Fuel Storage Roads & Tracks	Stable Landform	Rehabilitated areas will be structurally stable and surfaces will develop resistance to erosive forces.	Assessment of soil stability and erosion through Landscape Function Analysis (LFA) monitoring. Erosion monitoring conducted in conjunction with Ecosystem Function Analysis (EFA) monitoring.	Soil surface stability greater than or equal to the lower limit of the average regional range for three years of monitoring. Erosion features less than or equal to the upper limit of the average regional range for three monitoring years.
		Sustainable Ecosystems	Disturbed land will be rehabilitated such that it is ecologically stable and reflects the surrounding ecology.	Topsoiling and seeding of disturbance footprint. Weed populations do not require specific management above that of the surrounding land. Monitoring of weeds along permanent transects as part of EFA assessment.	All legal requirements are met for declared or noxious weed management (compliance with QLD weed management legislation).
		Contaminants Managed	Rehabilitated areas will not release contaminants that result in adverse environmental impact to the receiving environment.	Contaminated sites will be managed in accordance with the *Contaminated Sites Act 2003*. Groundwater chemistry monitoring at bores NMLMB29 and NMLMB34. * Surface water indicators will be determined after the Receiving Environment Monitoring Program (REMP) is complete and site specific limits have been determined.	Audit of contaminated sites and compliance with *Contaminated Sites Act 2003.* Groundwater chemistry in shallow groundwater system meets criteria for stock watering (ANZECC 2000), other than in the stock watering exclusion zone. * Surface water completion criteria will be determined after the Receiving Environment Monitoring Program (REMP) is complete and site specific limits have been determined.
		Safe	Ensure rehabilitated areas are physically safe and do not pose a risk to human, livestock or wildlife.	Infrastructure will be removed, except as agreed with key stakeholders and the area rehabilitated for integration into the surrounding landscape. Access roads not required for post-closure access are rehabilitated. Public access to the site is restricted (fencing and signage).	Infrastructure removed unless otherwise agreed and asset transfer agreement in place for infrastructure retained. Audit of contaminated sites and compliance with *Contaminated Sites Act 2003.* Evidence in Final Rehabilitation Report (FRR) that redundant roads have been adequately rehabilitated. DEHP approval of FRR.
Voids and Pit ML10144	Pit	Stable Landform	Pit walls will be structurally stable.	Permanent landforms are not located within the zone of potential pit instability. A geotechnical review of the pit void by an appropriate specialist on completion of decommissioning works.	Acceptance of the geotechnical review by the State Regulatory Mining Engineer (or equivalent).
		Pit Lake Elevation Managed	The pit void will not release contaminants that result in adverse environmental impact to the receiving environment.	Pit lake elevation to remain below 340m AHD. Piezometric elevation in shallow groundwater system to remain above 345m AHD as defined at: • Monitoring bore NMLMB19 • VWP sensor VWP 3-4	Pit lake acts a groundwater sink to the shallow groundwater system.
		Safe	The pit void is physically safe and does not pose a risk to human, livestock or wildlife.	Access to the open pit is restricted by abandonment bunds built to regulatory guidelines. Bunds are position outside the zone of potential pit instability. Access roads not required for post-closure access are rehabilitated. Public access to the site is restricted (fencing and signage).	Compliance with Department of Mines and Petroleum guideline "Safety Bund Walls around Abandonment Open Pit Mines (DoIR 1997)". Evidence in Final Rehabilitation Report (FRR) that redundant roads have been adequately rehabilitated. DEHP approval of FRR.

Mine Domain and Tenure	Mine Feature Name	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
Dams ML10144	Plum Tree Creek Dam Raw Water Dam Settlement Dam Mt Hope Dam	Stable Landform	Removal of embankments and filling of voids (cut and fill operation). Additional filling of voids will be undertaken as required so that the dam is water shedding. Erosion and sediment control works within the dam area where appropriate. Rehabilitated areas will be structurally stable and surfaces will develop resistance to erosive forces.	Assessment of soil stability and erosion through Landscape Function Analysis (LFA) monitoring. Erosion monitoring conducted in conjunction with Ecosystem Function Analysis (EFA) monitoring.	Soil surface stability greater than or equal to the lower limit of the average regional range for three years of monitoring. Erosion features less than or equal to the upper limit of the average regional range for three monitoring years.
	Mt Hope Extension Dam Mt Mawe Dam	Sustainable Ecosystems	Disturbed land will be rehabilitated such that it is ecologically stable and reflects the surrounding ecology.	Topsoiling and seeding of dam disturbance footprint. Weed populations do not require specific management above that of the surrounding land. Monitoring of weeds along permanent transects as part of EFA assessment.	All legal requirements are met for declared or noxious weed management (compliance with QLD weed management legislation).
	Supergene Dam Decommissioned and Reclaimed Water Treatment Pond	Contaminants Managed	Rehabilitated areas will not release contaminants that result in adverse environmental impact to the receiving environment.	Removal of contaminated sediment from the floor of the dams (disposal in pit). Contaminated sites will be managed in accordance with the *Contaminated Sites Act 2003*. Groundwater chemistry monitoring at bores NMLMB29 and NMLMB34. * Surface water indicators will be determined after the Receiving Environment Monitoring Program (REMP) is complete and site specific limits have been determined.	Audit of contaminated sites and compliance with *Contaminated Sites Act 2003.* Groundwater chemistry in shallow groundwater system meets criteria for stock watering (ANZECC 2000), other than in the stock watering exclusion zone. * Surface water completion criteria will be determined after the Receiving Environment Monitoring Program (REMP) is complete and site specific limits have been determined.
		Safe	Ensure rehabilitated areas are physically safe and do not pose a risk to human, livestock or wildlife.	Infrastructure will be removed, except as agreed with key stakeholders and the area rehabilitated for integration into the surrounding landscape. Access roads not required for post-closure access are rehabilitated. Public access to the site is restricted (fencing and signage).	Infrastructure removed unless otherwise agreed and asset transfer agreement in place for infrastructure retained. Audit of contaminated sites and compliance with *Contaminated Sites Act 2003.* Evidence in Final Rehabilitation Report (FRR) that redundant roads have been adequately rehabilitated. DEHP approval of FRR.

9 Appendix 2 (2018 Rehabilitation Monitoring Report)

Appendix G:
Mt Leyshon Plan of Operations

NEWMONT LANDCO PTY LTD

PLAN OF OPERATIONS (MT LEYSHON)

31 March 2019 – 1 April 2022

Mt Leyshon Raw Water Dam

Document	Issue Date	Authored and Approved By	Position
REV 1	MARCH 2019	GLEN WARE	PRINCIPAL ADVISOR LEGACY SITES

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1. Term of Plan of Operations

This Plan of Operations is intended to cover activities at Mt Leyshon for the period 31 March 2019 to 1 April 2022. Mt Leyshon commenced operation in 1986 and production ended in 2002. The site has therefore been in closure for 17 years, final closure designs for nearly all the facilities have been fully implemented and the site is now primarily in a monitoring and maintenance phase.

2. Project Description

2.1 Project Name and Location

The Mt Leyshon Mine ('Mt Leyshon') is an open pit gold mine located 24 km south of Charters Towers in North Queensland. Figure 1 shows the location of Mt Leyshon.

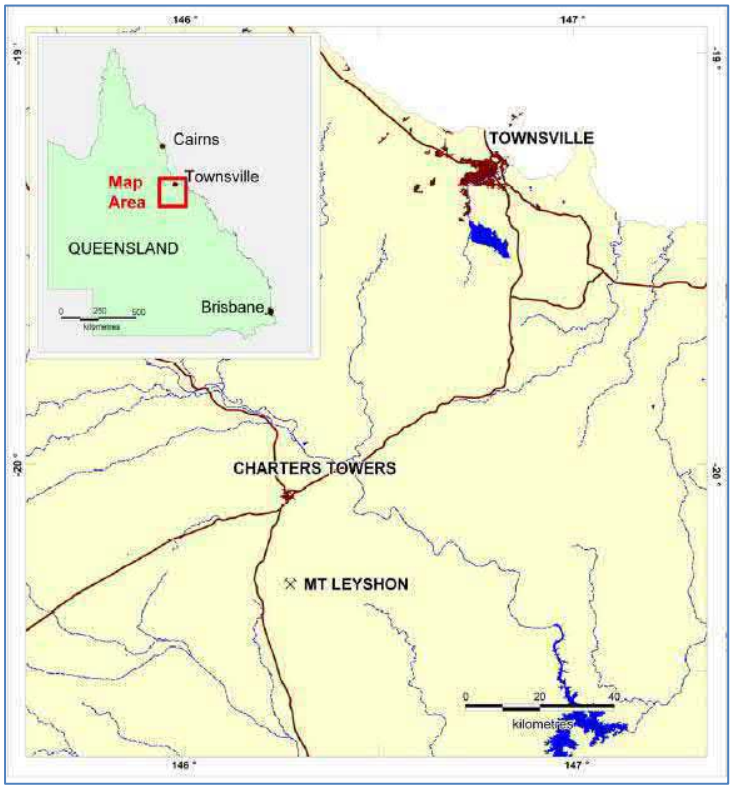

Figure 1: Location of Mt Leyshon Mine Site

2.2 Holders of the EA

Ownership of the Mt Leyshon mine has a complicated history. Exploration of the Mt Leyshon orebody was undertaken from the 1960s to the 1980s by MIM, Marathon Petroleum Australia Ltd, and Noranda Australia Ltd. The mine was developed in the 1980s by Pan Australian Mining Ltd, after purchasing a 50% interest in the operation from Noranda Australia and becoming the sole owners in 1986. In June 1989, Pan Australian Mining Ltd became part of the Normandy Poseidon Group of companies. During the mining period, in June 1991, the holder of the mining leases was changed to Mt Leyshon Gold Mines Ltd. In 1997 the company changed its name to Normandy Mt Leyshon Ltd. In 2002, Newmont outbid Anglogold to acquire all of the Normandy Mining operations, including the Mt Leyshon mine. Under the conditions of the takeover, the Mt Leyshon mine leases and rights to the resource remained with a company called Leyshon Resources Limited (LRL). A management agreement was enacted, in which LRL appointed Newmont to manage the low grade stockpiles, and

to implement the remainder of the site closure and rehabilitation plan. In May 2016, Newmont entered into a Deed of Settlement with LRL which resulted in Newmont acquiring the Mt Leyshon mining tenements and land owned by LRL. Newmont Landco Pty Ltd became the Environmental Authority (EPML00863713) holder for Mt Leyshon on 21st October 2016.

2.3 Description of Tenements

Mineral Lease	Description	Status
ML10144	Mining, stockpiling, ore reserves, waste rock disposal, environmental buffer, tailings disposal, plant, Heap leach facility, borrow pit area, water storage (2,482 ha)	Closure and reclamation phase
ML 10148	Environmental buffer (35.97ha)	No project activity
ML 10172	Environmental buffer (0.99 ha)	No project activity
ML 10173	Eastern Waste Rock Storage Facility. Containment dams and pumping infrastructure for AMD management (18.06 ha)	Closure and reclamation phase
ML 1546	Eastern Waste Rock Storage Facility. Containment dams and pumping infrastructure for AMD management (6.5 ha)	Closure and reclamation phase

2.4 List of Notifiable Activities (extract from page 1 of EA Permit Number EPML00863713)

Mineral Lease	Location
33-Crushing, milling, grinding or screening >5000t year 8-(3a)-Chemical storage>10m3 but <500m3 class C1 or C2 Mining - ML gold ore - 16, Site Specific	ML 1546, ML 10144, ML 10148, ML 10172, ML 10173

Figure 2: Mt Leyshon site features

3. Nature and Extent of Mining Activities

ML 1546

- Potential earthworks to repair and maintain Eastern Waste Rock Facility cover.
- Water containment in constructed dams and pumping to the pit void for storage.
- Use of access roads for maintenance and monitoring.
- Haulage activities to transport materials for rehabilitation works within the lease.

ML 10144

- Earthworks to repair and maintain existing rehabilitated landforms.
- Further minor rehabilitation of Roche Hill following significant rehabilitation in 2017.
- Water containment in constructed dams and pumping to the pit void for storage.
- Bulk storage of diesel (up to 55KL).
- Excavation to source cover materials such as rock armouring, clay, topsoil and growth medium for use in rehabilitation earthworks. Most likely locations are immediately west of the scats stockpile (existing quarry borrow area) and to the North East of the New Northern Tailings Dam (previously cleared area with a quality clay resource).
- Use of access roads for maintenance and monitoring.
- Haulage activities to transport materials for rehabilitation works within the lease.
- General administrative activities carried out at the site office.
- Pest management, including the use of herbicides for weed control and a baiting program facilitated by the local council.
- Dust suppression with the use of water trucks. Sourcing water from the Raw Water Dam.
- Environmental monitoring, including surface water, groundwater, vegetation, sediment, macro-invertebrate and fish.
- Investigations to assist in developing final rehabilitation designs for the site.
- Infrastructure maintenance including power lines, pumps and polylines.
- Cattle grazing to reduce fuel loads in areas away from landforms and waterways.

ML 10148

- Environmental buffer and environmental monitoring. This area is primarily used to access riparian areas for the Receiving Environment Monitoring Program (REMP) and lease boundary compliance monitoring.
- Cattle grazing to reduce fuel loads in areas away from landforms and waterways.

ML 10172

- Use of access roads for maintenance and monitoring.

ML 10173

- Potential earthworks to repair and maintain Eastern Waste Rock Facility cover.
- Water containment in constructed dams and pumping to the pit void for storage.
- Use of access roads for maintenance and monitoring.
- Infrastructure maintenance including power lines, pumps and polylines.

4. Action Program

	EA CONDITION	CONTROL STRATEGY	ACTION PROGRAM
	Schedule A – General: Activity		
(A1-1)	In carrying out the mining activity the holder must comply with Schedule A -Table 1 (Authorised Mining Activities):	Consult with the DES and seek appropriate approvals prior to disturbance of any new areas.	Schedule A – Table 1 was updated to comply with EA requirements in 2013. Newmont will apply for an EA amendment if any of the specifications detailed in Table 1 change in the future and require updating.
	Financial Assurance		
(A2-1)	Prior to the commencement of mining activities under this environmental authority, provide a financial assurance of an amount and in a form determined by the administering authority in accordance with the latest version of administering authority's guideline for calculating financial assurance.	ANZ bank guarantee issued to Newmont Landco 9th March 2017 advises that financial assurance has been lodged and the total amount of security held for the Mt Leyshon mining leases is $45,372,347 as per the estimate agreed with the DES 13th August 2014 (email from Laura Rehn).	The FA for Mt Leyshon was updated in March 2019. Newmont proposes that the FA amount for Mt Leyshon should be $44,679,633 (excl. GST)
(A2-2)	The amount of financial assurance required may be reviewed by the administering authority at any time.	Noted.	Nil.
(A2-3)	Financial assurance must be lodged with the appropriate Queensland Government department within ten (10) business days following any decision made by the administering authority that increases financial assurance for the environmental authority holder.	Newmont commits to lodging the FA in accordance with A2-3.	Newmont commits to lodging the FA in accordance with A2-3. Please refer to comments under A2-1.
	Maintenance of Measures, Plant and Equipment		
(A3-1)	The holder must: a) Install all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority; and b) Maintain such measures, plant and equipment in a proper condition; and c) Operate such measures, plant and equipment in a proper manner.	Maintenance of equipment is undertaken by the Closure Superintendent, who is a qualified mechanical fitter and has extensive experience with equipment maintenance and installations. Equipment at Mt Leyshon includes diesel and electric pumps, environmental instrumentation and flow meters. Maintenance and inspection of the heavy and light voltage electrical reticulation system and equipment is conducted under contract through registered electrical companies. The fixed stream monitoring equipment and telemetry is serviced biannually by specialist's contractors (Aquamonix). Site personnel are trained to operate equipment in a proper manner.	Continue to maintain and operate plant equipment as per site procedures.
(A3-2)	No change, replacement or alteration of any plant or equipment is permitted if the change, replacement or alteration increases, or is likely to increase, the risk of environmental harm.	Replacement and alterations are completed in accordance with the appropriate equipment manuals. Risk assessments are used to determine the potential for environmental harm associated with any changes.	Continue to assess the environmental risk associated with any changes made to plant or equipment.
(A3-3)	All instruments and devices used for the measurement or monitoring of any parameter under any condition of this environmental authority must be calibrated, and appropriately operated and maintained.	The fixed stream monitoring equipment and telemetry is serviced biannually by specialist's contractors (Aquamonix). Site personnel are trained to operate equipment, including the portable water quality meters and groundwater monitoring equipment in a proper and competent manner. Australian Laboratory Service (ALS) is responsible for calibration of analytical laboratory equipment.	Continue to calibrate, operate and maintain instruments appropriately.
	Monitoring and Measurements		
(A4-1)	Record, compile and keep for a minimum of five (5) years all monitoring results required by this environmental authority and	Electronic records are kept for a minimum of 5 years and are available to EHP upon request. Big Dog Hydrogeology Pty Ltd maintains and undertakes	Continue to record, compile and keep for a minimum of 5 years all monitoring results. In accordance with C1-4 of the EA, updated

	EA CONDITION	CONTROL STRATEGY	ACTION PROGRAM
	make available for inspection all or any of these records upon request by the administering authority.	quality assurance checks on data prior to import into the monitoring database.	monitoring data is provided to the DES in February of each year. Monitoring data will be provided upon request by the administering authority.
(A4-2)	The holder of this environmental authority must upon request from the administering authority, supply monitoring records, plans and reports in the form and by the means requested by the administering authority within five (5) business days.	Maintain an efficient and effective records management system.	Provide records, plans and reports to the administering authority within 5 business days when requested.
(A4-3)	Where monitoring is a requirement of this environmental authority, ensure that a competent person(s) conducts all monitoring.	Monitoring is undertaken by the Site Closure Superintendent and Site Senior Environmental Technician who have received appropriate training and have extensive experience.	Continue to ensure persons undertaking monitoring are experienced and appropriately trained.
(A4-4)	All analyses and tests required to be conducted under this environmental authority must be carried out by a laboratory that has NATA accreditation for such analyses and tests, except as otherwise authorised by the administering authority.	Analyses are conducted by the ALS Group (Townsville) which has NATA accreditation.	Continue to use NATA accredited laboratories.
	Emergency Response/ Contingency		
(A5-1)	An emergency response/contingency plan must be developed by the 30 September 2013, be contained within the current plan of operations and implemented to respond to emergency events and incidents.	The Emergency Response Plan was submitted to EHP (Laura Rehn) 26 September 2014 and is being updated in 2017.	The Emergency Response Plan will be reviewed regularly and contained within the current plan of operations.
(A5-2)	The emergency response/contingency plan required under condition A5-1 must address the following matters as a minimum: (a) response procedures to be implemented to prevent or minimise the risk of environmental harm arising from incidents; (b) response procedures to minimise the extent and duration of environmental harm caused by an incident; (c) the practices and procedures to be employed to rehabilitate the environment or mitigate any environmental harm caused; (d) the resources to be used in response to an incident; (e) procedures to investigate the cause of any incidents, including releases, and where necessary, implement remedial actions to reduce the likelihood of recurrence of similar events; (f) the provision and availability of documented procedures to staff attending any incident to enable them to effectively respond; and (g) training of staff that will be called upon to respond to incidents to enable them to effectively and safely respond; (h) timely and accurate reporting of the circumstance and nature of incidents to the administering authority in accordance with conditions A6-1 to A6-3. (i) procedures for accessing monitoring points during incidents; (j) procedures to notify any person who may be affected by the event within 24 hours, with information to be provided at a minimum: 1. the location of the release; 2. the date and time of the release; 3. the estimated quantity and type of any substances (if available concentrations) involved in the incident; 4. the potential impacts to environmental values caused by the	The Emergency Response Plan was updated in 2017 and submitted to the DES at the time of the 2017 PoO amendment.	Continue to review and update the ERP periodically.

	EA CONDITION	CONTROL STRATEGY	ACTION PROGRAM
	release.		
	Notification of Emergencies, Incidents and Exceedence		
(A6-1)	The authority holder must notify the administering authority either by phone and email or fax as soon as possible (no later than 24 hours) after becoming aware of: (a) any emergency or incident which results in the release of contaminants not in accordance, or reasonably expected to be not in accordance with the conditions of this environmental authority; or (b) any monitoring result that indicates an exceedence of any environmental authority limit.	Complete notifications in accordance with the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting".	Continue to follow the updated version of the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting".
(A6-2)	The notification in condition (A6-1) must include, but not be limited to, the following: (a) the environmental authority number and name of the holder. (b) the name and telephone number of the designated contact person. (c) the location of the emergency, incident or exception (d) the date and time of the emergency, incident or exception. (e) the time the holder of the environmental authority became aware of the emergency, incident or exception. (f) the estimated quantity and type of substances involved in the emergency, incident or exception. (g) the actual or potential cause of the emergency, incident or exception. (h) a description of the nature and effects of the emergency, incident or exception, including environmental risks, any risks to public health or live stock (i) immediate actions taken to prevent or mitigate any further environmental harm caused by the release. (j) what notification of persons who may be affected by the event has occurred/is being undertaken.	Complete notifications in accordance with the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting".	Continue to follow the updated version of the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting".
(A6-3)	Within twenty eight (28) days following the initial notification of an emergency or incident, further written advice must be provided to the administering authority, including the following: (a) results and interpretation of any samples taken and analysed. (b) outcomes of actions taken at the time to prevent or minimise unlawful environmental harm. (c) proposed actions to prevent a recurrence of the emergency or incident.	Complete notifications in accordance with the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting".	Continue to follow the updated version of the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting".
	Risk Management		
(A7-1)	The environmental authority holder must develop and implement a risk management system for mining activities which conforms to the Standard for Risk Management (ISO31000:2009) or the latest edition of the Australian Standard for Risk Management by 28 February 2014.	Risk is managed according to the Newmont Integrated Management System (IMS) which incorporates principles of ISO31000:2009	Continue to manage risk according to the Newmont Integrated Management System (IMS) which incorporates principles of ISO31000:2009.
	Third Party Auditing		
(A8-1)	Compliance with the conditions of this environmental authority must be audited by an appropriately qualified third party auditor, nominated by the environmental authority holder and accepted by the administering authority, before the 28 February 2014, and	The EA audit was completed by Engeny Water Management Pty Ltd and submitted to the DES in 2016 and 2018. Acceptance of Engeny as the auditor was received from EHP (Niall Connelly) as below, 3rd December 2015:	Continue to undertake EA audits biennially. The next due date for the EA audit will be 28 February 2020.

	EA CONDITION	CONTROL STRATEGY	ACTION PROGRAM
	then at regular intervals not exceeding once every two (2) years.	"Thank you for providing the details of your nominated auditor, Dr. Andrew Vitale from Engeny Water Management. Based on the information you have provided and outlined on the Engeny Water Management web site the Department of Environment and Heritage Protection accepts that Dr. Vitale has the relevant qualifications and experience to undertake the work as a third party auditor in accordance with Condition A8-1 of Environmental Authority EPML00863713."	
(A8-2)	Upon receipt of the third party audit report, the environmental authority holder must submit a copy to the administering authority.	Last completed 27 February 2018 (emailed to Genevieve Tassan).	Continue to provide a copy of the third party audit to the DES biennially.
(A8-3)	The third party auditor must certify the independent findings of the audit in the report.	The Environmental Authority Audit 2018 Mt Leyshon report prepared by Engeny Water Management for Newmont included Section 6 "Statement of Certification" which certifies that the audit team possessed qualifications and experience relevant to the audit and had no direct or financial interest in the auditing exercise and that the report is factually correct with honest and reasonably held opinions and without any knowingly false, misleading or incomplete information or withheld relevant information or documents.	Certified audit reports will continue to be provided to the DES.
(A8-4)	The financial cost of the third party audit is the responsibility of the holder of this environmental authority.	Newmont accepts that it is responsible for the costs associated with the third party audit.	Newmont will fund the third party audits.
(A8-5)	The holder of this environmental authority must immediately act upon any recommendations arising from the audit report by: a) investigating any non-compliance issues identified; and b) implementing measures or taking necessary action to ensure compliance with the requirements of this environmental authority.	Newmont developed an action plan to address non-compliance issues identified by Engeny Water Management during the EA audit. This action plan was submitted to the DES (emailed to Genevieve Tassan) 27 March 2018.	Complete EA audit action plans in accordance with the nominated timeframes for implementation specified in A8-5.
(A8-6)	Subject to condition (A8-5), and not more than one (1) months following the submission of the audit report to the administering authority, the holder of this environmental authority must provide a written report to the administering authority addressing the: a) actions taken by the holder to ensure compliance with this environmental authority; and b) actions taken to prevent a recurrence of any non-compliance issues identified.	Newmont developed an action plan to address non-compliance issues identified by Engeny Water Management during the EA audit. This action plan was submitted to the DES (emailed to Genevieve Tassan) 27 March 2018.	Complete EA audit action plans in accordance with the nominated timeframes for implementation specified in A8-5.
	Schedule B – Air: Dust Nuisance		
(B1-1)	Subject to Conditions (B1-2) and (B1-3) the release of dust or particulate matter or both resulting from the mining activity must not cause an environmental nuisance, at any sensitive place.	Standard measures are implemented, for example the use of water carts to suppress wheel generated dust at times when substantial earthworks are being undertaken.	Implement measures to suppress the release of dust at times when activities warrant these measures.
(B1-2)	When requested by the administering authority, dust and particulate monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive place, and the results must be notified within 14 days to the administering authority following completion of monitoring.	Newmont has the ability to install depositional dust bottles to monitor particulate dust if the need arises.	Install depositional dust bottles to monitor particulate dust if the need arises and report results to EHP in accordance with B1-2.
(B1-3)	If the environmental authority holder can provide evidence	Monitor and report in accordance with B1-3 if required.	Monitor and report in accordance with B1-3 if required.

	EA CONDITION	CONTROL STRATEGY	ACTION PROGRAM
	through monitoring that the following limits are not being exceeded then the holder is not in breach of (B1-1): a) Dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with AS 3580.10.1 Methods for sampling and analysis of ambient air - Determination of particulates - Deposited matter - Gravimetric method of 1991; and b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometre (µm) (PM10) suspended in the atmosphere of 50 micrograms per cubic metre over a 24 hour averaging time, at a sensitive place downwind of the operational land, when monitored in accordance with: - Particulate matter - Determination of suspended particulate PM10 high-volume sampler with size-selective inlet - Gravimetric method, when monitored in accordance with AS 3580.9.6 Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM (sub) 10 high volume sampler with size-selective inlet - Gravimetric method of 1990; or - Any alternative method of sampling PM10, which may be permitted by the 'Air Quality Sampling Manual' as published from time to time by the administering authority. NOTE: You must propose which monitoring method is appropriate in accordance with condition (B1-3) (a) or (b) or both.		
(B1-4)	If monitoring indicates exceedence of the relevant limits in Condition (B1-3), then the environmental authority holder must: a) Address the complaint including the use of appropriate dispute resolution if required; or b) Immediately implement dust abatement measures so that emissions of dust from the activity do not result in further environmental nuisance.	Newmont has the ability to address complaints and implement dust abatement measures if in the very unlikely event that the need arises.	Implement dust abatement measures if the need arises.
	Schedule C – Water: General		
(C1-1)	Contaminants that will, or have the potential to cause environmental harm, must not be released directly or indirectly to any waters except as permitted under the conditions of this environmental authority.	The Mt Leyshon water management system is designed to capture in dams and sumps, water containing contaminants with the potential to cause environmental harm and pump these waters to the pit void. The objective of the pit void is to maintain this storage as a sink to the shallow groundwater systems (i.e. pit lake level' maintained <340 m AHD). High flow bypass structures are in place at Mt Hope Dam and Settlement Dam to allow water which complies with EA release limits to be released to the receiving environment. Reference can be made the current Mt Leyshon Water Management Plan.	Continue to operate the water management system in accordance with the Water Management Plan and requirements in the EA.
(C1-2)	The maintenance and cleaning of vehicles and any other equipment or plant must not be carried out in areas from which contaminants can be released into any receiving waters.	Maintenance and cleaning of vehicles and equipment on site is restricted to the absolute minimum. A wash-down area for cleaning vehicles is located on a designated flat surface on the Scats Stockpile. The waste water is evaporated naturally and/or seeps through the scats. No degreaser is used in wash-down. There is a significant volume of scats between the wash-down area and the base of the stockpile where the Upper Plum Tree Creek Dam receives	Ensure that if activity levels change on site, compliance measures are reviewed to meet requirements of C1-2. Undertake sampling if any unusual field observations are made, e.g. smell of hydrocarbons or visible sheen on water in the Plum Tree Creek Dams.

	EA CONDITION	CONTROL STRATEGY	ACTION PROGRAM
		seepage, which drain into Plum Tree Creek Dam and is then pumped to the pit.	Hydrocarbon spills are reported through the Newmont Cintellate reporting system and cleaned up in an appropriate and timely manner.
(C1-3)	Any spillage of wastes, contaminants or other materials must be cleaned up as quickly as practicable to minimise the release of wastes, contaminants or materials to any receiving waters.	The site Emergency Response Plan stipulates how to manage a chemical or oil spill. A spill kit is located in the maintenance workshop.	Keep the spill kits well stocked. Ensure staff are trained to manage spills and the Emergency Response Plan is understood.
(C1-4)	By 6 February each year the holder of this environmental authority must provide the administering authority an update of monitoring data and associated trigger levels and contaminant limits specified in Schedule C of this environmental authority, incorporating monitoring data obtained during the previous twelve (12) months.	Big Dog Hydrology Pty Ltd maintains the environmental monitoring database for Mt Leyshon and provides a report detailing results for the previous 12 months at the start of each year in accordance with this condition.	Continue to meet compliance with C1-4 by providing annual reports.
(C1-5)	All determinations of water quality/sample analysis required under a condition of this environmental authority must be: (a) performed by a person or body possessing appropriate experience and qualifications to perform the required measurements; (b) made in accordance with methods prescribed in the latest edition of the administering authorities Monitoring and Sampling Manual; (c) carried out on representative samples; (d) collected from the monitoring locations identified in this environmental authority, within two (2) hours of each other where possible; and (e) for laboratory determinations, carried out in a laboratory accredited (e.g. NATA) for the method of analysis being used except as otherwise authorised by the administering authority.	Monitoring is undertaken by appropriately trained and experienced site personnel and consultants. Monitoring is undertaken in accordance with the administering authorities Monitoring and Sampling Manual and a hard copy of this manual is kept in the office for reference. The Mt Leyshon Receiving Environment Monitoring Plan (REMP) - May 2017, details sampling protocols for water and other monitoring. Analyses are conducted by ALS Group which has NATA accreditation.	Ensure training and competency standards are maintained.
(C1-6)	The following information must be recorded in relation to all water quality monitoring data for a specified period as required by this environmental authority and submitted to the administering authority in the specified format when requested: (a) the date and time when the sample was taken; (b) the monitoring point where the sample was taken; (c) the release flow rate at the time of sampling for each release point; (d) the measured or estimated daily quantity of the contaminants released from all release points; (e) the results of all monitoring and details of any exceedences with the conditions of this environmental authority; and (f) all water quality monitoring data.	Monitoring field sheets and laboratory Chain of Custody (CoC) forms are used to record details including the date, time and location the sample was taken. Flow rates are measured using automatic monitoring equipment with telemetry at some locations, for example level sensors and auto-samplers at the high flow bypasses. Flow rates for a number of critical locations are also presented on Envault (an Aquamonix data acquisition application), which allows for remote and real-time viewing via the internet. Contaminant release quantities are calculated once laboratory results are received and these are reported to the administering authority. The Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" details the procedure required to meet the conditions of this EA.	Continue to monitor, record and report information to the administering authority as required in condition C1-6.
(C1-7)	The release of contaminants directly or indirectly to waters must not: (a) produce any visible discolouration of receiving waters; or (b) produce any slick or other visible or odorous evidence of oil, grease or petrochemicals nor contain visible floating oil, grease, scum, litter or other objectionable matter.	The Newmont procedure "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" requires site personnel to undertake field observations to identify and report any discolouration, slick, odorous evidence or other objectionable matter in receiving waters.	Continue to monitor and report in accordance with the procedure "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting".
(C1-8)	The holder of this environmental authority must develop a Sulphate Management Plan by 31 October 2013. The Sulphate Management plan must address as a minimum:	The Sulphate Management Plan was submitted to EHP (Laura Rehn) 29 October 2013.	Complete actions in accordance with the Sulphate Management Plan and condition C1-8 during the term of this PoO.

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	a) Measures to prevent sulphate release from the New Northern TSF, Southern TSF and Eastern WRD as identified in the Mt Leyshon Environmental Evaluation Report, May 2012; b) Measures to ensure water leaving the site contains sulphate at levels that comply with Schedule C of this environmental authority; c) A remedial works plan for areas downstream of the mine that details; o the degree to which the measured sulphate concentrations are an issue for environmental values of surface waters and ground waters; o actions to address any existing sulphate related issues known to be currently occurring or causing environmental harm; and o actions to address potential sulphate related issues that may cause environmental harm, such as the formation of Monosulfidic Black Ooze (MBO). d) Develop site-specific water quality objectives for sulphate using local biological effects data to assess risks to the aquatic ecosystem values		
	Contaminant Release to Waters		
(C2-1)	Unless otherwise permitted under the conditions of this environmental authority, the release of contaminants to waters must only occur from the release points specified in Schedule C - Table 1 (Release Points) and depicted in Figure1. Note: Figure 1 is to be provided by the holder of this environmental authority by 30 September 2013.	Figure 1 (contaminant release locations) was submitted to the administering authority (Laura Rehn) 25 September 2014. These points are recognised by Newmont to be locations where releases could potentially occur. A release from either a dam or sump is highly unlikely, whilst releases from high flow bypass facilities are likely to occur during the wet season. Newmont has in place measures to effectively manage the risk of spill events at Mt Leyshon through its preventative maintenance programs, routine inspections and the use of quality components when establishing water management infrastructure at Mt Leyshon. Please refer to Newmont's response letter regarding the pipeline spill incident that occurred 31 May 2017 at Mt Leyshon for more details on Newmont's strategy to mitigate these types of incidents.	Continue to release water which meets EA limits through the Mt Hope Dam and Settlement Dam bypass facilities. For other locations, capture and pump back contaminated water to the pit void for containment.
(C2-2)	The release of contaminants to waters from the authorised release points must be monitored at the locations and frequencies specified in Schedule C – Table 1 (Release Points) for each quality characteristic specified in Schedule C – Table 2 (Contaminant Release Trigger Levels and Limits).	The Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" states the required frequency and refers to the relevant EA tables for locations. Awareness of releases requiring monitoring is supported by field monitoring equipment. This instrumentation is equipped with telemetry which allows remote viewing of flow conditions in real-time (Aquamonix – Envault). Autosamples are also in place at a number of locations to capture first flush events.	Continue to undertake monitoring in accordance with the EA and site procedures which are in place.
(C2-3)	With the exception of high flow releases permitted under condition C4-3 of this environmental authority, the release of contaminants to waters must not exceed the contaminant limits for each quality characteristic stated in Schedule C – Table 2 (Contaminant Release Trigger Levels and Limits).	The Mt Leyshon water management system is designed to capture in dams and sumps, water containing contaminants with the potential to cause environmental harm and pump these waters to the pit void. With the exception of the high flow bypasses as per condition C2-3, the likelihood of releasing water exceeding contaminant limits defined in Schedule C – Table 2 is considered very low. This is due to the pumping capacity at the storages and back-up systems in place.	Continue to operate and where practicable, improve the water management system to prevent the release of contaminants which have the potential to exceed the limits stated in Schedule C – Table 2.

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(C2-4)	If quality characteristics of the release exceed any of the trigger levels specified in Schedule C – Table 2 (Contaminant Release Trigger Levels and Limits) during a release event, the holder of this environmental authority must complete an investigation in accordance with the ANZECC and ARMCANZ (2000) methodology into the potential for environmental harm and provide a written report to the administering authority within three (3) months detailing: (i) details of the investigations carried out; (ii) details of the environmental impacts observed; and (iii) actions taken to prevent environmental harm. Note: An exceedence of pH relates to a value below the minimum pH or above the maximum pH levels identified in Schedule C – Table 2 (Contaminant Release Trigger Levels and Limits). Note: Investigations maybe undertaken to develop impact-based limits in accordance with ANZECC methodology (ANZECC guidelines – Chapter 3.5.1).	The Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" states the reporting requirements in the event of a release exceeding any of the trigger levels specified in Schedule C – Table 2.	Comply with the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" in the event of a release exceeding any of the trigger levels specified in Schedule C – Table 2.
	Stream Flow Monitoring		
(C3-1)	The holder of this environmental authority must install, operate and maintain a stream flow gauging station to determine and record stream flows with respect to each release point, as specified in Schedule C – Table 3 (Contaminant Release During Flow Events).	There are continuous water level sensors in the following waterways: • Clarke Creek at the northern lease boundary (RSSCC) • Two Mile Creek at the eastern lease boundary (RSSMM) • Puddler Creek upstream of the south-eastern lease boundary (PCC) Discharge rating curves have been developed for these three monitoring locations which provide an estimate of stream discharge based on the measured water levels. Continuous EC sensors, auto samplers and tipping bucket rain gauges are also installed at these three sites. Continuous water level and EC sensors are also located at the following locations downstream of the Mt Leyshon Mine: • Clarke Creek at Mountain View Road (CC3) • Seventy Mile Creek at Bluff Road (SM4) All sites have telemetry which allows data to be viewed remotely and in real-time on the Aquamonix Envault webpage. Historical data can also be downloaded from Envault. Aquamonix instrument technicians visit site twice per year (pre and post wet season) to undertake maintenance and calibration of the equipment.	Continue to operate and maintain the stream gauging stations that are in place at Mt Leyshon.
(C3-2)	With the exception of high flow releases permitted under condition C4-3 of this environmental authority, the release of contaminants to waters must only take place during periods of natural flow events specified as the minimum flow in Schedule C – Table 3 (Contaminant Release During Flow Events) and at the contaminant release point(s) specified in Schedule C – Table 1 (Release Points).	The water management system is set up so that only during a period of natural flow can there be a release. There are no upstream users who can influence discharge from the EA specified release points. With the exception of the high flow bypasses as per condition C3-2, the likelihood of releasing water from the EA specified release points is considered very low. This is due to the pumping capacity at the storages and back-up systems that are in place.	Continue to operate the water management system in accordance with the Water Management Plan and site procedures.

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(C4-1)	With the exception of high flow releases permitted under condition C4-3 of this environmental authority, at the time of release from the authorised release points specified in Schedule C – Table 3 (Contaminant Release During Flow Events) the water flow volume in the respective receiving water must be at least twenty (20) times the volume at which respective contaminated waters are released.	With the exception of the high flow bypasses as per condition C3-2, the likelihood of releasing water from the EA specified release points is considered very low. Level sensors are in place and rating curves have been developed for the creek gauging stations described in C3-1 and at the main dams which allow flow rates and discharge volumes to be determined. Large pumping capacity and the ability to control the volume of water entering Mt Hope Dam and Settlement Dam (i.e. operation of valves on low flow pipes), provides operational control to increase the likelihood water flow volume in the receiving water is at least twenty (20) times the volume at which respective contaminated waters are released.	Continue to operate the water management system in accordance with the Water Management Plan and site procedures.
(C4-2)	The daily quantity of contaminants released from each release point specified in Schedule C – Table 1 (Release Points) must be measured and recorded.	Flow data is generated from continuous monitoring of stream height, coupled with modelled stream height-flow rate relationships. Samples are collected during flow events either by automatic samplers or by site personnel. Flow rates and contaminant concentrations are then used to calculate the daily quantity of contaminants. These quantities are however calculated only once laboratory results have been received (normally 2 weeks after sample collection).	Continue to monitor and report in accordance with the Newmont procedure "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting"
	High Flow By-Pass		
(C4-3)	The high flow release of mine affected water from the Mt Hope and Settlement Dam Bypass identified Schedule C – Table 1 (Release Points), to receiving waters must not: (a) exceed the contaminant limits stated in Schedule C – Table 10 (Receiving Waters Contaminant Limits) at the receiving water monitoring points in Schedule C – Table 7 (Receiving Water Reference Sites and Downstream Monitoring); and (b) from the 30 June 2013, exceed the release limits at the spillway stated in Schedule C - Table 4 (Release Limits for High Flow Releases).	The document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" describes the monitoring requirements to conform to C4-3, including frequency and locations. Monitoring is undertaken at the bypasses (auto samplers) and downstream by site personnel at times when a release event occurs. Control valves on low flow pipes reporting to Mt Hope Dam and Settlement Dam, allow for more water to be sent to the dams in the event that water quality for bypass releases is not meeting required quality characteristics defined in the EA.	Continue to monitor in accordance with the EA and site procedures. Rising stage samplers at the bypass monitoring compliance locations have been installed to improve monitoring capability.
(C4-4)	An investigation into the potential for environmental harm in the mixing zone immediately downstream of the high flow bypass release points must be completed and submitted to the administering authority by 30 June 2014.	An investigation into the potential for environmental harm in the mixing zone immediately downstream of the high flow bypass release points was submitted to the administering authority (Shalika Walker) 30 June 2014.	Complete
(C4-5)	An estimate of the daily quantity of contaminants released from each release point must be based on available measured data recorded at the release points in Schedule C - Table 1 (Contaminant Release Points).	Flow data is generated from continuous monitoring of stream height, coupled with modelled stream height-flow rate relationships. Samples are collected during flow events either by automatic samplers or by site personnel. Flow rates and contaminant concentrations are then used to calculate the daily quantity of contaminants. These quantities are calculated once laboratory results have been received (normally 2 weeks after sample collection).	Continue to monitor and report in accordance with the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting".
(C4-6)	The release of contaminants directly or indirectly to waters: (a) must not produce any visible discolouration of receiving waters; nor (b) must not produce any slick or other visible or odorous evidence of oil, grease or petrochemicals; nor (c) contain visible floating oil, grease, scum, litter or other objectionable matter.	The Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" requires site personnel to undertake field observations to identify any discolouration, slick, odorous evidence or other objectionable matter in receiving waters.	Continue to monitor and report in accordance with the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting".
(C4-7)	Releases to waters must be undertaken so as to minimise erosion	The following principles provide the foundation for the Mt Leyshon Mine	Continue to follow site procedures and implement appropriate controls

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	of the bed and banks of the receiving waters, or cause a material build-up of sediment in such waters.	Erosion and Sediment Control Plan: ▪ Minimise surface disturbance and restrict access to undisturbed areas; ▪ Progressively rehabilitate and stabilise disturbed areas with vegetation; ▪ Separate catchment runoff from disturbed and undisturbed areas where practicable; ▪ Reduce potential for erosion through velocity controls and reduced runoff volume; ▪ Use of suitably sized and protected drainage structures to manage surface runoff; ▪ Use of existing onsite containment structures for the capture of sediment laden surface water runoff; and ▪ Regular monitoring and maintenance to ensure continual operation of the individual erosion and sediment control elements.	where necessary, in accordance with the site Erosion and Sediment Control Plan.
	Notification of Release Event		
(C5-1)	The holder of this environmental authority must notify the administering authority of a release event (no later than twenty four (24) hours after having commenced releasing contaminated water to the receiving environment). Notification must include the submission of written verification to the administering authority of the following information: (a) release commencement date/time; (b) expected release cessation date/time; (c) release point(s); (d) release volume and contaminant load (estimated); (e) receiving water(s) including the natural flow rate; and (f) any details (including available data) regarding likely impacts on the receiving water(s).	The Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" specifies the notification requirements in accordance with C5-1.	Continue to follow the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting", which specifies the notification requirements in accordance with C5-1.
(C5-2)	The holder of this environmental authority must notify the administering authority within twenty-four (24) hours after cessation of a release as notified under condition (C5-1) and within twenty (20) business days provide the following information in writing: (a) release cessation date/time; (b) natural flow volume in receiving water; (c) volume of water released; (d) details regarding the compliance of the release with the conditions of Schedule C in this environmental authority (i.e. contaminant limits, natural flow, discharge volume); (e) all in-situ water quality monitoring results; and (f) any other matters pertinent to the release.	The Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" specifies the notification requirements in accordance with C5-1.	Continue to follow the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting", which specifies the notification requirements in accordance with C5-1.
	Onsite Water Storages		
(C6-1)	Water storages stated in Schedule C – Table 5 (Onsite Water Storage Monitoring Locations) must be monitored for the water quality characteristics specified in Schedule C -Table 6 (Onsite Water Storage Contaminant Limits) at the monitoring locations and at the monitoring frequency specified in Schedule C – Table 5 (Onsite Water Storage Monitoring Locations).	Monitoring of water storages is undertaken in accordance with the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting", which conforms to condition C6-1.	Continue to follow the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting", which specifies the monitoring requirements for water storages.
(C6-2)	In the event that waters storages defined in Schedule C – Table 5 (Onsite Water Storage Monitoring Locations) exceed the	Lease perimeter fencing is in place to prevent access to waters by all livestock and minimise access by native fauna. The administering authority has	Continue to maintain the lease permitter fencing.

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	contaminant limits defined in Schedule C -Table 6 (Onsite Water Storage Contaminant Limits) the holder of this environmental authority must implement measures to prevent access to waters by all livestock and minimise access by native fauna.	previously stated "As per the meeting held between EHP and Newmont on 12 July 2014. EHP understands that the Mt Leyshon site is fully fenced with gates and cattle grids. As per the meeting, EHP considers this to constitute adequate measures in accordance with C6-2".	
(C6-3)	In the event that waters storages defined in Schedule C – Table 5 (Onsite Water Storage Monitoring Locations) exceed the contaminant limits defined in Table 3 (Contaminant concentrations and minimum dam volumes) in the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (and any subsequent versions), condition (H1-8) of this environmental authority applies.	Monitoring of water storages is undertaken in accordance with the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting". Apply condition H1-8 if any contaminant limits are exceeded.	Continue monitoring in accordance with the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting".
	Receiving Waters Monitoring		
(C7-1)	Receiving waters must be monitored at the locations specified in Schedule C – Table 7 (Receiving Water and Downstream Monitoring Points) for each quality characteristic and at the frequency stated in Schedule C – Table 9 (Receiving Waters Contaminant Trigger Levels) and Schedule C – Table 10 (Receiving Waters Contaminant Limits).	The Newmont document "Mt Leyshon EA - Procedures for Monitoring, Notification and Reporting" describes the monitoring requirements to conform to C7-1, including frequency and locations.	Continue to undertake monitoring in accordance with site procedures and the EA.
(C7-2)	If quality characteristics of the receiving water at the downstream monitoring points exceed any of the trigger levels specified in Schedule C – Table 9 (Receiving Waters Contaminant Trigger Levels), the holder of this environmental authority must complete an investigation in accordance with the ANZECC and ARMCANZ 2000 methodology, into the potential for environmental harm and provide a written report to the administering authority within three (3) months, outlining: i. details of the investigations carried out; ii. details of the environmental impacts observed; and iii. actions taken to prevent environmental harm. Note: Investigations maybe undertaken to develop impact-based limits in accordance with ANZECC methodology (ANZECC guidelines – Chapter 3.5.1).	The Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" states the reporting requirements in the event of any water quality exceedance in receiving waters. Big Dog Hydrogeology (BDH) is currently commissioned to complete these reports, with input from Newmont personnel and aquatic ecologists from Tropwater (James Cook University).	In the event that receiving waters exceed any of the trigger levels specified in Schedule C – Table 9, comply with the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting".
(C7-3)	The release of contaminants must not result in an exceedence of the contaminant limits stated in Schedule C – Table 10 (Receiving Waters Contaminant Limits). Note: Investigations maybe undertaken to develop impact-based limits in accordance with ANZECC methodology (ANZECC guidelines – Chapter 3.5.1).	The Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" describes the monitoring requirements to conform to C7-3, including frequency and locations. Monitoring is undertaken at the bypasses (auto samplers) and downstream by site personnel at times when a release event occurs. Control valves on low flow pipes reporting to Mt Hope Dam and Settlement Dam, allow for more water to be sent to the dams in the event water quality for bypass releases is not meeting required quality characteristics defined in the EA. With the exception of the high flow bypasses, the likelihood of releasing water from the EA specified release points is considered very low.	Continue to undertake monitoring in accordance with site procedures and the EA. Undertake site activities in accordance with the site water management plan and regulated dams operational plan. Implement control measures to mitigate the release of contaminants that have the potential to exceed contaminant limits.
	Receiving Environment Monitoring Program		
(C8-1)	A Receiving Environment Monitoring Program (REMP) must be	The REMP was developed and implemented prior to 1 November 2013. A	Continue with the REMP and provide annual reports to the DES in

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	developed and implemented by 1 November 2013 to monitor and record the effects of the release of contaminants on the receiving environment periodically and whilst contaminants are being released from the licensed place with the aim of identifying and describing the extent of any adverse impacts on local environmental values and to monitor any changes in the receiving water (including groundwater). A copy of the REMP and any update or variation of the REMP must be provided to the administering authority prior to its implementation and due consideration given to any comments made on the REMP by the administering authority.	copy of the REMP was submitted to the administering authority (Laura Rehn) 1 November 2013. Updated versions have been provided annually to EHP since 2013.	accordance with the EA.
(C8-2)	The REMP must address (but not necessarily be limited to) the following: (a) description of potentially affected receiving groundwaters and surface waters including key communities and reference water quality and sediment characteristics based on accurate and reliable monitoring data that takes into consideration any temporal variation (e.g. seasonality); (b) description of applicable environmental values and water quality objectives to be achieved (i.e. as scheduled pursuant to the Environmental Protection (Water) Policy 2009); (c) any relevant reports prepared by other governmental or professional research organisations that relate to the receiving environment to which the REMP applies; (d) Water and sediment quality targets within the receiving environment to be achieved, and clarification of contaminant concentrations or level indicating adverse environmental impacts during the REMP; (e) monitoring for any potential adverse environmental impacts caused by a release; (f) monitoring of stream flow and hydrology; (g) monitoring of toxicants that must consider the indicators specified in Schedule C – Table 2 (Contaminant Release Trigger Levels and Limits) to assess the extent of the compliance of concentrations with water quality objectives and/or the ANZECC and ARMCANZ (2000) Guidelines for slightly to moderately disturbed ecosystems; (h) monitoring of physical and chemical parameters including as a minimum those specified in Schedule C – Table 2 (Contaminant Release Trigger Levels and Limits) (in addition to dissolved oxygen saturation and temperature); (i) monitoring biological indicators (for macroinvertebrates in accordance with the administering authority's monitoring and sampling manual (AusRivas Methodology) and metals/metalloids in sediments (in accordance with ANZECC and ARMCANZ (2000), BATLEY (A guide to the Application of the ANZECC/ARMCANZ Water Quality Guidelines in the Minerals Industry) and/or the most recent version of AS5667.1 Guidance on Sampling of Bottom Sediments) for permanent, semi-permanent water holes and water storages;	The REMP was developed and implemented prior to 1 November 2013. A copy of the REMP was submitted to the administering authority (Laura Rehn) 1 November 2013. Updated versions have been provided annually to EHP since 2013.	Continue with the REMP and provide annual reports to the DES in accordance with the EA.

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	(j) the locations of monitoring points (including the locations of reference/upstream and downstream potentially impacted sites for each release point). Reference sites must comply with the following criteria: i. be from the same bio-geographic and climatic region; ii. have similar geology, soil types and topography; iii. contain a range of habitats similar to those at the potentially impacted sites; iv. have a similar flow regime; and v. (v) not be so close to the potentially impacted sites that any disturbance at the potentially impacted sites also results in a change at the reference site. (k) the frequency or scheduling of sampling and analysis that is sufficient to determine water quality objectives and to derive site specific reference values within two (2) years (depending on wet season flows) in accordance with the Queensland Water Quality Guidelines. For ephemeral streams, this should include periods of flow irrespective of mine or other release; (l) specify sampling and analysis methods and quality assurance and control; (m) any historical datasets to be relied upon; (n) description of the statistical basis on which conclusions are drawn; and (o) any spatial and temporal controls to exclude potential confounding factors.		
(C8-3)	A report outlining the findings of the REMP including all monitoring results and interpretations in accordance with condition (C8-2) must be prepared and submitted in writing to the administering authority by 1 May 2015 and thereafter once every twelve (12) months. The report must include an assessment of reference water quality, any assimilative capacity for those contaminants monitored and the suitability of current release limits to protect downstream environmental values.	The REMP was developed and implemented prior to 1 November 2013. A copy of the REMP was submitted to the administering authority (Laura Rehn) 1 November 2013. Updated versions have been provided annually to EHP since 2013.	Continue with the REMP and provide annual reports to the DES in accordance with the EA.
	Stream Sediment Monitoring		
(C9-1)	Sediment quality of receiving waters must be monitored once a year (at the end of the wet season) at the monitoring locations defined in Schedule C – Table 8 (Receiving Stream Sediment Monitoring Points) and for the parameters defined in Schedule C – Table 11 (Stream Sediment Trigger Levels and Contaminant Limits). Note: 1M HCL digestion and <2mm fraction is required for sample analysis conducted in accordance with ANZECC methodology.	The Newmont document "Mt Leyshon EA - Procedures for Monitoring, Notification and Reporting", describes the monitoring requirements to conform with C9-1, including frequency and locations for stream sediment monitoring.	Continue to follow the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting", which specifies requirements for sediment monitoring.
(C9-2)	If the quality characteristics of sediments exceed any of the trigger levels specified in Schedule C –Table 11 (Stream Sediment Trigger Levels and Contaminant Limits), the holder of this environmental authority must complete an investigation in accordance with the ANZECC and ARMCANZ (2000) methodology, into the potential for environmental harm and provide a written report to the administering authority within four (4) months, outlining:	The Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" states the reporting requirements in the event of any stream sediment exceedances. Big Dog Hydrogeology (BDH) is currently commissioned to complete these reports, with input from Newmont personnel and aquatic ecologists from Tropwater (James Cook University).	In the event that stream sediments exceed any of the trigger levels specified in Schedule C – Table 9, comply with the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" and condition C9-2.

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	i) details of the investigations carried out; ii) details of the environmental impacts observed; and iii) actions taken to prevent environmental harm. Note: Investigations maybe undertaken to develop impact-based limits in accordance with ANZECC methodology (ANZECC guidelines – Chapter 3.5.1).		
(C9-3)	The release of contaminants must not result in an exceedence of the sediment contaminant limits stated in Schedule C – Table 11 (Stream Sediment Trigger Levels and Contaminant Limits).	The Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" describes the monitoring requirements to conform to C9-3, including frequency and locations. Monitoring is undertaken at the bypasses (auto samplers) and downstream by site personnel at times when a release event occurs. Control valves on low flow pipes reporting to Mt Hope Dam and Settlement Dam, allow for more water to be sent to the dams in the event water quality for the bypasses is not meeting required quality limits defined in the EA. With the exception of the high flow bypasses, the likelihood of releasing water from the EA specified release points is considered very low.	Continue to monitor in accordance with the EA and site procedures.
(C9-4)	All stream sediment sampling must be undertaken in accordance with the most recent version of Australian Standard AS 5667.12 Guidance on Sampling of Bottom Sediments.	The Australian Standard AS 5667.12 Guidance on Sampling of Bottom Sediments is kept on-site and used by site personnel.	Continue to use The Australian Standard AS 5667.12 Guidance on Sampling of Bottom Sediments.
	Water Management Plan		
(C10-1)	A water management plan must be developed and implemented by 30 September 2013 which provides for the proper and effective management of the actual and potential environmental impacts resulting from the mining activity and to ensure compliance with the conditions of this environmental authority.	The Water Management Plan was submitted to the administering authority (Laura Rehn) 28 September 2014. Annual updates have been completed since 2013.	Complete annual reviews of the Water Management Plan to ensure it stays current.
(C10-2)	The water management plan must be developed in accordance with the most recent edition of the administering authority's guideline Preparation of Water Management Plans for Mining Activities and must include at least the following components: a) contaminant source study; b) site water balance and model; c) water management system; d) saline drainage prevention and management measures; e) acid rock drainage prevention and management measures; f) emergency and contingency planning; and g) monitoring and review.	The Water Management Plan was submitted to the administering authority (Laura Rehn) 28 September 2014, which meets the requirements of condition 10-2. Annual updates have been completed since 2013.	Complete annual reviews of the Water Management Plan to ensure it stays current.
(C10-3)	The holder of this environmental authority must undertake a review of the water management plan before 1 November each year to ensure that proper and effective measures, practices or procedures are in place so that the mine is operated in accordance with the conditions of this environmental authority and that environmental harm is prevented or minimised.	Annual reviews are scheduled within the Water Management Plan.	Complete annual reviews in accordance with C10-3 and the schedule outlined in the Water Management Plan.
	Site Water Balance		
(C11-1)	The holder of this environmental authority must develop a site specific operational site water balance model.	A site specific water balance model was developed for the Mt Leyshon site in 2007 and is updated periodically by Engeny Water Management Pty Ltd.	Continue to periodically update the water balance model.

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		Using GoldSim software, two water balance models have been developed: • a deterministic model that uses available historical climate data inputs over 100 years and; • a probabilistic model that uses stochastically generated climate data inputs.	
(C11-2)	The water balance model must be: (a) run prior to the wet season; (b) promptly after each rainfall event greater than fifty (100) millimetres within a twenty four (24) hour period within the relevant surface water containment area; (c) with documentation of inputs and outputs from each run being stored and retrievable for a minimum period of one (1) year; (d) performed in response to rainfall to be undertaken by an appropriately qualified person; and (e) assessed using the operational simulation water balance model using a minimum of 100 years of historical rainfall data.	Engeny Water Management Pty Ltd is commissioned to complete the actions detailed in C11-2.	Continue to engage Engeny Water Management Pty Ltd to complete the tasks associated with condition C11-2.
	Erosion and Sediment Control		
(C12-1)	An erosion and sediment control plan must be developed by the 28 February 2014, by an appropriately qualified person and implemented for all stages of the mining activity on the licensed place to prevent or minimise erosion and the release of sediment to receiving waters and the contamination of stormwater.	The Erosion and Sediment Control Plan, as a component of the Water Management Plan was submitted to the administering authority (Laura Rehn) 28 September 2014.	Periodically review the Erosion and Sediment Control Plan to ensure it stays current.
(C12-2)	The erosion and sediment control plan must provide for at least the following functions: (a) prevent or minimise the contamination of receiving waters and stormwater; (b) diverting uncontaminated stormwater run-off around areas disturbed by the mining activity or where contaminants or wastes are stored or handled; (c) contaminated stormwater runoff, incident rainfall and leachate is collected; and treated, reused, or released in accordance with the conditions of this environmental authority; (d) roofing or minimising the size of areas where contaminants or wastes are stored or handled; (e) erosion and sediment control structures are placed to minimise erosion of disturbed areas and prevent the contamination of any waters; (f) procedures to ensure that erosion and sediment control structures are maintained and adequate storage is available in sediment dams in accordance with design criteria; and (g) training of staff that will be responsible for maintenance and operations of sediment and erosion control structures.	The Erosion and Sediment Control Plan (ESCP) was submitted to the administering authority (Laura Rehn) 28 September 2014, which meets the requirements of condition 10-2 The ERCP is reviewed annually.	Periodically review the Erosion and Sediment Control Plan to ensure it stays current.
(C12-3)	Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build-up of sediment in such waters.	The following principles provide the foundation for the Mt Leyshon Mine Erosion and Sediment Control Plan: ▪ Minimise surface disturbance and restrict access to undisturbed areas; ▪ Progressively rehabilitate and stabilise disturbed areas with vegetation; ▪ Separate catchment runoff from disturbed and undisturbed areas where practicable; ▪ Reduce potential for erosion through velocity controls and reduced runoff	Continue to follow procedure and implement appropriate controls in accordance with the site Erosion and Sediment Control Plan.

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		volume; ▪ Use of suitably sized and protected drainage structures to manage surface runoff; ▪ Use of existing onsite containment structures for the capture of sediment laden surface water runoff; and ▪ Regular monitoring and maintenance to ensure continual operation of the individual erosion and sediment control elements.	
(C12-4)	Erosion protection measures and sediment control measures must be implemented and maintained to minimise erosion and the release of sediment and contamination of storm water.	The following principles provide the foundation for the Mt Leyshon Mine Erosion and Sediment Control Plan: ▪ Minimise surface disturbance and restrict access to undisturbed areas; ▪ Progressively rehabilitate and stabilise disturbed areas with vegetation; ▪ Separate catchment runoff from disturbed and undisturbed areas where practicable; ▪ Reduce potential for erosion through velocity controls and reduced runoff volume; ▪ Use of suitably sized and protected drainage structures to manage surface runoff; ▪ Use of existing onsite containment structures for the capture of sediment laden surface water runoff; and ▪ Regular monitoring and maintenance to ensure continual operation of the individual erosion and sediment control elements.	Continue to follow procedure and implement appropriate controls in accordance with the site Erosion and Sediment Control Plan.
	Groundwater Monitoring Program		
(C13-1)	By 30 November 2013 the holder of this environmental authority must submit a groundwater monitoring program to the administering authority that must include: (a) groundwater monitoring bore locations; (b) justification for the location of the proposed groundwater monitoring locations, including, but not limited to; i) sufficient background/reference monitoring sites, that are unaffected by the mining activity authorised under this environmental authority to allow scientifically justifiable conclusions on the level of impact from the mining activity; ii) natural/un-impacted flow assessment of all watercourses affected by mining activity; and iii) sufficient number of monitoring bores to enable early detection of any groundwater contamination. (c) monitoring of both shallow and deep groundwater and includes an adequate number of monitoring bores which provides sufficient spatial coverage to enable scientifically justifiable conclusions in relation to potential environmental impacts from the mining activity; (d) provision for development of baseline groundwater quality, groundwater flow direction and rate and hydraulic conductivity. In addition, consideration must be given to how these parameters may change during the life of the mining project. (e) characterisation of the potential impacts to the local	The Groundwater Monitoring Plan was submitted to the administering authority (Laura Rehn) 26 September 2013, which met the requirements of condition C13-1.	Complete

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	groundwater system arising from the mining activity; (f) representative groundwater samples for the aquifers being sampled; (g) bore construction details; and findings from any resistivity studies undertaken at the licensed place		
(C13-2)	The groundwater monitoring program specified in condition (C13-1) must be independently certified by an appropriately qualified person.	Certification of the Groundwater Management Plan (by Big Dog Hydrogeology Pty Ltd) was submitted to the administrating authority (Laura Rehn) 19 December 2013.	Complete
(C13-3)	The Groundwater Monitoring Program must be reviewed at least once a year before 1 October to ensure that proper and effective measures, practices or procedures are in place so that the mine is operated in accordance with the conditions of this environmental authority and that environmental harm is prevented or minimised.	The Groundwater Management Plan is scheduled for review, currently by Big Dog Hydrogeology Pty Ltd, prior to 1 October each year.	Continue to review the Groundwater Monitoring Plan annually in accordance with condition C13-3.
	Monitoring bore construction, maintenance and decommissioning		
(C14-1)	Groundwater monitoring bores must be constructed, maintained and decommissioned in accordance with methods prescribed in the latest edition of the Agriculture and Resource Management Council of Australia and New Zealand manual titled Minimum Construction Requirements for Water Bores in Australia.	19 bores were decommissioned by a licensed water driller in 2016. No new groundwater monitoring bores or replacements are planned. Big dog Hydrogeology Pty Ltd (Newmont's groundwater specialist) is aware of the Minimum Construction Requirements for Water Bores in Australia.	Construct, maintain and decommission water bores in accordance with Australian and New Zealand standards if applicable.
(C14-2)	Oil-based drilling fluids, oil-based additives, synthetic based drilling fluids or synthetic based additives must not be used in the construction of groundwater monitoring bores.	Not applicable – no bore construction is planned for the term of the plan of operations	Not applicable – no bore construction is planned for the term of the plan of operations
(C14-3)	Current Material Safety Data Sheets for all substances used for the drilling of groundwater monitoring bores must be made available to the administering authority promptly upon request.	Not applicable – no bore construction is planned for the term of the plan of operations	Not applicable – no bore construction is planned for the term of the plan of operations
(C14-4)	Remedial measures must be taken immediately if the holder of this environmental authority becomes aware that either monitoring bore construction, maintenance or decommissioning have resulted in a change in groundwater quality, groundwater levels or have caused the interconnection of aquifers.	Remedial measures will be undertaken if Newmont becomes aware that either monitoring bore construction, maintenance or decommissioning have resulted in a change in groundwater quality, groundwater levels or have caused the interconnection of aquifers.	Remedial measures will be undertaken Newmont becomes aware that either monitoring bore construction, maintenance or decommissioning have resulted in a change in groundwater quality, groundwater levels or have caused the interconnection of aquifers.
	Groundwater monitoring		
(C15-1)	Groundwater quality and level must be monitored at the locations and frequencies defined in Schedule C – Table 12 (Groundwater Monitoring Locations and Frequency) for quality characteristics identified in Schedule C – Table 13 (Groundwater contaminant and trigger limits)	The Newmont document "Mt Leyshon EA - Procedures for Monitoring, Notification and Reporting", describes the monitoring requirements to conform with C15-1, including frequency and locations for groundwater monitoring.	Continue to follow the Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting", which specifies requirements for groundwater monitoring.
(C15-2)	If quality characteristics of groundwater from compliance bores identified in Schedule C – Table 12 Groundwater Monitoring Locations and Frequency) exceed any of the trigger levels stated in Schedule C – Table 13 (Groundwater contaminant and trigger limits), the holder of this environmental authority must complete an investigation in accordance with the ANZECC and ARMCANZ 2000, into the potential for environmental harm and provide a written report to the administering authority within three (3) months, outlining: i) details of the investigations carried out; ii) details of environmental impacts observed; and	The Newmont document "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" states the reporting requirements in the event of any groundwater exceedances. Big Dog Hydrogeology (BDH) is currently commissioned to complete these reports, with input from Newmont personnel and aquatic ecologists from Tropwater (James Cook University).	In the event that groundwater results exceed any of the trigger levels specified in Schedule C – Table 9, comply with the procedure "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting" and condition C15-2.

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	iii) actions taken to prevent environmental harm. *Note: Where an exceedence of a trigger level has occurred and is being investigated, in accordance with clause (b) of this condition, then no further reporting is required for subsequent trigger events for that quality characteristic within the three month investigation period.* *Note: Investigations maybe undertaken to develop impact-based limits in accordance with ANZECC methodology (ANZECC guidelines – Chapter 3.5.1).*		
(C15-3)	Results of monitoring of groundwater from compliance bores identified in Schedule C – Table 12 (Groundwater Monitoring Locations and Frequency), must not exceed any of the limits defined in Schedule C – Table 13 (Groundwater contaminant and trigger limits).	The actions which have been undertaken in response to the groundwater exceedance in the past include: 1. Newmont own the land underlying and surrounding the mine lease, and continue to take the action of retaining control of the pastoral water supply bores which are within or down-gradient of the zone of mine influenced groundwater and ensuring that groundwater is not abstracted for potable use or for stock watering. 2. Vegetation health across the mine lease area is informally inspected during routine maintenance and management of the site, including weed inspections, maintaining access tracks and fire breaks, and maintaining the mine water management system, which provides warning of any influence of groundwater quality on vegetation. A formal vegetation monitoring scheme has been defined in the Receiving Environment Monitoring Plan 3. The mine water management system is routinely inspected to identify the occurrence of any flows which could be an expression of groundwater at surface (such as the seeps at the LS-A pond) and to ensure that these components are retained within the mine water management system and not released to the environment. 4. Sampling of surface water quality is undertaken during flow events, as required under the EA. Interpretations of these surface water samples, and any resulting investigations into the potential for environmental harm, take account of the possibility that groundwater discharge may be a potential contribution to the surface water quality.	The current control strategies will continue to be applied throughout the term of the PoO.
	Annual Groundwater Monitoring Report		
(C16-1)	The holder of this environmental authority must complete an annual groundwater monitoring report by 1 February each year and submit this report to the administering authority. The report be prepared by an appropriately qualified person and must address the following requirements as a minimum: (a) analyses of groundwater chemistry and hydrogeological data for all groundwater monitoring bores required in condition (C15-2) (b) identify exceedence of any contaminant trigger levels or limits listed in Schedule C – Table 13 (Groundwater contaminant and trigger limits); (c) discuss effectiveness of the current groundwater monitoring regime and any improvements that could be made to ensure	Big Dog Hydrogeology Pty Ltd is commissioned to complete the Annual Groundwater Monitoring Reports.	Continue to complete the annual groundwater reports prior to 1 February each year in accordance with C16-1.

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	early detection of impacts to groundwater; (d) detail proposed actions and timeframes to undertake further investigation of potential environmental impacts for any exceedence identified; (e) detail proposed mitigation measures for any detected impact to groundwater resulting from the mining activity; (f) changes in groundwater levels plotted as a function of time to identify seasonal patterns and possible draw-down effects; (g) groundwater elevation contours and flow direction; and (h) interpretation and discussion of exceedence of any contaminant trigger levels or limits listed in Schedule C – Table 13 (Groundwater contaminant and trigger limits) and the implications for compliance with this environmental authority.		
(C16-2)	The method of sampling of groundwater must comply with that set out in the latest edition of the Administering Authority's Water Quality Sampling Manual.	The last EA audit undertaken by Engeny Pty Ltd in 2018 identified that groundwater sampling procedures undertaken at Mt Leyshon comply with Administering Authority's Water Quality Sampling Manual.	Continue to comply with the Administering Authority's Water Quality Sampling Manual.
	Saline, acid and metalliferous drainage		
(C17-1)	The holder of this environmental authority must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of saline, acid and/or metalliferous mine drainage as a result of the mining activity.	The Sulphate Management Plan details methods to avoid or minimise the generation and release of acid and metaliferous drainage from the mine site. These control strategies include: 1. Continued operation and calibration of the mine water management system, to minimise the potential for overtop of containment dams, and to calibrate the operation of high flow bypass systems. 2. Surface water mapping and re-routing to remove any point discharge sources of sulphate to the environment. 3. Upgrading facility drainage to minimise infiltration through the covers which drives seepage entering the groundwater system. 4. Ongoing facility rehabilitation to minimise sediment migration. 5. Control of access to groundwater to reduce the likelihood of impacts within the extent of the sulphate influenced groundwater zone, with the current and future extent of this zone being well defined from the detailed groundwater investigation programme, and being within Newmont owned and controlled properties.	Avoid or minimise the generation and/or release of AMD by implementing the actions described under control strategy.
	Schedule D – Noise and Vibration: Noise Nuisance		
(D1-1)	Noise from the mining activity must not cause an environmental nuisance, at any sensitive or commercial place.	Mt Leyshon is a closed mine site and is not undertaking activities that typically generate significant noise (e.g. haul truck movements, blasting etc.) Newmont has acquired the surrounding properties around Mt Leyshon and therefore no nearby sensitive or commercial places exist.	Not Applicable
	Schedule E – Waste: Waste Management Program		
(E1-1)	A waste management program in accordance with Part 5 of the *Environmental Protection (Waste Management) Policy 2000* must be developed, implemented and maintained for all mining activities. The waste management program must be submitted to the administering authority (To be provided to the administering authority by 28 February 2014 and be included in each	The Waste Management Plan was submitted to the administering authority (Laura Rehn) 26 February 2014.	Complete. The Waste Management Program is periodically reviewed

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	subsequent Plan of Operations. The program must include: (a) a description of the mining activities that may generate waste; (b) waste management control strategies including; i) recording of the types and amounts of wastes generated by the mining activities; ii) segregation of the wastes; iii) storage of the wastes; iv) transport of the wastes; v) monitoring and reporting matters concerning the waste. (c) the hazard characteristics of the wastes generated including disposal procedures for hazardous wastes; (d) a program for reusing, recycling or disposing of all wastes; (e) how the waste will be dealt with in accordance with the waste management hierarchy, including a description of the types and amounts of waste that will be dealt with under each of the waste management practices in the waste management hierarchy (i.e. avoidance, reuse, recycling, energy recovery, disposal); (f) procedures for identifying and implementing opportunities to minimise the amount of waste generated, promote efficiency in the use of resources and improve the waste management practices employed; (g) procedures for dealing with accidents, spills, and other incidents that may impact on waste management; (h) details of any accredited management system employed, or planned to be employed, to deal with the waste; (i) how often the performance of the waste management practices will be assessed; (j) the indicators or other criteria on which the performance of the waste management practices will be assessed; and (k) staff training and induction to the waste management program.		
	Off Site Movement of Regulated Wastes		
(E2-1)	Where regulated waste is removed from the licensed place (other than by a release as permitted under another schedule of this environmental authority), the holder of this environmental authority must ensure that: (a) the removal and transport of such wastes, where it constitutes an environmentally relevant activity under the Environmental Protection Regulation 2008, is carried out by a person licensed for carrying out this activity under the Environmental Protection Act 1994; (b) records are kept of the following: i) the date, quantity and type of waste removed; ii) name of the regulated waste transporter that removed the waste; and iii) the intended treatment/disposal destination of the waste. *Note: Records of documents maintained in compliance with a waste tracking system established under the*	Transpacific Industries (licenced contractor) is responsible for the removal and disposal of regulated waste generated at Mt Leyshon, as detailed in the Waste Management Plan.	Continue to follow procedures detailed in the Waste Management Plan.

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	Environmental Protection Act 1994 or any other law for regulated waste will be deemed to satisfy this environmental authority condition.		
(E2-2)	Regulated waste awaiting removal may be temporarily stored on site.	The storage area for regulated hydrocarbon waste is located next to the maintenance workshop.	Continue to temporarily store regulated waste next to the maintenance workshop and follow regulated waste transport requirements.
(E2-3)	Each container of regulated waste stored awaiting movement off-site must be clearly marked to identify the contents.	The regulated waste containers are marked to identify the contents.	Any new containers will be marked to identify the contents.
	Notification of Improper Disposal of Regulated Waste		
(E3-1)	If the holder of this environmental authority becomes aware that a person has removed regulated waste from the licensed place and disposed of the regulated waste in a manner which is not authorised by this environmental authority or improper or unlawful, then the holder of this environmental authority must, as soon as practicable, notify the administering authority of all relevant facts, matters and circumstances known concerning the disposal	Mt Leyshon is a closed site and most times there is only 2 staff present. In the unlikely event that a person has removed regulated waste from the site and disposed of the waste in a manner which is not authorised by this environmental authority or is improper or unlawful, then Newmont will notify the administering authority of all relevant facts, matters and circumstances known concerning the disposal.	Comply with condition E3-1.
(E3-2)	Regulated waste generated by maintenance of plant and equipment and absorbent materials used to clean up spills must only be disposed of at a facility whose operator is permitted to accept such waste in accordance with the requirements of the *Environmental Protection Act 1994.*	Regulated wastes include waste oil, filters, and rags which are disposed as per E2-1. Waste disposal is conducted at Lot 551 Plan EP2062, 77-97 Enterprise Street, Bohle QLD 4818 (Certificate of Registration No: ENRE00266205 issued by the Environmental Protection Agency effective from 10-MAY-2005 for registered operator NQ Resource Recovery Pty Ltd).	Regulated waste will continue to be disposed of at Lot 551, or another licenced facility.
	Other Wastes		
(E4-1)	The only wastes that may be disposed of onsite are those authorised under this Environmental Authority.	The only wastes that may be disposed of on-site are those authorised under this Environmental Authority.	The only wastes that may be disposed of on-site are those authorised under this Environmental Authority.
	General waste disposal		
(E5-1)	All waste (other than mined waste rock and tailings or their derivatives) produced as part of the mining operation must be transported to the Charters Towers licensed waste disposal facility or another lawful facility and disposed of correctly at a minimum on a monthly basis.	All general waste is disposed of at the council waste disposal facility which is a government licenced facility.	Continue to dispose of general waste at the licenced government facility (council landfill).
(E5-2)	The environmental authority holder shall not cause, allow or permit any waste generated outside the mine to be received at the mine for storage, treatment, processing or disposal.	No waste is received onsite and the gate is locked outside of operating hours.	Continue to control access to site.
	Tailings Management		
(E7-1)	Tailings must be managed in accordance with procedures contained within the current plan of operations. These procedures must include provisions for: (a) Containment of tailings in accordance with design plans for each storage facility; (b) The management of seepage and leachates both during operation and post closure; (c) The control of fugitive emissions to air; (d) Rehabilitation strategy which meets the rehabilitation objectives specified in Schedule F; and (e) Monitoring of rehabilitation, research and/or trials to verify the requirements and methods for decommissioning and final rehabilitation of tailings, including the prevention and management of acid drainage, erosion minimisation and establishment of vegetation cover.	The operating strategy for tailings deposition was similar for all of the conventional on-land impoundments at the Mt Leyshon mine. The strategy followed industry standard protocols, and took account of the highly seasonal nature of precipitation conditions at the mine. Components of the operating strategy designed to minimise the risk of emissions were: • Slope angles applied during construction of the starter embankments and subsequent lifts were selected to ensure physical stability of the impoundments under all conditions, including potential liquefaction during seismic events. • A decant pumping system was operated to return supernatant water to the plant, to minimise the pond volume on the facility, and mitigate the risk of overtopping cyanide containing process solutions from the facility. • Tailings deposition was sub-aerial, with beaching employed to	Continue to manage tailings in accordance with the Newmont document "Mt Leyshon Tailings Management Strategy".

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		maximise the strength of the deposited tailings near the embankment, to improve the strength of the embankment during subsequent lift construction. • The planned lift schedule for each facility was compared against potential precipitation which may have been received in the future wet seasons, to ensure that sufficient freeboard capacity was maintained to accommodate all potential inflows. • The tailings stream and decant pond were maintained at a high pH by the addition of lime in the plant, to ensure the stability of cyanide in the decant pond, and to mitigate against the risk of fugitive emissions of hydrogen cyanide gas. • Monitoring bores were installed down-gradient of all facilities, and groundwater elevations and groundwater quality were monitored to identify the influence of any seepage potentially entering the groundwater system. Reference should be made to the Plan of Operations Newmont document "Mt Leyshon Tailings Management Strategy" for more detail.	
	Schedule F – Land: General		
(F1-1)	Contaminants that will or may cause environmental harm must not be directly or indirectly released to land except as permitted under this environmental authority.	No contaminants are released to land.	Not applicable. No contaminants are released to land.
(F1-2)	Any spillage of wastes, contaminants or other materials must be cleaned up as quickly as practicable. Such spillages must be cleaned up using dry methods that minimise the release of wastes, contaminants or materials to any stormwater drainage system, roadside gutter or waters.	Spill response processes are detailed in the Emergency Response Plan.	Follow the Emergency Response Plan in the event of any significant spills. A spill response kit will be used to contain and clean-up any minor hydrocarbon spills during the term of the Plan of Operations.
(F1-3)	The holder of this environmental authority must develop and submit to the administering authority a plan for the remediation or processing of the scats stockpile by 30 October 2013.	The Scats Stockpile Remediation Plan was submitted to the administering authority (Laura Rehn) 29 October 2014. A revised version was submitted to EHP (Genevieve Tassan) 27th June 2017.	Undertake activities in accordance with the Scats Stockpile Remediation Plan.
	Rehabilitation landform criteria		
(F2-1)	Land disturbed by mining must be rehabilitated in accordance with Schedule F - Table 1 (Rehabilitation Requirements).	Refer to the Closure Plan submitted to the administering authority (Shalika Walker) 30 June 2014, and 2019 version submitted with this PoO.	Adhere to the Mt Leyshon Closure Plan and revised Scats Stockpile Remediation Plan (2017).
(F2-2)	Progressive rehabilitation must commence when operational areas become available in accordance with the plan of operations.	Mt Leyshon is in an advanced stage of rehabilitation and final decommissioning. Rehabilitation is mainly undertaken to rectify poor performing covers. Some areas are not available for rehabilitation due to long-term management requirements e.g. offices, dams. Areas requiring rehabilitation or maintenance work have been scheduled.	Undertake rehabilitation in accordance with the works schedule.
(F2-3)	Rehabilitated areas must be managed to minimise the proliferation of species not consistent with rehabilitation objectives.	Reference should be made to the control strategies detailed in the Pest Management Plan submitted to the administering authority (Laura Rehn) 26 February 2014.	Undertake the activities detailed in the Pest Management Plan.
(F2-4)	All land subject to mining activities must be rehabilitated to: (a) a stable landform and with a self-sustaining vegetation cover and species that are similar to adjoining undisturbed areas;	Refer to the Closure Plan submitted to the administering authority (Shalika Walker) 30 June 2014.	Adhere to the Mt Leyshon Closure Plan (2019) and revised Scats Stockpile Remediation Plan (2017).

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	(b) a safe landform, which is non-polluting, geo-chemically and geo-technically stable. (c) ensure that all land is reinstated to the pre-disturbed land use and suitability class (Land Suitability Assessment Techniques); (d) ensure that the maintenance requirements for rehabilitated land is no greater than that required for the land prior to its disturbance by mining activities; and (e) ensure that the water quality of any residual void or water bodies constructed by mining activities meets criteria for subsequent uses and does not have potential to cause environmental harm.		
(F2-5)	Maintenance of rehabilitated areas must take place to ensure and demonstrate: (a) stability of landforms; (b) erosion control measures remain effective; (c) stormwater runoff and seepage from rehabilitated areas does not negatively affect the environmental values of any waters; (d) plants show healthy growth and recruitment is occurring; and (e) e) rehabilitated areas are free of any declared pest plants.	Refer to the Closure Plan submitted to the administering authority (Shalika Walker) 30 June 2014.	Adhere to the Mt Leyshon Closure Plan (2019) and revised Scats Stockpile Remediation Plan (2017).
(F2-6)	Rehabilitation can be considered successful when: (a) the site can be managed for its designated land-use (e.g. similar to that of surrounding undisturbed areas); (b) the rehabilitation is carried out in accordance with the goals, objectives indicators and completion criteria as specified in Schedule F – Table F1 and in the Post Mine Land Use Plan; and (c) written agreement is obtained from the landowner/holder and administering authority.	Refer to the Closure Plan submitted to the administering authority (Shalika Walker) 30 June 2014.	Adhere to the Mt Leyshon Closure Plan (2019) and revised Scats Stockpile Remediation Plan (2017).
	Topsoil		
(F3-1)	Topsoil and subsoil stockpiles must be managed to ensure stability and minimise the release contaminants. Measures must include: (a) vegetating stockpiles; (b) minimising the height of stockpiles: and (c) re-using stockpiles as soon as possible.	The growth media stockpiles are mostly vegetated and of moderate height (2-3 m). Growth media is scavenged as required.	Continue to manage growth media as per site procedures.
	Post Mine Land Use Plan		
(F4-1)	The holder of this environmental authority must develop and submit to the administering authority by 30 June 2014 a Post Mine Land Use Plan (PMLUP) with the Plan of Operations and update the plan with each subsequent Plan of Operations. The PMLUP must describe how the rehabilitation objectives in Schedule F - Table F1 (Rehabilitation Requirements) will be achieved. The Post Mine Land Use Plan must include: (a) schematic representation of final land form inclusive of drainage features; and (b) slope designs; and (c) cover design; and (d) drainage design; and (e) erosion controls proposed on reformed land; and (f) description of experimental design for monitoring of analogue and rehabilitated areas inclusive of statistical	Refer to the Closure Plan submitted to the administering authority (Shalika Walker) 30 June 2014. The PMLUP and the PCMP have several elements in common, and have therefore been combined for the Mt Leyshon mine, and are both included in the Closure Plan document. This Closure Plan has been submitted to EHP to satisfy the requirements of conditions F4-1 and F10-1 of the EA.	Adhere to the Mt Leyshon Closure Plan (2019) and revised Scats Stockpile Remediation Plan (2017).

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	design; and (g) proposed revegetation criteria including : i) species diversity, abundance and composition, ii) projective cover, iii) dry matter production and iv) stocking rates to ensure self-sustaining vegetation is maintained; (h) proposed revegetation methods inclusive of plant species selection, re-profiling, respreading soil, soil ameliorants/amendments, surface preparation and method of propagation; and (i) materials balance including available top soil and low permeability capping material ; and (j) research program and associated milestones. (k) geotechnical, geochemical and hydrological studies; (l) chemical, physical and biological properties of soil and water; (m) clear objectives and success criteria for the each land unit including establishment in accordance with outcomes stipulated in the Administering Authority's Guideline for Rehabilitation Requirements for Mining Projects; (n) measurable completion criteria for each rehabilitation indicator (for each land unit) that enables determination of rehabilitation success for each disturbance type (or land unit); (o) rehabilitation monitoring program.		
	Rehabilitation Monitoring Program		
(F5-1)	A rehabilitation monitoring program must be developed and be implemented on commencement of rehabilitation identified in Schedule F – Table F1(Rehabilitation Requirements) by a person nominated by the holder of this environmental authority possessing appropriate qualifications and experience in the field of mine site rehabilitation.	In 2013 Outback Ecology, a division of MWH Australia Pty Ltd, were commissioned to implement a monitoring program to meet conditions F5-1, F5-2 and F5-3 of Environment Authority EPML00863713. The methodology, including cover monitoring consists of the following: • Each landform is separated into sub-domains, each comprising a particular age of rehabilitation, lift, vegetation community or aspect. In total, rehabilitation sub-domains on eleven landforms have been identified in addition to three analogue areas that are used as reference sites. • On each sub-domain monitoring involves assigning a scale based score to a range of parameters relating to landform and soil surface characteristics, vegetation condition and structure, declared weeds and erosion. Each parameter score ranges from one to five, with one representing the highest score possible. For example the soil surface stability scores ranged from Unstable (one point) through to Very Stable (five points). • An aggregated numerical score of 20 parameters (maximum score of 100) is assigned to each sub-domain so changes in rehabilitation condition can be detected over time. All parameters are treated equally with no numerical weighting • In addition to the scale base assessment, the monitoring consists of: o Photo-point monitoring of existing EFA transects	Undertake rehabilitation monitoring annually in accordance with F5-1. Periodically review the rehabilitation monitoring program and investigate the use of innovative technologies, like remote sensing, to achieve improved monitoring outcomes.

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		○ Way-pointing and photographing erosion gullies ○ Way-pointing declared weed species ○ Documentation of other potential factors affecting condition (e.g. tree death) ○ Incidental notes relating to vegetation and landform condition including the observation of fauna or surface expression of potentially hostile material.	
(F5-2)	The holder of this environmental authority must conduct rehabilitation monitoring in accordance with the program developed in Condition (F5-1) on at least a yearly basis which must include sufficient spatial and temporal replication to enable scientifically justifiable conclusions as established under the rehabilitation program or other methodology to the satisfaction of the administering authority.	The results of statistical analysis are presented in the annual monitoring reports.	Conduct rehabilitation monitoring in accordance with the program developed in Condition (F5-1) on at least a yearly basis.
(F5-3)	Verification of rehabilitation success is to be carried out for each domain. Monitoring must be carried out for each domain at a minimum sampling intensity of 1:15,000 and must include sufficient replication to enable statistical analysis of results at an acceptable power.	Monitoring is conducted over a 10,000 m^2 (1 ha) area at each sampling point. For example, one sampling point on a 22 ha area would be 1:22.	Monitoring will be carried out for each domain at a minimum sampling intensity of 1:15,000.
	Pest management		
(F6-1)	In carrying out the mining activities the holder of this environmental authority must develop and implement an effective pest management program by 28 February 2014 that includes but is not limited to the following: (a) identification of pest species and infestation areas; (b) prevents and/or minimises the introduction and/or spread of pests; and (c) control and management of pest outbreaks as a result of mining activities including measures to ensure that all vehicle movements are controlled to prevent the spread of declared weeds; and (d) strategies to prevent introduction of declared weeds to the mine site and surrounding areas.	The Pest Management Plan was submitted to the administering authority (Laura Rehn) 26 February 2014 and includes the elements required in condition F6-1	The Pest Management Program will continue throughout the term of the Plan of Operations.
(F6-2)	A copy of the pest management program must be made available to the administering authority on request.	The Pest Management Plan was submitted to the administering authority (Laura Rehn) 26 February 2014.	Complete. Periodic reviews of the plan will be undertaken.
	Infrastructure		
(F7-1)	All infrastructure, mining equipment and processing plant constructed by or for the environmental authority holder during the mining activities including water storage structures must be removed from the site prior to mining lease surrender, except where agreed to in writing by the post mining landholder.	Not applicable during the term of this Plan of Operations	Not applicable during the term of this Plan of Operations.
	Contaminated Land		
(F8-1)	Upon decommissioning the environmental authority holder must undertake a contaminated land assessment / investigation of the licensed place in accordance with the Administering Authority Guidelines for the Assessment & Management of Contaminated Land in Queensland.	Not applicable during the term of this Plan of Operations	Not applicable during the term of this Plan of Operations.

	EA CONDITION	CONTROL STRATEGY	ACTION PROGRAM
	Residual Void Outcome		
(F9-1)	Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself, and subject to any other condition within this environmental authority.	Reference should be made to the Plan of Operations document "Final Void Decommissioning Strategy".	Adhere to the Mt Leyshon Final Void Decommissioning Strategy.
(F9-2)	Mining voids must be managed during the operation and decommissioning phases to maximise the potential post mine beneficial uses, by consideration of the following: (a) limiting sulphide exposures in void walls; and (b) capping of sulphide exposures in void base; and (c) limiting period of exposure of sulphides in void walls and base to oxidising conditions; and (d) managing catchment into the void; and (e) geo-technical stability of final void.	Reference should be made to the Plan of Operations document "Final Void Decommissioning Strategy".	Adhere to the Mt Leyshon Final Void Decommissioning Strategy.
(F9-3)	Decommissioning strategies for the final voids must be provided in the Plan of Operations including the following information: (a) final potential wall and base rock exposure quality in terms of acid producing potential and levels of environmentally relevant salts and metals; and (b) expected periods of exposure for wall and base rock with acid producing potential; and (c) management options for maximising final void water quality; and (d) assessment of potential final void water quality.	Reference should be made to the Plan of Operations document "Final Void Decommissioning Strategy".	Adhere to the Mt Leyshon Final Void Decommissioning Strategy.
(F9-4)	Decommissioning strategies for the final voids must be updated with each update of the Plan of Operations.	Reference should be made to the Plan of Operations document "Final Void Decommissioning Strategy".	Adhere to the Mt Leyshon Final Void Decommissioning Strategy.
	Post Closure Management Plan		
(F10-1)	A Post Closure Management Plan for the site must be prepared by 30 June 2014 and implemented for a nominal period of: (a) At least thirty (30) years following final production on site; or (b) A shorter period if the site is proven to be geo-technically and geo-chemically stable and it can be demonstrated to the satisfaction of the administering authority that no release of contaminants from the site will result in environmental harm and be prepared at least 6 months prior to final production onsite.	The PMLUP and the PCMP have several elements in common, and have therefore been combined for the Mt Leyshon mine, and are both included in the Closure Plan document. This Closure Plan has been submitted to EHP 30 June 2014 to satisfy the requirements of conditions F4-1 and F10-1 of the EA.	Complete.
(F10-2)	The Post Closure Management Plan must include the following elements: (a) operation and maintenance of: i) wastewater collection and reticulation systems; ii) wastewater treatment systems; iii) the groundwater monitoring network; iv) final cover systems; and v) vegetative cover. (b) monitoring of: i) surface water quality; ii) groundwater quality; iii) seepage rates; iv) erosion rates; v) the integrity and effectiveness of final cover systems;	The PMLUP and the PCMP have several elements in common, and have therefore been combined for the Mt Leyshon mine, and are both included in the Closure Plan document. This Closure Plan has been submitted to EHP 30 June 2014 to satisfy the requirements of conditions F4-1 and F10-1 of the EA.	Complete.

	EA CONDITION	CONTROL STRATEGY	ACTION PROGRAM
	and vi) the health and resilience of vegetative cover.		
	Storage and Handling of Flammable and Combustible Liquids		
(F11-1)	All explosives, hazardous chemicals, corrosive substances, toxic substances, gases, dangerous goods, flammable and combustible liquids must be stored and handled in accordance with the relevant Australian Standard where such is available.	The chemical storage shed is kept locked when not in use, has appropriate signage and concrete flooring.	Hazardous materials will continue to be stored in accordance with Australian Standards.
(F11-2)	Notwithstanding the requirements of any Australian Standard, any liquids stored on site that have the potential to cause environmental harm must be stored in or serviced by an effective containment system that is impervious to the materials stored and managed to prevent the release of liquids to waters or land. Where no relevant Australian Standard is available, the following must be applied: (a) storage tanks must be bunded so that the capacity and construction of the bund is sufficient to contain at least 110% of a single storage tank or 100% of the largest storage tank plus 10% of the second largest storage tank in multiple storage areas; and (b) All chemical product drum storages must be bunded so that the capacity of the bund is sufficient to contain at least 100% of the maximum design storage volume within the bund.	Hazardous liquids are stored within bunded areas. The Trans-tanks used for bulk diesel storage are double walled and inspected by qualified specialists routinely to maintain compliance certification.	Hazardous materials will continue to be stored in accordance with Australian Standards.
(F11-3)	All containment systems for chemicals and flammable or combustible liquids must be designed to minimise rainfall collection within the system.	Bunded storages have sheds with roof covers installed to minimise rainfall collection. The Trans-tanks diesel storage is completely enclosed in bladders with leak detection.	Complete.
(F11-4)	Spillage of any contaminant must be contained and rectified to prevent environmental harm.	Spill kits are available on-site and will be used for containment and clean-up of any minor spills. Earthmoving equipment kept on site can be used to construct bunds for containment and clean-up any larger spills.	Keep spill kits well stocked. Follow the Emergency Response Plan in the event of any significant spill.
	Schedule G – Community: Complaint Response		
(G1-1)	All complaints received must be recorded including details of complainant, reasons for the complaint, investigations undertaken, conclusions formed and actions taken. This information must be made available for inspection by the administering authority on request.	Newmont maintains a complaints register and will investigate all complaints received (which are neither frivolous, nor vexatious, nor based on mistaken belief).	Record and investigate complaints in accordance with G1-1.
	Complaints and Community		
(G2-1)	Records must be kept of all environmental complaints received about the mining activities including the following details: (a) name, address and contact number for complainant (if not available record - not identified); (b) time and date of complaint; (c) reasons for the complaint; (d) investigations undertaken; (e) conclusions formed; (f) actions taken to resolve complaint; (g) any abatement measures implemented; and	Newmont maintains a complaints register and will investigate all complaints received (which are neither frivolous, nor vexatious, nor based on mistaken belief), which includes the items listed under G2-1.	Record complaints in accordance with G2-1

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	(h) person responsible for resolving the complaint.		
(G2-2)	Information required in G2-1 must be available for inspection by the administering authority on request.	Information required in G2-1 will be available for inspection by the administering authority on request.	Make available for inspection by the administering authority on request the complaints register.
(G2-3)	When requested by the administering authority, the environmental authority holder must undertake relevant specified monitoring within a timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental harm. The results of the investigation (including an analysis and interpretation of the monitoring results) and abatement measures implemented must be provided to the administering authority within fourteen (14) days of completion of the investigation.	Undertake monitoring in accordance with G2-3 if requested by the administering authority.	Undertake monitoring in accordance with G2-3 if requested by the administering authority.
(G2-4)	The holder of this environmental authority must establish, promote and maintain easily accessible lines of communication between residents, relevant stakeholders and land owners to ensure that social impacts are identified and managed.	Newmont purchased all adjacent pastoral properties in 2011, so the nearest neighbour is now some distance from the mining lease. Newmont maintains accessible lines of communication with landholders adjacent to Newmont owned properties.	Continue to maintain accessible lines of communication with all stakeholders.
	Schedule H – Dams: Assessment of Hazard Category		
(H1-1)	The consequence category of any structure must be assessed by a suitably qualified and experienced person in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635) at the following times: (a) prior to the design and construction of the structure, if it is not an existing structure; or (b) if it is an existing structure, prior to the adoption of this schedule; or (c) prior to any change in its purpose or the nature of its stored contents.	The water containment dams and seepage sumps were constructed prior to the release of the *Manual for Assessing Consequence Categories and Hydraulic Performance Structures (EM 635)*. The consequence categories of the water containment dams and seepage sumps were assessed by Engeny Water Management in 2014 (*Mt Leyshon Mine – Consequence Category Assessment of Water Storage*, 22 August 2014) prior to the date of effect of the current EA. The consequence category assessment was undertaken in accordance with the current version (Version 4) of the Manual for Assessing Consequence Categories and Hydraulic Performance Structures. In 2014, the consequence category assessment identified six regulated dams at the mine (Settlement Dam, Supergene Dam, Plum Tree Creek Dam, Raw Water Dam, Mt Mawe Dam and Mt Hope Dam).	As required, assess the consequence categories of the water storage structures at the Mt Leyshon Mine in accordance with the most recent version of the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures.
(H1-2)	A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.	The consequence category assessments for the water containment dams and seepage sumps were summarised in the report *Mt Leyshon Mine – Consequence Category Assessment of Water Storages* (Engeny Water Management, 22 August 2014). A certification statement by the suitably qualified and experienced person who performed the consequence category assessment was included in Appendix D of the consequence category assessment report.	Engeny's 2014 consequence category assessment included a certified assessment report in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures.
(H1-3)	Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635).	A certification statement by the suitably qualified and experienced person who performed the consequence category assessment was included in Appendix D of the consequence category assessment report. The certification statement was in the form specified in the *Manual for Assessing Consequence Categories and Hydraulic Performance Structures*.	Engeny's 2014 consequence category assessment included a certification statement by a suitably qualified and experienced person in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures.

	EA CONDITION	CONTROL STRATEGY	ACTION PROGRAM
(H2-1)	Conditions (H2-2) to (H2-6) inclusive do not apply to existing structures.	All regulated structures are existing structures constructed prior to the date of commencement of the EA. This condition confirms that the retrospective certification of the design and construction of existing dams is not required.	No action required.
(H2-2)	All regulated structures must be designed by, and constructed under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635).	This condition applies to new regulated structures or modification of existing regulated structures. No new regulators structures are planned to be built or modified during the term of this Plan of Operations.	If any modifications are made to existing regulated structures, then they will be undertaken in accordance with the requirements of H2-2.
(H2-3)	Construction of a regulated structure is prohibited unless the holder has submitted a consequence category assessment report and certification to the administering authority has been certified by a suitably qualified and experienced person for the design and design plan and the associated operating procedures in compliance with the relevant condition of this authority.	This condition applies to new regulated structures or modification of existing regulated structures. No new regulators structures are planned to be built or modified during the term of this Plan of Operations.	If any modifications are made to existing regulated structures, then they will be undertaken in accordance with the requirements of H2-3.
(H2-4)	Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635), and must be recorded in the Regulated Dams/Levees register.	This condition applies to new regulated structures or modification of existing regulated structures. No new regulators structures are planned to be built or modified during the term of this Plan of Operations.	If any modifications are made to existing regulated structures, then they will be undertaken in accordance with the requirements of H2-4.
(H2-5)	Regulated structures must: (a) be designed and constructed in accordance with and conform to the requirements of the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635); (b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of: i) floodwaters from entering the regulated dam from any watercourse or drainage line; and ii) wall failure due to erosion by floodwaters arising from any watercourse or drainage line. (c) have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam.	This condition applies to new regulated structures or modification of existing regulated structures. No new regulators structures are planned to be built or modified during the term of this Plan of Operations.	If any modifications are made to existing regulated structures, then they will be undertaken in accordance with the requirements of H2-5.
(H2-6)	Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that: (a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure; (b) construction of the regulated structure is in accordance with	This condition applies to new regulated structures or modification of existing regulated structures. No new regulators structures are planned to be built or modified during the term of this Plan of Operations.	If any modifications are made to existing regulated structures, then they will be undertaken in accordance with the requirements of H2-6.

	EA CONDITION	CONTROL STRATEGY	ACTION PROGRAM
	the design plan.		
(H3-1)	Operation of a regulated structure, except for an existing structure, is prohibited unless: (a) the holder has submitted to the administering authority: (i) one paper copy and one electronic copy of the design plan and certification of the'design plan' in accordance with condition (H2-3), and (ii) a set of 'as constructed' drawings and specifications, and (iii) certification of those 'as constructed drawings and specifications' in accordance with condition (H2-6), and (iv) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, a copy of the certified system design plan. (v) the requirements of this authority relating to the construction of the regulated structure have been met; (vi) the holder has entered the details required under this authority, into a Register of Regulated Dams; and (vii) there is a current operational plan for the regulated structures.	This condition applies to new regulated structures or modification of existing regulated structures. No new regulators structures are planned to be built or modified during the term of this Plan of Operations.	If any modifications are made to existing regulated structures, then they will be undertaken in accordance with the requirements of H2-7.
(H3-2)	For existing structures that are regulated structures: (a) where the existing structure that is a regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, the holder must submit to the administering authority within 12 months of the commencement of this condition a copy of the certified system design plan including that structure; and (b) There must be a current operational plan for the existing structures.	There is a Regulated Dams Operational Plan (RDOP) in place for the regulated structures at the Mt Leyshon Mine. The operational plan meets the requirements of a system design plan in that it provides details of the methodology and assumptions utilised for the assessment of the Design Storage Allowance volumes for the regulated dams. The RDOP was last updated in 2018.	An annual review of the RDOP will be undertaken at the same time as the annual regulated structure inspections to ensure that the RDOP reflects the current operating and maintenance procedures for the regulated structures.
(H3-3)	Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in a manner that is consistent with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.	The regulated structures are currently operated in accordance with the RDOP. The RDOP will be updated if the operating procedures for any of the regulated structures change in the future.	An annual review of the RDOP will be undertaken at the same time as the annual regulated structure inspections to ensure that the RDOP reflects the current operating and maintenance procedures for the regulated structures.
(H4-1)	Conditions (H4-2) to (H4-5) inclusive only apply to Regulated Structures which have not been certified as low consequence category for 'failure to contain – overtopping'.	All regulated structures are likely to be classified as significant consequence category for 'failure to contain – overtopping' and will be required to be managed with a MRL.	Mandatory Reporting Level markers are installed in the regulated dams. No further action.
(H4-2)	The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable.	Mandatory Reporting Level markers are installed in the regulated dams.	Complete.
(H4-3)	The holder must, as soon as practical and within forty-eight (48) hours of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL.	A procedure is in place for managing notifications.	Complete required notifications in accordance with the procedure "Mt Leyshon EA – Procedures for Monitoring, Notification and Reporting".

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(H4-4)	The holder must, immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.	Normal dam operating procedure is to operate pumps to reduce water levels in the dams to prevent the occurrence of a discharge. This demonstrates compliance with this condition.	Operate pumps to reduce water levels in the dams to prevent the occurrence of a discharge.
(H4-5)	The holder must record any changes to the MRL in the Register of Regulated Structures.	Develop and maintain a Register of Regulated Structures for the Mt Leyshon Mine.	Newmont maintains a Register of Regulated Structures for the Mt Leyshon Mine.
(H5-1)	The holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to 1 July of each year.	For the last 7 years, Newmont has commissioned a review of the performance of the water containment dams as part of an overall review of wet season monitoring data.	Newmont will continue the annual review of wet season monitoring data.
(H5-2)	By 1 November of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems).	The capacity of the regulated dams to provide a design storage allowance at the start of the wet season is assessed as part of the annual regulated structure inspection program.	Continue to keep water levels in regulated dams as low as possible through the operation of pumps (i.e. pumping to the pit void)
(H5-3)	The holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.	Normal dam operating procedure is to operate pumps to reduce water levels in the dams to prevent the occurrence of a discharge. This demonstrates compliance with this condition.	Operate pumps to reduce water levels in the dams to prevent the occurrence of a discharge.
(H6-1)	Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.	A program of formal inspections of the regulated structures at the Mt Leyshon Mine has been in place since 2005. The dams are inspected annually prior to the start of the wet season (typically in October) by a suitably qualified and experienced engineer.	Newmont will continue the annual regulated structure inspection program.
(H6-2)	At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include recommended actions to ensure the integrity of the regulated structure.	A program of formal inspections of the regulated structures at the Mt Leyshon Mine has been in place since 2005. The dams are inspected annually prior to the start of the wet season (typically in October) by a suitably qualified and experienced engineer, in accordance with condition H6-2.	Newmont will continue annual regulated structure inspection program.
(H6-3)	The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635).	Previous annual regulated structure inspection reports have included certification by a suitably qualified and experienced person.	Newmont will continue the annual regulated structure inspection program.
(H6-4)	The holder must: (a) Within 20 business days of receipt of the annual inspection report, provide to the administering authority: (i) The recommendations section of the annual inspection report; and (ii) If applicable, any actions being taken in response to those recommendations; and	Newmont will provide the entire annual regulated structure inspection report to EHP, in accordance with H6-4.	Newmont will continue to provide the entire annual regulated structure inspection report to the DES, in accordance with H6-4.

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	(b) If, following receipt of the recommendations and (if applicable) actions, the administering authority requests a full copy of the annual inspection report from the holder, provide this to the administering authority within 10 business days of receipt of the request.		
(H7-1)	The holder must provide a copy of any reports, documentation and certifications prepared under this authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.	This condition is only relevant when the EA is transferred to a new holder.	No action currently required.
(H8-1)	Dams must not be abandoned but be either: (a) decommissioned and rehabilitated to achieve compliance with condition (H8-2); or (b) be left in-situ for a beneficial use(s) provided that: (i) it no longer contains contaminants that will migrate into the environment; and (ii) it contains water of a quality that is demonstrated to be suitable for its intended beneficial use(s); and (iii) the administering authority, the holder of the environmental authority and the landholder agree in writing that the dam will be used by the landholder following the cessation of the environmentally relevant activity(ies).	Decommissioning commitments for the regulated dams are described in a general fashion in the RDOP, Plan of Operations and other closure planning documents. The timeframe for the decommissioning of the regulated structures is not yet known and will depend on other mine rehabilitation works. Specific decommissioning plans for the regulated dams will be prepared closer to the actual decommissioning timeframes for these structures.	Decommissioning plans for the regulated dams to be prepared closer to the actual decommissioning timeframes for these structures.
(H8-2)	After decommissioning, all significantly disturbed land caused by the carrying out of the environmentally relevant activity(ies) must be rehabilitated to meet the following final acceptance criteria: (a) the landform is safe for humans and fauna; (b) the landform is stable with no subsidence or erosion gullies for at least three (3) years; (c) any contaminated land (e.g. contaminated soils) is remediated and rehabilitated; (d) not allowing for acid mine drainage; or (e) there is no ongoing contamination to waters (including groundwater); (f) rehabilitation is undertaken in a manner such that any actual or potential acid sulfate soils on the area of significant disturbance are treated to prevent or minimise environmental harm in accordance with the Instructions for the treatment and management of acid sulfate soils (2001); (g) all significantly disturbed land is reinstated to the pre-disturbed soil suitability class; (h) for land that is not being cultivated by the landholder: (i) groundcover, that is not a declared pest species is established and self-sustaining (ii) vegetation of similar species richness and species diversity	Decommissioning commitments for the regulated dams are described in a general fashion in the RDOP, Plan of Operations and other closure planning documents. The timeframe for the decommissioning of the regulated structures is not yet known and will depend on other mine rehabilitation works. Specific decommissioning plans for the regulated dams will be prepared closer to the actual decommissioning timeframes for these structures.	Decommissioning plans for the regulated dams to be prepared closer to the actual decommissioning timeframes for these structures.

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	to pre-selected analogue sites is established and self-sustaining, and (iii) the maintenance requirements for rehabilitated land is no greater than that required for the land prior to its disturbance caused by carrying out the petroleum activity(ies). (i) for land that is to be cultivated by the landholder, cover crop is revegetated, unless the landholder will be preparing the site for cropping within 3 months of petroleum activities being completed.		
(H9-1)	A Register of Regulated Dams must be established and maintained by the holder for each regulated dam.	Develop and maintain a Register of Regulated Structures for the Mt Leyshon Mine.	Newmont will continue to maintain a Register of Regulated Structures for the Mt Leyshon Mine.
(H9-2)	The holder must provisionally enter the required information in the Register of Regulated Dams when a design plan for a regulated dam is submitted to the administering authority.	Condition applies to new regulated structures or modification of existing regulated structures. This is not expected to occur within the term of this plan of operations.	No action required.
(H9-3)	The holder must make a final entry of the required information in the Register of Regulated Dams once compliance with condition (H3-1) and (H3-2) has been achieved.	Condition applies to new regulated structures or modification of existing regulated structures. This is not expected to occur within the term of this plan of operations.	No action required.
(H9-4)	The holder must ensure that the information contained in the Register of Regulated Dams is current and complete on any given day.	Amendments to the Regulated Structure Register will only be required when a regulated structure is modified.	Ensure that the Regulated Structure Register is up to date at all times.
(H9-5)	All entries in the Register of Regulated Dams must be approved by the chief executive officer for the holder of this authority, or their delegate, as being accurate and correct.	Newmont submits the Regulated Structure Register to EHP with the annual return, in accordance with condition H9-6.	Newmont will continue to submit the Regulated Structure Register to EHP with the annual return, in accordance with condition H9-6.
(H9-6)	The holder must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Dams, in the electronic format required by the administering authority.	Maintain a current version of the Regulated Structure Register.	Newmont will provide the current version of the Regulated Structure Register to EHP with the annual return.
(H10-1)	All existing structures that have not been assessed in accordance with either the Manual or the former Manual for Assessing Hazard Categories and Hydraulic Performance of Dams must be assessed and certified in accordance with the Manual within 6 months of amendment of the authority adopting this schedule.	The hazard categories and hydraulic performance compliance of all existing regulated structures have been previously assessed in accordance with the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams.	Complete.
(H10-2)	All existing structures must subsequently comply with the timetable for any further assessments in accordance with the Manual specified in Table 1 (Transitional requirements for existing structures), depending on the consequence category for each existing structure assessed in the most recent previous certification for that structure.	The assessment of transitional arrangements for regulated dam compliance determined that the Settlement Dam was the only regulated structure that does not comply with the hydraulic performance requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* and for which the transitional arrangements in Schedule H Table 1 of the EA apply. The degree of DSA compliance for the Settlement Dam was assessed as 94% (i.e. ratio of usable storage capacity to DSA volume). In accordance with Schedule H Table 1 of the EA, the Settlement Dam was not required to be transitioned to achieve compliance with the DSA requirements of the Manual	Continue to keep water levels in regulated dams as low as possible through the operation of pumps (i.e. pumping to the pit void)

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		since the dam has greater than 90% compliance and has a history of good compliance performance in the last 5 years. One additional low flow pipe at the high flow bypass facility upstream of the Settlement Dam was closed in 2016. This reduced the DSA volume for the Settlement Dam and the dam is now considered compliant with the hydraulic performance requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures*.	
(H10-3)	Table 1 ceases to apply for a structure once any of the following events has occurred: (a) It has been brought into compliance with the hydraulic performance criteria applicable to the structure under the Manual; or (b) It has been decommissioned; or (c) It has been certified as no longer being assessed as a regulated structure.	As described in the control strategy for condition H10-2 of the EA, the transitional arrangements for regulated dam compliance have been achieved and accordingly Schedule H Table 1 of the EA is considered to no longer apply for the regulated dams.	No action required.
(H10-4)	Certification of the transitional assessment required by (H10-1) and (H10-2) (as applicable) must be provided to the administering authority within 6 months of amendment of the authority adopting this schedule.	Certification of the transitional assessment required by Condition H9-3(a)(i) of the previous version of the EA was submitted to EHP 31 March 2014.	No action required.

5. Rehabilitation and Monitoring Program

Filled green cells indicate the years when works are scheduled to be undertaken during the term of this Plan of Operations.

Area Category	2019	2020	2021	2022
Roads				
Remediation of haul road footprints				
Repair bitumen access road				
Drill Sites				
Drill pad remediation (50 pads)				
Drill Hole Abandonment				
Plug/cap Groundwater Monitoring Bores (36 bores)				
Backfill Groundwater Monitoring Bores (36 bores)				
Plug exploration drill hole (50 holes)				
Pits and Borrow Areas				
Relocation of Existing Bunds around pit				
Upgrade of Existing Bunds around pit				
Water Treatment				
Pump Maintenance				
Fuel - diesel				
Power				
Pump and Fittings Replacements				
Seepage Collection & Pumpback to Pit				
Emergency Backup				
Aerial Reticulation - including replacement of wooden power poles with concrete poles				
Water Reticulation - including polypipe upgrades for Mt Hope and Mt Mawe				
Instrument Maintenance / Repairs				
Water treatment plant - construction				
Water treatment plant - operation				
Heap leach pad reclamation				
Heap leach pad reclamation				
Waste Rock Storage Facilities and Stockpiles				
Engineering and Design (North, East and South WRSF)				
Northern Waste Rock Storage Facility				
Repair cover				
Drainage Channel Installation				
Eastern Waste Rock Storage Facility				
Drop structure repair (EWRD)				
Investigations - geophysical survey to ID water ingress areas				
Potential Filling of low lying areas to prevent ponding				
Southern Waste Rock Storage Facility				
Remove and repair failed areas of cover				
Scats Stockpile				
Undertake monitoring activities in accordance with Scats Stockpile Remediation Plan (2017)				

Area Category	2019	2020	2021	2022
Tailing Storage Facilities				
Investigations - geophysical survey to ID water ingress areas				
Old North TSF				
Erosion repair on Old Nth TSF				
Capping to prevent ponding				
Revegetation of disturbed areas (batters)				
New North TSF				
Erosion repair on New Nth TSF				
Revegetate bare areas on batters				
South TSF				
Erosion repair on Southern TSF				
Revegetate bare areas on batters				
Raw Water Dam				
Investigate options to reduce or eliminate seepage through embankment wall				
Potential decommissioning of Raw Water Dam				
Post Closure Monitoring				
Stream Sediment Sampling				
Continuous Monitoring				
Rehabilitation Monitoring				
Receiving Environment Monitoring Program				
Groundwater Sampling				
Surface Water Sampling				
Consultant Services				
Annual Ground and Surface Water Review				
Compliance reporting (EA) - including REMP				
Annual Dams Engineering Inspection				
Weed Control and Fire Management				
Mobilisation and Demobilisation				

6. Financial Assurance

The following provides a summary of the Financial Assurance calculation undertaken in 2019. The FA calculation worksheets have be provided as an electronic file with the submitted Plan of Operations.

Summary Report of Financial Assurance Estimator

Environmental Authority Number:	EPML00863713
Tenure Numbers:	ML1546, ML10144, ML10148, ML10172, ML10173
Site Name (if applicable):	Mt Leyshon Mine
EA Holder:	Newmont Landco Pty Ltd
Current Financial Assurance Amount:	$44,679,633
Date of Last Financial Assurance Review:	1 April 2014

Domain	Rehabilitation Liability
Domain 1: Infrastructure	$912,780
Domain 2: Tailings Storage Facilities (1)	$336,589
Domain 2: Tailings Storage Facilities (2)	$97,400
Domain 2: Tailings Storage Facilities (3)	$2,243,309
Domain 3: Overburden & Waste Dumps (1)	$4,252,625
Domain 3: Overburden & Waste Dumps (2)	$1,980,626
Domain 3: Overburden & Waste Dumps (3)	$3,087,476
Domain 4: Water Management	$20,893,050
Domain 5: Pits (1)	$118,000
Domain 5: Pits (2)	$0.00
Domain 5: Pits (3)	$0.00
Domain 6: Other Management Issues	$4,930,000
Subtotal	**$38,851,855**

Contingencies	Rehabilitation Liability
Project Management (10%)	$3,885,186
Environmental Maintenance and Monitoring (5%)	$1,942,593
Subtotal	**$5,827,778**

Total Rehabilitation Liability for the Operation (excl. GST)	**$44,679,633**

Recommended Bond (excl. GST)	**$44,679,633**

7. Environmental Audit Statement (2019)

Provided as a stand-alone document.

8. Compliance Statement 2019

Provided as a stand-alone document.

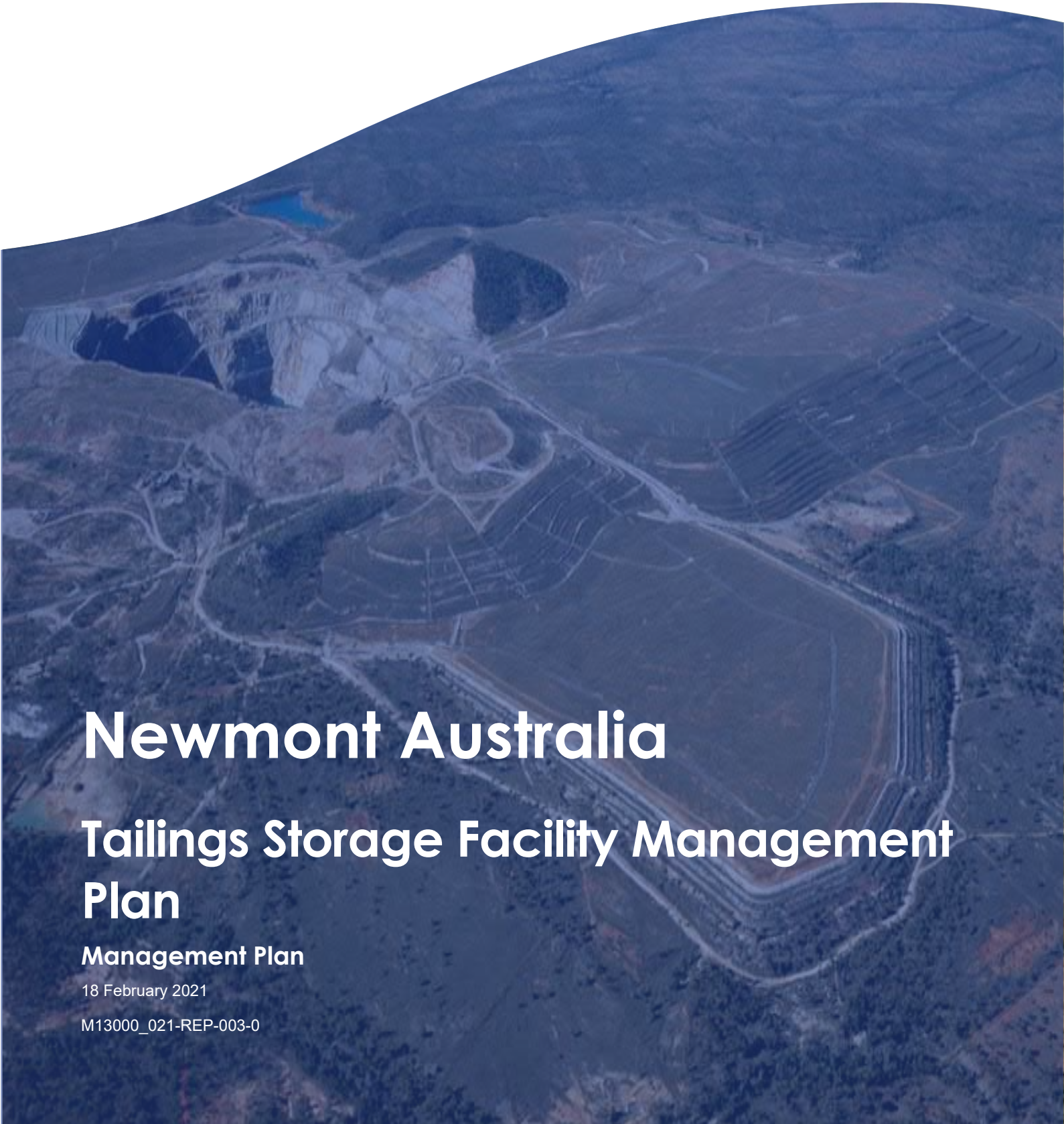
9. Appendices

a) Closure Plan (2019)
b) Scats Remediation Plan (2017)
c) Sulphate Management Plan (2013)
d) Waste Management Plan (2017)
e) Pest Management Plan (2017)
f) Hazard Category Assessment of Water Storages (2013)
g) Regulated Dam Operational Plan (2017)
h) Annual Regulated Dams Inspection (2018)
i) Water Management Plan – includes Erosion and Sediment Control Plan (2018)
j) Emergency Response Plan (2017)
k) Receiving Environment Monitoring Plan (2018)
l) Groundwater Management Plan (2018)
m) Tailings Management Strategy (2018)
n) Final Void Decommissioning Strategy (2018)
o) Financial Assurance Calculator (2019)

Appendix H:
Mt Leyshon Tailings Management Plan

ENGENY
WATER MANAGEMENT

Newmont
AUSTRALIA



Newmont Australia

Tailings Storage Facility Management Plan

Management Plan

18 February 2021

M13000_021-REP-003-0

Job no. and Project Name: M13000_001 Mt Leyshon Mine TSF Management Plan
Doc Path File: M:\Projects\M13000_Newmont Asia Pacific\M13000_021 Mt Leyshon Mine 2020 EA Compliance Services\07 Deliv\Docs\Report\Revs\M13000_021-REP-003-0-Mt Leyshon TSF Mgmt Plan.docx

Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	18/02/2021	Final Issue	Andrew Vitale	Raymond Yau	Aaron Baldwin	Andrew Vitale
Signatures						

DISCLAIMER

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1 INTRODUCTION

The Mount Leyshon Mine is located 24 km south of Charters Towers. The mine was an open cut mine producing gold and silver. Operations commenced in September 1986, initially as a heap leach operation of oxide ore and expanding in 1989 to carbon-in-pulp (CIP) processing of primary un-oxidised ore. The ore processing operations at the Mt Leyshon Mine resulted in the generation of a tailings stream containing cyanide which required storage in the period 1989 to March 2002. Engineered facilities constructed for the storage of tailings during this operating period were:

- The Old Northern Tailings Storage Facility (ONTSF) – above-ground tailings storage facility (TSF).
- The New Northern Tailings Storage Facility (NNTSF) – above-ground TSF.
- The Southern Tailings Storage Facility (STSF) – above-ground TSF.
- The open pit – in-pit TSF.

Operating protocols were implemented at each tailings storage facility (TSF) during the operating period to minimise the risk of emissions. Closure of the TSFs commenced in 1997 with capping of the ONTSF, and was undertaken concurrently with mining operations. The closure works implemented at each facility were designed to minimise the potential for emissions in long term closure, based on characterisation studies which were considered to be industry leading practice at that time. Closure of the Mt Leyshon mine is now in a maintenance and monitoring phase.

The following report documents the Tailings Storage Facility Management Plan (TSFMP) for the Mt Leyshon Mine. The TSFMP has been prepared in response to Condition E6-1 (Tailings Management) of Environmental Authority EPML00863713 (EA) for the Mt Leyshon Mine. The TSFMP replaces the previous Mt Leyshon Tailings Management Procedure (Newmont Australia, 2018a) which is an appendix to the Plan of Operations (Mt Leyshon) – 31 March 2019 to 1 April 2022 (Newmont Australia, 2019a).

The TSFMP aims to provide a summary of:

- The original operational aspects of the TSFs.
- The works that were undertaken to close and decommission the TSFs.
- Strategies implemented to minimise the potential for emissions from the tailings storage facilities in both operations and closure.
- Closure criteria for the TSFs.
- Ongoing monitoring and management requirements for the TSFs.
- Current roles and responsibilities in relation to the management of the TSFs.

It is noted that Newmont has recently developed a Tailings Management Governance Framework in response to adopting the new Global Industry Standard on Tailings Management (GISTM) and the implementation of this Framework may impose additional management requirements on the TSFs at the Mt Leyshon Mine. Any additional management requirements will be captured in future updates of the TSFMP.

2 BACKGROUND INFORMATION

2.1 RELEVANT GUIDELINES

2.1.1 Environmental Authority

Condition E6-1 of the EA specifies the following requirements for tailings management at the Mt Leyshon Mine.

Tailings must be managed in accordance with procedures contained within the current plan of operations. These procedures must include provisions for:

a) *Containment of tailings in accordance with design plans for each storage facility;*
b) *The management of seepage and leachates both during operation and post closure;*
c) *The control of fugitive emissions to air;*
d) *Rehabilitation strategy which meets the rehabilitation objectives specified in Schedule F; and*
e) *Monitoring of rehabilitation, research and/or trials to verify the requirements and methods for decommissioning and final rehabilitation of tailings, including the prevention and management of acid drainage, erosion minimisation and establishment of vegetation cover.*

The tailings management procedures in the current Plan of Operations for the Mt Leyshon Mine were previously contained in the Mt Leyshon Tailings Management Procedure (Newmont Australia, 2018a) which is an appendix to the Plan of Operations. The Mt Leyshon Tailings Management Procedure is now superseded by the TSFMP (i.e. this document).

Schedule H of the EA sets out the requirements of the administering authority for consequence category assessment, design, construction, operation and decommissioning and rehabilitation of regulated structures. A regulated structure is a water or tailings containment or flood protection structure, constructed as part of environmentally relevant activities (ERAs) under the *Environmental Protection Act 1994* (EP Act), that has been assessed as Significant or High consequence category in accordance with the Department of Environment and Science (DES) Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (DES, 2016).

The above-ground TSFs at the Mt Leyshon Mine were designed, constructed and operated as regulated structures during their operational life. A significant period of time (approximately 20 years) has passed since the above-ground TSFs were decommissioned and rehabilitated, during which the tailings contained in the TSFs have drained down. The top surfaces of the above-ground TSFs are free draining and cannot store any significant volumes of water. For these reasons, the above-ground TSFs at the Mt Leyshon Mine are primarily managed as decommissioned TSF landforms and are not considered to be regulated structures.

The tailings deposited in the open cut pit are at elevations below the surrounding groundwater systems and are submerged by the pit lake that has developed in the pit void. The open cut pit is managed as a final void landform and is not considered to be a regulated structure.

2.1.2 ANCOLD Guidelines

The ANCOLD Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure (ANCOLD, 2019) is the Australian industry guideline for the management of tailings dams throughout all phases of the tailings dam lifecycle, including the post-closure phase. ANCOLD recommendations for the post-closure management of TSFs are summarised in Section 6.4.

2.1.3 Global Industry Standard on Tailings Management (GISTM)

In response to a number of recent tailings dam failures, the International Council on Mining & Metals (ICMM), Principles for Responsible Investment (PRI) and United Nations Environment Programme (UNEP) co-convened an independent review to develop the Global Industry Standard on Tailings Management (GISTM) (ICMM et al., 2020). The GISTM strives to achieve the ultimate goal of zero harm to people and the environment with zero tolerance for human fatality. It requires mining companies to take responsibility and prioritise the safety of tailings facilities, through all phases of a facility's lifecycle, including closure and

post-closure. It also requires the disclosure of relevant information to support public accountability. ICMM's Tailings Working Group is developing a technical guidance to support implementation of the Standard. The GISTM is being implemented over a 5 year period (by 2025), with priority facilities required to comply with the standard within three years (by 2023).

2.1.4 Newmont Standards

Newmont has committed to complying with the GISTM and has developed a Tailings Management Governance Framework which proposes a Line of Defence (LoD) model to prevent catastrophic failures of TSFs. The LoD model defines 4 different Lines of Defence as follows:

- 1st LoD:
  - Regional Leadership Team (RLT)
  - Dam Owner (GM)
  - Responsible Tailings Facility Engineer/Person (RTFE/RTFP)
  - Engineer of Record (EoR).
- 2nd LoD:
  - Systematic Third-Party Review
  - Independent Tailings Review Board (ITRB)/Senior Independent Technical Reviewer
  - Periodic Dam Safety Review (DSR).
- 3rd LoD:
  - Accountable Executive
  - Corporate Tailings Management Team (TS)
  - Support by S&ER, Social and Risk Teams.
- 4th LoD:
  - Executive Leadership Team (ELT)
  - Board of Directors.

The governance structure for the 1st and 2nd LoDs are not required for TSFs that have achieved "safe closure" which Newmont has defined as meeting the following criteria:

- Ponded water will not propagate a failure or uncontrolled release of contents.
- Contents do not and cannot flow (i.e. are not fluid like) and do not rely on a barrier structure to prevent an uncontrolled release.
- Contents do not and cannot migrate or pipe (i.e. internally erode) through the structure or foundation.
- Conditions will not develop in the future that could violate the previous three criteria.

Newmont has also recently developed new and revised Corporate Standards and Guidelines for tailings management. These Standards and Guidelines are listed in Table 2.1.

Further work is required to assess whether the TSFs at Mt Leyshon Mine can be considered to be safely closed and the extent to which the Newmont LoDs and Corporate Standards and Guidelines for tailings management should apply to these TSFs.

Table 2.1: Newmont Standards and Guidelines for Tailings Management

Standard/Guideline	Accountable Function
Tailings Storage Facility (TSF) Technical & Operations Standard (NEM-TES-STA-017-New)	Technical Services
Tailings Storage Facility (TSF) Technical & Heap Leach Facility (HLF) Environmental Management Standard (NEM-SER-STA-002-Revised)	S&ER
Breach Analysis, Inundation Studies & ERP Guideline (NEM-SER-GDL-013-NEW)	S&ER

Standard/Guideline	Accountable Function
Tailings Management Governance Framework Guideline (NEM-TES-GDL-600-NEW)	Technical Services
TSF Critical Control Reporting Guideline (NEM-TES-GDL-603-NEW)	Technical Services

2.2 OPERATIONAL HISTORY

The Mt Leyshon Mine is located 24 km south of Charters Towers. The mine was an open cut mine producing gold and silver. Operations commenced in September 1986, initially as a heap leach operation of oxide ore and expanding in 1989 to Carbon-In-Pulp (CIP) processing of primary un-oxidised ore. Mining ceased due to depletion of the ore body in early 2001, after which ore was sourced from low grade stockpiles which were processed until their exhaustion in March 2002.

Initial decommissioning and rehabilitation earthworks were completed, and the site is now in the post-closure monitoring and rehabilitation stage. Engineered covers have been placed over the tailings storage facilities and waste rock dumps and these landforms have been vegetated with various grass species.

Under previous management arrangements for the Mt Leyshon Mine, the responsibility for operation and maintenance of the site was delegated by the EA holder at the time, Leyshon Resources Limited (LRL), to Newmont. In 2016, Newmont acquired the Mt Leyshon Mine from LRL and is now the current EA holder.

The mine currently comprises five mining leases (Table 2.2). ML 10149 (water storage and supply) was surrendered in 2002.

Newmont has purchased all pastoral properties immediately adjacent to the mining leases. These properties are utilised by Newmont for cattle grazing purposes.

Table 2.2: Mt Leyshon Mining Leases

Mining Lease	Area (ha)	Operational Activities
10144	2482	Mining, stockpiling, reserves, waste disposal, environmental buffer, tailings disposal, plant, heap leach pads, water storage
10148	36	Access for water quality monitoring
10172	1	Satellite reserve, waste disposal
10173	18	Satellite reserve, waste disposal
1546	9	Satellite reserve, waste disposal

The TSFs at Mt Leyshon Mine are all located within ML 10144 (refer Figure 2.1)

Figure 2.1: Mt Leyshon Mining Leases (Source: Queensland Globe)

2.3 CLIMATE

The Mt Leyshon Mine is located in the vicinity of Charters Towers which is located in the dry tropics and has a climate characterised by relatively hot summers and mild winters. The area has a summer dominant wet season, typically occurring between the months of December and March. The majority of the wet season rainfall typically occurs in a relatively small number of short duration, high intensity rainfall events. As a result, the surface water features within and down-gradient of the mine lease are ephemeral, flowing only during the wet season. During the dry season, these features may be completely dry or reduced to small disconnected surface water pools. Average climate statistics for Charters Towers (BoM Station 034002) are shown in Table 2.3.

Table 2.3: Average Climate Data Statistics for Charters Towers (Source: Bureau of Meteorology)

Month	Mean Rainfall (mm)	Mean No. of Days of Rain >1mm	Mean Maximum Temperate (°C)	Mean Minimum Temperate (°C)	Pan Evaporation (mm)[1]
Jan	136.9	8.8	33.7	21.9	198
Feb	130.1	8.3	32.6	21.7	161
Mar	103.5	6.4	31.6	20.5	170
Apr	43.4	3.5	29.9	17.9	140
May	24.0	2.4	27.2	14.8	113
Jun	26.5	2.5	24.8	12.1	92
Jul	16.8	1.9	24.5	11.0	101
Aug	13.0	1.1	26.6	12.1	130
Sep	14.8	1.4	29.6	14.7	171
Oct	22.0	2.1	32.4	17.6	215
Nov	41.4	3.4	34.1	19.9	219
Dec	86.9	5.6	34.8	21.2	219
Annual	659.2	47.4	30.2	17.1	1,930

[1] Data obtained through SILO Data Drill.

2.4 RECEIVING ENVIRONMENT

2.4.1 Description of Receiving Environment

The Mt Leyshon Mine is located within the Broughton River sub-catchment of the Burdekin River basin. The Broughton River flows into the Burdekin River approximately 80 km upstream of the Burdekin Falls Dam. The Burdekin Falls Dam is the largest dam in Queensland and supplies water for rural, industrial and urban uses.

Matters of State Environmental Significance (MSES) are located greater than 30 km downstream of the Mt Leyshon Mine along the Broughton River (lower reaches only) and Burdekin River and are associated with regulated vegetation.

Cattle grazing is the dominant land-use in the region. Some irrigated agriculture occurs along the lower reaches of the Broughton River and along the Burdekin River.

There are a number of homesteads located on the pastoral properties surrounding the mine that are owned by Newmont.

2.4.2 Environmental Values

Environmental Values are the qualities of waterways that need to be protected from the effects of pollution, waste discharges and other threats to ensure aquatic ecosystems are healthy and continue to provide essential ecosystem services, and waterways are safe for community use.

The uses of water down-gradient of the Mt Leyshon Mine have been identified in an Environmental Values Study for the Mt Leyshon Mine (Engeny, 2013) on the basis of the collection and review of existing information on the Broughton River catchment and through stakeholder consultation.

A summary of the Environmental Values for the receiving waters of the Mt Leyshon Mine (downstream to confluence of Broughton River and Burdekin River) is provided in Table 2.4. Different environmental values are assigned for surface waters and groundwater in the following zones:

- Newmont-owned properties down-gradient of the mine lease; and,
- Areas down-gradient of the Newmont-owned properties (to confluence of Broughton River and Burdekin River).

The dominant human use of water (surface water and groundwater) in these zones is for stock watering. Surface water is used for crop irrigation in the lower reaches of the Broughton River. Surface water and groundwater is used as a back-up water supply for drinking water and domestic use (rainwater tanks are primary supply) in the pastoral properties downstream of the Newmont-owned properties. The waterways downstream of the Newmont-owned properties are also used for primary and secondary recreation by riparian landholders.

Table 2.4: Environmental Values for the Receiving Waters of the Mt Leyshon Mine (Source: Engeny, 2013)

Symbol	Environmental Value	Surface Water (down-gradient of Newmont Properties)	Surface Water (Newmont properties)	Groundwater (down-gradient of Newmont Properties)	Groundwater (Newmont properties)
	Aquatic ecosystems (slightly to moderately disturbed)	✓	✓	✓	✓
	Irrigation	✓	X	X	X
	Farm or property use	✓	X	✓	X
	Stock watering	✓	✓	✓	✓
	Aquaculture	X	X	X	X
	Human consumption of aquatic foods	✓	X	X	X
	Primary recreation	✓	X	✓	X
	Secondary recreation	✓	X	X	X
	Visual appreciation	✓	X	X	X
	Drinking water	✓	X	✓	X
	Industrial use	X	X	X	X
	Cultural and spiritual values	✓	✓	✓	✓

2.4.3 Surface Water Resources

Local Waterways

Ephemeral waterways between the edge of the mine disturbance area and the mine lease boundary are identified in Figure 2.2. In the limited periods when runoff occurs, the topography within the mine lease area drains to:

- The north towards Clarke Creek (flows in an easterly direction along the northern mine lease boundary).
- The south towards Puddler Creek (flows in an easterly direction along southern mine lease boundary).
- The east towards Two Mile Creek (flows in an easterly direction across eastern mine lease boundary).
- The south-east towards One Mile Creek (flows in a south-easterly direction across eastern mine lease boundary; and,
- The north-east towards Fenian Creek (flows in a north-easterly direction across eastern mine lease boundary).

Clarke Creek and Puddler Creek are the two largest waterways in the immediate vicinity of the mine. Clarke Creek and Puddler Creek flow along the northern and southern boundaries of the mine lease area respectively. The upstream catchments of these two waterways extend to the west of the mine. All other site waterways originate within the mine lease area.

Plum Tree Creek (downstream of scats stockpiles and Plum Tree Creek Dam) receives runoff from the Northern Waste Rock Dump and the ONTSF. Plum Tree Creek discharges into Clarke Creek within the mine lease area.

Schreibers Creek is located downstream of the Raw Water Dam and discharges across the north-east corner of the mine lease boundary, in the periods when flow occurs. The top surface of the NNTSF drains to Schreibers Creek. Schreibers Creek discharges into Clarke Creek a short distance downstream of the lease boundary.

The southern part of the mine disturbance area drains to Puddler Creek via a number of drainage gullies which flow in periods when precipitation of sufficient intensity is received in the wet season. One Mile Creek is located downstream of the Mt Hope Extension Dam and receives runoff from the southern batter slopes of the Eastern Waste Rock Dump. One Mile Creek discharges across the south-eastern corner of the mine lease boundary before discharging into Puddler Creek.

Two Mile Creek flows across the eastern boundary of the mine lease area in the wet season. This waterway receives runoff from the eastern batter slopes of the Eastern Waste Rock Dump.

The Fenian Creek catchment is located to the north of the Two Mile Creek catchment and also flows across the eastern boundary of the mine lease area in the wet season. A small part of the mine lease area within the environmental buffer zone (not disturbed by mining activities) drains to Fenian Creek. A topographic ridge is located between the rehabilitated mine facilities on the eastern side of the mine and Fenian Creek.

Sections of the larger waterways downstream of the Mt Leyshon Mine (e.g. Clarke Creek, Puddler Creek, Seventy Mile Creek and the Broughton River) receive groundwater contributions to stream flows. This typically occurs as baseflow during and immediately following significant rainfall events and spring-fed recharge of waterholes during the dry season.

Regional Waterways

The receiving waterways downstream of the mine lease area are shown in Figure 2.3. All of the local receiving waterways eventually discharge into the Broughton River, which flows into the Burdekin River 25 km to the north-east of the mine site (straight line distance).

Stream flow gauging data for the Broughton River (Gauging Station No. 120014A Broughton River at Oak Meadows) indicates that the Broughton River flows approximately 16% of the time upstream of the Clarke Creek confluence. The Burdekin River is a perennial waterway, with stream flow gauging data upstream of the Broughton River confluence (Gauging Station No. 120002C Burdekin River at Sellheim) indicating the river flows more than 95% of the time.

The sequence and connectivity of waterways downstream of the mine lease area is summarised in Table 2.5.

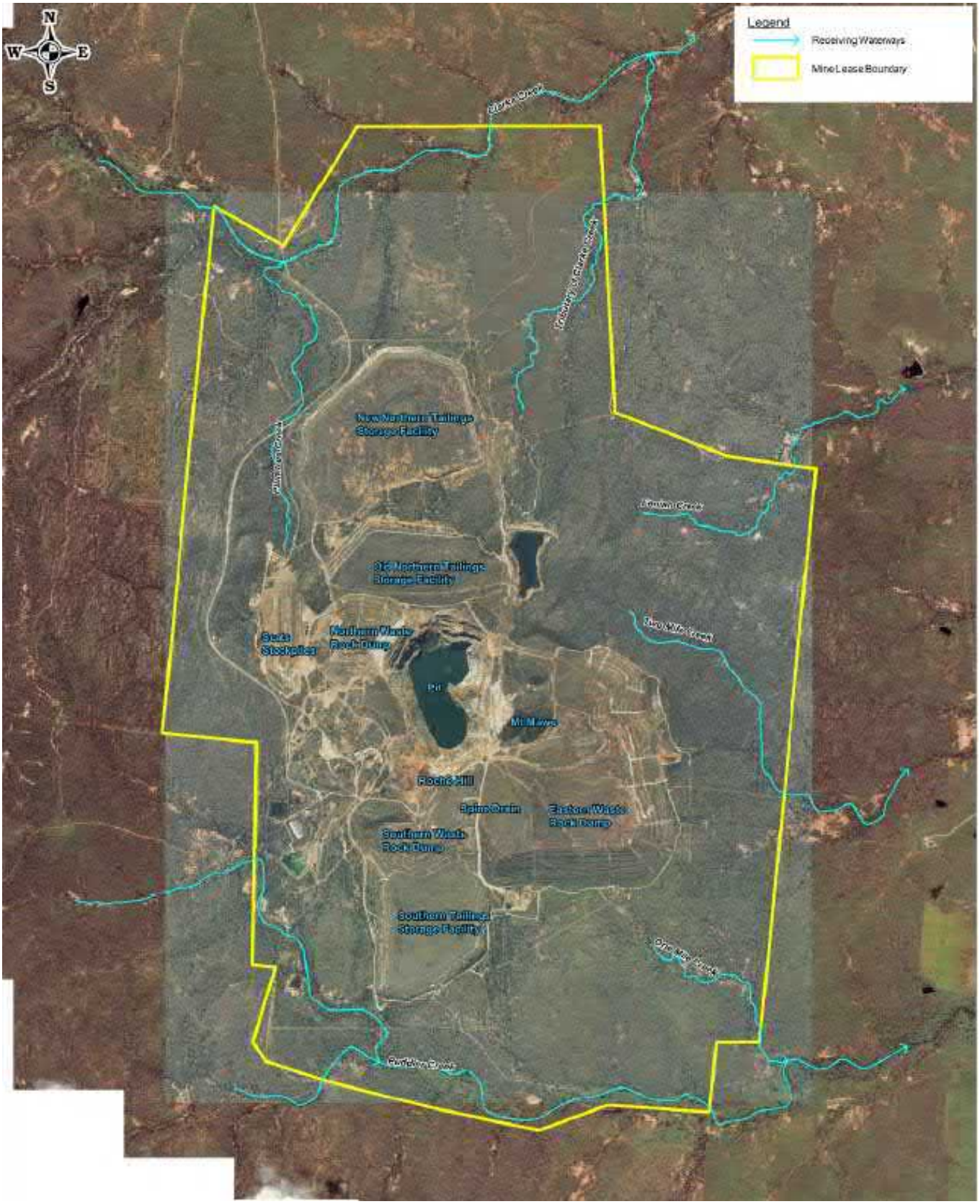

Figure 2.2: Local Receiving Waterways (Source: Engeny, 2020a)

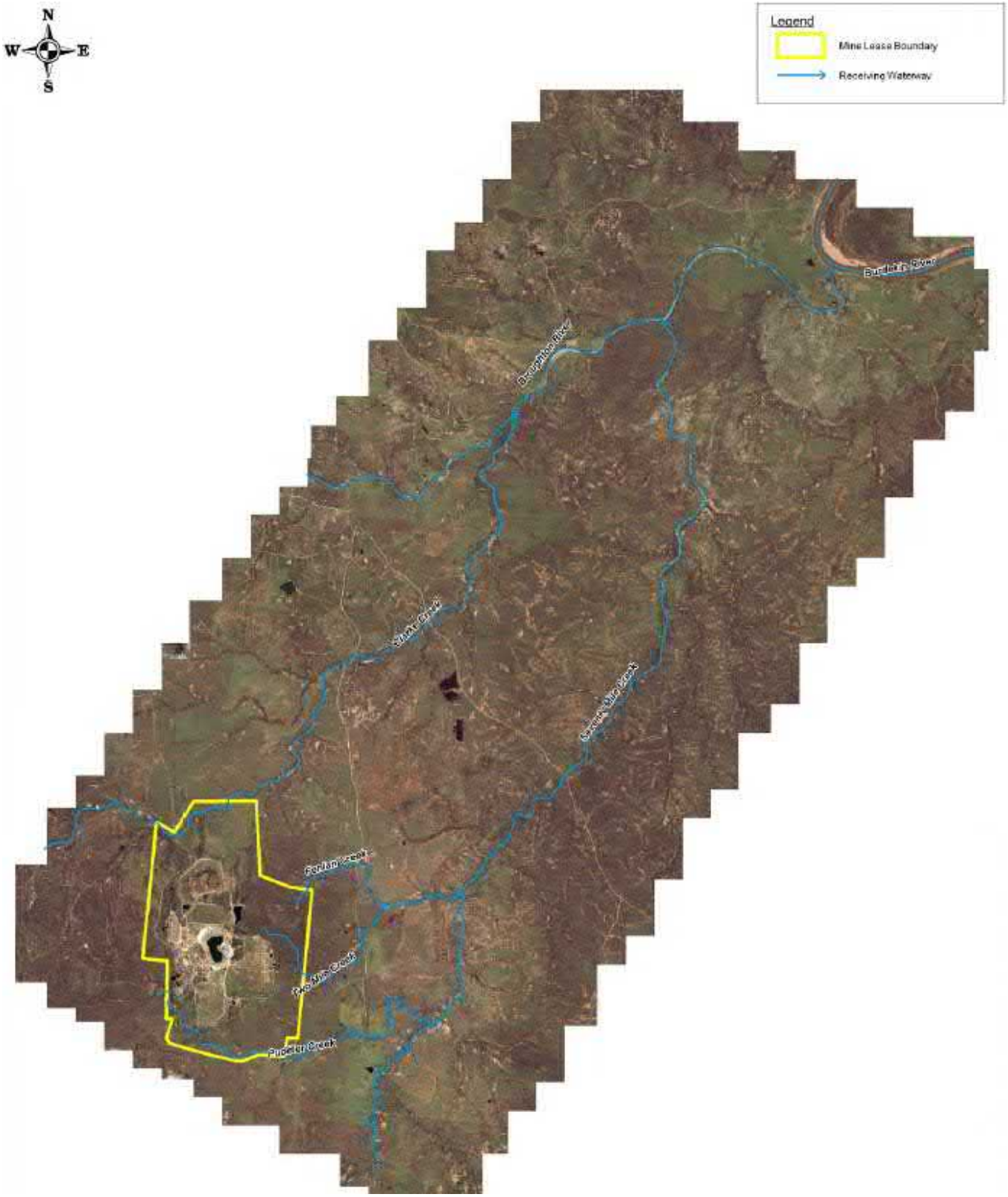

Figure 2.3: Regional Receiving Waterways (Source: Engeny, 2020a)

Table 2.5: Connectivity of Receiving Waterways Downstream of the Mine Lease Area

Waterway	Receiving Waterway
Clarke Creek	Broughton River
Two Mile Creek	Fenian Creek
Fenian Creek	Seventy Mile Creek
Puddler Creek	Seventy Mile Creek
Seventy Mile Creek	Broughton River
Broughton River	Burdekin River

2.4.4 Groundwater Resources

Regional Groundwater Systems

The surface geology of the Charters Towers region is dominated by the Ordovician-Devonian Ravenswood Granodiorite Complex in the north. This granite complex intruded into the neoproterozoic basement schists approximately 100 million years ago. In the south, near Mount Nolan, surficial Quaternary alluvium and Tertiary Campaspe Beds are more prevalent. The alluvium is comprised of silt, sand and gravel, while the Campaspe beds consist of sands and gravels [SKM & SMI, 2010].

The two main hydrostratigraphic units of the Charters Towers region are the alluvial aquifer and the fractured rock aquifer. The alluvial aquifer consists of Tertiary and Quaternary gravel, sand and silt. The fractured rock aquifer consists of the basement schist and the younger intrusive granites. Groundwater flow within fractured rock units is facilitated mainly via secondary porosity such as faults and fractures. This aquifer underlies the alluvial aquifer in the south of the region and is present at the surface where the alluvial aquifer is absent in the north of the region. The degree of hydraulic connection between the two aquifers is largely unknown [SKM & SMI, 2010].

Local (On-Lease) Groundwater Systems

Characterisation of the groundwater systems at the Mt Leyshon Mine has been undertaken by Schlumberger Water Services (2012) and Big Dog Hydrogeology (2017) based on several geophysical surveys, and the results from drilling and collecting monitoring data at over 100 groundwater monitoring locations.

There are two main groundwater transmitting systems at Mt Leyshon Mine, being:

- The shallow groundwater system; and,
- The deep groundwater system.

Shallow Groundwater System:

The shallow groundwater system has been defined to comprise the upper weathered and fractured surface of the basement rocks, typically occurring between around 5 and 25 m below ground level (mBGL). It takes the form of either; sandy and gravely weathered basement material or less weathered material where relict structural features remain.

Recent groundwater investigations (Schlumberger Water Services, 2012 and Big Dog Hydrogeology, 2017) have identified that:

- Precipitation is the primary input of water to the Mt Leyshon Mine site, driving intermittent runoff flows in the surface water systems, and seasonal recharge to the groundwater systems. Groundwater elevations respond to the larger daily precipitation events, to seasonal conditions, and also to long term trends in annual precipitation totals.
- Groundwater flow directions follow the general surface topography and the main watercourses, being to the northeast (towards Clarke Creek), to the east (following Two Mile Creek), and to the southeast (following Puddler Creek). Very little groundwater flow occurs to the west.

- Groundwater likely leaves the shallow groundwater system as surface discharge into the surface drainage systems down-gradient of the mine facilities, where structures are present which allow vertical movement of groundwater.
- Groundwater elevations near the pit are in the range 368 to 375 m AHD, which is more than 100 m higher than the pit lake elevation. This suggests there is minimal depressurisation within the shallow groundwater system associated with groundwater flow towards the open pit, with most flow being radially away from the pit.
- Despite the hydraulic conductivity of the shallow groundwater system being locally variable, there is regional continuity of hydraulic connection within the system.
- The shallow groundwater system represents the primary means by which groundwater flows away from the Mt Leyshon Mine.

Deep Groundwater System

The deep groundwater system comprises fracture zones within the deep unweathered basement rocks, which include the breccias close to the open pit, and the surrounding dolerite and granite country rocks. Most of the basement rocks across the Mt Leyshon Mine demonstrate relatively high resistivity, consistent with a low degree of fracturing (porosity) and limited presence of pore waters. Fracturing may be present in the basement rocks at depths of up to 200 m, but is limited to the area close to, and to the northeast of the open pit. This is consistent with observations during mining that the main structural feature in the area was the Mine Fault, which was primarily identified within the open pit. The available data indicate that there is little development of fracturing beyond about 1 to 2 km from the open pit, and the granite/dolerite country rocks in the surrounding area have limited fracturing.

Groundwater responses within the deep groundwater system have been monitored through the use of vibrating wire piezometer (VWP) sensors. Most sensors display a smoothed response to seasonal precipitation trends, indicative of wet season recharge, which may occur as direct infiltration to exposed fractured basement rocks in the pit area, or as downward leakage from the shallow groundwater system.

VWP sensors indicate that within the deep groundwater system:

- In locations more than around a few hundred metres from the margins of the open pit, and at most depths, hydraulic gradients indicate groundwater flow directions are away from the pit. The drawdown cone within the deep groundwater system surrounding the pit is relatively steep and close to the pit, consistent with the inferred relatively low hydraulic conductivity in this system.
- A fracture zone intersected northeast of the pit at around 200 m AHD contains groundwater at lower pressures. The depressurised area potentially extends up to 500 m from the pit boundary.
- VWP sensors installed at depths equivalent to the base of the pit demonstrate high groundwater pressures, comparable to pressures measured at shallow depths, and consistent with groundwater flow towards the pit for the basement rocks at depth and close to the pit.

The shallow groundwater system is present in all locations at Mt Leyshon Mine, other than in the open pit, or at localised discrete locations where unweathered basement rocks may crop out at surface. The deep groundwater system is limited in occurrence to the area close to the open pit (typically within 1 to 2 km), and the greatest extent of fracturing occurs at around 200 m AHD, within 500 m of and northeast of the open pit.

In locations where both the shallow groundwater system and the deep groundwater system are present (near the open pit), these two groundwater transmitting systems are separated vertically by unweathered and mostly unfractured breccia, granite and dolerite. Mechanisms which may act to provide vertical connection through these basement rocks potentially include pervasive zones of fracturing associated with major structural features, or artificial connection created by un-grouted drill holes installed near the ore body during the development and mining periods.

Based on the groundwater elevations measured in the VWP sensors, in all locations vertical groundwater gradients act downwards, with the groundwater elevation being higher in the shallow groundwater system. In any locations where vertical hydraulic connection is present, this suggests the occurrence of downward seepage from the shallow groundwater system into the deeper groundwater system. There are no locations in which the groundwater pressure in the deep system suggests that discharge could occur into the shallow system where pathways are present. (Above information sourced from Big Dog Hydrogeology, 2017).

3 TAILINGS STORAGE FACILITY DETAILS

3.1 TAILINGS STORAGE FACILITY DESCRIPTIONS

3.1.1 General

Summary details of the TSFs at the Mt Leyshon Mine are provided in Table 3.1.

Table 3.1: Key Details of TSFs

TSF	Original Referable Dam Licence No.	Years of Operation	Estimated Tailings Volume Contained (ML)	Number of Construction Stages	Dam Crest Length (m)	Maximum Landform Height (m)	Landform Surface Area[3] (ha)	TSF Design Plans
ONTSF	55012A	1988 to 1999	11,400[1]	7	1,200	43	65	Coffey Partners International and BHP Engineering
NNTSF	57218A	1998 to 2001	14,000[1]	4	2,700	23	109	Coffey Partners International
STSF	54965AA	1995 to 2000	6,600[1]	7	2,800	36	62	Coffey Partners International and BHP Engineering
Open Pit	N/A	2001 to 2002	5,000[2]	N/A	N/A	Unknown	Unknown	None

[1] From Schedule H Table 3 of 2008 version of EA.
[2] Estimated from 2019 pit lake depth soundings and original pit shell survey.
[3] Area excludes seepage sumps.

3.1.2 ONTSF

The ONTSF was constructed as a conventional on-land unlined impoundment. Natural terrain below the ONTSF predominantly slopes north-west towards Plum Tree Creek and the highest embankment was constructed along the north-west boundary, with a total slope height of around 40m in this location. The ONTSF was constructed using an initial 21m embankment comprising a zoned earth and rockfill structure with a core of spent heap leach material. Subsequent lifts of the embankment were 2 to 5m in height and were constructed by a combination of downstream and upstream raises utilising heap leach and rockfill material.

The ONTSF was operated from 1988 to 1999 and has been fully rehabilitated.

3.1.3 NNTSF

The NNTSF was constructed to the north of the ONTSF as an on-land unlined impoundment utilising the same natural topography as the ONTSF. The resulting embankment was highest on the northern margins, reaching a total slope height of approximately 25m. The starter embankment was an engineered earth and rockfill structure, with subsequent smaller upstream lifts being completed using locally sourced materials such as compacted heap leach and waste rock fill.

The NTSF was operated from 1998 to 2001 and has been fully rehabilitated.

3.1.4 STSF

The STSF was constructed as a conventional on-land unlined impoundment, using the naturally sloping topography to the south of the Southern Waste Rock Storage Facility. The highest embankment occurs on the southern margin of the facility with an overall slope height of approximately 35m in this location. The starter embankment was an engineered structure and subsequent smaller lifts were constructed using upstream raise methods.

The STSF operated from 1995 to 2000 and has been fully rehabilitated.

3.1.5 Pit

When open pit mining terminated in 2001, the final void had a total volume to the overspill point of 69,000,000 m^3, and the void was acting as a groundwater sink, due to the dewatering operations undertaken during mining. The final void was therefore identified as the preferred location for storage of tailings when processing ore stockpiles which was completed between early 2001 and March 2002. This allowed closure and rehabilitation of the NNTSF and STSF to be commenced while the site was still in an operating phase.

3.2 GEOCHEMICAL CHARACTERISATION OF TAILINGS

Tailings at the Mt Leyshon Mine were ground relatively fine (140 µm), and were known to contain sulphides, and the risk of Acid Rock Drainage (ARD) generation was identified in the mine design and operating phases. In 1999, EGI reported results from tailings characterisation carried out on samples collected in 1997 from the ONTSF and STSF. Two bulk samples from each tailings storage facility were assessed along with 11 samples from a transect across the ONTSF. From the transect, the coarser fractions from the pond perimeter (beach) had the highest total sulphur (average 6.6%), the highest net acid production potential (NAPP of 180 kg H_2SO_4/t), and the highest net acid generation potential (NAG of 31 kg H_2SO_4/t). In contrast, the fine tailings from the decant pond area had the lowest sulphur (average 1.8%), the lowest NAPP (3 kg H_2SO_4/t), and a NAG of zero (0 kg H_2SO_4/t). The static testwork presented (EGI, 1999) indicated that the bulk of the tailings material would be likely to be ARD generating.

Static testwork simply determines the net balance between the components present which may potentially produce acid and the components present which may neutralise acid. The actual behaviour of the tailings in practice will be a function of how accessible each of these components are to oxidation and leaching, and whether all potential reactions extend to completion. The actual elements which would be released to the environment are not identified from static testwork.

Kinetic laboratory testwork simulates accelerated leaching of the materials, by exposing them to sequential oxidising and flushing cycles. The leachate generated during kinetic testwork is indicative of the amount of acid production which is likely to be observed in practice, and the elements which are likely to be present at elevated concentrations.

Two tailings samples were selected for use in column tests (kinetic testwork), one classified from the static testwork as Non Acid Forming (NAF) and the other as Potentially Acid Forming (PAF). The NAF sample test continued for 140 weeks and the pH remained around or above pH 7 for the duration of the test. The test estimated that Acid Neutralising Capacity (ANC) in the material would be consumed by around week 250, following which there was uncertainty as to whether acid conditions would develop. The leachate sulphate concentration in week 140 was 1,848 mg/L. In the final week where a range of trace metals were analysed (week 60), concentrations of 0.03 mg/L Cd, 1.16 mg/L Cu, 0.6 mg/L Fe, 6.4 mg/L Mn and 8.4 mg/L Zn were recorded, along with 1,558 mg/L sulphate. The PAF tailings column was operated for 80 weeks and the final leachate was pH 2.6. Multi-element data for leachate are available up to week 60, at which time the leachate was pH 3.4 with 2,576 mg/L sulphate, 22 mg/L Al, 0.9 mg/L Cd, 25 mg/L Cu, 10 mg/L Fe, 130 mg/L Mn and 220 mg/L Zn.

In combination, the static and kinetic testwork indicated that the tailings would produce acid, along with elevated concentrations of sulphate, Cd, Cu, Mn and Zn, if exposed to ongoing oxidation and flushing, although the testwork indicated that there would be a lag period prior to the onset of acid generation, which was estimated to be at least 6 months and possibly more than 3-5 years, assuming exposure to surficial oxidation. A key component of the closure strategy for the tailings facilities was therefore to minimise oxidation and flushing of the stored tailings.

3.3 OPERATING STRATEGIES

3.3.1 Above-Ground TSFs

The operating strategy for tailings deposition in the above-ground TSFs was similar for all of the conventional on-land impoundments at the Mt Leyshon Mine. The strategy followed industry standard protocols and took account of the highly seasonal nature of precipitation conditions at the mine. Components of the operating strategy designed to minimise the risk of emissions were:

- Slope angles applied during construction of the starter embankments and subsequent lifts were selected to ensure physical stability of the impoundments under all conditions, including potential liquefaction during seismic events.
- A decant pumping system was operated to return supernatant water to the plant, to minimise the pond volume on the facility, and mitigate the risk of overtopping cyanide containing process solutions from the facility.
- Tailings deposition was sub-aerial, with beaching employed to maximise the strength of the deposited tailings near the embankment, to improve the strength of the embankment during subsequent lift construction.
- The planned lift schedule for each facility was compared against potential precipitation which may have been received in the future wet seasons, to ensure that sufficient freeboard capacity was maintained to accommodate all potential inflows.
- The tailings stream and decant pond were maintained at a high pH by the addition of lime in the plant, to ensure the stability of cyanide in the decant pond, and to mitigate against the risk of fugitive emissions of hydrogen cyanide gas.
- Monitoring bores were installed down-gradient of all facilities, and groundwater elevations and groundwater quality were monitored to identify the influence of any seepage potentially entering the groundwater system.

Data from the monitoring bores indicated that seepage from the on-land TSFs did occur during the mining period. Groundwater elevations immediately down-gradient of the facilities were noted to increase within months of commissioning of tailings deposition, followed by increasing sulphate concentrations in groundwater, and eventually increasing concentrations of cyanide and metals. As a result of the observed changes in groundwater conditions, seepage interception trenches were installed along the down-gradient perimeters of the ONTSF and NNTSF between 1989 and 1995. The trenches were backfilled with coarse rock and covered over to minimise surface water ingress. Groundwater and seepage reporting to the trenches were routed to sumps equipped with pumps to return the impacted water to the operational mine water management system. Interception sumps were also subsequently installed down-gradient of the STSF.

3.3.2 Open Pit

Mining operations in the open pit resulted in a pit floor elevation of around RL 60 m AHD, and groundwater elevations close to the pit had also been reduced to RL 60 m AHD, compared to a pre-mining groundwater elevation estimated to be around RL 360 m AHD. Groundwater flow at this time was acting towards the pit, as illustrated by the groundwater inflows which were observed once pit dewatering was decommissioned.

Deposition of tailings in the open pit occurred from early 2001 to March 2002. Deposition was sub-aqueous rather than sub-aerial, and tailings beaches were not generated, resulting in a lower settled density for tailings in the pit compared to the on-land impoundments. This strategy was necessarily adopted due to the very small area of the pit near the base, and the resulting very high rate of rise for the tailings, and this strategy is consistent with other in-pit tailings storage facilities operated across Australia.

Management and modelling of the pond volume in the open pit was not undertaken during deposition, as there was zero risk of overtop from the facility, given that there was 318 m of freeboard available between the base of the pit and the spill point at RL 378 m AHD.

A bathymetric survey of the pit lake undertaken in 2019 indicated that the deposited tailings surface in the floor of the open pit ranges from RL 165 m to 200 m AHD.

3.4 CLOSURE STRATEGIES

3.4.1 Above-Ground TSFs

The closure strategy implemented to manage potential emissions in the long term was similar for all of the on-land impoundments, and comprised:

- Creating a domed surface on the facility to ensure that it would be water shedding in closure, using a combination of tailings deposition and placement of waste rock.
- Installing a cover over the entire facility surface, designed to minimise the ingress of oxygen and water to the stored tailings.
- Vegetating the covers to prevent erosion and dust generation and remove shallow infiltration by evapotranspiration.
- Constructing engineered drainage channels on the cover surface to route as much precipitation incident on the facility off the surface as runoff and minimise infiltration.

- Continuing to operate the seepage interception trenches and sumps, with the intercepted impacted flows pumped into the open pit final void.

Designs for covers on the tailings storage facilities were refined by undertaking trials on the ONTSF during the operating period. Compaction trials were undertaken on the mounded surface using locally sourced materials to investigate the seals which could be achieved, and these field verified results were used in modelling of potential infiltration (EGI, 2000). The seal methods trialled were:

- 600 mm oxide heap leach, 4 passes impact roller.
- 300 mm clay, 4 passes impact roller.
- 600 mm NAF oxide waste rock, 4 passes impact roller.
- 600 mm NAF oxide waste rock, 10 passes impact roller.
- In situ waste rock capping material, 10 passes impact roller.

The resulting cover design for tailings storage facilities comprised:

- 1.5 to 3 m of run-of-mine (ROM) waste rock capping, also acting as a capillary break.
- Minimum 600 mm of compacted oxide heap leach seal. To be placed at a degree of saturation of more than 90% and compacted to a dry density of 97% in order to achieve a hydraulic conductivity less than 1x 10^{-7} m/s. Placed by scraper and compacted via scraper traffic.
- 300 mm topsoil growth medium.

3.4.2 Open Pit

The primary components of the strategy to prevent emissions from the tailings stored at the base of the open pit comprise:

- Ensuring that the tailings remain saturated due to the presence of an overlying lake, preventing ongoing oxidation of the PAF material.
- Ensuring that the overlying lake acts as a groundwater sink in long term closure.

More detail on the closure of the in-pit tailings facility is provided in the Mt Leyshon Final Void Decommissioning Strategy (Newmont Australia, 2018b).

Figure 3.1 shows the surface topography at the Mt Leyshon Mine, while surface drainage catchments and flow paths are shown in Figure 3.2. Recent imagery of the TSFs is provided in Figure 3.3 to Figure 3.6.

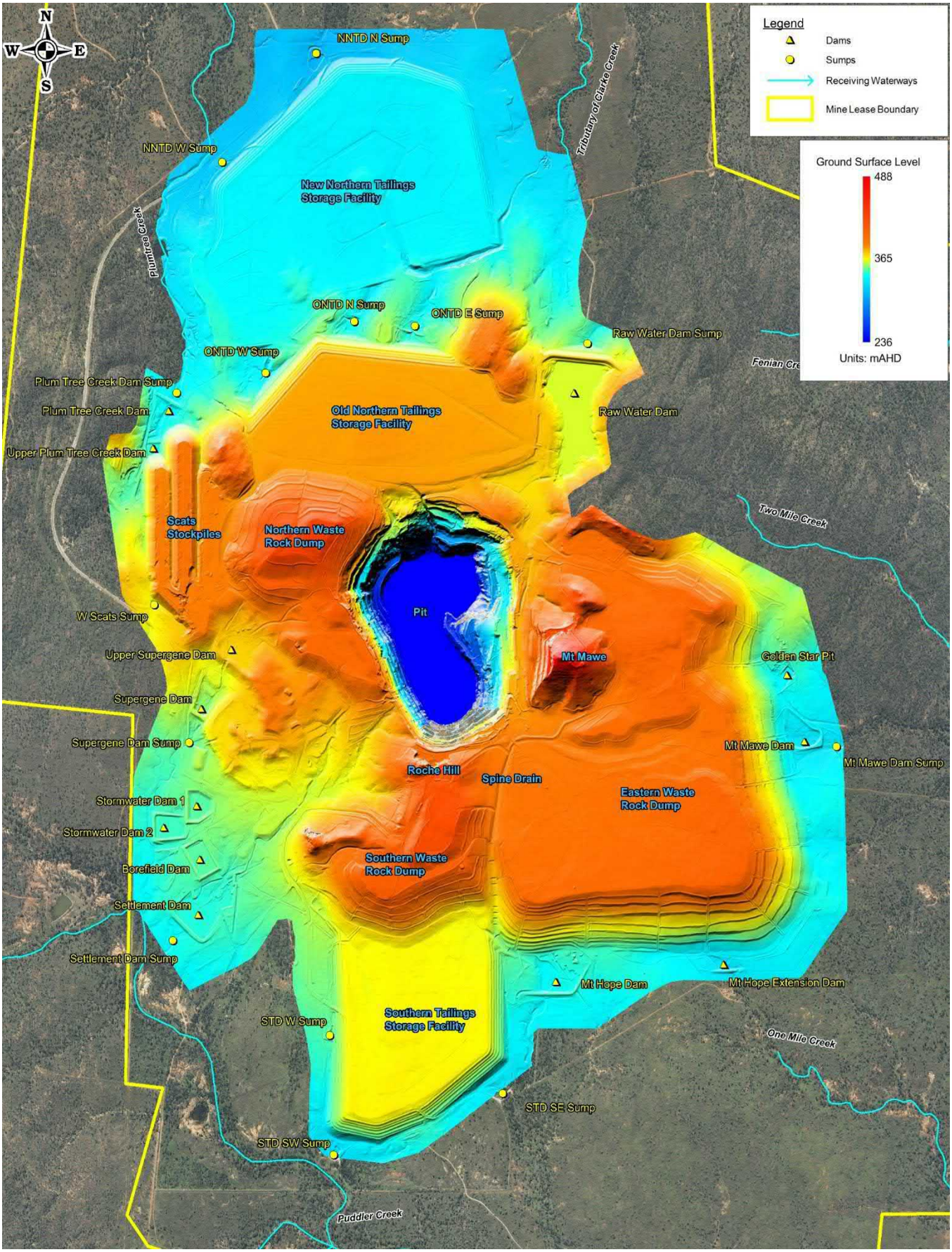

Figure 3.1: Mt Leyshon Mine Layout Plan with Topography (Source: Engeny, 2020a)

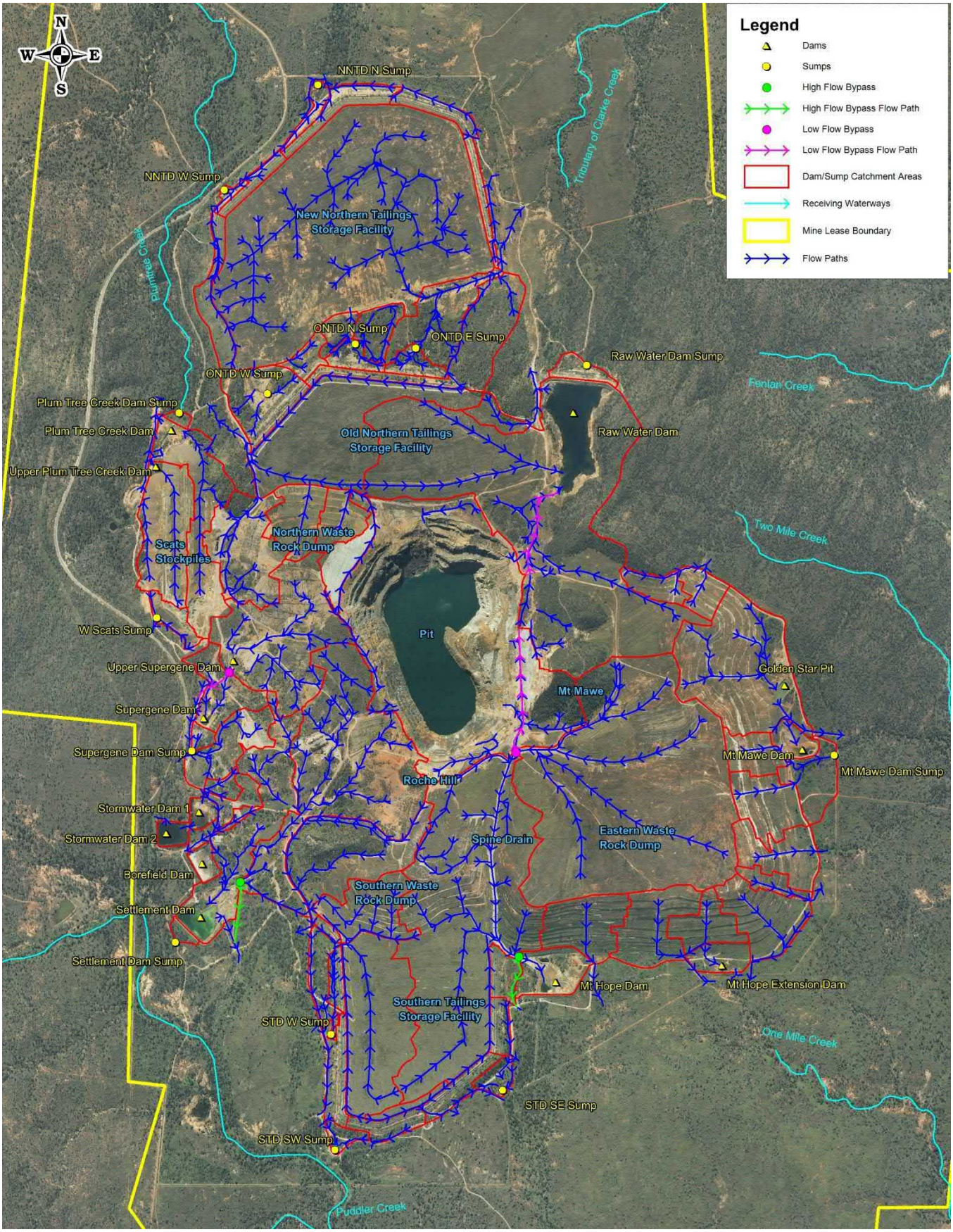

Figure 3.2: Mt Leyshon Mine Layout Plan with Catchments and Flow Paths (Source: Engeny, 2020a)

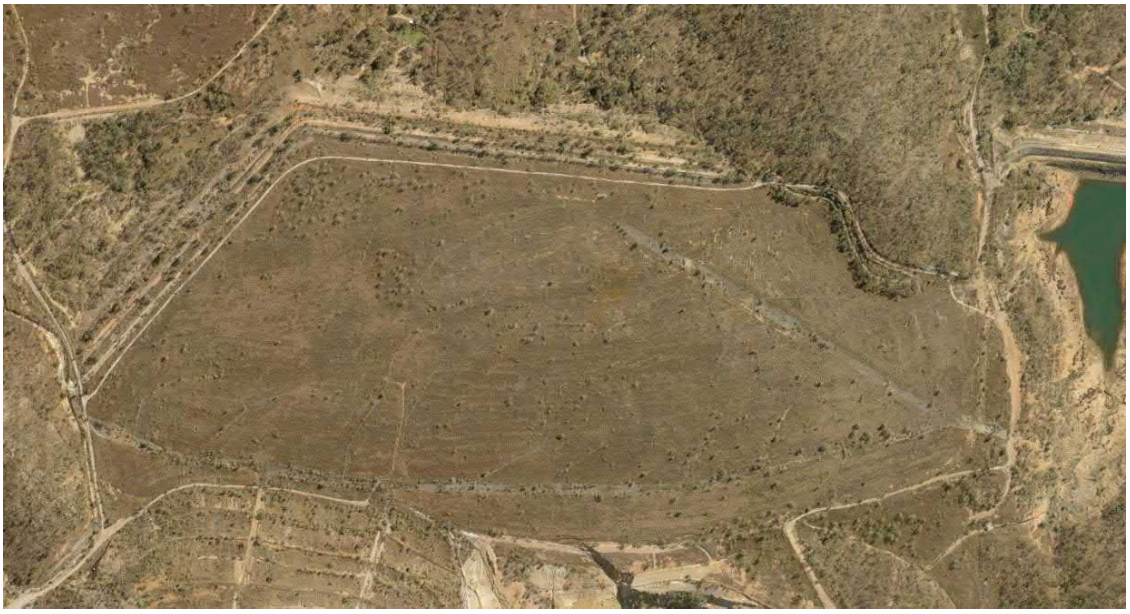

Figure 3.3: Recent Imagery – ONTSF (Source: Queensland Globe)

Figure 3.4: Recent Imagery – NNTSF (Source: Queensland Globe)

Figure 3.5: Recent Imagery – STSF (Source: Queensland Globe)

Figure 3.6: Recent Imagery – Open Pit (Source: Queensland Globe)

4 TAILINGS STORAGE FACILITY MANAGEMENT

4.1 WATER MANAGEMENT

4.1.1 Surface Runoff

ONTSF

The surface drainage on the rehabilitated ONTSF landform is shown in Figure 4.1. The top surface of the ONTSF drains via a number of contour banks and rock-lined open drains to the following destinations:

- Western parts of the ONTSF drain to Plum Tree Creek (the northern batters of the Northern Waste Rock Dump drain into this drainage system).
- Eastern parts of the ONTSF drain to the Raw Water Dam.
- Small area at the north-east corner of the ONTSF drains to Schreibers Creek.

The northern embankment batters drain via bench drains to the ends of the embankments. There are no ramps or drop structures that convey runoff from the embankment batters.

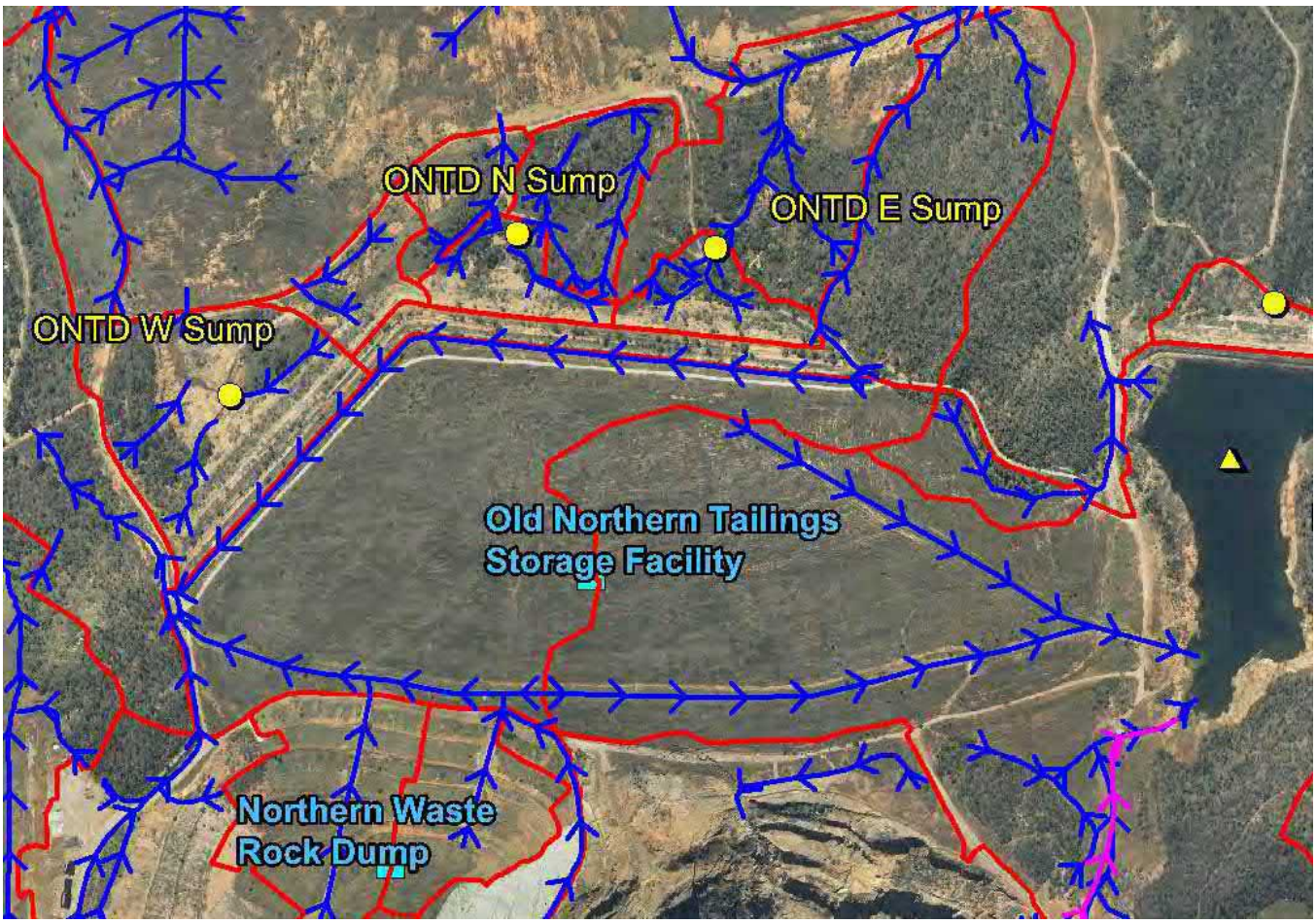

Figure 4.1: ONTSF Landform Surface Drainage

An assessment of the adequacy of the surface drainage on the ONTSF was undertaken by GHD Pty Ltd in 2010 (GHD, 2010b) based on a ground survey of the ONTSF by Rowlands Surveys in April/May 2010 (Figure 4.2).

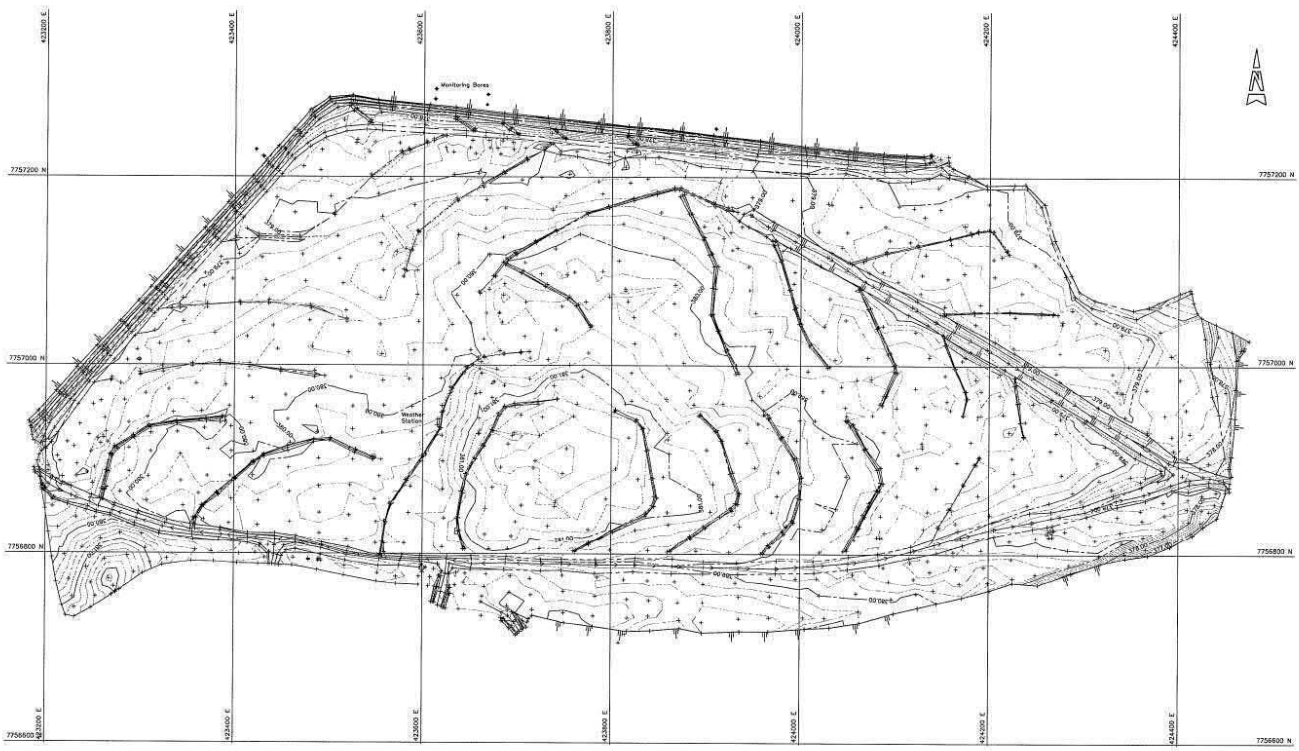

Figure 4.2: 2010 ONTSF Landform Topographic Survey by Rowlands Surveys

The assessment indicated the following problems with the drainage on the ONTSF:

- A large ponding area related to flat topography in the south-west corner of the site (approximately 1 hectare). The surrounding areas fall east to west into the perimeter drain, but there is no grade in this area.
- Smaller local ponding areas, low points and poorly graded overland flow paths. These locations are both adjacent to main drains and dispersed within the landform.
- The perimeter drains to the south and east of the site contain reaches with an undulating invert profile. There appear to be minor areas of ponding relating to these points.
- The perimeter drain along the northern and western edges of the dam has a very flat and, in parts, undulating longitudinal gradient.
- A small number of the contour banks have a flat or adverse longitudinal gradient (possibly a result of differential settlement in the tailings dam surface). In these cases, the contour banks intercept surface runoff and cause ponding as opposed to directing overland flows.

Concept designs were prepared for proposed drainage upgrade works (GHD, 2010b) including filling and regrading of depressions in the surface of the tailings dam, improving the consistency and extent of the gradient of the main drainage channels (including widening of the drain along the western perimeter of the dam), minor adjustments to contour banks and the construction of an additional drain in the north-eastern corner of the landform. The drain at the north-eastern corner of the TSF was constructed and some of the perimeter drains along the northern/western edges of the landform were widened. The other proposed drainage upgrade works were not constructed. The drainage problems on the rehabilitated TSF landform are likely to be contributing to rainfall infiltration through the TSF cover system and corresponding seepage flows expressing down-gradient of the landform. Seepage sump pump flow metering data indicates that the TSF landform has not produced significant seepage flows into the seepage sumps in recent years; however, high rainfall conditions have not been experienced during this period.

NNTSF

The surface drainage on the rehabilitated NNTSF landform is shown in Figure 4.3. The top surface of the NNTSF drains via a number of rock-lined open drains to the south-eastern corner of the landform and then to Schreibers Creek.

The embankment batters drain via bench drains to a number of access ramps which convey the drainage to the base of the batters.

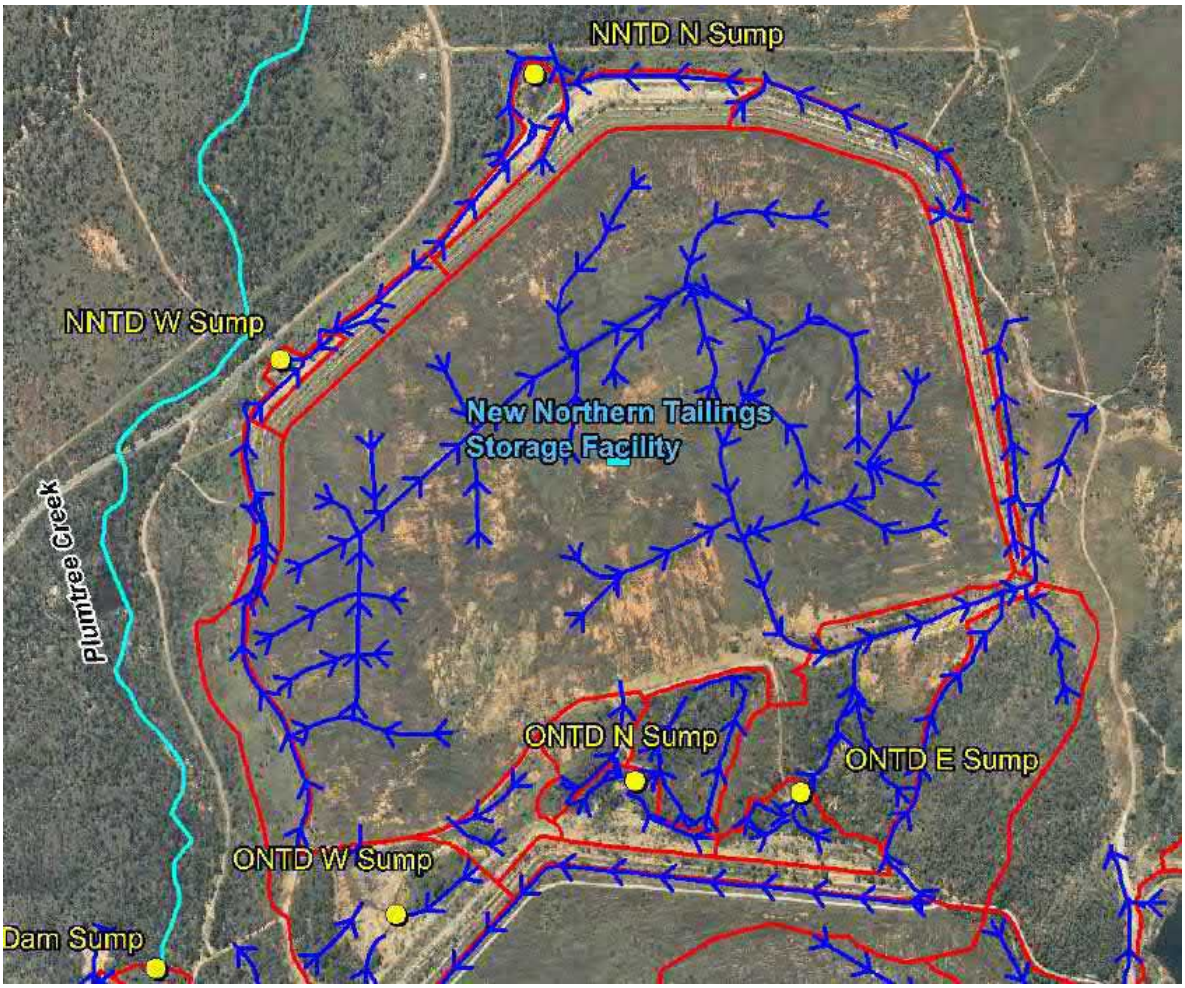

Figure 4.3: NNTSF Landform Surface Drainage

An assessment of the adequacy of the surface drainage on the NNTSF was undertaken by GHD Pty Ltd in 2010 (GHD, 2010a) based on a ground survey of the NNTSF by Rowlands Surveys in April/May 2010 (Figure 4.4).

The assessment indicated the following problems with the drainage on the NNTSF:

- Large ponding areas or areas of flat topography adjacent to open drains. This seems to be where the tailings dam surface adjacent to the drains has experienced greater settlement than the drains, resulting in the banks of the drains being higher than the surrounding topography.
- Smaller local ponding areas, low points and poorly graded overland flow paths. These locations are typically away from the open drains.
- The last 1.5 km of the main drain is very flat and has a negligible longitudinal gradient. There are two rock bars and an earth bund that protrude above the drain invert near the downstream end of the drain (near south-east corner of the tailings dam). The combination of the flat gradient and the blockages near the downstream end of the drain result in ponding in the lowest 500 m of the drain following significant rainfall events.
- The bed width of the last 850 m of the main drain is very narrow (down to 3 m bed width). The last 850 m of the main drain is in a deep cut with relatively steep side slopes (as steep as 1V:2H). Although the drain is deep, the narrow width of the

drain means that there will be a large flow depth in the drain during flood events. A large flow depth in the lower section of the main drain will drown out upstream sections of the main drain and feeder drains. The lower section of the main drain needs to be widened if the drain is intended to convey large flood flows.

- The upstream section of the main drain is very shallow (typically shallower than 0.3 to 0.5 m deep). Many of the feeder drains are also very shallow (typically shallower than 0.3 m deep). These drains do not have capacity to convey large flood flows.
- Some of the feeder drains have a very flat longitudinal gradient (possibly a result of differential settlement in the tailings dam surface).

Concept designs were prepared for proposed drainage upgrade works (GHD, 2010a) including filling and regrading of depressions in the surface of the tailings dam, increasing the depth, width and gradient of the main drainage channel, and increasing the depth and width of the feeder drains. These proposed drainage upgrade works have not been constructed. The drainage problems on the rehabilitated TSF landform are likely to be contributing to rainfall infiltration through the TSF cover system and corresponding seepage flows expressing down-gradient of the landform. Seepage sump pump flow metering data indicates that the TSF landform has only produced very small seepage flows into the seepage sumps in recent years; however, high rainfall conditions have not been experienced during this period.

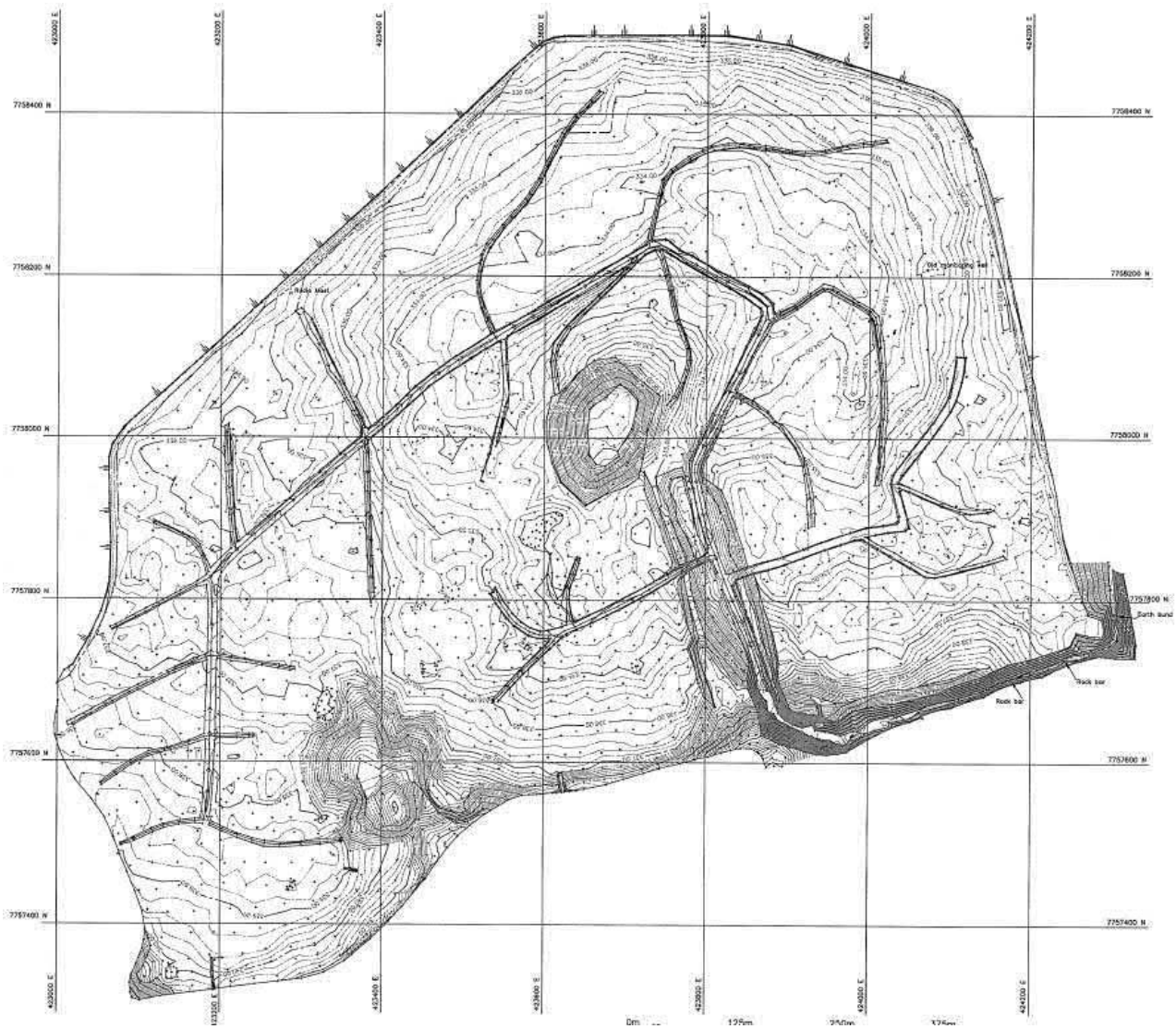

Figure 4.4: 2010 NNTSF Landform Topographic Survey by Rowlands Surveys

STSF

The surface drainage on the rehabilitated STSF landform is shown in Figure 4.5. The top surface of the SNTSF drains via a number of contour banks and rock-lined open drains to the following destinations:

- Western parts of the STSF drain to a drop structure at the north-western corner of the TSF and then ultimately to Puddler Creek.
- Eastern parts of the STSF drain to the Spine Drain upstream of the Mt Hope Dam High Flow Bypass Structure (low flows in the Spine Drain enter the Mt Hope Dam and high flows bypass the dam). Parts of the southern batters of the Southern Waste Rock Dump drain into this drainage system

The embankment batters drain via bench drains to a number of access ramps which convey the drainage to the base of the batters. A new drop structure was installed below the lowest bench at the south-western corner of the landform in 2018 to repair an erosion gully that had formed at this location.

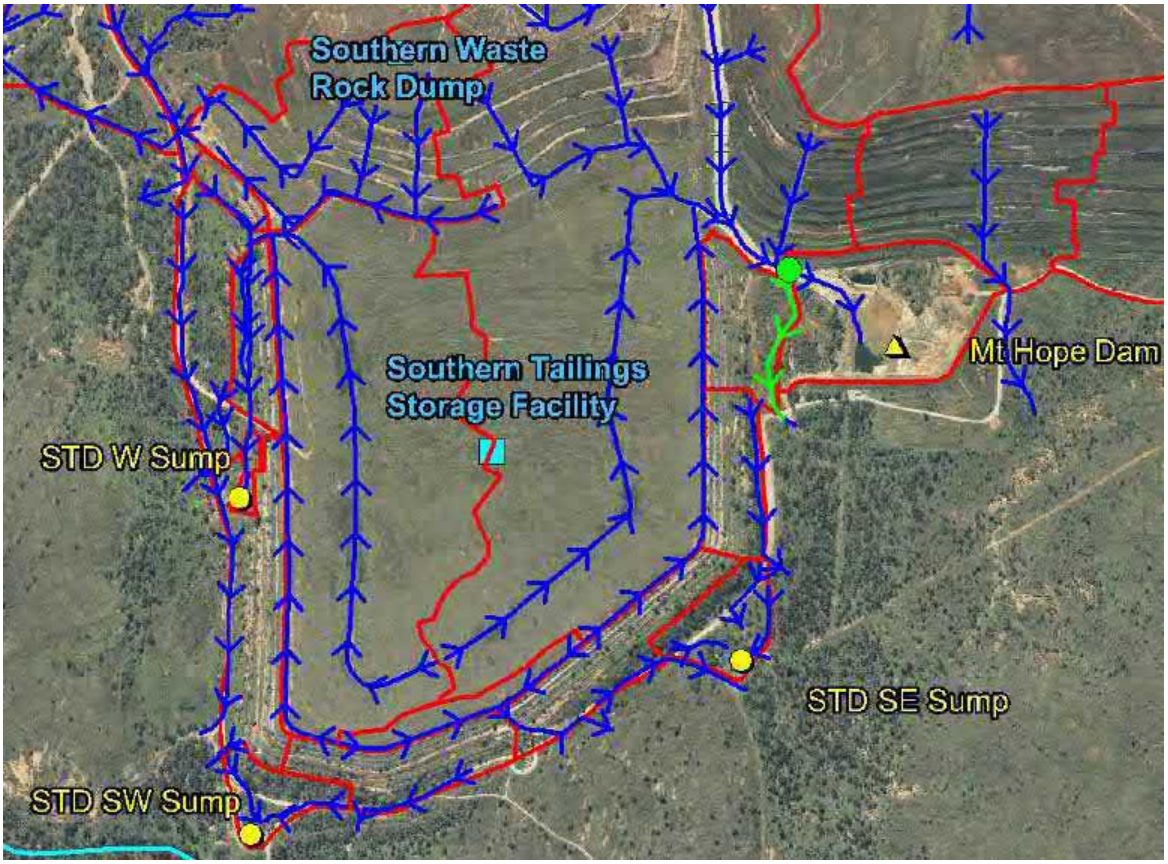

Figure 4.5: STSF Landform Surface Drainage

An assessment of the adequacy of the surface drainage on the STSF was undertaken by GHD Pty Ltd in 2010 (GHD, 2010c) based on a ground survey of the STSF by Rowlands Surveys in April/May 2010 (Figure 4.6).

The assessment indicated the following problems with the drainage on the STSF:

- Large ponding areas or areas of flat topography adjacent to open drains. This seems to be where the tailings dam surface adjacent to the drains has experienced greater settlement than the drains, resulting in the banks of the drains being higher than the surrounding topography.
- Smaller local ponding areas, low points and poorly graded overland flow paths. These locations are typically away from the open drains.
- The upstream section of the main drainage channel on the western side of the landform is very shallow and does not have capacity to convey flood flows.

- The entire length of the main drainage channel on the eastern side of the dam is shallow and has insufficient capacity to convey flood flows. There are bunds running parallel to the downstream section of this drain which would seem to restrict the flow of surface water into the drain itself.
- The perimeter drains on the edge of the top surface of the landform have an undulating bed profile and sections of the drains have a very flat longitudinal gradient.
- A small number of the feeder drains have flat or adverse gradients, presenting isolated drainage problems adjacent to these points.

Concept designs were prepared for proposed drainage upgrade works (GHD, 2010c) including filling and regrading of depressions in the surface of the tailings dam, regrading and increasing the depth of the main drainage channels, and regrading and increasing the depth of two feeder drains. These proposed drainage upgrade works have not been constructed. The drainage problems on the rehabilitated TSF landform are likely to be contributing to rainfall infiltration through the TSF cover system and corresponding seepage flows expressing down-gradient of the landform. Seepage sump pump flow metering data indicates that the TSF landform has only produced very small seepage flows into the seepage sumps in recent years; however, high rainfall conditions have not been experienced during this period.

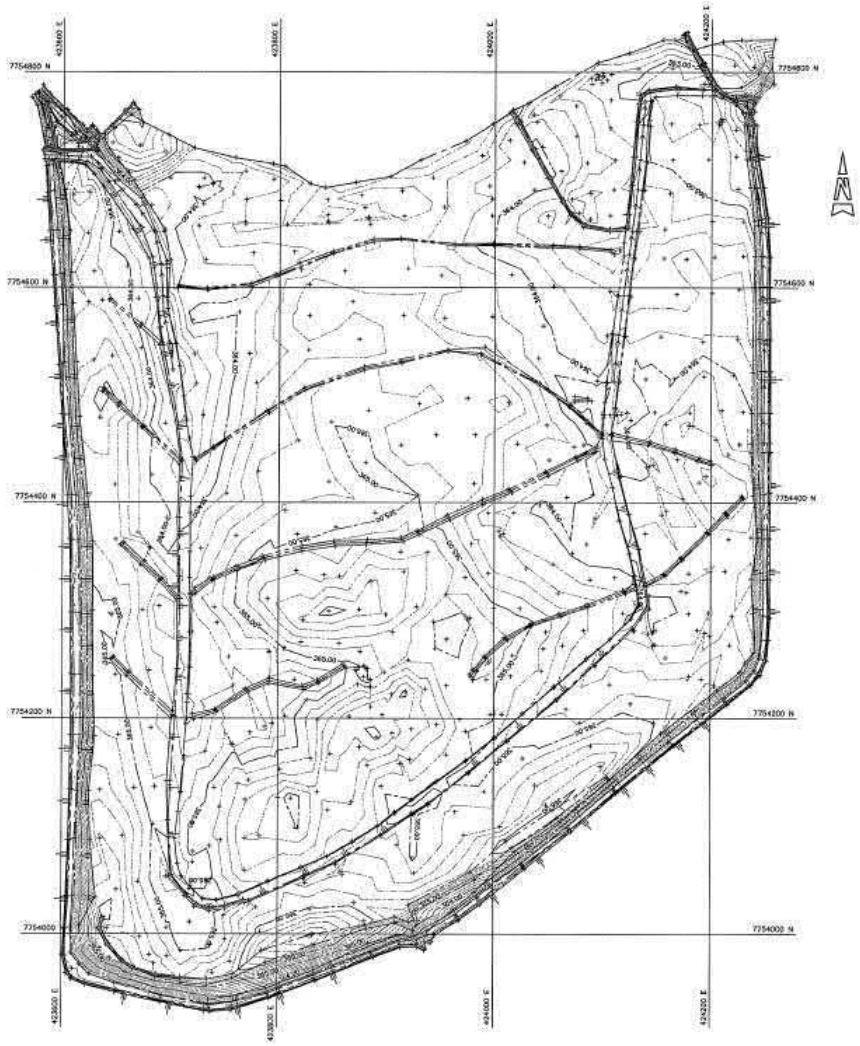

Figure 4.6: 2010 STSF Landform Topographic Survey by Rowlands Surveys

Open Pit

The surface drainage in the vicinity of the Open Pit is shown in Figure 4.7. Drainage on the landforms surrounding the Open Pit is typically diverted away from the pit, resulting in the pit having minimal external catchment beyond the pit rim. The small external catchment areas outside of the pit rim that drain into the pit include:

- Area to the north of the pit adjoining the ONTSF (this area has previously subsided as a result of a slip of the northern wall of the pit along a fault line).
- Mt Hope quarry area on the southern edge of the pit.
- Parts of Mt Mawe which is a natural hill adjacent to the south-eastern corner of the pit.

The pit receives pumped inflows from the water containment dams and seepage sumps that collect impacted surface runoff and seepage flows from the rehabilitated mine landforms. These pumped inflows are typically larger than the rainfall inflows to the pit from its' direct catchment area.

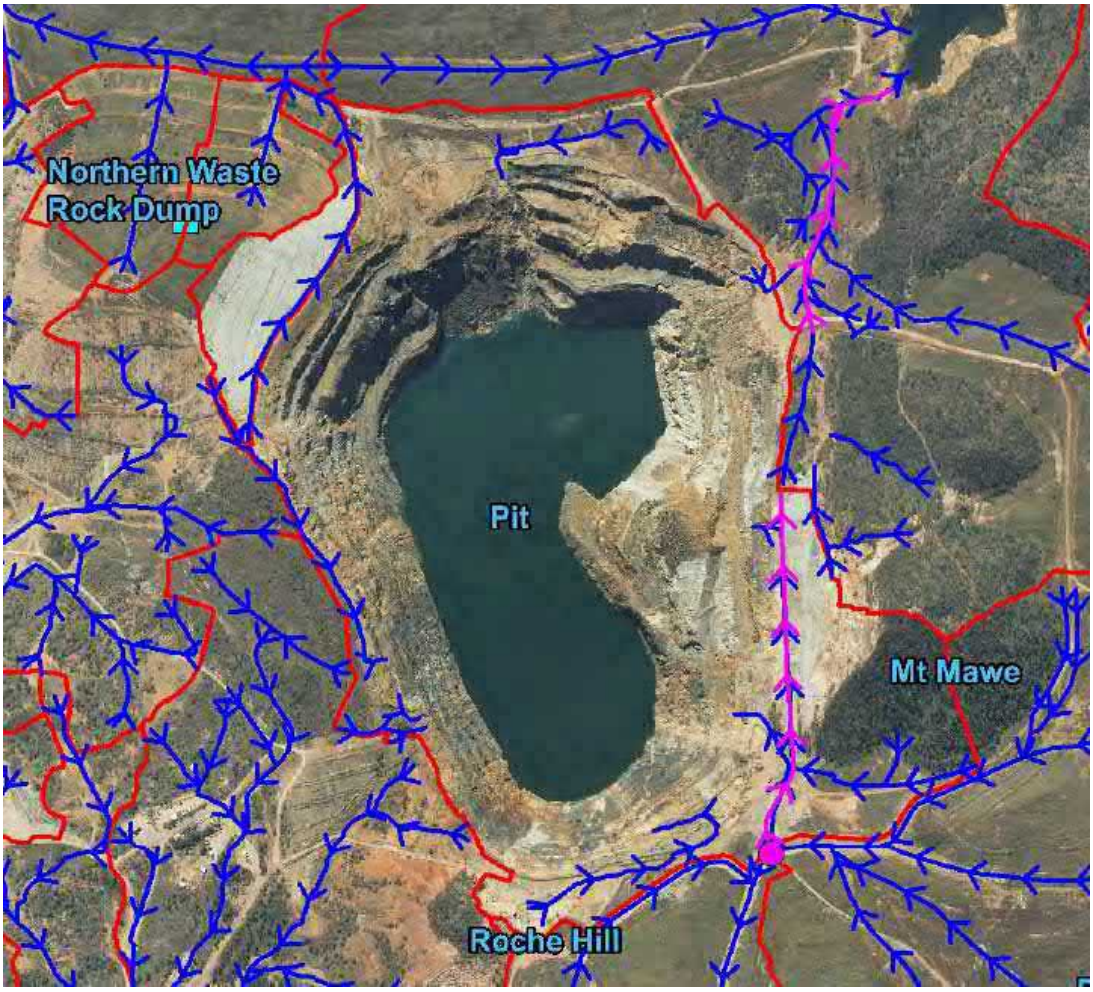

Figure 4.7: Open Pit Surface Drainage

A lake has progressively formed in the Open Pit since pit dewatering ceased in 2001 at the end of mining (Figure 4.8). The pit lake is currently approximately 90 m deep above the lowest point in the tailings deposition surface in the floor of the pit. Water balance modelling of the Open Pit residual void (Engeny, 2020a) indicates that there will always be a deep pit lake in the residual void, ensuring that the tailings in the floor of the pit will remain saturated and preventing ongoing oxidation of the PAF tailings material.

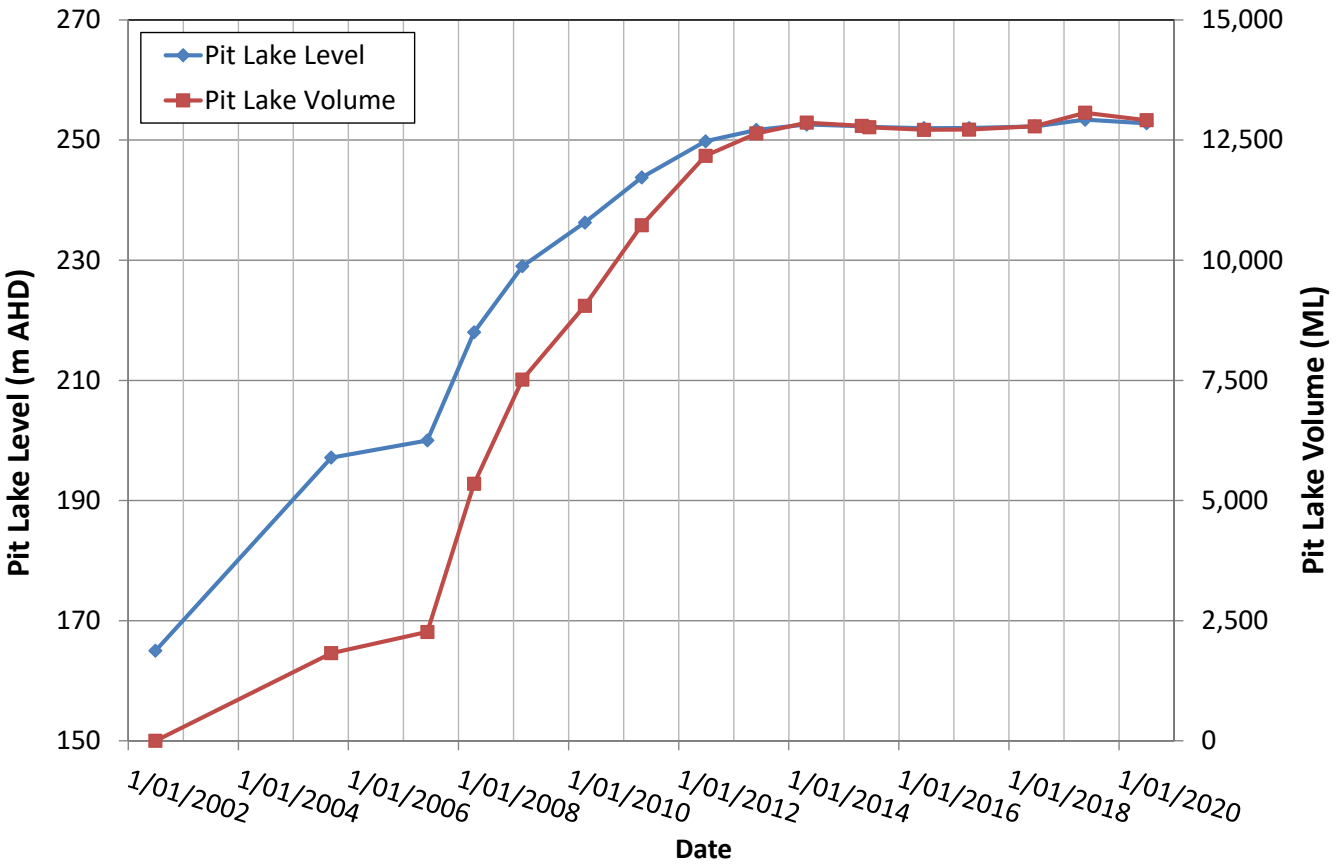

Figure 4.8: Pit Lake Filling History Since Mine Closure

4.1.2 Seepage Management

Above-Ground TSFs

As indicated in Section 3.3.1, seepage interception trenches/sumps were installed along the down-gradient perimeters of the above-ground TSFs while the TSFs were in operation. These seepage collection sumps have been continued to be used in the post-closure phase of the mine to intercept seepage flows from the TSF landforms, with the seepage flows intercepted in the sumps pumped to the Open Pit via pumping systems installed in the sumps. The seepage sumps currently in use at the above-ground TSFs are shown in Figure 3.2 and comprise:

- ONTSF:
  - ONTD E Sump (pumps to ONTD N Sump).
  - ONTD N Sump (pumps to the pit).
  - ONTD W Sump (pumps to the Plum Tree Creek Dam and then to the pit).
- NNTSF:
  - NNTD N Sump (pumps to the Plum Tree Creek Dam and then to the pit).
  - NNTD W Sump (pumps to the Plum Tree Creek Dam and then to the pit).
- STSF:
  - STD SE Sump (pumps to the STD SW Sump).
  - STD W Sump (pumps to the pit).

The seepage sump pumps all operate automatically off float switches. Further details of the TSF seepage sump pumping systems are provided in the Water Management Plan (Engeny Water Management, 2020a).

Flow meters are installed on the seepage sump pumping systems and are typically read on a monthly basis to provide seepage pumping volumes. Indicative seepage pumping volumes in recent years (2015 to 2020) are indicated below:

- ONTSF seepage sumps: 30 to 40 ML/year.
- NNTSF seepage sumps: 5 ML/year.
- STSF seepage sumps: 0 to 2 ML/year.

The recent seepage pumping volumes (2015 to 2020) have been significantly lower than previous metered pumping volumes (2010 to 2015) as a result of generally below average rainfall conditions in recent years, but also potentially due to the extended period of drainage of pore water out of the tailings since the TSFs ceased operation.

The closure design criteria for the major landform covers at the Mt Leyshon Mine was to achieve net infiltration rates (i.e. net of surface runoff and evapotranspiration) through the covers of less than 10% of mean annual rainfall. Engeny Water Management (2015) estimated the net infiltration rates for the major landform covers at the Mt Leyshon Mine, including the above-ground TSFs. The net annual infiltration rates were estimated for the three TSFs using the available down-gradient seepage sump pump flow metering data for these facilities and assuming that all infiltration through the landform footprints reports as seepage flow into the seepage sumps. This is an approximation only since seepage flows from the TSFs may bypass the seepage sumps or report to other storages (e.g. the pit). The landform infiltration rates were estimated separately for the 2011/12, 2012/13 and 2013/14 water years. The range of annual infiltration rates estimated for the three TSFs for these periods were:

- ONTSF: 13% to 21%.
- NNTSF: 7% to 13%.
- STSF: 5% to 17%.

It is noted that the TSF seepage pumping volumes have been significantly lower than previous years since 2015, which is likely to be a combination of lower rainfall conditions and also the continued drain down of the pore water in the tailings.

Open Pit

Groundwater investigations have identified the following preliminary values of the minimum elevation at which the pit lake could begin to impact on the adjacent groundwater systems.

- RL 295 m AHD: localised deep fracture zone.
- RL 350 m AHD: deep basement groundwater system.
- RL 365 m AHD: regional shallow groundwater system.

Newmont's closure objective is that the pit lake acts as a groundwater sink to the shallow groundwater system and therefore the closure criteria is that the pit lake elevation is to remain below RL 340 m AHD (Newmont, 2018b).

Water balance modelling of the Open Pit residual void (Engeny, 2020a) predicts a very slow filling response as the pit lake level continues to rise and the evaporation losses from the larger pit lake area increases. The water balance model predictions indicate that the pit lake will fill to an equilibrium level (i.e. where average evaporation losses balance average inflows) of approximately RL 360 m AHD over a period of around 200 years, with a range of fluctuation of the pit lake level of approximately ±20 m after equilibrium conditions have been reached depending on climate conditions.

The current pit lake filling forecasts indicate that an alternative water disposal strategy for the water containment dams and seepage sumps that currently pump to the pit lake will be required to prevent the pit lake filling above RL 340 m AHD. The pit lake filling forecasts indicate that there is a significant period of time available (approximately 100 years) before an alternative water management strategy for the mine needs to be implemented.

The significant slow-down in the pit lake filling rate observed over the last 7 years (2013 to 2020) (Figure 4.8) cannot be fully explained by the current knowledge of the pit lake water balance and groundwater conditions and further monitoring of the pit lake response to different wet season rainfall totals is required to predict the future pit lake conditions with greater confidence.

4.2 EROSION AND SEDIMENT CONTROL

The Water Management Plan for the Mt Leyshon Mine (Engeny, 2020a) outlines the measures and ongoing operational requirements for erosion and sediment control.

The principles on which the erosion and sediment control plan has been founded are:

- Minimise surface disturbance and restrict access to undisturbed areas;
- Progressively rehabilitate and stabilise disturbed areas with vegetation;
- Separate catchment runoff from disturbed and undisturbed areas where practicable;
- Reduce potential for erosion through velocity controls and reduced runoff volume;
- Use of suitably sized and protected drainage structures to manage surface runoff;
- Use of existing onsite containment structures for the capture of sediment laden surface water runoff; and
- Regular monitoring and maintenance to ensure continual operation of the individual erosion and sediment control elements.

Because the top surfaces of the rehabilitated above-ground TSF landforms are relatively flat and well-vegetated, the surface runoff from these landforms does not have a high sediment load. The batters of the rehabilitated above-ground TSF landforms are also generally well vegetated and the regularly spaced benches on the batters provide drainage controls which minimise the potential for erosion of the batters.

The tailings deposited in the floor of the Open Pit are submerged by the pit lake and the walls of the pit are primarily excavated into rock. Drainage on the landforms surrounding the Open Pit is typically diverted away from the pit. Erosion and sediment control is not a concern for the in-pit TSF.

4.3 MAINTENANCE

Maintenance of the rehabilitated above-ground TSF landforms is undertaken as required in response to the rehabilitation monitoring programme and routine inspections of the landforms by site personnel during normal post-closure management activities. Periodic maintenance activities include:

- Erosion repairs.
- Filling areas with clean material to prevent ponding.
- Revegetation of bare areas (typically only required on the external batters of the landforms).
- Maintenance of drainage channels.
- Vegetation maintenance (e.g. weed control).
- Maintenance of access ramps and tracks.
- Maintenance of seepage collection pumping systems.

Current revegetation methods involve:

- Topsoil placed to a minimum depth of 250 mm.
- Seed applied at a rate of 5 to 8 kg/ha of grasses (Seca, Rhodes, Cooch, Wynn-Cassia, Buffel). The seed mix varies depending on seed type and terrain. In general:
  - Seca is added to all mixed as it is a legume (Nitrogen fixation)
  - Buffel is applied on flat areas
  - Wynn –Cassia is applied mainly to dryer areas and on slopes.
  - Rhodes and Cooch grasses are applied to the wetter areas.
  - Topsoil which has been stockpiled for lengthy times is seeded with Triticale (a hybrid of wheat and rye) initially to add organics and improve soil condition. Normal application and seeding of the soil is then undertaken the following season.
- Fertiliser is applied at a rate of 80 kg/ha. The seed is mixed with the fertilizer in a 12 volt, 40 litre spreader mounted on the back of a Gator vehicle.

Management of weeds within rehabilitated areas is undertaken by the Site Closure Superintendent and Senior Environmental Technician in accordance with the Pest Management Plan (Newmont Australia, 2017) required under condition F6-1 of the EA.

Historically, the rehabilitated above-ground TSF landforms have required minimal maintenance. A new drop structure was installed below the lowest bench at the south-western corner of the STSF landform in 2018 to repair an erosion gully that had formed at this location.

There are no maintenance activities performed on the Open Pit. Access into the Open Pit is precluded due to safety concerns over pit wall instabilities and rock falls.

5 TAILINGS STORAGE FACILITY MONITORING AND ASSESSMENTS

5.1 PIEZOMETER MONITORING

Standpipe piezometers were installed in the embankments of the above-ground TSFs during the decommissioning of the facilities. The locations of the piezometers are shown in Figure 5.1 (ONTSF), Figure 5.2 (NNTSF) and Figure 5.3 (STSF).

The primary purpose of the piezometers during the closure phase is to allow ongoing monitoring and verification of whether the water level (phreatic surface) within the TSF perimeter embankments is continuing to trend downwards as would be expected for TSFs that have been capped with a water shedding cover.

The only available monitoring data for the piezometers is a single set of readings in April 2009 and then typically quarterly readings from February 2019. In February 2019, the piezometers were located / surveyed to allow for future ongoing routine monitoring (quarterly monitoring frequency).

The piezometer monitoring data indicates that the piezometer water levels declined between April 2009 and February 2019 and then have either remained relatively constant or continued to decline during 2019 and 2020. In September 2020, all piezometers were dry with the exception of one piezometer at the NNTSF (NNL1/4) and four piezometers at the STSF (SL1/1, SL1/3, SL1/4 and SL1/5).

The lowering of the water level (phreatic surface) within the TSF embankments indicates that the tailings can be inferred to have continued to drain down. The absence of piezometers across the top surface of the TSFs does not allow for direct measurement of the phreatic surface level within the tailings deposits and accordingly makes it difficult to quantify the performance of the TSF cover systems in minimising rainfall infiltration.

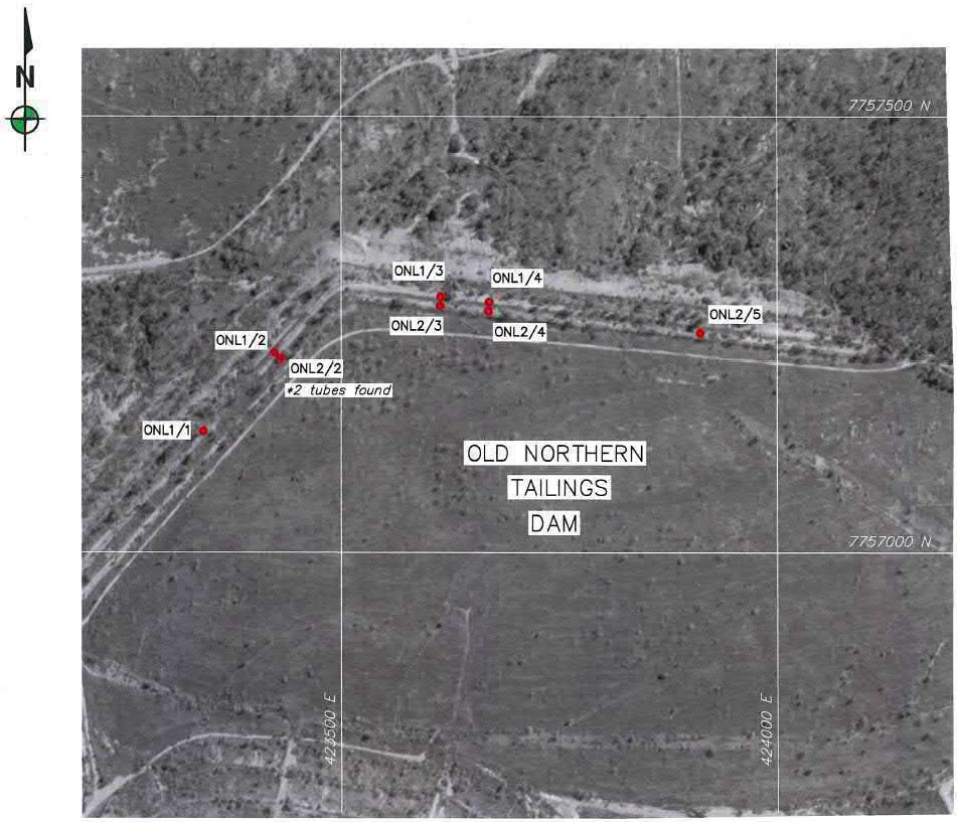

Figure 5.1: ONTSF Piezometer Locations

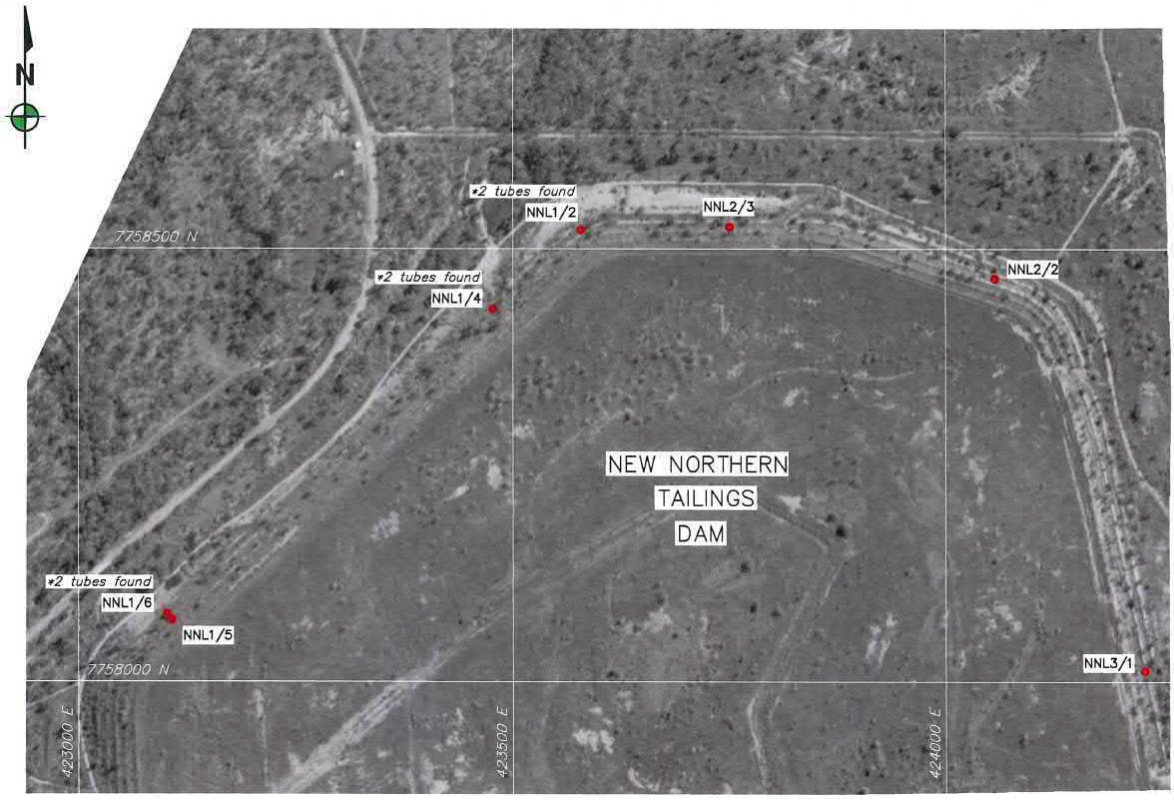

Figure 5.2: NNTSF Piezometer Locations

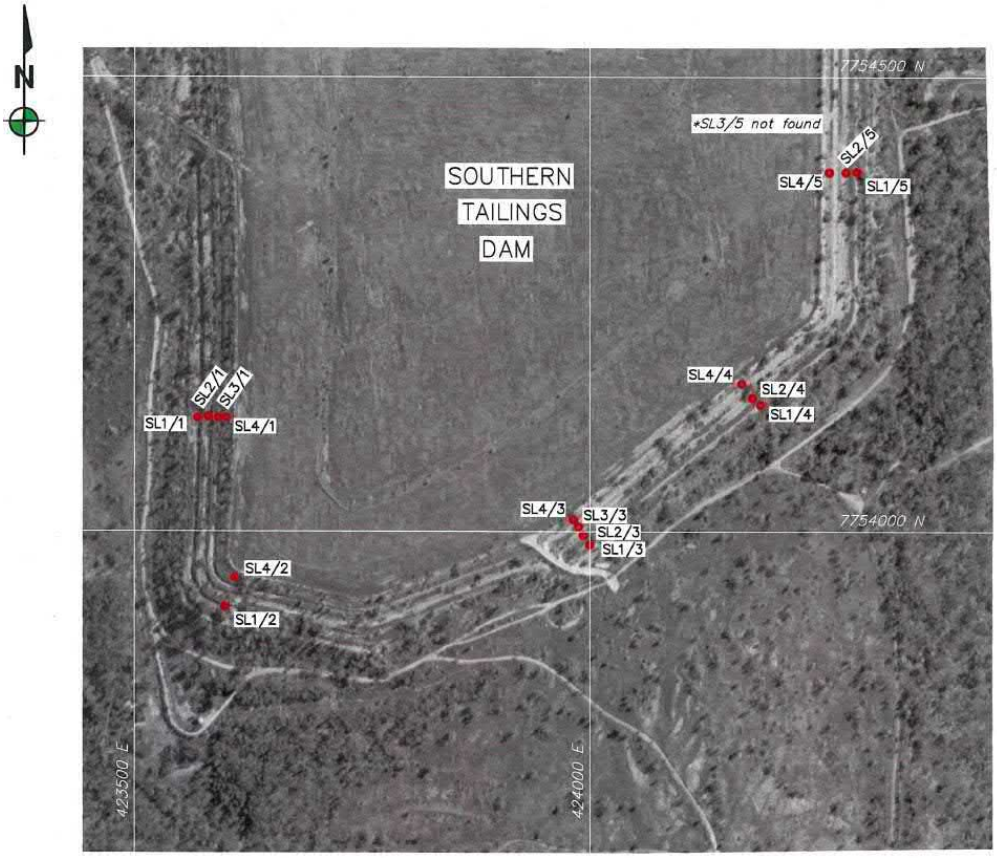

Figure 5.3: STSF Piezometer Locations

5.2 SURFACE WATER AND GROUNDWATER MONITORING

Monitoring undertaken at the closed Mt Leyshon Mine is described in detail in closure documentation, including the Groundwater Management Plan (Big Dog Hydrogeology, 2017), the Water Management Plan (Engeny Water Management, 2020a), the Receiving Environment Monitoring Program (Newmont Asia Pacific, 2015) and the Closure Plan (Newmont Australia, 2019b). Components of the post closure monitoring which are employed to investigate the success of the closure strategy implemented at the TSFs are:

- Monitoring of groundwater elevations in the shallow groundwater system near the on-land impoundments to identify potential groundwater mounding associated with seepage.
- Monitoring of vibrating wire piezometer (VWP) sensors installed in the deep groundwater system near the open pit to confirm that the lake in the final void acts as a groundwater sink.
- Sampling groundwater chemistry in the shallow and deep groundwater systems to identify the extent and any changes in impacts from TSF seepage.
- Calibration of the site wide water balance model using continuous monitoring of pumped flows to refine the understanding of runoff and seepage from the facilities.
- Sampling of the TSF seepage interception sumps to identify any improvement in chemistry in the long term.
- Monitoring of surface water chemistry in the downstream receiving environment to identify any impacts from the rehabilitated mine landforms.

5.3 REHABILITATION MONITORING

In 2013 Outback Ecology were commissioned to implement a monitoring program to meet conditions F5-1, F5-2 and F5-3 of the EA. The methodology (Outback Ecology, 2014), including cover monitoring consists of the following:

- Each landform is separated into sub-domains, each comprising a particular age of rehabilitation, lift, vegetation community or aspect. In total, rehabilitation sub-domains on eleven landforms have been identified in addition to three analogue areas that are used as reference sites.
- On each sub-domain, monitoring involves assigning a scale based score to a range of parameters relating to landform and soil surface characteristics, vegetation condition and structure, declared weeds and erosion. Each parameter score ranges from one to five, with one representing the highest score possible.
- An aggregated numerical score of 20 parameters (maximum score of 100) is assigned to each sub-domain so changes in rehabilitation condition can be detected over time. All parameters are treated equally with no numerical weighting.
- In addition to the scale base assessment, the monitoring consists of:
  - Photo-point monitoring of existing EFA transects
  - Way-pointing and photographing erosion gullies
  - Way-pointing declared weed species
  - Documentation of other potential factors affecting condition (e.g. tree death)
  - Incidental notes relating to vegetation and landform condition including the observation of fauna or surface expression of potentially hostile material.

The rehabilitation monitoring has been performed annually since 2013 and includes the three rehabilitated above-ground TSF landforms. The 2019 annual rehabilitation monitoring report (Stantec, 2020) indicated that the overall condition scores for the NNTSF were relatively constant between 2013 and 2019, while the overall condition scores for the ONTSF and STSF were relatively constant between 2013 and 2016 but reduced (i.e. condition declined) between 2016 and 2019 as a result of an increase in weed abundance and low rainfall conditions.

The Open Pit is a residual void rather than a rehabilitated landform and rehabilitation monitoring is not conducted on the Open Pit.

5.4 2019 TSF GEOTECHNICAL AUDIT

Because the three above-ground TSFs have been rehabilitated for almost 20 years, they are primarily managed as rehabilitated landforms rather than tailings dams. In response to recent international tailings dam failures and the extended period of time since the rehabilitated above-ground TSF landforms were inspected by a geotechnical engineer, Newmont commissioned a geotechnical audit of the rehabilitated TSF landforms at the Mt Leyshon Mine in 2019.

The geotechnical audit of the TSFs was performed by Engeny Water Management (2019) and comprised:

- Desktop identification of areas of the TSF landforms with potential landform erosion / stability or poor surface water drainage issues.
- Visual inspection of the TSF landforms (including photographs).
- Condition assessment.
- Review of piezometer monitoring data.
- Recommended actions to address identified issues including a framework for ongoing surveillance inspections of the TSF landforms.

The visual inspection of the TSF landforms was focussed on dam safety aspects critical to the retention function (integrity) of the facilities. The inspections included visual inspections of the condition of the following components:

- Dam crest.
- Downstream embankment slopes.
- Downstream embankment toes.
- Abutments.
- Drainage channels adjacent to the crest, abutments and along downstream embankment toe.
- Downstream seepage sumps.

The rehabilitated above-ground TSF landforms were observed to be generally in good condition at the time of the inspections. There were no observable signs of embankment instability. The identified embankment defects consisted of localised erosion only which is consistent with what would be expected for facilities rehabilitated approximately 15 to 20 years ago with relatively steep batter slopes.

The audit included a visual inspection of the previous slope failure (fault zone) of the northern pit wall which occurred in January 2009 and has extended into the southern end of the ONTSF impoundment. An assessment undertaken at the completion of mining determined that failure of the northern pit wall (West Mine Fault) was inevitable but it was predicted that failure would not encroach further than 70m from the pit rim. The existing extent of the slope failure surface is similar to what was predicted.

No exposed tailings were observed as a result of the slope failure and associated surface settlement. Cracking was observed on the capped TSF surface as far north as the existing overhead powerline alignment across the southern side of the ONTSF.

The 2019 TSF audit recommended monitoring and/or repairs to erosion and drainage problem areas which were all assigned as low priority actions due to the generally minor and localised nature of these defects. The audit also recommended the following actions for the northern pit wall slope failure:

- Installation of an array of survey monuments (deep star pickets or similar) on the rehabilitated ONTSF impoundment surface to allow for monitoring of any movement of the slip surface. Commence annual monitoring of the installed survey monuments.
- Install a hard barrier (e.g. bund) to prevent vehicle access to the pit slope failure area. Newmont has decided to install a fence as a temporary measure to exclude access to the pit slope failure area.

5.5 SURVEILLANCE INSPECTIONS

The 2019 TSF audit (Engeny Water Management, 2019) provided recommendations for ongoing surveillance inspections of the rehabilitated above-ground TSF landforms as indicated in Table 5.1. No surveillance inspections are proposed relating to the tailings deposition in the floor of the Open Pit.

Table 5.1: Recommended Surveillance Inspection Regime for Rehabilitated Above-Ground TSF Landforms

Inspection Type	Inspector	Frequency	Inspection Scope
Routine Inspection	Closure Superintendent or designated representative	Quarterly; or Following a significant rainfall event (>100mm in 24 hours); or Following a significant seismic event (Magnitude 5 or greater within 50km of site)	Dam crest inspection for dam safety deficiency indicators including cracking, depressions, misalignment and erosion. Downstream slope inspection for dam safety deficiency indicators including cracking, slides, depressions, bulges, seepage and erosion. Downstream toe / foundation area inspection for dam safety deficiency indicators including seepage, cracking, bulging and erosion. Surface drainage inspection for dam safety deficiency indicators including obstruction / ponded water and erosion. Inspection and measurement of TSF piezometers. Inspection outcomes to be documented in a checklist or similar.
External Audit	Suitably Qualified and Experienced External Dams Engineer (RPEQ)	Biennial (every 2 years); or Where a significant defect (to be defined in the Routine Inspection checklist) is identified in the Routine Inspection	Review of routine quarterly site inspections. Review of piezometer monitoring data. Review of available imagery and survey data. Comprehensive site inspection and condition assessment of the TSFs and associated components. Audit / inspection outcomes to be documented in a report including recommendations for any remedial works, investigations or assessments.

5.6 OPEN PIT NORTH WALL SLOPE FAILURE MONITORING

Aerial imagery and a ground surface topographic scan of the north wall slope failure area of the Open Pit was acquired by Rowlands Surveys using a drone in July 2020. The aerial imagery is shown in Figure 5.4.

Figure 5.4: July 2020 Aerial Imagery of Open Pit North Wall Slope Failure Area

Seven survey monuments have been installed on the southern edge of the ONTSF approximately 50m away from the northern-most edge of the existing slip surface / surface cracking (Figure 5.5). These monuments will be surveyed annually to detect any ongoing movement of the slip surface.

Figure 5.5: Movement Detection Survey Monuments for Open Pit North Wall Slope Failure Area

5.7 2019 INSAR DISPLACEMENT ASSESSMENT

In November 2019, Newmont commissioned 3v Geometrics Inc. (2020) to undertake an assessment of historical ground displacements (InSAR analysis) at the Mt Leyshon Mine using archive satellite imagery spanning May 2016 to November 2019. This was the first InSAR analysis conducted for Mt Leyshon Mine.

The Synthetic Aperture Radar (SAR) data used for this analysis was acquired by the Sentinel-1 (S1) satellite in interferometric wide swath mode. The Interferometric Wide (IW) swath mode acquires data with a 250 km swath at 5 m by 20 m spatial resolution and a usual revisit time of 12 days over Australia.

The 2019 InSAR displacement assessment did not identify any material ground displacements over any of the three rehabilitated above-ground TSF landforms between 2016 and 2019. The InSAR displacement assessment did identify ground displacements within the north wall slope failure area of the Open Pit.

Newmont plans to continue the InSAR displacement assessments for the foreseeable future with an update frequency of every 3 years. These InSAR displacement assessments will assist with quantifying future ground movements within the north wall slope failure area of the Open Pit, in conjunction with the survey monuments (refer Section 5.6).

5.8 2020 ANCOLD CONSEQUENCE CATEGORY ASSESSMENT

In 2020, Engeny Water Management (2020b) performed a consequence category assessment for the three rehabilitated above-ground TSFs at the Mt Leyshon Mine in accordance with the ANCOLD Guidelines on the Consequence Categories for Dams. (ANCOLD, 2012).

The ANCOLD Guidelines on the Consequence Categories for Dams (ANCOLD, 2012) provides a procedure for determining a consequence category classification for a dam based on the Population at Risk (PAR) and the severity of damages and loss for a dam failure scenario. Generally, the ANCOLD consequence category procedure involves:

- Dam break assessment to determine the extent of impact under possible failure scenarios.
- Identification of Population at Risk (PAR) for failure scenarios.
- Assessment of severity of damage and loss for failure scenarios.
- Determination of the consequence category based on the PAR and the severity of damage and loss.

The ANCOLD Guidelines on Tailings Dams (ANCOLD, 2019) provides criteria for the assessment of the severity of damage and loss which is tailored towards tailings dams (Table 5.2). This criteria was adopted for the consequence category assessment.

Table 5.3 shows the ANCOLD consequence category assessment matrix based on the PAR and the severity of damage and loss for dam failures.

Table 5.2: Criteria for Assessment of Severity of Damage and Loss for Dam Failures (ANCOLD, 2019)

Damage Type	Minor	Medium	Major	Catastrophic
Infrastructure replacement cost	< $10M	$10M - $100M	$100M - $1B	> $1B
Business Importance	Some restrictions	Significant Impacts	Severe Impacts	Bankruptcy
Public Health (Person's Affected)	< 100	100 – 1000	<1,000 (> 1 month)	>10,000 (> 1 year)
Social Dislocation (P: person months, B: business months)	< 100 P < 20 B	100 – 1000 P 20 – 2000 B	> 1000 P > 200 B	> 10,000 P Numerous business failures.
Impact Area	< 1 km²	< 5 km²	< 20 km²	> 20 km²
Impact Duration	< 1 year	< 5 years	< 20 years	> 20 years
Impact on Natural Environment	Damage to items of low conservation value. Remediation possible.	Significant effects on rural land and local fauna and flora. Limited effects on A[1] & B[2]	Extensive rural effects. Significant effects on A[1] & B[2] Limited effects on C[3] & D[4] Remediation difficult	Significant effects on A[1] & B[2] Limited effects on C[3] & D[4] Remediation involves significantly altered ecosystems

[1] Items of local and state heritage.
[2] Forestry, aquatic and conservation reserves, habitat corridors, wetlands, breeding areas.
[3] Items of Natural or World heritage.
[4] National parks, wilderness areas, RAMSAR wetlands or national aquatic reserves.

Table 5.3: Consequence Category Assessment Matrix (ANCOLD, 2012)

Population at Risk	Severity of Damage and Loss			
	Minor	Medium	Major	Catastrophic
< 1	Very Low	Low	Significant	High C
≥ 1 to < 10	Significant (Note 2)	Significant (Note 2)	High C	High B
≥ 10 to < 100	High C	High C	High B	High A
≥ 100 to < 1,000	Note 1	High B	High A	Extreme
≥ 1,000		Note 1	Extreme	Extreme

Note 1: With a PAR in excess of 100, it is unlikely damage will be minor. Similarly, with a PAR in excess of 1,000 it is unlikely the damage will be classified as medium.

Note 2: Change to 'High C' where there is the potential for one or more lives to be lost.

Dam break assessments were performed for the three rehabilitated above-ground TSFs assuming failure of the TSF embankments at the location of the maximum embankment height and that liquefaction of the tailings would occur in a failure event. Three different empirical breach assessment methodologies were utilised with the largest failure extent assessed from the three methods conservatively adopted as the zone of failure impact for each TSF for the purpose of the consequence category assessment.

The dam break assessment determined there is no PAR downstream of the TSFs for all the breach scenarios assessed (i.e. no dwellings located within the failure zone of influence for all TSFs).

The severity of damage and loss was assessed in accordance with the criteria specified in the ANCOLD Guideline on Tailings Dams (ANCOLD, 2019).

Based on the assessment of PAR and the severity of damages and losses for failures of the TSFs, the consequence category for each landform was assessed using Table 3 of the ANCOLD Guidelines for Consequence Categories for Dams (ANCOLD, 2012). The TSF landforms at Mt Leyshon Mine were all classified as having a “Low” consequence category in accordance with the ANCOLD consequence category assessment methodology.

A consequence category assessment has not been undertaken for the in-pit TSF, but would be expected to be Very Low since there is no failure mechanism by which the tailings deposited in the floor of the pit could be released and the pit void will remain as a groundwater sink. Any further progression of the northern pit wall failure could not feasibly impact the integrity of the ONTSF perimeter embankments due to the large distance between the current extent of the failure surface and the perimeter embankments.

Table 5.4: TSF Consequence Category Assessment Summary (Engeny Water Management, 2020b)

Parameter	ONTSF	NNTSF	STSF
Population at Risk	0	0	0
Severity of Damage and Loss	Medium	Medium	Medium
Consequence Category	**Low**	**Low**	**Low**

6 CLOSURE CRITERIA

6.1 ENVIRONMENTAL AUTHORITY

Requirements for rehabilitation of land disturbed by mining at the Mt Leyshon Mine are defined in Schedule F (Land) of the EA. Rehabilitation requirements that are relevant to the TSFs are summarised below:

(F2-1) Land disturbed by mining must be rehabilitated in accordance with Schedule F – Table 1 (Rehabilitation Requirements). Schedule F – Table 1 identifies the following rehabilitation requirements for all landforms, including the TSFs:

- Rehabilitation Goals: Safe, non-polluting, stable and self-sustaining.
- Rehabilitation Objectives: In accordance with condition F2-4 and the Post Mine Land Use Plan (PMLUP).
- Rehabilitation Indicators and Completion Criteria: In accordance with the PMLUP.

(F2-2) Progressive rehabilitation must commence when operational areas become available in accordance with the plan of operations.

(F2-3) Rehabilitated areas must be managed to minimise the proliferation of species not consistent with rehabilitation objectives.

(F2-4) All land subject to mining activities must be rehabilitated to:

a) a stable landform and with a self-sustaining vegetation cover and species that are similar to adjoining undisturbed areas;
b) a safe landform, which is non-polluting, geo-chemically and geo-technically stable.
c) ensure that all land is reinstated to the pre-disturbed land use and suitability class (Land Suitability Assessment Techniques);
d) ensure that the maintenance requirements for rehabilitated land is no greater than that required for the land prior to its disturbance by mining activities; and
e) ensure that the water quality of any residual void or water bodies constructed by mining activities meets criteria for subsequent uses and does not have potential to cause environmental harm.

(F2-5) Maintenance of rehabilitated areas must take place to ensure and demonstrate:

a) stability of landforms;
b) erosion control measures remain effective;
c) stormwater runoff and seepage from rehabilitated areas does not negatively affect the environmental values of any waters;
d) plants show healthy growth and recruitment is occurring; and
e) rehabilitated areas are free of any declared pest plants.

(F2-6) Rehabilitation can be considered successful when:

a) the site can be managed for its designated land-use (e.g. similar to that of surrounding undisturbed areas);
b) the rehabilitation is carried out in accordance with the goals, objectives indicators and completion criteria as specified in Schedule F – Table F1 and in the Post Mine Land Use Plan; and
c) written agreement is obtained from the landowner/holder and administering authority.

Specific rehabilitation outcomes for the Open Pit (Residual Void) are also specified in conditions F9-1 to F9-4 of the EA as follows:

(F9-1) Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself, and subject to any other condition within this environmental authority.

(F9-2) Mining voids must be managed during the operation and decommissioning phases to maximise the potential post mine beneficial uses, by consideration of the following:

a) limiting sulphide exposures in void walls; and
b) capping of sulphide exposures in void base; and

c) limiting period of exposure of sulphides in void walls and base to oxidising conditions; and
d) managing catchment into the void; and
e) geo-technical stability of final void.

(F9-3) Decommissioning strategies for the final voids must be provided in the Plan of Operations including the following information:

a) final potential wall and base rock exposure quality in terms of acid producing potential and levels of environmentally relevant salts and metals; and
b) expected periods of exposure for wall and base rock with acid producing potential; and
c) management options for maximising final void water quality; and
d) assessment of potential final void water quality.

(F9-4) Decommissioning strategies for the final voids must be updated with each update of the Plan of Operations.

6.2 MT LEYSHON CLOSURE PLAN

The Mt Leyshon Closure Plan (Newmont Australia, 2019b) was developed to meet the combined requirements of the Post Mine Land Use Plan (EA condition F4-1) and the Post Closure Management Plan (EA condition F10-1 and F10-2).

Closure criteria for the TSFs at the Mt Leyshon Mine are provided in Appendix 1 of the Mt Leyshon Closure Plan and reproduced in Table 6.1.

6.3 NEWMONT STANDARDS

Newmont's revised Corporate Standards and Guidelines for tailings management indicates that a TSF can be reclassified as a landform and the associated perimeter dams reclassified as mine waste structures if they meet the following criteria:

- Ponded water will not propagate a failure or uncontrolled release of contents;
- Contents do not and cannot flow (i.e., are not fluid-like) and do not rely on a barrier structure to prevent an uncontrolled release;
- Contents do not and cannot migrate or pipe (i.e., internally erode) through the structure or foundation; and
- Conditions will not develop in the future that could violate the previous three criteria.

Confirmation of the TSF as a landform in accordance with the above criteria requires the following steps:

- Assessment by the EoR (or third-party consultant) that the TSF meets the criteria defined above, including ability to achieve long-term stability under extreme loading criteria (10,000 Annual Exceedance Probability events); and
- Third-party review/concurrence with the documentation that landform status has been achieved.

6.4 ANCOLD GUIDELINES

The ANCOLD Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure (ANCOLD, 2019) lists the following principles for the sustainable design and post closure performance of tailings dams:

- The main objective of mine closure should be the long-term stabilisation of physical, chemical, ecological and social conditions of the tailings dam within a reasonable time scale to prevent any ongoing degradation.
- The closed facility should not require ongoing maintenance and expenditure other than normally required for similar land use.
- The closed facility should not pose an unacceptable environmental risk.
- The facility is left with an appropriate and sustainable land use and water use that meets stakeholder and community objectives and supports a sustainable ecology.

Table 6.1: TSF Closure Criteria (Newmont Australia, 2019b)

Mine Domain and Tenure	Mine Feature Name	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
Rehabilitated Landforms ML10144	ONTSF NNTSF STSF	Stable Landform	Landforms will be structurally stable and surfaces will develop resistance to erosive forces.	Assessment of soil stability and erosion through Landscape Function Analysis (LFA) monitoring. Erosion monitoring conducted in conjunction with Ecosystem Function Analysis (EFA) monitoring.	Soil surface stability greater than or equal to the lower limit of the average regional range for three years of monitoring. Erosion features less than or equal to the upper limit of the average regional range for three monitoring years.
		Sustainable Ecosystems	Disturbed land will be rehabilitated such that it is ecologically stable and reflects the surrounding ecology.	Demonstrate that vegetation establishment trends towards relevant analogue sites, or it is appropriate in terms of plant species composition, diversity, abundance, cover and function. Weed populations do not require specific management above that of the surrounding land. Vegetation monitoring along permanent transects as part of EFA assessment.	70% of analogue median (to be verified through future monitoring) for three years of monitoring, applicable to: • Native grass cover and diversity • Woody species cover and diversity • Perennial grass species cover and diversity The capacity to retain water and nutrient resources is equivalent to target ecosystems. LFA infiltration index and nutrient cycling index are at least 70% of median for target ecosystem for three years of monitoring. All legal requirements are met for declared or noxious weed management (compliance with QLD weed management legislation).
		Contaminants Managed	Constructed landforms will not release contaminants that result in adverse environmental impact to the receiving environment.	Contaminated sites will be managed in accordance with the *Contaminated Sites Act 2003*. Groundwater chemistry monitoring at bores NMLMB29 and NMLMB34. *Surface water indicators will be determined after the Receiving Environment Monitoring Program (REMP) is complete and site specific limits have been determined.	Audit of contaminated sites and compliance with *Contaminated Sites Act 2003.* Groundwater chemistry in shallow groundwater system meets criteria for stock watering (ANZECC 2000 guidelines), other than in the stock watering exclusion zone. *Surface water completion criteria will be determined after the Receiving Environment Monitoring Program (REMP) is complete and site specific limits have been determined.
		Safe	Ensure landforms are physically safe and do not pose a risk to human, livestock or wildlife	Access roads not required for post-closure access are rehabilitated. Public access to the site is restricted (fencing and signage).	Evidence in Final Rehabilitation Report (FRR) that redundant roads have been adequately rehabilitated. Regulatory approval of FRR.
Voids and Pit ML10144	Pit	Stable Landform	Pit walls will be structurally stable.	Permanent landforms are not located within the zone of potential pit instability. A geotechnical review of the pit void by an appropriate specialist on completion of decommissioning works.	Acceptance of the geotechnical review by the State Regulatory Mining Engineer (or equivalent).
		Pit Lake Elevation Managed	The pit void will not release contaminants that result in adverse environmental impact to the receiving environment.	Pit lake elevation to remain below 340m AHD. Piezometric elevation in shallow groundwater system to remain above 345m AHD as defined at: • Monitoring bore NMLMB19 • VWP sensor VWP 3-4	Pit lake acts a groundwater sink to the shallow groundwater system.
		Safe	The pit void is physically safe and does not pose a risk to human, livestock or wildlife.	Access to the open pit is restricted by abandonment bunds built to regulatory guidelines. Bunds are position outside the zone of potential pit instability. Access roads not required for post-closure access are rehabilitated. Public access to the site is restricted (fencing and signage).	Compliance with Department of Mines and Petroleum guideline "Safety Bund Walls around Abandonment Open Pit Mines (DoIR 1997)". Evidence in Final Rehabilitation Report (FRR) that redundant roads have been adequately rehabilitated. Regulatory approval of FRR.

7 EMERGENCY AND CONTINGENCY PLANNING

The Mt Leyshon Emergency Response Management Plan (Newmont, 2019c) describes the activities that will be initiated at the mine in the event of any emergency.

The Emergency Response Management Plan defines emergency response procedures for discharge incidents, including failure of containment structures.

Contact details for emergency response key stakeholders for the Mt Leyshon Mine are provided in the Emergency Response Management Plan.

8 ROLES AND RESPONSIBILITIES

Key roles and responsibilities relating to the management of the TSFs at the Mt Leyshon Mine are defined in Table 8.1.

Table 8.1: Roles and Responsibilities for Management of TSFs

Role	Responsible Person or Company
Operation and maintenance activities	Site Closure Superintendent
Monitoring activities	Site Closure Superintendent
Emergency response	Site Senior Executive
Closure planning	Principal Advisor Legacy Sites
Compliance reporting	Principal Advisor Legacy Sites
Review and update of management plans	Principal Advisor Legacy Sites
Dams and geotechnical consultant	Engeny Water Management
Surface water consultant	Engeny Water Management
Groundwater consultant	Big Dog Hydrogeology
Receiving Environment Monitoring Program (REMP) consultant	TropWATER

9 PLAN REVIEW

Triggers for the review and update of this Plan are identified below and take into consideration the non-operational aspect of the TSFs at the Mt Leyshon Mine.

- Periodic Reviews: Biennially (every 2 years) following the biennial third party geotechnical audit of the TSFs.
- Special Reviews: Following any circumstances or events that result in the need to materially change the management requirements for the TSFs.

10 QUALIFICATIONS

a) In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

   i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or

   ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

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e) This document is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this Report.

f) If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the Report or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.

g) This Report does not provide legal advice.

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Appendix I:
Mt Leyshon Final Void Decommissioning Strategy

Mt Leyshon

Plan of Operations

Residual Void Outcome (EA Requirements F9-1, F9-2, F9-3 and F9-4)

1. Background

Open pit mining at Mt Leyshon ceased due to depletion of the ore body in early 2001 after which mill feed was sourced from low grade stockpiles which were processed until March 2002, with tailings from the low grade stockpile processing in this period directed to the open pit. Closure of the open pit has therefore been in progress for 13 years, and rather than presenting the planned final void decommissioning strategy, this section describes the strategy which has been implemented to date, and the planned changes to the strategy during the remainder of the filling period.

2. Final void storage characteristics

The storage characteristics of the final void at Mt Leyshon have been assessed and reported in a number of studies investigating the water balance for the void. Available storage volumes are summarised in Table 1, and are discussed as follows:

- Elevations in the mine area are referenced to the local datum (given as mRL). Although surveys undertaken in closure have identified there is a very small discrepancy between the local datum and mean sea level, the elevations quoted in mRL are generally comparable with mASL.
- The lowest mining elevation in the pit was planned to be 31 mRL, and this elevation was assumed in the final void water balances completed during the mining period. However a water balance completed close to the end of open pit mining (Water Studies Pty Ltd, 2000) noted that the pit would not be mined to the full planned depth and assumed a lowest pit elevation of around 60 mRL, and this estimate has been adopted for closure planning.
- During the processing of stockpiles, tailings were directed to the final void. At the end of this period, the combination of tailings and process water deposited in the void reportedly raised the water elevation to 160 mRL. The portion of this volume which comprises settled tailings is not known, however based on records of processing throughput, the tailings surface is estimated to be at around 130 mRL.
- The storage characteristics for the void below 200 mRL have been assumed to be consistent with the planned mine geometry used in the void models. The actual storage characteristics for the void above 200 mRL have been accurately calculated using survey data collected when the lake was at 200 mRL.
- The volume of water estimated to be currently stored in the void (between the February 2014 lake elevation at 252 mRL and the estimated tailings surface at 130 mRL) is 16,917,000 m^3.
- The maximum planned lake elevation is 340 mRL (see decommissioning strategy below), which would result in a lake volume of 47,789,000 m^3. At this elevation, the freeboard volume to the overspill point at 378 mRL is 21,353,000 m^3.

Table 1 Final void volume estimates

Feature	Elevation	Cumulative volume	Incremental volume
	mRL	m^3	m^3
Estimated base of pit	60	-	-
Estimated tailings surface	130	1,900,000	1,900,000
Lake elevation at end of tailings deposition	160	4,151,000	2,251,000
Lake elevation in February 2014	252	16,917,000	12,766,000
Planned highest lake elevation	340	47,789,000	30,872,000
Overspill elevation	378	69,142,000	21,353,000

3. Decommissioning strategy

Overview

The strategy for the decommissioning and management of the final void in closure was originally developed during closure planning and modelling studies undertaken at the end of the mining period from 1999 to 2001, and has subsequently been modified based on data collected during the closure period. The key aspects of the development of the current strategy for decommissioning of the final void were:

- The void was identified as the preferred option for the long term storage of tailings generated during stockpile processing, and this was subsequently completed.
- During the final years of mining, it was noted that seepage and some runoff from the mine facilities were impacted by the generation of Acid Rock Drainage (ARD) and would require containment and storage after processing operations had terminated. The final void was identified as the preferred location for the storage of all ARD impacted waters, the final void water balance models were updated to account for these inflows, and the closure mine water management system has been designed accordingly, with all impacted waters pumped to the final void.
- After investigating and modelling different management approaches, it was determined that runoff from rehabilitated mine facilities should be diverted away from the final void wherever possible.
- The void was identified as the lowest risk storage option for any contaminated soils or residual mineralised material encountered during rehabilitation of the mine facilities, and this was instituted during the rehabilitation works.
- It was planned to prevent access to the final void using a combination of the existing external slopes of waste rock storage facilities and tailings storage facilities located near the pit, the placement of an abandonment bund in selected locations at a sufficient distance from the pit crest to account for future instability, and fencing of the mine lease.

Geotechnical stability

During mining of the Mt Leyshon open pit, localised instability of the pit slopes was encountered, with failures predominantly occurring in the wet season as a result of surface water infiltration and pore pressure build-up in the slopes near structural features. Slope instability was managed during mining by:

1. Designing pit slope angles in the strongest lithologies (breccia) in the range 40 to 50 degrees.
2. Reducing slope angles to 35 degrees in lower strength units (the northeast pit, the Mine Fault, and in porphyry exposures).
3. Installing horizontal drains to reduce pore pressures in the pit slopes.
4. Applying shotcreting, meshing and cable bolting (24 m) in some areas.

At the completion of mining, an assessment was made of the potential for slope failures in the final void in long term closure. The assessment was undertaken by a mining engineer familiar with the site specific constraints, and was based on the structures identified during the mining period (Weekes, G., 2000). Table 2 summarises all of the locations of potential instability in the pit slopes. In each case the known orientation of the controlling structural features was employed to predict the maximum distance behind the pit crest that would be affected if failure occurred, and these analyses were employed to define the required position for the abandonment bund.

The analyses undertaken in 2000 identified the most significant failures in the long term would be associated with the Mine Fault in the north wall of the final void. This structure subsequently failed in January 2009, but ground movement was limited to the zone within 70 m of the pit crest as predicted prior to closure and summarised in Table 2.

Table 2 Assessment of long term slope stability in the final void

Location	Critical Structures	Mode of Failure	Likelihood of Failure
Northeast Porphyry	Wedge formed by continuous joints 67/320 and 78/224; also 56/344 and 60/230. Both sets of joints are known to form wedges in the upper porphyry benches.	Bench scale wedge failures	High
East Wall Buttress and Mt Mawe	Main structure unknown. Complex movement on a series of joints, some of which form visible wedges, at the leading edges in the northeast and southeast parts of the east wall.	Assumed to be confined failure associated with a low angle fault.	Moderate for overall failure; High for loss of pit crest at leading edges
Southeast Wall	Continuous joints oriented at 45/250 occur abundantly above RL180.	Plane sliding on these joints over lengths exceeding 30m will result in bench scale failures above 180 RL. These are unable to project through to the pit crest however.	High, but will not affect crest of pit.
Southwest and West wall	Nil	Nil; Possible ravelling at crest.	N/A
Northwest Wall	Fault oriented 40/230, shears 68/089, and joints on 60/225. Also examined potential wedge formed by 46/176 and 62/118.	Topple failure on sub-vertical northeast trending shears is likely, however these will not affect the pit crest.	Inevitable failure but confined to pit
North Wall and Mine Fault	The Mine Fault (55/255) has been a dominant control on the behaviour of this wall. Other important structures include the sub vertical northeast trending shears mentioned above and shallow continuous southeast dipping joints.	Failure will occur with plane sliding on the Mine Fault footwall and circular failure of fault gouge in the hanging wall. Wedges formed by the Mine Fault and continuous joints are also possible in the upper parts of the wall.	Wall will ultimately fail; Short-term failure confined to saturated lower wall; longer term encroachment on pit crest for a distance up to 70m.

Mine water management in closure

The mine water management strategy implemented during closure at the Mt Leyshon mine is described in the Water Management Plan (Engeny, 2013). Segregation of runoff flows is continually undertaken and refined, with acceptable quality runoff discharged to the receiving environment, and impacted seepage and runoff routed to containment dams and sumps.

Components of the mine water management plan relevant to the final void during the lake filling period are:

1. All impacted seepage and runoff routed to the containment dams and sumps is subsequently routed to the final void by pumping. Pumps operate to hold the volume in containment dams as low as possible.
2. The major catchment up-gradient of the open pit is the Eastern Waste Rock Storage Facility. Runoff from the rehabilitated surface of this facility is routed either to the Raw Water Dam (low flows), or the Mt Hope Bypass facility (high flows), to minimise inputs to the final void.

Groundwater interactions and final lake elevation

There are two groundwater systems present at the Mt Leyshon site. The shallow groundwater system comprises weathered and fractured volcanic rocks occurring between 5 and 25 metres below ground level (mbgl). The deep groundwater system occurs only in the area close to the final void and comprises fracture zones within the deep unweathered basement rocks.

Comprehensive investigations have been undertaken to characterise these groundwater systems during the closure period (Schlumberger Water Services, 2012). The investigations have concluded that the maximum safe elevation for the final pit lake is 340 mRL. For a lake at this elevation, it has been identified that:

1. The final void will act as a groundwater sink in all locations for the shallow groundwater system (ie groundwater will flow towards the lake, and lake waters will not migrate into the groundwater system).
2. The final void will act as a groundwater sink for the deep groundwater system, with the exception of an isolated fracture zone occurring at around 200 mRL, (at least 150 mbgl) which is located to the northeast of, and is connected to, the final void.

The decommissioning strategy therefore requires that inflows to the pit are managed to ensure that the pit lake elevation remains below 340 mRL.

4. Flow regime during pit filling

The contributions of individual flows to the final void during the lake filling period are well understood, and are defined from a site wide water balance model which has been calibrated using the measured changes in lake elevation in the final void, and continuous monitoring data defining the volumes pumped from the dams and sumps (Engeny, 2011).

Average contributions to the lake in the final void were most recently quantified using the updated site wide water balance model in 2013 (Engeny, 2013). At this time the lake in the final void was rising at an average rate of 3.1 m/year, in response to an annually averaged net inflow rate of 24.3 L/s which is driven by:

1. Precipitation incident on the lake entering at 5.2 L/s.
2. Runoff from undiverted catchments including the pit slopes entering the lake at 4.1 L/s.
3. Flows being pumped from the containment dams and sumps into the lake at 20.6 L/s.
4. Groundwater flow from the deep groundwater system into the lake at 2.0 L/s.
5. Shallow groundwater flow and seepage from the surrounding facilities entering the lake at 6.6 L/s.
6. Evaporation from the lake surface occurring at 14.2 L/s.

These estimates highlight that at the current time, impacted waters pumped from the containment dams are the largest input and the dominant control on the lake elevation. If the containment dams were to continue to be operated in the same manner, the pit lake would reach the maximum elevation of 340 mRL within 40 to 70 years, and would continue to rise (Engeny, 2013).

The decommissioning strategy for the final void therefore includes ongoing rehabilitation and segregation works at the closed mine facilities to achieve a reduction in volumes of impacted water pumped to the pit, and if necessary, the strategy includes allowance for installing enhanced evaporation systems, or construction of an active water treatment plant prior to the lake reaching 340 mRL, in order to be confident of achieving the required reduction.

5. Lake chemistry during lake filling

In most closed mines, the inflow component controlling the hydrochemistry of the lake developing in the final void is runoff from the pit slopes, which is influenced by the oxidation of sulphide minerals exposed in the pit slopes during mining (i.e. ARD generation). At these mines, significant effort is directed to mapping the lithologies and alteration types exposed in the pit slopes, and geochemical characterisation studies are undertaken to predict their leaching behaviour. Mapping of the pit slopes has not been undertaken at the Mt Leyshon mine, due to the following site specific constraints:

1. Runoff from the pit slopes makes up less than 10% of the total inflows.
2. Storage of contaminated and mineralised material in the open pit was achieved by depositing it from the pit crest. This included a disposal trial for the scats stockpile which involved trucking scats to the pit. During these operations, a proportion of the deposited material built up on the benches above the lake in the final void. This perched material is known to be mineralised, has been classified to be ARD generating (the scats material has a Net Acid Producing Potential in the range 30 to 100 kg H_2SO_4/tonne), and is relatively fine grained, which gives it a much larger surface area than the mineralisation exposed in the pit slopes. The perched material on the benches would therefore be expected to be a larger influence on the lake chemistry than the exposed pit slopes.
3. The dominant inflow to the final void is pumped impacted water (over 50% of total inflows). Flow meter and modelling data indicate that of this component, around 20% comprises runoff and seepage from the scats stockpile (ie, on average, 10% of all inflows to the final void are sourced from the scats stockpile). Monitoring data for runoff and seepage from the scats stockpile identify that it is strongly impacted by ARD (sulphate concentrations 20,000 to 60,000 mg/L), and as a result this component is expected to be far more important to lake chemistry than runoff from the pit slopes.

Access to the final void at the Mt Leyshon mine is restricted, due to safety concerns associated with localised instability of the access ramp. Samples of the lake developing in

the void have been collected opportunistically when possible. The results of the sampling are summarised in Table 3.

The lake hydrochemistry demonstrates the significant influence of ARD generating materials throughout the filling period, having a pH of 4.1, and elevated concentrations of sulphate and total metals. The lake hydrochemistry is also noted to be consistent with the dilution and mixing of the hydrochemistry defined in the containment dams. The lake waters in the final void would not be fit for animal consumption, as indicated by the standards for dairy cattle watering defined in ANZECC 2000 and reproduced in Table 3, which highlight that for that purpose exceedances occur for parameters including pH, EC, TDS, sulphate, TDS, Al, Cd, Co, Cu and Zn.

Table 3 Hydrochemistry of the lake developing in the final void

Date	**06-Oct-05**	**06-Jun-06**	**06-Jun-06**	**14-Aug-10**	**02-Feb-11**	**ANZECC**
Analyte						
pH	4.55			4.4	4.1	6.5 - 9
EC (µS/cm)	348			6630	7800	5970
TDS (mg/L)				9670	9780	4000
Suspended Solids (mg/L)				18	24	
Alkalinity (as mg/L $CaCO_3$)						
OH				<1	<1	
CO_3				<1	<1	
HCO_3				<1	<1	
Total Alkalinity				<1	<1	
Dissolved Major Anions (mg/L)						
Cl				100	79	
SO_4		3670	3680	6170	6360	1000
Dissolved Major Cations (mg/L)						
Calcium		514	513	546	456	
Magnesium				887	308	
Sodium				433	331	
Potassium				53	38	
Total Metals (mg/L)						
Aluminium	6.51	5.85	4.89	53.7	98.1	5
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.002	0.5
Barium	0.017	0.017	0.015	<0.01	0.018	
Cadmium	0.0917	0.0885	0.0832	0.652	0.635	0.01
Chromium	<0.001	0.002	<0.001	<0.01	0.004	1
Cobalt	1.06	1.02	0.931	1.75	1.75	1
Copper	1.96	1.62	1.49	7.42	10.4	1
Lead	0.008	0.005	0.005	0.159	0.08	0.1
Manganese	43.8	48.8	47	318	314	
Selenium	<0.01	<0.01	<0.01	<0.1	0.02	0.02
Strontium	1.11	1.1	1.06	1.85	1.76	

Uranium	0.012	0.012	0.011	0.072	0.081	
Zinc	15.8	16.3	14.4	120	119	20
Iron	0.09	0.98	0.91	0.56	1.68	
Mercury	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.002

6. Flow regime at final elevation

In the worst case scenario, where pumping from the containment dams continues at the same rates, and the lake in the final void reaches the maximum elevation of 340 mRL in a period of 40 to 70 years before pumping is terminated, then the calibrated water balance model indicates that compared to the flow regime during filling:

1. Average precipitation incident on the lake will increase from 5.2 L/s to 9.6 L/s as a result of the increased lake area.
2. Runoff from undiverted catchments will reduce from 4.1 L/s to 1.2 L/s as a result of the submergence of much of the pit slopes.
3. Flows being pumped from the containment dams and sumps into the lake will reduce from 20.6 L/s to zero, as an alternative disposal option such as enhanced evaporation or an active water treatment plant is implemented.
4. Groundwater flow from the deep groundwater system into the lake will decline from 2.0 L/s to 0.2 L/s in response to the reduced hydraulic gradients.
5. Shallow groundwater flow and seepage from the surrounding facilities entering the lake is conservatively assumed to remain the same in the model at 6.6 L/s.
6. Evaporation from the lake surface will increase from an average of 14.2 L/s to an average of 26.3 L/s due to the larger lake area.

These estimates confirm that for a lake elevation at 340 mRL, there would be an average negative water balance for the final void, with water lost from the lake at an average rate of 8.2 L/s. This would result in the lake in the final void declining to an equilibrium elevation below 340 mRL. These estimates of the flow regime at the maximum elevation are supported by the calibration data available from observations of lake filling in closure, and will be further refined by ongoing monitoring during lake filling, and there is therefore good confidence that the lake elevation will be maintained below 340 mRL, and the lake will act as a groundwater sink. There is also good confidence that the lake will never reach the overspill elevation at 378 mRL.

7. Final lake chemistry

The future hydrochemistry of the lake in the final void at the Mt Leyshon mine will be strongly controlled by:

- The period over which containment dams and sumps continue to be pumped to the final void.
- Changes in the flow rate and chemistry of seepage and runoff being intercepted by the containment dams and sumps. In particular, the selected option and the timing of implementation of the rehabilitation approach for the scats stockpile will be an influence on flows pumped to the void from the Plumtree Creek Dam, and the resulting lake chemistry.

It is therefore not possible to model the future evolution of the hydrochemistry of the lake in the final void until the long term water management plan is defined in more detail. However the currently available information suggests that a significant improvement over the lake chemistry as currently measured is unlikely, even if pumping to the pit were discontinued now, as:

- Once pumping to the pit is discontinued, the largest inputs to the lake will be classified as either low ionic strength (direct precipitation on the lake), or potentially impacted (shallow groundwater and seepage, and catchment runoff which encounters the mineralised material perched on the benches above the lake).
- The only input to the lake which is expected to contain significant alkalinity is groundwater inflow, and groundwater inflow has been defined to be a small component in the overall water balance regardless of whether pumping from the containment dams is in operation.
- Natural sources of alkalinity/neutralisation potential to the lake will therefore be small in comparison with the significant acidity contained within the existing lake volume which has a pH around 4.1.

The final void decommissioning strategy has therefore been based around the assumption that lake hydrochemistry is unlikely to be suitable for animal consumption through long term closure.

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Appendix J:
Risk Assessment Consequence Table

NEWMONT CONSEQUENCE TABLE

Impact Type	1 - Insignificant	2 - Minor	3- Moderate	4 - Major	5 - Catastrophic
Health	Exposure to health hazard resulting in temporary discomfort.	Exposure to health hazard resulting in symptoms requiring medical intervention and full recovery (no lost time)	Exposure to health hazard resulting in reversible impact on health (with lost time) or permanent change with no disability or loss of quality of life.	Exposure to health hazard (acute or chronic) resulting in a single fatality or, irreversible health impact and loss of quality of life for an individual.	Exposure to health hazard (acute) resulting in multiple fatalities or, irreversible health impact and loss of quality of life for multiple people.
Safety	Short term, low level Injury not affecting work performance and requiring first aid treatment at a maximum (FAI).	Injury requiring medical treatment (MTI) or resulting in temporary restrictions to normal work duties (RWI).	Injury resulting in lost workdays (LTI).	Single fatality, permanent disability or multiple lost time injuries.	Multiple fatalities or permanent disability to multiple people.
Environment Australia Regional Guidance	Environmental impacts within area already disturbed by operations; Addressed and/or remediated as part of routine processes	Environmental impact within the current or planned disturbance area or isolated offsite impacts; Non-routine effort to address and/or remediate.	Significant (relating to size, toxicity, location, or other site factors) on-site environmental impact or offsite impact requiring immediate response to contain and/or prevent residual effects. Remediation in the short to medium term without any anticipated long term environmental effects.	Environmental impacts with medium to long term impairment and residual ecosystem effects; and localized monitoring to determine extent of environmental impact from the event. May require changes to closure liability.	Offsite widespread impacts that are extensive and long term. Significant impacts on closure planning and liability.
External Relations	Impact on community requiring minimal corrective action. Isolated complaints from separate geographies and/or on separate issues. No media enquiry.	Impact on community reversible with limited corrective action. Repeated complaints from the same geography and/or on same issue. News story appears in local and/or lower-tier national media outlet.	Impact on community; reversible with corrective action. Complaints requiring third party or external resolution. News story appears in multiple local and/or lower-tier national media outlets.	Impact on community results in temporary loss, damage or disability requiring significant remediation. Short-term loss of trust with key stakeholders requiring significant corrective action. News story appears in major national / international media outlets.	Impact on community results in irremediable and significant loss, damage or disability / fatality. Long term loss of trust with key stakeholders. News story appears in multiple major international media outlets.
Security	Localized agitation/ activity with no imminent threat to site. Possession of illegal substances on site (personal Use quantity) Trespass of property for convenience	Minor disruption to operation Credible threat of labor unrest, or against personnel. Failure of physical controls with no loss. Possession of illegal substance by individual with intent to sell.	Moderate impact to operation or credible threat with potential for significant impact. Possession of unauthorized munitions. Low intensity civil unrest Workplace Violence. Criminal loss of information or intellectual property Trespass of property with willful intent	Major impact to operation. Civil disruption affecting operations or workforce. Attempted theft of explosive material/ components or munitions. Undetected theft or production loss over a prolonged period. Failure of physical control and/or unauthorized access that was exploited internally. Organized crime activity. Threats of terrorism, kidnapping, or extortion.	Complete disruption to operation. Threat that requires evacuation of personnel. Theft of explosive material/ components or munitions. Undetected major loss over a period>12months. Organized crime activity. Sabotage that requires extensive repair. Threats of terrorism, kidnapping, or extortion.
	Property theft, vandalism and property damage shall be rated in accordance with its relative disruption/impact to operations				
Legal & Other	Minor technical/legal issue unlikely to attract a third party response	Technical/legal issue which may attract a low level administrative/regulatory response.	Breach of regulation and/or other agreements with possible prosecution and penalties. Continuing occurrences of minor breaches with possible prosecution and penalties. Threat of legal action against Newmont.	Major breach of regulation and/or other agreements resulting in external party investigation. Prosecution, penalties or other action likely. Legal action against Newmont	Serious breach of regulation and/or agreements resulting in external party investigation. Operation suspended, licenses revoked. Legal action against Newmont.
Production	<1% deferred production against plan	1-3% deferred production against plan	3-5% deferred production against plan	5-10% deferred production against plan	>10% deferred production against plan
$ Loss due to Operational Event	< $10,000	$10,000 - $250,000	$250,000 - $1,000,000	$1,000,000 - $10,000,000	>$10,000,000
Information & Communication Technology (ICT)	Disclosure of information causing little to no harm to Newmont or its personnel; or Questionable but reliable information to make inconsequential business decisions; or System performance issues	Disclosure of information which should only be disclosed to internal Newmont personnel; or Unclear reliability of information for standard business decisions; or Intermittent loss of system availability	Disclosure of information used for day to day operational decisions; or Unreliable and unrecoverable information completeness & accuracy on systems of low business consequence; or Recoverable loss of system availability	Disclosure of information affecting Newmont's strategic direction; or Unreliable and unrecoverable information accuracy for standard operational business decisions; or Partial loss of full system availability	Disclosure of information causing significant regulatory, reputational, or future harm to financial performance; or Unreliable and unrecoverable information completeness and accuracy for strategic business decisions; or Full loss of system availability
Project Cost	STAGE 4 Life of Project Cost: < $50,000 STAGES 2A, 2B, 3 < 3% over AFE	STAGE 4 Life of Project Cost: $50,000-$500,000 STAGES 2A, 2B, 3 3%-5% over AFE	STAGE 4 Life of Project Cost: $500,000-$5,000,000 STAGES 2A, 2B, 3 5%-10% over AFE	STAGE 4 Life of Project Cost: $5,000,000-$50,000,000 STAGES 2A, 2B, 3 10%-20% over AFE	STAGE 4 Life of Project Cost: > $50,000,000 STAGES 2A, 2B, 3 >20% over AFE
Project Schedule (Schedule Impact affecting critical milestones)	- Gate Approval (all Gates): None - Reserve Declaration (Gate 2): 1 Month - Investment Decision Full Funds (Gate 3):1 Month - Commercial Production: 1 Month	- Gate Approval (all Gates):1 Month - Reserve Declaration (Gate 2): 2 Months - Investment Decision Full Funds (Gate 3): 2 Month - Commercial Production : 2 Months	- Gate Approval (all Gates): 2 Months - Reserve Declaration (Gate 2): 3 Months - Investment Decision Full Funds (Gate 3): 3 Months - Commercial Production: 3 Months	- Gate Approval (all Gates): 3 Months - Reserve Declaration (Gate 2): 3-6 months -Investment Decision Full Funds (Gate 3): 3 Months - Commercial Production: 3-6 months	- Gate Approval (all Gates): 3-6 months - Reserve Declaration: Unable to meet SEC Guide 7 for Reserve Declaration. - Investment Decision Full Funds (Gate 3): 3-6months. Need to evaluate Financial Metrics/NPV Erosion - Commercial Production: Unable to meet production targets. Need to evaluate Financial Metrics/NPV Erosion
Exploration / Reserves (Loss of Reserves Affecting Annual Regional Depletion Target Offset)	< 5% loss of reserves	10% - 5% loss of reserves	15% - 10% loss of reserves	20% - 15% loss of reserves	>20% loss of reserves

Appendix K:
Risk Assessment Likelihood Table

NEWMONT LIKELIHOOD TABLE

Level	Description	Criteria (read as either/or)
5	Certain	Event will occur Event could occur daily to monthly >90% probability of the event occurring or ≥10x OEL UCL (For HRA Only)
4	Likely	Event expected to occur Event could occur monthly to annually 60-90% probability of the event occurring or ≥ 100% <10x OEL UCL (For HRA Only)
3	Possible	Event will occur under certain circumstances Event could occur annually or within a 5 year period 30-60% probability of the event occurring or ≥50% < 100% OEL UCL (For HRA Only)
2	Unlikely	Event has occurred elsewhere Event could occur within a 5 to 10 year period 10-30% probability of the event occurring or ≥10% < 50% OEL UCL (For HRA Only)
1	Rare	Event has rarely occurred in the industry or may occur under exceptional circumstances Event could occur within a 10 to 30 year period <10% probability of the event occurring or <10% OEL UCL (For HRA Only)

Appendix L:
Mt Leyshon Geo-Environmental Assessment

Private and Confidential – Document to be provided to the Department of Environment and Resource Management by Newmont Mining Services Pty Ltd – Not for third party release without the prior consent of Newmont Mining Services Pty Ltd

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Mt Leyshon Geo-environmental Assessment

1 INTRODUCTION

The Mt Leyshon site is an open pit gold mine located 24 km south of Charters Towers, which has been closed since 2002. The Mt Leyshon ore body is located within an intrusive breccia complex occurring within Permo-Carboniferous sub-volcanic rocks. The intrusive breccia complex is intruded by later dolerite dykes and a quartz porphyry. The bulk of the mineralisation occurs within the breccia and porphyry and is dominated by sulphides consisting of pyrite, chalcopyrite, galena, and sphalerite. In the oxide zone, gold mineralisation is associated with iron oxides and hydroxides, jarosite, alunite, and kaolinite. Heavy metals of environmental concern which are associated with the mineralisation include copper, lead and zinc (GHD, 2005).

Mt Leyshon commenced operations in September 1986. It produced gold and silver, initially as a heap leach operation of oxide ore, and then via carbon in pulp processing of primary un-oxidised ore in 1989. Mining ceased due to depletion of the ore body in early 2001 after which mill feed was sourced from low grade stockpiles which were processed until March 2002. Maintenance and rehabilitation of the site is being undertaken by Newmont Mining Services Pty Ltd (Newmont), on behalf of Leyshon Resources Limited (LRL), and is ongoing. Facilities remaining at the site include the open pit, three tailings storage facilities, three waste rock storage facilities, and a scats stockpile. Newmont are undertaking a range of monitoring and investigation studies to determine the optimum long term closure approach for the site. As part of these investigations, Newmont requested that Water Management Consultants (WMC) undertake a geo-environmental assessment of the Mt Leyshon property, based on the existing available data.

The objectives of the geo-environmental assessment are:

- To identify and characterise materials which were mined and dispatched to rock or tailings storage facilities.
- To identify the current locations of each material type within the facility areas.
- To determine the current and future ARD and contaminant leaching potential of the various materials and facility areas.

The current report has been prepared by WMC to meet these objectives, drawing on existing available data from a series of geochemical investigations previously undertaken at Mt Leyshon.

2 MATERIALS AND FACILITY AREAS

2.0 Introduction

During mine life, approximately 55 million tons of ore was processed at Mt Leyshon. Varying quantities of waste rock have been reported, with the amount being between 240 million tons (Otek, 2005) and 450 million tons (Onkaparinga, 2006). The materials mined and currently stored in facility areas at Mt Leyshon may be categorised into four main types, these being, waste rock, tailings, mill scats and heap leach material. These materials are currently primarily located in a number of storage facilities, which have been rehabilitated to varying degrees. In addition, waste rock, heap leach material and scats have been placed in a number of facility areas as part of the closure of these facilities. The main materials and storage facilities and their relevant features in terms of geo-environmental characterisation are outlined in the following sections. The current report does not include the open pit. The hydrochemistry of the pit lake is governed by a combination of within pit processes, seepage and runoff from the open pit walls, and mixing of inputs pumped from water containment facilities around the Mt Leyshon property. As the pit is currently acting as a hydrological sink, it is considered to be "contained" and is therefore not included in the geo-environmental assessment.

2.1 Waste Rock

The bulk of the waste rock at Mt Leyshon is currently located in the three main waste rock storage facilities. These are the Northern Waste Rock Storage Facility (NWRSF), Southern Waste Rock Storage Facility (SWRSF) and Eastern Waste Rock Storage Facility (EWRSF). The facility locations are presented in Figure 1.

At an early stage in mining at Mt Leyshon it was recognised that the primary (unoxidised) waste rock contains varying levels of sulphides, mainly in the form of pyrite. Such materials, on exposure to atmospheric conditions, have the potential to produce acid rock drainage (ARD) and release contaminant metals to the hydrosphere. Recognition of this led to the development of a waste management strategy to segregate potentially acid forming (PAF) waste from non acid forming (NAF) waste. The Environmental Management Overview Strategy (EMOS) in 1993 stated that all materials with a sulphur content greater than 0.5% would be considered to be PAF. The EMOS refers to two studies completed by AGC Woodward Clyde in January and September 1992 which characterised the main pit lithologies with respect to metals and sulphur content and net acid production potential (NAPP). Although details of these studies are not available, it is assumed that the 0.5% sulphur cutoff originated in this research. Subsequent characterisation studies by Environmental Geochemistry International (EGI) in 1995 resulted in an increase in the NAF / PAF waste cutoff value to 1.5% sulphur, and submission of "Variation To The Mt Leyshon Gold Mine EMOS No. 9". This revised sulphur cutoff was based on correlations developed by EGI between sulphur content and the results of Net Acid Generation (NAG) tests. NAG testing was conducted on site to assist in the classification and placement of waste rock.

Although detailed waste scheduling information is not available, historical air photographs indicate that in July 1991, waste was being stored in the NWRSF and the north-east side of the SWRSF. Waste from the early years of mining was likely to be largely oxide material, as primary sulphide material was processed from 1989 onwards. Mainly due to the absence of pyrite in the oxide material, it would be expected to be less likely to generate ARD than the primary sulphidic waste. Primary sulphidic waste is assumed to form the EWRSF and a large part of the SWRSF. However, there may also be sulphidic waste in the NWRSF.

Waste rock was also stored in the Roche Hill area. This is primarily believed to be oxide material, however, some sulphide bearing primary waste may also be present. Additionally, a waste rock cover layer was utilised during rehabilitation of the tailings storage facilities. The waste applied to the ONTSF was Run Of Mine (ROM) waste rock which consisted of mineralised sub-grade breccia (Otek, 2005). The covers on the NNTSF and STSF used ROM and porphyry waste respectively (Newmont, 2009). Oxide waste rock was also used to construct a base platform under the western and southern sides of the heap leach pads. Additionally, waste rock is believed to have been used during rehabilitation of the supergene acid recycle dams, the pregnant pond, treatment pond and upper settlement pond. Waste rock (ROM) was also used in construction of the Raw Water Dam embankment.

2.2 Tailings

There are three tailings storage facilities at Mt Leyshon, these being the Old Northern Tailings Storage Facility (ONTSF), New Northern Tailings Storage Facility (NNTSF) and Southern Tailings Storage Facility (STSF). The tailings, produced by processing primary sulphidic ore, contain sulphides that have the potential to generate acid. In addition to the potential for the generation of ARD and release of contaminant metals, the tailings facilities were also considered to have the potential to create long term dust and erosion problems, as the material was ground to approximately 140 μm during processing (Normandy Mt Leyshon Ltd., 2000).

2.3 Scats

The three main scats stockpiles are located in the upper Plum Tree Creek catchment (Figure 1) and contain the resistant material rejected from the ore crushing circuit. The nominal size range of this material is 2.5 mm – 7 mm (Normandy Mt Leyshon Ltd. 2000). A final plan for the scats material has yet to be completed, with options including re-processing the scats as a resource, in-situ rehabilitation of the facility or relocation of scats material to the open pit. The scats stockpile is highly permeable and the materials contain sulphides, oxidation of which are currently evident. The three main scats stockpiles contain approximately 28 million tons of material (URS, 2002). Additionally, approximately 5 million tons of scats material was stored in the western side of the SWRSF, and an unknown quantity of scats was used during the construction of the access road to the mine from the Clermont highway. Layers of scats of unknown volume were also placed on the western side of Roche Hill, incorporated in the heap leach, and potentially placed in the ONTSF.

2.4 Heap Leach Material

Heap leach material was generated during the extraction of gold from the oxide ore at Mt Leyshon by a conventional cyanide leaching process. The majority of this material has been used in cover layers during rehabilitation of the tailings and waste rock storage facilities. Additionally, heap leach material has been used in the capping strategies during rehabilitation of the footprints of the ROM and B ore stockpiles, the supergene acid recycle dams, the pregnant pond, upper settlement pond, the plant and infrastructure areas, and the contractors areas which include Roche Hill, laydown area, and stores area. A core of heap leach material was used in construction of the Raw Water Dam embankment.

2.5 Other materials

An unknown quantity of material, which was originally an iron rich slurry, was produced during processing supergene material by the Kennecot method. This material was placed in either the south-west corner of the SWRSF or north-west corner of the STSF.

Various activities during mining are likely to have impacted soil at Mt Leyshon. For example, the contractors areas which include Roche Hill, laydown area, and stores area were used for fuel and oil storage, workshops, vehicle maintenance, battery storage, and sandblasting. Soil impacted with hydrocarbons and metals from these areas was removed and transferred to the pit (GHD, 2005).

2.6 Rehabilitation

The Normandy Mt Leyshon Ltd. Closure Plan, November 2000 indicated that, due to the presence of sulphide bearing material, the aim for waste rock storage facility closure was to encapsulate this material, to reduce the potential for ARD. The plan was also to create a rehabilitation profile that minimised erosion and provided for vegetation establishment. To facilitate this aim, covers for the waste rock storage facilities were designed which would reduce water infiltration and restrict oxygen diffusion. The original plan from the EMOS was to use washed oxide heap leach material as a seal due to its low permeability when compacted. Additionally, the heap leach material has a high gravel content and is therefore relatively erosion resistant. The SWRSF was capped with 300 mm compacted heap leach and the NWRSF was capped with either compacted NAF porphyry or heap leach (GHD, 2005). The EWRSF is believed to have been capped with compacted NAF porphyry material. All three waste rock storage facilities had a final layer of 300 mm of topsoil applied, which was then seeded and fertilised. Where compacted NAF porphyry was used in place of heap leach material, a minimum thickness of 800 mm was applied on flat surfaces and a minimum of 1,000 mm on side slopes (SRK, 2000). Rehabilitation plans for Roche Hill involved capping with 600 mm of compacted heap leach overlain with 300 mm of topsoil.

Field measurements carried out in studies by the Australian Nuclear Science and Technology Division (ANSTO) in 1996 and 1998 indicated that neither the NAF porphyry waste nor the heap leach effectively reduced oxygen diffusion. Modelling of the porphyry cover performance was undertaken by Australian Centre for Tropical Freshwater Research (ACTFR) using the 1D model SWIM. The results indicate that for a porphyry sealing layer of 1,000 mm, infiltration would be reduced to about 1.7% of mean annual precipitation. Investigations by Environmental Geochemistry International in 1996 indicated that the use of 300 mm of topsoil over 600 mm of compacted heap leach material is an effective infiltration barrier layer. These data indicate that although the waste rock cover systems would not effectively isolate the material from atmospheric oxygen, interaction with precipitation would be greatly restricted.

As the tailings contain sulphides, a sealing strategy was also employed for the tailings storage facilities. All three tailings storage facilities have been capped with waste rock, overlain with heap leach, overlain with topsoil. A range of cover options were modelled by Environmental Geochemistry International (EGI, 1995) and the design strategy selected utilised minimum thicknesses of 1.5 m of waste rock, 600 mm of compacted heap leach material and 300 mm of topsoil. The EGI modelling assumed that the heap leach material was conditioned with water during placement to achieve a degree of saturation of at least 90%.

The waste rock was applied at a thickness of 1 – 3 m and formed a working platform as well as creating the desired final profiles of the tailings facilities and forming a capillary break between the tailings material and the heap leach cover. The waste applied to the ONTSF was Run Of Mine (ROM) waste rock which consisted of mineralised sub-grade breccia (Otek, 2005). The covers on the NNTSF and STSF used ROM and porphyry waste respectively (Newmont, 2009). A minimum of 600 mm of compacted heap leach material was then applied over the waste rock covers and this in turn was overlain by 300 mm of topsoil. The ONTSF and STSF covers were constructed with a shallow domed profile to promote water shedding. The NNTSF cover has a concave design to allow management of runoff through an engineered channel. Both the convex and concave cover profiles are designed to minimise erosion and promote the establishment of vegetation. The central area of the NNTSF, towards which runoff is directed, was the only part of this facility where a 600 mm layer of compacted heap leach material was added prior to topsoil coverage, to ensure that sealing would be sufficient during a 100 year storm event (Otek, 2005).

The heap leach pads were constructed on natural ground to the eastern side and on an oxide waste base to the western and southern side. The oxide waste base, which is up to 3 metres thick, is believed to have been left in place and capped with 150 mm of topsoil which was seeded and fertilised.

The waste rock / subsoil footprints of the ROM and B Stockpiles have been capped with heap leach overlain with topsoil (GHD, 2005). Heap leach and topsoil capping have also been used for the plant and infrastructure areas, the contractors areas including Roche Hill, the laydown area, and stores area, the lower settlement pond landfill, the supergene acid recycle dams, the pregnant pond and upper settlement pond.

During decommissioning works, the surface of the solid cyanide storage area was excavated and deposited in the pit, while in the surface of the explosive magazine and dyno areas were capped with topsoil (GHD, 2005).

3 ANALYTICAL PROCEDURES FOR CHARACTERISATION OF ACID ROCK DRAINAGE (ARD) AND CONTAMINANT LEACHING POTENTIAL

3.1 Introduction

The potential for materials currently stored at Mt Leyshon to generate acid rock drainage (ARD) and release contaminant metals to the hydrosphere has been investigated at various stages of mine life using a range of geochemical testwork methods. Data are available from the following test methods:

1) Short term static tests and related analyses:
   a) Paste pH
   b) Acid Base Accounting (ABA)
   c) Net acid generation (NAG)
   d) Mineralogical Characterisation
   e) Bulk geochemistry
   f) Toxicity Characteristic Leaching Protocol (TCLP)

2) Kinetic (column leach) tests

The numbers of samples which have been characterised by each test method are summarised in Table 3.1.

Table 3.1 Sample numbers, material types and testwork data available

Material	paste pH	NAG	Total S	ABA	Multi - element	TCLP Leach	Kinetic (column)	Mineralogy	Source reference
Waste Rock		?		?	?				AGC Woodward Clyde, 1991/1992
Waste Rock			492		492				Mt. Leyshon Gold Mines Ltd., 1994
Porphyry Cover				22					SRK, 2000
Waste Rock				6					SRK, 2000
Porphyry Cover	16	16		16					EGI, 1995
Porphyry Cover		146	146	10					EGI, 1995
Heap Leach	16	16	16	16	16			16	CMLR, 2006
Tailings	15	25	15	15			2		EGI, 1999
Waste Rock		49							EGI, 1999
Scats	6	6	6	6	6			6	Woodward-Clyde, 1993
Scats	20	20	20	20	6	6	8		URS, 2002
Scats	4	4		4					Roseby, 2000 (internal memo)
Soil		4	4	4	4				Otek, 2005

3.2 Static test methods

Principles

Static test procedures were applied to provide cost effective data regarding the acid generation potential and possible leachate chemistry of materials. The methods utilised are described below.

Paste pH

Paste pH provides a qualitative estimate of the pH of a lixivant such as rainwater on contact with reactive rock material. Paste pH tests are performed by mixing distilled water with crushed rock in a fixed proportion such as 10 ml to 10 g, after which the pH of the resultant slurry is measured. In sulphide bearing rocks, pH values above 7 typically indicate that the sample contains significant neutralising capacity in the form of reactive carbonate. Paste pH values below 4 indicate the presence of mineral acidity in the form of weathering products which hydrolyse easily (notably secondary sulphates).

Acid Base Accounting (ABA)

Acid Base Accounting (ABA) is commonly performed using a conventional Sobek (1979) procedure. This involves the analytical determination of:

1) Total, sulphide and sulphate S by (i) LECO analysis and (ii) analysis of HCl leachable S.

2) Acid Neutralisation Capacity (ANC) by consumption of carbonate through the addition of HCl and subsequent alkali back-titration of the HCl consumed.

The above analyses are applied to calculate a range of ABA parameters including:

1) Acidification Potential (AP) – based on the assignment of all sulphide S to pyrite, and calculation of the potential acidity which may be generated from the sulphide S mass in accordance with the stoichiometry of pyrite oxidation. In Mt Leyshon samples, AP has generally been calculated based on total S concentrations as SO_4 has typically not been determined.

2) Net Acid Production Potential (NAPP) – calculated as the difference between ANC and AP, with values for both parameters expressed in terms of either kg H_2SO_4/t or kg $CaCO_3$/t equivalence.

Net Acid Production Potential (NAPP) values reflect the difference between Acid Neutralisation Capacity (ANC) and Acidification Potential (AP). These values are commonly used as a general indication of acid production potential. Samples with NAPP values higher than 20 kg $CaCO_3$/t are generally considered to be non-acid generating and samples with NAPP values lower than -20 kg $CaCO_3$/t are considered to be acid generating. Samples with NAPP values in the range –20 to 20 kg $CaCO_3$/t are classified as having uncertain potential for acid generation. In Mt Leyshon ABA testwork, units of H_2SO_4/t have been used rather than $CaCO_3$/t. These two units are broadly similar, as 20 kg $CaCO_3$/t is equal to 19.6 kg H_2SO_4/t. As with NAPP values, the ANC:AP ratio is also commonly used to categorise samples in terms of acid generation potential. Values of ANC/AP < 1 and > 3 are considered to be acid generating and non-acid generating respectively.

NAG tests

The NAG test procedure is designed to measure the response of sulphide bearing rock to rapid chemically induced oxidation. For each sample, hydrogen peroxide (H_2O_2) is applied, after which the pH of the solution is measured (NAG pH). The NAG pH is generally inversely proportional to long-term ARD generation potential. In addition to the measurement of NAG pH, test solutions are back-titrated with NaOH to pH 4.5 and subsequently pH 7.0. The volume of NaOH consumed during the titration process is used to calculate the amount of acidity originally generated on hydrogen peroxide addition. In addition to the standard NAG test, kinetic NAG tests involve monitoring changes in pH and temperature during the reaction which occurs due to addition of the H_2O_2. Kinetic NAG tests can provide information on sulphide reactivity and are indicative of typical lag periods which may precede acid generation.

Mineralogical characterisation

The mineralogical compositions of Mt Leyshon samples have been carried out by a range of optical methods using transmitted light with thin sections and scanning electron microscopy (SEM). Additionally, mineralogical compositions of selected samples have been determined by X-Ray Diffraction (XRD).

Bulk geochemistry

Major and trace element determinations on solid materials are commonly performed by a range of methods. One example, which has been used on Mt Leyshon samples is a mixed acid (e.g. aqua regia) digestion followed by analysis of the resulting solution by ICP-MS (inductively coupled plasma - mass spectrometry).

Toxicity Characteristics Leaching Protocol (TCLP)

Short term leach tests provide data regarding the range and concentration of elements which may be dissolved and mobilised in leachate from rock material when exposed to natural precipitation or infiltrating water. One short term leach test used on Mt Leyshon samples has been the Toxicity Characteristics Leaching Protocol (TCLP). Although the exact laboratory set-up for Mt Leyshon samples is not known, TCLP testwork typically involves leaching a sample with a buffered organic acid, such as acetic acid. The resulting leachate is then filtered and analysed.

3.3 Kinetic testwork

Long-term column leach tests are designed to define oxidation and related rock weathering reaction trends under controlled laboratory or field conditions. Unlike short term static tests, these kinetic tests typically run for several months or years. Column leach tests are particularly valuable for simulating in a period of months, processes which may naturally occur in the field setting over periods of years. Such kinetic tests are fundamentally of value for indicating the likely evolution over time of contact waters interacting with mineralised rock, as they can provide an insight into the relative rates of reaction of discrete components of the mineral assemblage. The kinetic test design used for Mt Leyshon samples has involved the use of free draining leach columns. In this method, an open top column with a height and capacity of around 10 cm and 2.5 L respectively is filled with 2 – 2.5 kg of crushed rock. Water is applied to the material surface weekly and leachate samples are collected from below the column on a monthly basis. Water is applied at a rate of 100 ml per kg of sample material each week, with the volume increased to 400 ml per kg in each fourth week to facilitate leachate sample collection. Additionally, a heat lamp is used during the test to create a temperature on the material surface of around 30 – 35°C (EGI, 1999). The free draining leach columns using Mt Leyshon samples have been operated for various durations ranging from 8 – 140 weeks.

4 ACID FORMING CHARACTERISTICS

4.1 Introduction

The acid forming characteristics of mined materials at Mt Leyshon have been investigated in a range of studies using various combinations of the test methods described in Section 3. The main details and conclusions available from these investigations are summarised below, followed by an interpretation of the collated data. Appendix A presents the collated data.

4.2 Summary of investigations of acid forming characteristics of Mt Leyshon materials

Waste Rock

A waste rock characterisation study was carried out in 1991 - 1992 by AGC Woodward-Clyde. This study characterised the major waste lithologies in terms of acid production potential and metals content. However, the results from the AGC Woodward-Clyde work are currently unavailable.

Data for total sulphur analyses are available from waste rock samples analysed as part of waste segregation studies carried out in the early years of mining (Mt Leyshon Gold Mines Ltd., 1994). At that time, waste with < 0.5% S was considered to be suitable for future use as a Non-Acid Forming (NAF) cover material. The 1994 study analysed 492 6 m drillcore composites for total S and estimated that 7 million tons of porphyry waste with an average sulphur content of 0.31% S would be produced during mining. This is a small proportion of the total waste produced, as up to 450 million tons of waste is believed to have been generated during mine life (Onkaparinga, 2006). The Acidification Potential (AP) for waste with 0.31% S, assuming all S is present as pyrite, would be 9.5 kg H_2SO_4/tonne.

In 1995, Environmental Geochemistry International (EGI) investigated a range of samples of porphyry seal material, as used in rehabilitation projects. One of the main results of the EGI study was to change the waste segregation cutoff value for total S from 0.5% to 1.5%. The EGI study led to the development of a simplified on-site Net Acid Generation (NAG) test to facilitate the segregation of NAF waste. EGI estimated that 50 samples were collected per month as part of a quality control program investigating the in-place porphyry seal. Details from the initial 11 NAG tests from this program and an additional 135 porphyry block samples were reported by EGI. Additionally, EGI reported 16 total S results from earlier work by Woodward-Clyde, as EGI selected the same batch of samples for re-analysis. Problems with sampling protocol which allowed contamination of NAF porphyry samples by underlying Potentially Acid Forming (PAF) Breccia material were highlighted, allowing modification of the methodology. The EGI (1995) study found that 5 from 16 of the porphyry seal samples were classifiable as PAF and that two of those samples may have been contaminated by underlying PAF Breccia waste. Additionally, in an investigation of the reactivity of the materials, EGI reported that the Acid Neutralisation Capacity (ANC) of the porphyry material was readily available. Results from the initial porphyry seal quality control program indicated that all 11 samples tested were NAF. The testwork from 135 porphyry block samples indicated that 90% were NAF, and that all samples with < 1.5% S were NAF.

The waste rock platform on the ONTSF was sampled in 1999 and 49 samples were subjected to field NAG testing (EGI, 1999). The results from this testwork indicated that 33 of the 49 samples were PAF and the majority of these had the capacity to generate > 5 kg H_2SO_4/t of acidity.

In 2000, SRK completed an investigation to assess the design requirements for lysimeters, to be constructed beneath the engineered cover layers on the waste rock storage facilities. This work involved collection of samples from the engineered cover layers (porphyry) and from the underlying waste rock. Samples collected during this investigation were characterised using ABA analyses. The waste rock storage facility locations selected for sample collection are not known (due to the lack of Figure 2.1 from the available report). However, it is known that samples were collected from the top and bottom of the NAF porphyry cover as well as from the underlying waste rock. Six out of seven waste rock samples classified as PAF, with Net Acid Production Potential (NAPP) values of > 20 kg H_2SO_4/t. The maximum NAPP value was 72.1 kg H_2SO_4/t. Only one porphyry cover sample exhibited a NAPP value > 20 kg H_2SO_4/t. This was a sample with a NAPP value of 21.9 kg H_2SO_4/t. It was believed that the samples, from the base of the porphyry cover, were potentially contaminated with underlying waste rock material (SRK, 2000). Values for ANC:AP ratio categorise all six waste rock samples as potentially acid generating, with values < 1. Thirteen of the porphyry cover samples categorise as non-acid forming (NAF) based on NAPP values < -20 kg H_2SO_4/t, with a minimum value of -60.5 kg H_2SO_4/t.

The acid forming characteristics of twelve samples collected from the NAF oxide waste rock cover placed on the New North Tailings Storage Facility (NNTSF) were reported as part of a site-wide contamination survey by Otek in 2005. The findings of this study were that nine of the twelve samples had positive NAPP values with five of these being > 20 kg H_2SO_4/t. The NAG pH values for the 12 samples ranged from pH 3.3 – 9.2 with six of the samples recording NAG pH values < pH 4.

Heap Leach Material

In 2004, seven samples of heap leach material were collected from the residual Heap Leach Pad area for characterisation of acid forming potential. Results from this work indicate that six out of seven of the samples recorded positive NAPP values, with four of these being > 20 kg H_2SO_4/t (Otek, 2005). Only two of the samples recorded NAG pH values < pH 4 and in all cases the NAG acidity (pH 7 titration) was lower than the NAPP value.

The potential for acid drainage from the heap leach stockpile at Mt Leyshon was assessed using 16 heap leach samples by the Centre for Mined Land Rehabilitation (CMLR) in 2006. Fifteen samples exhibited positive NAPP values, with 13 having NAPP values > 20 kg H_2SO_4/t and therefore classifiable as Potentially Acid Forming (PAF). However, this information combined with NAG testing indicated that only 6 samples should be classified as PAF, with the remainder being in the uncertain category with respect to acid formation. This discrepancy is due to the NAPP calculation assuming that all S in the sample is present as pyrite. Mineralogical investigation indicated that although pyrite was present, at varying stages of oxidation, other S minerals such as alunite were also identifiable.

Tailings

In 1999, EGI reported results from tailings characterisation carried out on samples collected in 1997 from the ONTSF and STSF. Two bulk samples from each tailings storage facility were assessed along with 11 samples from a transect across the ONTSF. From the transect, the coarser fractions from the pond perimeter (beach) had the highest total sulphur (average 6.6%), the highest net acid production potential (NAPP of 180 kg H_2SO_4/t), and the highest net acid generation potential (NAG of 31 kg H_2SO_4/t). In contrast, the fine tailings from the decant pond area had the lowest sulphur (average 1.8%), the lowest NAPP (3 kg H_2SO_4/t), and a NAG of zero (0 kg H_2SO_4/t). The testwork presented (EGI, 1999) indicated that the bulk of the tailings material would be likely to be PAF. Additionally, kinetic testwork indicated that there would be a lag period prior to the onset of acid generation of at least 6 months and possibly more than 3-5 years, assuming exposure to surficial oxidation.

Scats

In 1993, Woodward-Clyde reported testwork carried out on six scats samples. Four of these samples were classified as Breccia and two as porphyry. All six samples exhibited higher potentials to be acid forming rather than consuming, and consequently NAPP values ranged from 35.3 – 106.8 kg H_2SO_4/t. Values from NAG testing were lower, with values ranging from 0 – 66.2 kg H_2SO_4/t.

A geochemical characterisation of four scats samples was carried out by the Mt Leyshon environmental department in 2000 (Roseby, 2000). Results from this study confirmed the earlier Woodward-Clyde work, with NAPP values in the range 60 – 82 kg H_2SO_4/t and NAG acidity values of 50.8 – 64.3 kg H_2SO_4/t.

The suitability of the use of scats in road construction was investigated by URS in 2002 on behalf of Dalrymple Shire Council. Nineteen samples from the three main stockpiles were analysed and all were determined to be PAF. The ranges of NAPP and NAG (pH 7 titration) values were 39 – 100 kg H_2SO_4/t and 29 - 77 kg H_2SO_4/t respectively. The final NAG pH values were all < pH 3. Additionally kinetic column testwork indicated lower pH values than may have been predicted by paste pH, NAPP or NAG acidity values. For example, two samples with paste pH values of pH 8.2 and pH 7.8 had initial leach test pH values of pH 4.15 and pH 3.5 respectively. This may have been due to ANC being physically unavailable in the natural scats material used in the columns. In the paste pH, NAPP and NAG testwork, crushed scats material was used, therefore maximising the availability of minerals to participate in reactions.

Other Material

The only results available for characterisation of the acid forming potential of other materials from Mt Leyshon are from samples of “soil” collected from the eastern footprint area of the former PAF oxide waste stockpile. It is believed that the stockpile plus the underlying 0.5 m of material had been removed prior to collection of these samples (Otek, 2005). Characterisation of five samples indicated that all had positive NAPP values, with one of these being > 20 kg H_2SO_4/t. The NAG pH values ranged from pH 3.9 – 4.4 and NAG acidity (pH 7 titration) values ranged from 3.6 – 11.9 kg H_2SO_4/t.

4.3 Paste pH

Available results from paste pH tests on Mt Leyshon materials are presented in Appendix B, Figure B1. Paste pH provides a qualitative estimate of the pH of a lixivant such as rainwater on initial contact with reactive rock material. The lowest value in the Mt Leyshon testwork was pH 4.5 and was recorded for a sample of scats material. The majority of samples produced paste pH values > 7. This indicates that the samples contained readily soluble neutralising minerals which were more prevalent than sources of mineral acidity which hydrolyse easily such as secondary sulphates.

4.4 Acid Base Accounting (ABA)

In the Mt Leyshon Acid Base Accounting (ABA) testwork, the Acidification Potential (AP) values of the site materials have been calculated from total S analyses. This calculation assumes that all sulphur in the sample exists as pyrite. The results for total S and AP are presented in Appendix B, Figure B2. Total S values ranged from 0.02 – 9.09% with minimum and maximum values in samples of heap leach and porphyry cover material respectively. A total S cutoff value was used at site to separate waste material which would be suitable for NAF cover for facility areas. Figure B2 exhibits the differences in the SRK (2000) samples with the majority of the porphyry cover containing < 1.5% S and the underlying waste containing > 1.5% S. The New North Tailings Storage Facility (NNTSF) waste rock platform samples all had < 1.5% S (Otek, 2005). All of the samples of scats and tailings analysed contained > 1.5% S. The majority of the heap leach and all of the soil samples from the PAF stockpile footprint contained < 1.5% S. The AP values, calculated from total S, ranged from 0.6 – 278 kg H_2SO_4/t. The majority of tailings samples had AP values > 100 kg H_2SO_4/t and the majority of scats samples were in the range 50 – 100 kg H_2SO_4/t. In general, samples from porphyry cover on facility areas had AP values < 50 kg H_2SO_4/t and samples of underlying waste rock were > 50 kg H_2SO_4/t.

Results for Acid Neutralisation Capacity (ANC) are presented in Figure B3. In general, ANC values are lower than the AP values presented in Figure B2. The overall range in ANC values was < 0.1 – 72.4 kg H_2SO_4/t with the lowest and highest ANC values in samples of waste rock and porphyry cover material respectively. As a grouping, the lowest ANC values were exhibited by the heap leach samples analysed in 2006 by CMLR. The largest range in ANC values was observed in samples of porphyry cover material. Tailings samples generally exhibited higher ANC values than either heap leach or scats.

Figure B3 also presents the results for Net Acid Production Potential (NAPP), which is a function of AP and ANC. As a guide, values of +/- 19.6 kg H_2SO_4/t are commonly used to distinguish Non Acid Forming (NAF) and Potentially Acid Forming (PAF) material (Section 3.2). Values between -19.6 and 19.6 kg H_2SO_4/t are generally considered to be of uncertain NAPP. The values -19.6 and 19.6 kg H_2SO_4/t are indicated on the NAPP chart in Figure B3. All of the scats samples and the majority of the tailings and heap leach samples and waste rock (SRK, 2000) have NAPP values > 20 kg H_2SO_4/t and would therefore be considered as PAF materials. The only materials which would be considered as NAF on the basis of NAPP values are samples of porphyry cover material and two samples of the NNTSF waste rock platform. As groupings, the NAPP values for tailings were generally higher than for scats, which in turn were higher than heap leach and porphyry cover material. The average NAPP values were 100 kg H_2SO_4/t for tailings, 69 kg H_2SO_4/t for scats and 27 kg H_2SO_4/t for heap leach. The average NAPP values for porphyry cover and underlying waste material analysed by SRK in 2000 were -24 and 42 kg H_2SO_4/t respectively. Samples from the NNTSF waste rock platform had an average NAPP of 9 kg H_2SO_4/t.

In addition to NAF / PAF cutoff values for NAPP, the ratio of ANC:AP is also utilised to distinguish the potential of material to either generate or consume acid. Figure B4 presents ANC versus AP and includes lines to distinguish materials which may be considered as NAF and PAF. ANC/AP values > 3 are generally present in NAF materials and values < 1 distinguish PAF materials. Material of uncertain potential with respect to acid generation are characterised by ANC/AP values in the range 1 - 3. It is clear from Figure B4 that samples of tailings, scats, heap leach and waste rock would be classified as PAF. The porphyry cover samples generally plot in the uncertain or NAF sectors.

4.5 Net Acid Generation (NAG)

Results from Net Acid Generation (NAG) testwork are presented in Figure B5. In their 1995 study, EGI defined a NAG pH cutoff value of pH 4 to distinguish NAF / PAF material. This value was used for waste segregation. Samples with NAG pH values < pH 4 were deemed to contain reactive sulphides and were considered as PAF. All categories of materials contain samples with NAG pH values < pH 4, with all of the scats samples classifying as PAF. Tailings samples form two distinct groups, either PAF with NAG pH < 3 or NAF, with NAG pH > 8.5. Heap leach samples exhibit a large range in NAG pH values, from pH 2.8 – 8.4. Large ranges in NAG pH values are also observed in the samples from the waste rock platforms on both the Old and New North Tailings Storage Facilities (ONTSF and NNTSF), with many of the samples classifying as PAF.

Values available from NAG acidity values (pH 7 titration) indicate that scats samples would be predicted to generate the largest quantities of acidity, with a maximum value of 67 kg H_2SO_4/t. In general, samples of heap leach, porphyry cover and the NNTSF waste rock platform recorded NAG acidity values < 10 kg H_2SO_4/t. Tailings samples either exhibited NAG acidity values in the range 19 - 38 kg H_2SO_4/t or had values of 0 kg H_2SO_4/t depending on which NAG pH grouping (PAF or NAF) the samples were from.

In all cases where results are available for both test methods, the NAG acidity values are lower than the NAPP values. This is largely a result of the NAPP value being a function of ANC and AP, with the AP value calculated assuming that all S in the sample exists as pyrite. The feature of NAPP > NAG acidity values is common in geo-environmental characterisation programs and indicates that it is unlikely that S is present exclusively in pyrite. Figure B6 presents the values of NAG acidity against NAPP to highlight the differences. The scats samples exhibit smaller differences between NAPP and NAG values than the tailings. This suggests that a higher proportion of the S in the scats may present as pyrite whereas the tailings are likely to contain a greater proportion of non-pyrite S minerals than scats.

Kinetic NAG tests have been carried out on samples of porphyry seal (EGI, 1995), tailings (EGI, 1999) and scats (URS, 2002). The porphyry seal samples were found to be only slowly reactive and any acid generated was rapidly neutralised. Tailings were found to contain reactive sulphides and the majority of samples were PAF. The lag period preceding the formation of acid conditions in tailings was predicted to be from around 6 months to more than five years depending on the relative quantities of reactive sulphides and neutralising minerals. Kinetic NAG tests performed on scats samples used material which had already been exposed to weathering conditions for 2 – 3 years. Results indicated that there would be variable additional lag times preceding the onset of net acid generation. The timescales estimated ranged from a few months to two or more years.

4.6 Mineralogy

To reinforce and help explain results from ABA and NAG testwork, material characterisation studies often include mineralogical determination. The presence or absence of certain key minerals are important in terms of acid generation. These, and their occurrence in Mt Leyshon materials, are outlined below.

Source of Acid Neutralisation Capacity (ANC)

The source of ANC is commonly calcium carbonate and this is likely to be the case in the Mt Leyshon samples, in the form of calcite veining.

The calcium carbonate dissolution reaction, which neutralises acidity is as follows:

$$CaCO_3 = Ca^{2+} + CO_3^{2-}$$

The presence of calcite as a gangue mineral in the primary mineralisation zone has been noted (Mt Leyshon Gold Mines Ltd., 1991). Calcite has also been observed in scats samples (Woodward-Clyde, 1993). In mineralogical investigation of tailings (EGI, 1999) and heap leach material (CMLR, 2006) no calcite has been reported as being present in samples.

Source of Acidification Potential (AP)

Commonly, the major source of acidity associated with mine wastes is the oxidation of sulphide minerals, particularly iron sulphides such as pyrite. Reactions 1 and 2 show the principal acid generating reactions involving pyrite.

1) Pyrite oxidation by oxygen:

$$2FeS_2 + 7O_2 + 2H_2O = 2Fe^{2+} + 4SO_4^{2-} + 4H^+.$$

2) Pyrite oxidation by ferric iron:

$$FeS_2 + 14Fe^{3+} + 8H_2O = 15Fe^{3+} + 2SO_4^{2-} + 16H^+.$$

Mineralogical analysis of Mt Leyshon materials indicates the presence of pyrite in veins and cavity fillings, and disseminated throughout the majority of lithologies (Mt Leyshon Gold Mines Ltd., 1991). Pyrite has also been observed in tailings (EGI, 1999), scats (Woodward-Clyde, 1993) and heap leach material (CMLR, 2006).

As previously noted, the ABA process calculates acidification potential from the total sulphur content assuming that all of the S is present as reactive pyrite. This is a conservative approach, as S in the Mt Leyshon materials is also present in non pyritic sulphides such as galena, sphalerite and chalcopyrite (Mt Leyshon Gold Mines Ltd., 1991).

The mineralogical data currently available are not sufficient to determine the relative proportions of different mineral phases or the relative abundance of minerals between material types.

4.7 Summary of Acid Forming Characteristics

Investigation of the acid forming characteristics of Mt Leyshon materials indicates that:

- Porphyry cover materials are generally likely to be NAF, and are characterised by negative NAPP values and NAG pH values > pH 4.
- Waste rock, not including NAF cover materials, is generally classified as PAF, with NAPP values > 20 kg H_2SO_4/t and ANC/AP values < 1.
- Heap leach material ranges from NAF to PAF, with a greater number of samples classifying as the latter, with NAPP values > 20 kg H_2SO_4/t and ANC/AP values < 1.
- Tailings material generally classifies as PAF, with the majority of samples having NAPP values > 20 kg H_2SO_4/t and ANC/AP values < 1.
- Scats also classify as PAF, with all samples tested having NAG pH values < pH 3, NAPP values > 20 kg H_2SO_4/t and ANC/AP values < 1.
- ABA testwork generally indicated that tailings have the greatest potential for acid generation, whereas NAG testwork indicated that scats have the potential to generate greater quantities of acid than tailings. This is likely to be due to scats containing a larger proportion of their S content as pyrite. As more of the S in tailings is likely to be in sulphides other than pyrite, the scats material would be predicted to have a greater potential for acid generation, as indicated by NAG testing.

Testwork to characterise the acid forming characteristics of Mt Leyshon materials has therefore indicated that the majority of materials mined and currently stored on site would be classified as Potentially Acid Forming (PAF). The testwork indicates that the porphyry seal material used as rehabilitative cover for facility areas is generally NAF. Although the majority of heap leach samples classified as PAF, the capacity of this material to generate acid is lower than for either scats or tailings.

5 INVESTIGATION INTO THE RELEASE OF CONTAMINANTS

5.1 Introduction

The potential release of metals to the hydrosphere during weathering has been investigated by bulk geochemical analysis of Mt Leyshon materials and by both short term (TCLP) and long-term (free draining column) leach tests.

5.2 Multi-Element Composition

Data are available for the multi-element composition of heap leach, scats and porphyry seal and NAF oxide cover material used on facility areas.

The composition of heap leach material was investigated in 16 samples by CMLR in 2006. They reported that 1998 Environmental Protection Agency (EPA) Environmental Investigation Levels (EILs) for contaminated lands were exceeded for several analytes. These were Cd in 1 sample, Cu in 15 samples, Mn in 5 samples, Zn in 3 samples and SO_4 in 9 samples. It was also noted that concentrations of Cd, Mn and Zn were lower than those reported in scats samples by Woodward Clyde in 1993.

Selected data from additional characterisation programs which have included multi-element determinations are presented in Table 5.1. Also included in Table 5.1 are the EPA (1998) EIL values for contaminated land. It should be noted that the values for Cu, Pb and Zn are specific values set for the Mt Leyshon site (Otek, 2005).

Table 5.1 Average values from multi-element characterisations of Mt Leyshon materials

Analyte (mg/kg)	EPA 1998	Otek, 2005	Otek, 2005	Otek, 2005	URS, 2002	Woodward-Clyde, 1993
	E.I.L	Porphyry Seal	NAF Oxide on NNTSF	Heap Leach	Scats	Scats
		n=5	*n=12*	*n=41*	*n=6*	*n=6*
As	20	12.9	10	16.6	31.5	21
Cd	3	0.3	1.3	1.4	3	4
Cr	50	<5	13.8	9.8	48	239
Cu	60	15.1	198	151	248	278
Hg	1	-	<0.1	<0.25	<0.05	-
Mn	500	-	-	-	2880	2252
Ni	60	<2	7.2	3.3	14	19
Pb	300	14.9	43	45	127	83
Zn	200	57.2	182	142	793	676

The average data presented in Table 5.1 indicates that the highest concentrations of all of the metals presented are in samples of scats, which exceed EIL concentrations for As, Cd, Cr, Cu, Mn and Zn. Scats material exhibited average concentrations up to 278 mg/kg Cu, 2,880 mg/kg Mn and 793 mg/kg Zn. The porphyry seal average values do not exceed any of the EIL concentrations presented and only Cu is exceeded in the NAF Oxide cover and heap leach material, with values of 198 mg/kg and 151 mg/kg respectively.

5.3 Leach Tests

Although multi-element analyses indicate material compositions, they give no indication of the likelihood of individual elements to be released under weathering conditions. To achieve this, short and long term leach tests are commonly carried out. Long term leach tests also assist in confirmation of the propensity of materials to generate acid drainage. These are particularly important for materials which classify in the uncertain range according to ANC:AP ratios or NAPP values.

Short Term Tests

Short term leach tests, such as the Toxicity Characteristic Leaching Protocol (TCLP) method, outlined in Section 3.2, provide data regarding the range and concentration of elements which may be dissolved and mobilised in leachate from rock material when exposed to natural precipitation or infiltrating water. However, in making this comparison, it requires emphasis that the solid-solution ratios in TCLP tests may differ substantially from those prevalent in the field setting. The results do not, therefore, necessarily reflect precisely the

leachate chemistries which may be associated with the sample types analysed in a tailings or waste facility environment.

The scats investigation by URS (2002) indicates that a single scats sample was analysed by Dalrymple Shire Council in 2000 using the TCLP method. This study indicated that there was negligible immediate solubility of dominant trace elements. URS (2000) also presented data from water extracts of six scats samples, using a ratio of 1:5 rock:water extract ratio. The majority of trace elements were below detection limits and five of the six samples produced water extracts with pH > 7. However, one sample produced an extract with pH 4.5 and 1,150 mg/L SO_4, 81 mg/L Fe and 13 mg/L Mn.

No other data are available for the reported short term leach tests on Mt Leyshon materials.

Long Term Tests

Kinetic tests, such as free draining leach columns, are designed to define long-term oxidation and related rock weathering reaction trends under controlled laboratory conditions. Unlike short term static tests, kinetic tests typically run for several months or years. Data are available for free draining column leach tests using tailings (EGI, 1999) and scats (URS, 2002).

Two tailings samples were selected for use in column tests, one classified as NAF and the other as PAF. The NAF sample test continued for 140 weeks and the pH remained around or above pH 7 for the duration of the test. The test estimated that ANC in the material would be consumed by around week 250, following which there was uncertainty as to whether acid conditions would develop. The leachate SO_4 concentration in week 140 was 1,848 mg/L . In the final week where a range of trace metals were analysed (week 60), concentrations of 0.03 mg/L Cd, 1.16 mg/L Cu, 0.6 mg/L Fe, 6.4 mg/L Mn and 8.4 mg/L Zn were recorded, along with 1,558 mg/L SO_4. The PAF tailings column was operated for 80 weeks and the final leachate was pH 2.6. Multi-element data for leachate are available up to week 60, at which time the leachate was pH 3.4 with 2,576 mg/L SO_4, 22 mg/L Al, 0.9 mg/L Cd, 25 mg/L Cu, 10 mg/L Fe, 130 mg/L Mn and 220 mg/L Zn. Selected data from the week 60 leachate chemistry are presented in Table 5.2. Both the PAF and NAF tailings exhibited week 60 leachate concentrations which were elevated in SO_4, Cd and Cu. Additionally the PAF tailings were elevated in Zn and demonstrated a reduced pH.

Table 5.2 Selected column test leachate concentrations

Parameter	Units	EGI, 1999 PAF Tailings (week 60)	EGI, 1999 NAF Tailings (week 60)	URS, 2002 Scats (week 8) sample no. 7	URS, 2002 Scats (week 8) sample no. 9A
pH	pH units	3.4	6.7	3.26	3.98
SO_4	mg/L	2576	1558	1070	109
As	mg/L	no data	no data	0.002	<0.001
Cd	mg/L	0.88	0.032	0.18	0.011
Cu	mg/L	25	1.16	4.8	0.24
Pb	mg/L	no data	no data	0.003	0.012
Zn	mg/L	220	8.4	38	3.27

Six kinetic leach columns were set up containing PAF classified scats material and operated for between 8 and 32 weeks. The standard column design was modified in four of the tests to include the application of variable quantities of limestone to investigate its effect on pH and element concentrations in leachate. These tests indicated that limestone addition increased pH and decreased the concentrations of SO_4 and metals in the leachate. The effect was greater when the limestone was crushed prior to addition. Two tests which did not involve limestone addition were operated for 8 weeks. In the first case, the week 8 leachate was pH 3.3 and contained 1,070 mg/L SO_4, 0.2 mg/L Cd, 4.8 mg/L Cu, 4.4 mg/L Fe, 81 mg/L Mn and 38 mg/L Zn. The second column, in week 8, had leachate with pH 4 and contained 109 mg/L SO_4, 0.01 mg/L Cd, 0.24 mg/L Cu, 0.62 mg/L Fe, 5.4 mg/L Mn and 3.27 mg/L Zn. The week 8 concentrations for the two scats column tests are included in Table 5.2. Both of the columns had week 8 leachate which demonstrated a moderately low pH. The long term column tests using scats material produced lower initial pH values than had been expected based on ABA and NAG testing. This was attributed to ABA and NAG tests being carried out on crushed scats material, whereas the long term column tests used scats as received from site. It was proposed that the inherent neutralising capacity of the scats was not available for acid buffering in un-crushed material.

The free draining column leach tests have demonstrated that tailings and scats materials have the capacity to generate acidic runoff with elevated concentrations of SO_4 and trace metals.

5.4 Summary of Contaminant Release Potential

Multi element testwork has indicated elevated concentrations of metals such as As, Cu and Zn in scats material. Relatively high Cu and Zn concentrations have also been determined in samples of heap leach and the NAF oxide material used to cover the NNTSF. Leach testwork to investigate the release of metals under weathering conditions indicated that both scats and tailings have the capacity to generate low pH conditions with elevated concentrations of SO_4, Cd, Cu and Zn. No long term leach data are currently available to characterise porphyry cover or heap leach materials which were used extensively during facility rehabilitation.

6 SITE WATER QUALITY IN RELATION TO TEST WORK DATA

6.1 Introduction

Geo-environmental characterisation programs are commonly carried out during the early stages of any mining project in order to predict and plan for any future problems which may arise from ARD and contaminant leaching. At Mt Leyshon, early geochemical test work resulted in a waste management strategy to separate NAF waste and a rehabilitation program to limit the exposure of PAF materials to surface weathering conditions. The Mt Leyshon site has now been closed since 2002 and the rehabilitation program is ongoing. Therefore, it is possible to compare the predicted ARD and contaminant leaching potentials of site materials with actual conditions observed at site. As materials have been stored and used in various locations during rehabilitation (see Section 2), the chemistries associated with individual facility areas are likely to be influenced by a number of material types, as discussed in the following sections. All water chemistry data discussed are post-2001.

6.2 Waste Rock Storage facilities

The bulk of the Potentially Acid Forming (PAF) waste rock is stored in the three main waste rock storage facilities. These are the Northern Waste Rock Storage Facility (NWRSF), Southern Waste Rock Storage Facility (SWRSF) and Eastern Waste Rock Storage Facility (EWRSF). The facility locations are presented in Figure 1. During rehabilitation, the SWRSF was capped with 300 mm compacted heap leach and the NWRSF was capped with either compacted NAF porphyry or heap leach (GHD, 2005). The EWRSF is believed to have been capped with compacted NAF porphyry material. Physical tests on the capping strategies employed at Mt Leyshon have indicated that although the rehabilitative covers are not an effective barrier to oxygen diffusion, they do generally inhibit the movement of water. Therefore, the involvement of PAF waste on site in surface weathering reactions should be greatly reduced. The NAF porphyry material in the cover would not be predicted to form Acid Rock Drainage (ARD). However, heap leach material in the covers has been indicated to have the potential to generate ARD.

The Mt Mawe Dam is located at the eastern flank of the Eastern Waste Rock Storage Facility and water chemistry data are available for 18 sampling events between January 2002 and June 2008. The Mt Mawe Dam has received runoff and seepage from a section of the eastern slope of the Eastern Waste Rock Storage Facility.

Key observations from the Mt Mawe Dam chemical data are:

- Since mine closure in 2002, the maximum pH value recorded in the Mt Mawe Dam has been pH 4.3, recorded in January 2007. A pH of 3.7 was recorded in June 2008.

- A maximum SO_4 concentration of 25,400 mg/L was measured in the Mt Mawe Dam in September 2004.

- The Environmental Authority (EA) governing operations at Mt Leyshon sets limits for surface water chemistry in the receiving environment. Although these limits do not apply to the containment dams at Mt Leyshon, they provide a convenient means of comparing water qualities at the site. In June 2008, the Mt Mawe Dam was elevated compared to the receiving surface water guidelines set in the EA for pH, SO_4, Cd, Cu, Pb and Zn. The total concentrations of Cd, Cu and Zn were 4.35, 76.4 and 701 mg/L respectively. The June 2008 sample potentially reflects the influence of flushing of the waste rock as a result of increased infiltration driven by the unusually large 2007-2008 wet season. Table 6.1 presents selected chemical data for the Mt Mawe Dam and sites within the catchment area.

Table 6.1 Selected analytical data for Mt Mawe Dam and EWRSF seepages

		25-Jun-08	17-Feb-05	15-Jan-09
analyte	**units**	**Mt Mawe Dam**	**SW34**	**S5**
pH	pH units	3.7	3.1	3.1
EC	µs/cm	16,600	15,260	12,700
SO_4	mg/L	3,370	24,700	16,700
Cd	mg/L	4.4	4.3	0.002
Cu	mg/L	76.4	67.4	0.02
Zn	mg/L	701	884	0.05
As	mg/L	0.0005	0.05	0.014
Pb	mg/L	0.12	0.19	0.0005
Hg	mg/L	0.00005	0.00005	0.00005
WAD CN	mg/L	0.002	0.002	-

Laboratory data available to characterise drainage flowing to the Mt Mawe Dam from the eastern slope of the Eastern Waste Rock Storage Facility consists of two samples from site SW34, collected in February 2003 and February 2005. The 2005 sample was pH 3.1 with 24,700 mg/L SO_4, 4.3 mg/L Cd, 67.4 mg/L Cu and 884 mg/L Zn. These values are comparable to those observed in the Mt. Mawe Dam and are indicative of the influence of seepage from the Eastern Waste Rock Storage Facility. Additional information on seepage from the EWRSF is from site S5 which emanates from the lower eastern slope of the EWRSF and was sampled in January 2009. At that time the seepage was pH 3.1 with 16,700 mg/L SO_4, 0.002 mg/L Cd, 0.02 mg/L Cu and 0.054 mg/L Zn.

The Mt Mawe Dam is constructed within a surface water drainage system which underlies a portion of the Eastern Waste Rock Storage Facility. The poor water quality in the dam appears primarily controlled by seepage at the base of the facility entering this drainage, and seepage from the external slopes.

The data for Mt. Mawe Dam and seepages SW34 and S5 indicate that the EWRSF is generating ARD with significantly elevated concentrations of SO_4 and trace metals. The general chemistry of the seepage is consistent with that which would be expected from the available geochemical characterisation data for the PAF waste rock stored in the facility, and is significantly worse than would be expected in runoff from the NAF porphyry material used in the cover of the EWRSF. The chemistry suggests that infiltration through the cover material is occurring and flushing the products of ongoing oxidation of the PAF waste rocks.

There are insufficient hydrochemical data to characterise runoff and seepage associated with the NWRSF and SWRSF. However, heap leach material in the cover layers of the storage facilities has the potential to form ARD. Additionally, the covers are known to perform poorly in some locations in both facilities. Anecdotally, the area of the SWRSF which contains the 5 million tons of scats material has been reported to generate reduced pH and elevated sulphate in runoff and seepage.

6.3 Tailings Dams

There are three tailings storage facilities at Mt Leyshon, these being the Old Northern Tailings Storage Facility (ONTSF), New Northern Tailings Storage Facility (NNTSF) and Southern Tailings Storage Facility (STSF). All three tailings storage facilities have been capped with waste rock, overlain with heap leach, overlain with topsoil. Potentially Acid Forming (PAF) waste was used in the cover layer on the ONTSF and NNTSF and Non Acid Forming (NAF) waste was used in capping the STSF. The NAF waste on the STSF would not be predicted to form ARD. The compacted heap leach material used as the main seal on the tailings storage facilities would be predicted to form ARD. However, the greatest potential for ARD generation and the release of metals from these facilities would be from the PAF waste in the cover on the ONTSF and NNTSF and from the tailings material within all of the storage facilities.

Seepage and runoff from parts of the ONTSF and NNTSF are collected in five sumps The sumps are ONTSF W, ONTSF N, ONTSF E, NNTSF N and NNTSF NW. Since January 2006, the pH in these sumps has been within the EA limit of pH 6.5 – 9 which applies to receiving surface water chemistry, with one exception (the ONTSF W sump was pH 4.3 in June 2008). In general, the SO_4 concentrations in these 5 sumps have been elevated compared to the EA value of 1,000 mg/L. In June 2006, the range in SO_4 concentrations between the sumps was relatively small, being 3,430 – 3,980 mg/L. Concentrations of Cd and Cu in these sumps have been very variable since closure. In June 2008 all of the Cd concentrations were elevated compared to the EA limit of 0.01 mg/L as the range recorded was 0.011 – 0.15 mg/L. The minimum and maximum values were recorded for the NNTSF NW and ONTSF W sumps respectively. The same two sumps recorded the minimum and maximum Cu concentrations of 0.24 and 7.8 mg/L respectively. Since closure, the only Mt Leyshon tailings sumps to exhibit elevated values compared to the EA WAD CN guideline concentration of 0.2 mg/L have been ONTSF E, ONTSF W and NNTSF N. In June 2008, the maximum WAD CN concentration of 0.3 mg/L was recorded for the ONTSF E sump. Examples of chemistries associated with the seepage sumps in the vicinity of the ONTSF and NNTSF are presented in Table 6.2. Sump locations are indicated in Figure 1.

Table 6.2 Selected analytical data for ONTSF and NNTSF seepage sumps

analyte	units	25-Jun-08	04-Aug-03	25-Jun-08	25-Jun-08	25-Jun-08	25-Jun-08	25-Jun-08
		ONTSF W	ONTSF N	ONTSF E	NNTSF N	NNTSF NW	STSF SSE	STSF SSW
pH	pH units	4.3	7.2	7.1	7.3	7.4	7.8	7.9
EC	us/cm	4250	4020	5440	6190	5340	6810	6280
SO4	mg/L	3480	3620	3980	3940	3430	3600	3610
Cd	mg/L	0.15	0.0025	0.02	0.045	0.011	0.003	0.002
Cu	mg/L	7.8	0.01	0.6	2.9	0.24	0.05	0.06
Zn	mg/L	5.6	0.01	0.5	2.8	1.1	0.35	0.16
As	mg/L	0.0005	0.007	0.006	0.002	0.003	0.009	0.005
Pb	mg/L	0.0020	0.0005	0.0010	0.0005	0.0005	0.0005	0.0005
Hg	mg/L	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005
WAD CN	mg/L	0.002	0.06	0.3	0.12	0.07	0.03	0.04

Seepage and runoff water from the Southern Tailings Storage Facility is collected in two sumps at the southern end of the tailings storage facility. These are the STSF SSW and STSF SSE sumps. Throughout the sampling period, from 2002 onwards, the water in the STSF SSE Sump has generally remained comparable with the EA pH range for receiving waters of pH 6.5 – 9. In June 2008, a pH of 7.8 was recorded and the water contained 3,600 mg/L SO_4, 0.003 mg/L Cd, 0.05 mg/L Cu and 0.35 mg/L Zn. The only analyte which was elevated compared to the EA guideline concentration for receiving waters was SO_4, as the guideline concentration is 1,000 mg/L. Example chemistries from the STSF seepage sumps are presented in Table 6.2 and their locations are indicated in Figure 1.

The ONTSF, NNTSF and STSF are therefore not in general generating low pH ARD. However, SO_4 concentrations in seepages are relatively high and the ONTSF in particular is associated with elevated metals concentrations. The high Cu and Cd concentrations associated with the ONTSF may indicate the influence of PAF waste material in the cover layer. Additionally, the influence of tailings material seepage in the sump chemistries is demonstrated by measureable WAD CN concentrations. Although WAD CN was generally not measured during geochemical testwork programs, it would be expected to be measured associated with any seepage from tailings material. If the tailings materials should become exposed to surface weathering conditions due to breaks in the cover, they may be in a lag period prior to the onset of ARD generation. This period would be associated with elevated SO_4 concentrations and circum-neutral pH conditions. Following consumption of the Acid Neutralisation Capacity (ANC) of this material, it would be predicted to form low pH (< pH 4) ARD with elevated concentrations of SO_4 and metals such as Cd, Cu and Zn.

6.4 Scats Stockpile

The majority of the scats material is stockpiled in the upper Plum Tree Creek catchment (Figure 1). The scats stockpiles have not been rehabilitated and the material is highly permeable and contains pyrite, oxidation of which is currently evident.

The Upper Plum Tree Creek Dam (UPTCD) is at the base of the scats stockpile and collects runoff and seepage from the stockpile. Data are available for two samples from the UPTCD and selected results are presented in Table 6.3.

Table 6.3 Selected analytical data for Upper Plum Tree Creek Dam

		30-Nov-05	13-Sep-07
analyte	**units**	**UPTCD**	**UPTCD**
pH	pH units	3.1	3.5
EC	µs/cm	-	39600
SO4	mg/L	22600	59300
Cd	mg/L	7.39	11.3
Cu	mg/L	36.5	110
Zn	mg/L	2440	2050
As	mg/L	0.064	0.0025
Pb	mg/L	0.49	0.35
Hg	mg/L	0.00005	0.00005
WAD CN	mg/L	-	0.002

In Table 6.3, it should be noted that the November 2005 sample represents dissolved concentrations whereas total concentrations were analysed in September 2007. In September 2007, water in the UPTCD was pH 3.5 and contained 59,300 mg/L SO_4, 11.3 mg/L Cd, 110 mg/L Cu and 2,050 mg/L Zn. This characteristic low pH ARD with elevated concentrations of SO_4 and trace metals is consistent with the prediction from the static geochemical test work.

6.5 Heap Leach and Ore Stockpile Area

The heap leach and former ore stockpile areas lie to the SW of the Mt Leyshon pit (Figure 1). Oxide waste material was used in construction of the base of the heap leach pads and this base, which is up to 3 metres thick, is believed to have been left in place and capped with topsoil. The waste rock / subsoil footprints of the ROM and B Stockpiles have been capped with heap leach, and overlain with topsoil. Heap leach and topsoil capping have also been used for the plant and infrastructure areas, the contractors areas including Roche Hill, the laydown area and stores area, the Lower Settlement Pond landfill, the supergene acid recycle dams, the pregnant pond and upper settlement pond. Heap leach material is therefore likely to be a major influence on the water chemistry in this area.

The Supergene Stormwater Dam and Sump are located down-gradient of the heap leach stockpile. Example chemical data from the Supergene Stormwater Dam and Sump are presented in Table 6.4. In June 2008, the Supergene Stormwater Dam had a pH of 3.9 and SO_4 concentration of 1,740 mg/L, both of which were elevated compared to the EA guidelines for receiving surface waters. Also elevated were the total concentrations of 2.6 mg/L Cd, 137 mg/L Cu and 161 mg/L Zn. The June 2008 concentration of Cu was the highest recorded in any sample from the Mt Leyshon surface water containment facilities.

Table 6.4 Selected analytical data for sites in heap leach and ore stockpile area

		25-Jun-08	**25-Jun-08**	**2008 (mean *n=4*)**	**30-Jul-08**
analyte	**units**	**Supergene Stormwater Dam**	**Supergene Sump**	**SW44**	**S10**
pH	pH units	3.9	6.7	3.8	7.8
EC	µs/cm	7,770	5,430	5,618	5,730
SO_4	mg/L	1,740	3,510	4,275	2,530
Cd	mg/L	2.6	0.48	0.9	0.0007
Cu	mg/L	137	6.1	29.5	0.06
Zn	mg/L	161	18.5	84.03	-
As	mg/L	0.002	0.0005	0.003	0.002
Pb	mg/L	0.013	0.001	0.023	0.003
Hg	mg/L	0.00005	0.00005	0.00005	0.00005
WAD CN	mg/L	0.005	0.008	0.003	-

Monitoring site SW44 collects drainage from the former ore stockpile areas. SW44 was sampled on four occasions in 2008 and the average concentrations were consistent with the chemistries recorded at this site since mine closure. During 2008, the average pH was 3.8 and average total concentrations recorded were, 4,275 mg/L SO_4, 0.9 mg/L Cd, 29.5 mg/L Cu, 210 mg/L Mn, 0.02 mg/L Pb and 84 mg/L Zn.

Seepage monitoring site S10 is in the former stockpile area, on the SW side of the heap leach Stockpile area. During monitoring in July 2008, this water was pH 7.8, with total concentrations of 2,530 mg/L SO_4, 0.0007 mg/L Cd, 0.056 mg/L Cu, 0.7 mg/L Mn and < 0.005mg/L Zn. This is distinct from the chemistry at SW44, with a higher pH and lower metals load. This indicates a high variability in water chemistry associated with this area and may be a result of differences in rehabilitative cover, including the length of period of oxidation before the cover was placed.

Heap leach material was predicted from geochemical testing to be a mixture of NAF and PAF, with a tendency towards the latter. The variability in the surface water data may be indicative of the variability observed in the test work. Additionally, variations in the nature or timing of emplacement of the rehabilitative cover may have influenced the water chemistries presented. This area may also still contain remnants of ore grade material which would be likely to generate ARD.

6.5 Comparison of seepage chemistries

In order to highlight the differences in surface water chemistries associated with seepages from the different material types, selected data for the sites detailed in the previous sections are presented in Figures C1 – C4 in Appendix C. Data are presented for samples collected since January 2002 to represent post-closure conditions. Additionally, average seepage chemical values associated with each material type are presented in Table 6.5. The data presented in Table 6.5 represent the post-2001 values for the sites included in Appendix C.

Table 6.5 Selected average data for seepages associated with each material type

		Waste Rock	**Heap Leach**	**Tailings**	**Scats**
	n=	*20*	*18*	*53*	*2*
analyte	**units**				
pH	pH units	3.8	4.3	6.9	3.3
EC	µs/cm	13,230	3,892	5,555	20,820
SO4	mg/L	15,687	2,718	3,686	40,950
Cd	mg/L	2.2	0.6	0.1	9.3
Cu	mg/L	35.6	24.7	2.2	73.3
Zn	mg/L	379	60	8	2,245
As	mg/L	0.02	0.003	0.005	0.03
Pb	mg/L	0.2	0.015	0.005	0.4
Hg	mg/L	0.0001	0.0001	0.0001	0.0001
WAD CN	mg/L	0.002	0.02	0.15	0.002

The data highlights that the lowest pH values are associated with the scats and waste rock seepages, which both have average pH values < pH 4. The tailings sump pH values are circum-neutral, with an average of pH 6.9. Figure C1 presents the seepage SO_4 concentrations and indicates that the scats are associated with distinctively high values, having an average SO_4 concentration of 40,950 mg/L. The waste rock, with an average seepage SO_4 concentration of 15,687 mg/L is generally distinct from the heap leach and tailings, which have average seepage SO_4 concentrations of 2,718 and 3,686 mg/L respectively. Concentrations of Cd and Cu are presented in Figure C2. Scats seepage has distinctively high Cd concentrations with an average of 9.3 mg/L Cd. Tailings sump Cd and Cu concentrations are generally distinctively low, although there are some overlaps, in particular for Cu in sump NNTSF N and Cd in sump STSF SE. However, in general, the tailings are associated with low seepage Cd and Cu concentrations, with averages of 0.1 and 2.2 mg/L respectively. In general, waste rock is associated with higher seepage Cd concentrations than heap leach. The average waste rock and heap leach seepage Cd concentrations are 2.2 and 0.6 mg/L respectively. As with Cd, Pb and Zn concentrations indicate distinct concentrations associated with material types, as presented in Figure C3. The highest Pb and Zn concentrations are associated with scats seepage, with averages of 0.4 mg/L Pb and 2,245 mg/L Zn. Waste rock is generally associated with higher Pb and Zn concentrations than heap leach, with average concentrations of 0.2 mg/L Pb and 379 mg/L Zn in waste rock seepage and 0.015 mg/L Pb and 60 mg/L Zn in heap leach seepage. Tailings is associated with the lowest seepage Pb and Zn concentrations with averages of 0.005 and 8 mg/L respectively. Tailings seepage is also distinguishable by WAD CN concentration, having an average of 0.15 mg/L. This compares to the next highest average WAD CN concentration of 0.02 mg/L, in heap leach seepage.

As part of a previous review of water quality monitoring, a mine water fingerprinting investigation was carried out (CMLR, 2006b). This study used the “Ficklin diagram” to distinguish water types. The “Ficklin diagram” plots the variation of divalent metal cations (Cd, Co, Cu, Ni, Pb and Zn) against pH and was originally used to classify waters associated with different styles of mineralisation. Insufficient data for Co and Ni are available to carry out water fingerprinting for the material type seepages using this method. However, as material type seepage distinctions have been indicated in the available data, a modified Ficklin type diagram is presented in Figure C4. Figure C4 plots Cd + Cu + Pb + Zn against pH and indicates that there are good distinctions between the material types. Values range from scats, with low pH and high metals concentrations through waste rock, then heap leach, to tailings, with high pH and low metals concentrations. The materials groupings are also highlighted by plotting Cd + Cu + Pb + Zn against SO_4, which is also shown in Figure C4. The previous fingerprinting exercise also highlighted features such as high Sr and Mo concentrations in the tailings sumps and high U concentrations in the scats seepage (CMLR, 2006b). However, insufficient data exist for any more detailed fingerprinting using these elements than was presented in the earlier investigation.

6.6 Current Site Water Quality Summary

Data available from surface water monitoring at Mt Leyshon confirms many of the features indicated by geochemical test work. In summary, these are:

- Weathering of scats material produces low pH ARD with highly elevated concentrations of SO_4 and metals, in particular Cd, Cu and Zn. Scats material therefore appears to have the greatest capacity for acid generation and the release of SO_4 and contaminant metals.

- Weathering of PAF waste rock also produces low pH ARD with elevated concentrations of SO_4, Cd, Cu and Zn. However, average concentrations are significantly lower than observed in scats seepage.

- Weathering of heap leach material also produces low pH waters with elevated SO_4 and generally elevated concentrations of Cd, Cu and Zn. In general, the concentrations of SO_4 and metals in seepage associated with heap leach are lower than observed in waste rock seepage, although this distinction is least clearly shown for Cu.

- At the current time, water in the tailings sumps is generally classifiable as being of circum-neutral pH with low concentrations of SO_4 and metals when compared to the other material types.

6.7 Future trends

Waste rock is currently producing seepage with pH values < 4, elevated concentrations of metals, and SO_4 concentrations of around 15,000 mg/L. Indications from testwork are that waste rock is classified as potentially acid forming (PAF). Non acid forming (NAF) waste has been shown to contain elevated concentrations of metals such as Cu and Zn (Table 5.1). The concentrations of metals in PAF waste would be predicted to contain equal or higher concentrations of metals than NAF waste. The available data would indicate that the present seepage chemistry associated with waste rock is representative of predictions from testwork. Additionally it would be predicted that weathering of PAF waste rock at Mt Leyshon has the potential to maintain the current seepage chemistry for an extended period of time, measureable in 10's of years as a minimum.

Heap leach material is currently associated with seepage < pH 4 and a SO_4 concentration of around 3,000 mg/L. As with waste rock, from the available testwork data it would be predicted that heap leach material would be predicted to maintain the currently observed seepage chemistries for an extended period of time.

Of the four main material types, tailings are currently associated with the best seepage chemistries at Mt Leyshon, having an average pH of 6.9 and relatively low metals concentrations. However, testwork indicates that tailings in general are classified as PAF and the majority of tailings material would be expected to eventually be acid generating. Long term leach tests and kinetic NAG tests indicated that there would be a lag period prior to the development of acid conditions. During this lag period, the acid buffering capacity of the tailings would be gradually consumed. Predictions for lag periods for the tailings materials ranged from 6 months up to 3 – 5 years or more. As all of the tailings material has been in place for longer than 5 years, it could be expected that the lag period should be over. However, prediction of the lag periods was based on an assumption of the material being exposed to surface conditions. As various covers have been applied to the tailings storage facilities, therefore inhibiting exposure to surface conditions, it would be assumed that lag periods may be extended.

A prediction of when tailings seepage chemistry may change to become more acidic and contain higher metals concentrations would be unreliable based on current data. However, it is predicted that in the future the acid neutralisation capacity (ANC) of the tailings will become depleted and continued weathering of sulphides will generate acidity and release elevated concentrations of contaminant metals. This would then be predicted to continue for an extended number of years. One long term improvement which would be expected to be observed in tailings seepage would be a reduction in WAD CN concentrations due to CN degradation by processes such as biological activity and adsorption onto Fe, Al and Mn oxides and hydroxides and the surfaces of clay minerals.

Scats material is indicated to have the greatest potential to generate acidity and release contaminant metals and SO_4 during weathering. Seepage associated with the scats stockpile concurs with the testwork prediction and has an average pH < 3.5 and SO_4 concentration of > 40,000 mg/L. No rehabilitation has thus far been carried out on the scats stockpile. If the stockpile remains in its current state, the associated seepage chemistry, including highly elevated metals concentrations would be expected to be maintained for many 10's of years as a minimum.

7 SUMMARY AND CONCLUSIONS OF GEO-ENVIRONMENTAL CHARACTERISATION

By collating all of the studies conducted during the development, mining and closure of the Mt Leyshon site, sufficient data have been gathered to characterise the geochemical properties of the main material types at the site. Static geochemical data which define acid generation potential are available for all of the major material types, although there are very few tests on Potentially Acid Forming (PAF) sulphidic waste rock material. Although there are limited kinetic testwork data for the site materials, such as from column leach tests, for heap leach and waste rock material, these data may be supplemented by observations of seepage chemistry made during closure. In general, sufficient data are available to characterise the Mt Leyshon materials as follows:

- Porphyry cover materials are generally likely to be Non-Acid Forming (NAF), as indicated by Acid Base Accounting (ABA) and Net Acid Generation (NAG) testwork.

- Waste rock, not including NAF cover materials, is generally classified as PAF, with Net Acid Production Potential (NAPP) values > 20 kg H_2SO_4/t and Acid Neutralisation Capacity / Acidification Potential (ANC/AP) values < 1.

- Heap leach material ranges from NAF to PAF, with a greater number of samples classifying as the latter, with NAPP values > 20 kg H_2SO_4/t and ANC/AP values < 1.

- Tailings material generally classifies as PAF, with the majority of samples having NAPP values > 20 kg H_2SO_4/t and ANC/AP values < 1.

- Scats also classify as PAF, with all samples tested having NAG pH values < pH 3, NAPP values > 20 kg H_2SO_4/t and ANC/AP values < 1.

- A combination of ABA and NAG testwork indicates that scats have the greatest potential for acid generation, followed by tailings (in the long term).

- Multi element testwork has indicated elevated concentrations of metals such as As, Cu and Zn in scats material. Relatively high Cu and Zn concentrations have also been determined in samples of heap leach and NAF oxide material

- Leach testwork to investigate the release of metals under weathering conditions indicated that both scats and tailings have the capacity to generate low pH conditions with elevated concentrations of SO_4, Cd, Cu and Zn.

Testwork to characterise the acid forming and contaminant release characteristics of Mt Leyshon materials has therefore indicated that the majority of materials mined and currently stored on site would be classified as Potentially Acid Forming (PAF). Additionally, tailings and scats materials have been indicated to have the potential to release elevated concentrations of SO_4 and metals such as Cd, Cu and Zn.

Data available from surface water monitoring at Mt Leyshon confirms many of the features indicated by geochemical test work. In summary, these are:

- Weathering of scats material produces low pH ARD with highly elevated concentrations of SO_4 and metals, in particular Cd, Cu and Zn.

- Weathering of PAF waste rock also produces low pH ARD with elevated concentrations of SO_4, Cd, Cu and Zn. However, average concentrations are significantly lower than observed in scats seepage.

- Weathering of heap leach material also produces low pH seepage with elevated SO_4 and generally elevated concentrations of Cd, Cu and Zn. In general, the concentrations of SO_4 and metals in seepage associated with heap leach are lower than observed in waste rock seepage, although this distinction is least clearly shown for Cu.

- At the current time, water in the tailings sumps is generally classifiable as being of circum-neutral pH with low concentrations of metals when compared to the other material types.

Site data indicates that the tailings material is potentially currently in the lag period, predicted by testwork, prior to the onset of ARD generation. It is predicted that in the future, the acid neutralisation capacity (ANC) will become depleted and continued weathering of sulphides in the tailings will generate acidity and release elevated concentrations of contaminant metals.

If no further rehabilitation is carried out, it is predicted that scats material will continue to produce seepage with pH < 4 and highly elevated concentrations of SO_4 and metals such as Cd, Cu and Zn. It is also predicted that seepage associated with waste rock and heap leach will continue to have low pH and elevated concentrations of SO_4 and metals. All of these material types are predicted to have the capacity to maintain the currently observed seepage qualities on a long term basis, likely to be measureable in many 10's of years.

Chemistry of water collected in dams and sumps below the facilities is indicative of seepage through the stored materials, not runoff from the covers. Geochemical assessment indicates the chemistry is unlikely to improve and may degenerate in the long term. Therefore to minimise potential down-gradient influences, it is important to minimise infiltration rates, and hence seepage volumes. The current program to repair and rehabilitate the covers on the facilities and to identify and remediate any preferential infiltration zones should therefore be continued.

We trust that the discussions provided above, and the attached figures and appendices provide you with a clear geo-environmental assessment of the Mt Leyshon site, based on the available data. Please contact us if you would like any further details.

Yours sincerely

Simon Barrett
Operations Manager
Water Management Consultants Pty Ltd

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Figure

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A Schlumberger Company

Figure 1 Mt Leyshon facility areas and surface water monitoring locations

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Appendix A
Collated geochemical testwork data

Sample ID	EC (mS/cm)	paste pH	Total S (wt. %)	Sulphide S (wt%)	ANC (kg H2SO4/T)	AP (kg H2SO4/T)	NAPP	NAG pH	NAG (pH 4.5)	NAG (pH 7)	Rock type	Comment	Reference
67	300	7.6	0.71		30	22	-8	7.7	0	0	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
80	440	8.2	0.79		60	24	-36	8.6	0	0	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
108	490	7.9	0.96		18	29	11	2.4	4	8	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
119	530	8	1.79		48	55	7	7.6	0	0	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
126	410	8	2.11		41	64	23	2.3	6	10	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
133	450	8.1	1.26		48	38	-10	7.7	0	0	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
140	400	8.1	1.2		54	37	-17	8.5	0	0	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
178	540	7.7	1.87		43	57	14	3.2	1	5	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
182	520	8.1	1.79		45	55	10	7.1	0	0	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
185	630	7.4	9.09		26	278	252	1.6	28	34	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
196	510	7.9	2.89		38	88	50	2.5	3	7	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
198	510	7.7	2.2		31	67	36	5.1	0	3	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
215	430	8.2	0.7		57	21	-36	8.4	0	0	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
236	650	7.6	1.22		28	37	9	7.8	0	0	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
246	480	8.8	1.37		42	42	0	8.4	0	0	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
259	710	8	1.24		34	38.0	4.0	8.5	0	0	Porphyry Cover	AP calculated as ANC + NAPP	EGI, 1995
560			0.46		48	14.1	-33.9	11			Porphyry Cover	AP calculated as Total S * 30.625, NAPP calculated as AP - ANC	EGI, 1995
561			0.63		65	19.3	-45.7	10.9			Porphyry Cover	AP calculated as Total S * 30.625, NAPP calculated as AP - ANC	EGI, 1995
563			0.53		50	16.2	-33.8	11			Porphyry Cover	AP calculated as Total S * 30.625, NAPP calculated as AP - ANC	EGI, 1995
565			0.73		55	22.4	-32.6	11			Porphyry Cover	AP calculated as Total S * 30.625, NAPP calculated as AP - ANC	EGI, 1995
566			0.73		50	22.4	-27.6	11			Porphyry Cover	AP calculated as Total S * 30.625, NAPP calculated as AP - ANC	EGI, 1995
567			0.63		46	19.3	-26.7	11			Porphyry Cover	AP calculated as Total S * 30.625, NAPP calculated as AP - ANC	EGI, 1995
568			0.49		53	15.0	-38.0	11.1			Porphyry Cover	AP calculated as Total S * 30.625, NAPP calculated as AP - ANC	EGI, 1995
569			0.43		59	13.2	-45.8	11.1			Porphyry Cover	AP calculated as Total S * 30.625, NAPP calculated as AP - ANC	EGI, 1995
570			0.35		63	10.7	-52.3	11.2			Porphyry Cover	AP calculated as Total S * 30.625, NAPP calculated as AP - ANC	EGI, 1995
571			0.79		52	24.2	-27.8	11			Porphyry Cover	AP calculated as Total S * 30.625, NAPP calculated as AP - ANC	EGI, 1995
x			0.8			24.5		10			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.4			12.3		10.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.74			22.7		10.7			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.48			14.7		10.7			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.51			15.6		10.7			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.28			39.2		5.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			2.24			68.6		8.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.48			45.3		8.9			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			2.48			76.0		3.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.04			31.9		6.9			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			2.44			74.7		7.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.46			44.7		9.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.47			14.4		10.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.29			8.9		10.5			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.55			16.8		10.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.31			9.5		10.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.32			9.8		10.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.78			23.9		10.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.81			24.8		10.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.22			6.7		10.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.59			18.1		10.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.96			29.4		9.7			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.26			38.6		5.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			2.47			75.6		3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			3.16			96.8		2.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			4.05			124.0		9.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			2.94			90.0		9.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			3.39			103.8		2.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.94			28.8		5.9			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			3.5			107.2		2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			3.41			104.4		2.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			2.31			70.7		8.7			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			4.64			142.1		1.7			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			5.43			166.3		1.7			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.35			41.3		8.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.39			42.6		7.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			3.06			93.7		3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			3.2			98.0		2.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			2.33			71.4		2.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			3.53			108.1		2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			3.79			116.1		2.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995

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Sample ID	EC (mS/cm)	paste pH	Total S (wt. %)	Sulphide S (wt%)	ANC (kg H2SO4/T)	AP (kg H2SO4/T)	NAPP	NAG pH	NAG (pH 4.5)	NAG (pH 7)	Rock type	Comment	Reference
x			3.63			111.2		7.9			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			2.77			84.8		1.9			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			3.93			120.4		2.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			4.58			140.3		5.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			2.43			74.4		1.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.24			38.0		8.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.39			42.6		9.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.7			21.4		10.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.45			13.8		9.5			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.63			19.3		9.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.87			26.6		9.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.34			10.4		10.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.46			14.1		9.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.48			14.7		9.7			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.2			6.1		10.7			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.66			20.2		9.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.22			6.7		10.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.21			6.4		10.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.22			6.7		10.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.28			8.6		10			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.47			14.4		10.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.29			8.9		9.7			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.22			6.7		10.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.46			14.1		10.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.52			15.9		10.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.32			9.8		9.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.39			11.9		9.7			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.43			13.2		9.7			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.39			11.9		9.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.53			16.2		9.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.21			6.4		10.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.49			15.0		9.9			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.38			11.6		9.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.31			9.5		9.9			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.77			23.6		9.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.51			15.6		9.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.34			10.4		9.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.32			9.8		10			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.39			11.9		10.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.6			18.4		9.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.77			23.6		9.9			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.31			9.5		10.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.68			20.8		10.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.44			13.5		10.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.53			16.2		10.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.51			15.6		10.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1			30.6		9.9			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.81			24.8		10.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.34			10.4		10.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.26			8.0		10.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.59			18.1		10			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.88			27.0		10.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.62			19.0		10.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.62			19.0		9.9			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.57			17.5		10.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.56			17.2		10.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.47			14.4		10.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.34			10.4		10.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.32			9.8		10.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.46			14.1		10.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.54			16.5		10.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.33			10.1		10.5			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.35			10.7		10.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.51			15.6		10.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.64			19.6		10.5			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.55			16.8		10.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.49			15.0		10.5			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995

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Sample ID	EC (mS/cm)	paste pH	Total S (wt. %)	Sulphide S (wt%)	ANC (kg H2SO4/T)	AP (kg H2SO4/T)	NAPP	NAG pH	NAG (pH 4.5)	NAG (pH 7)	Rock type	Comment	Reference
x			0.41			12.6		10.5			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.79			24.2		10.5			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.67			20.5		10.5			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.73			22.4		10.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			2.88			88.2		9.5			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.09			33.4		10.5			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.2			36.8		10.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.97			29.7		8.5			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.1			33.7		9.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.06			32.5		10.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.86			26.3		11			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.1			33.7		10.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.04			31.9		8.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.5			45.9		7.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.04			31.9		9			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.01			30.9		9.2			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.88			27.0		9.5			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.84			25.7		9.5			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.96			29.4		9.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.83			25.4		9.4			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.02			31.2		9.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.88			27.0		9.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.8			24.5		9.7			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.93			28.5		10.1			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.9			27.6		9.8			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			1.56			47.8		9.3			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.44			13.5		9.6			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
x			0.42			12.8625		10			Porphyry Cover	AP calculated as Total S * 30.625	EGI, 1995
TDRC 01								3.35			ONTSF Waste Rock Platform		EGI, 1999
TDRC 02								7.48			ONTSF Waste Rock Platform		EGI, 1999
TDRC 03								2.24			ONTSF Waste Rock Platform		EGI, 1999
TDRC 04								6.2			ONTSF Waste Rock Platform		EGI, 1999
TDRC 05								3.65			ONTSF Waste Rock Platform		EGI, 1999
TDRC 06								5.86			ONTSF Waste Rock Platform		EGI, 1999
TDRC 07								2.38			ONTSF Waste Rock Platform		EGI, 1999
TDRC 08								3.04			ONTSF Waste Rock Platform		EGI, 1999
TDRC 09								7.89			ONTSF Waste Rock Platform		EGI, 1999
TDRC 10								2.18			ONTSF Waste Rock Platform		EGI, 1999
TDRC 11								2.37			ONTSF Waste Rock Platform		EGI, 1999
TDRC 12								2.11			ONTSF Waste Rock Platform		EGI, 1999
TDRC 13								1.9			ONTSF Waste Rock Platform		EGI, 1999
TDRC 15								3.5			ONTSF Waste Rock Platform		EGI, 1999
TDRC 16								2.22			ONTSF Waste Rock Platform		EGI, 1999
TDRC 17								8.99			ONTSF Waste Rock Platform		EGI, 1999
TDRC 18								8.28			ONTSF Waste Rock Platform		EGI, 1999
TDRC 19								2.71			ONTSF Waste Rock Platform		EGI, 1999
TDRC 20								2.68			ONTSF Waste Rock Platform		EGI, 1999
TDRC 21								1.88			ONTSF Waste Rock Platform		EGI, 1999
TDRC 22								2.35			ONTSF Waste Rock Platform		EGI, 1999
TDRC 23								3.04			ONTSF Waste Rock Platform		EGI, 1999
TDRC 24								5.92			ONTSF Waste Rock Platform		EGI, 1999
TDRC 25								7.8			ONTSF Waste Rock Platform		EGI, 1999
TDRC 26								4.21			ONTSF Waste Rock Platform		EGI, 1999
TDRC 27								7.99			ONTSF Waste Rock Platform		EGI, 1999
TDRC 28								6.21			ONTSF Waste Rock Platform		EGI, 1999
TDRC 29								2.4			ONTSF Waste Rock Platform		EGI, 1999
TDRC 30								2.13			ONTSF Waste Rock Platform		EGI, 1999
TDRC 31								2.1			ONTSF Waste Rock Platform		EGI, 1999
TDRC 32								2.26			ONTSF Waste Rock Platform		EGI, 1999
TDRC 33								2.52			ONTSF Waste Rock Platform		EGI, 1999
TDRC 34								2.59			ONTSF Waste Rock Platform		EGI, 1999
TDRC 35								2.98			ONTSF Waste Rock Platform		EGI, 1999
TDRC 37								3.95			ONTSF Waste Rock Platform		EGI, 1999
TDRC 38								4.92			ONTSF Waste Rock Platform		EGI, 1999
TDRC 39								5.71			ONTSF Waste Rock Platform		EGI, 1999
TDRC 40								2.45			ONTSF Waste Rock Platform		EGI, 1999
TDRC 41								2.88			ONTSF Waste Rock Platform		EGI, 1999

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Sample ID	EC (mS/cm)	paste pH	Total S (wt. %)	Sulphide S (wt%)	ANC (kg H2SO4/T)	AP (kg H2SO4/T)	NAPP	NAG pH	NAG (pH 4.5)	NAG (pH 7)	Rock type	Comment	Reference
TDRC 42								2.71			ONTSF Waste Rock Platform		EGI, 1999
TDRC 43								2.49			ONTSF Waste Rock Platform		EGI, 1999
TDRC 44								6.33			ONTSF Waste Rock Platform		EGI, 1999
TDRC 45								2.32			ONTSF Waste Rock Platform		EGI, 1999
TDRC 46								2.8			ONTSF Waste Rock Platform		EGI, 1999
TDRC 47								5.2			ONTSF Waste Rock Platform		EGI, 1999
TDRC 48								7.45			ONTSF Waste Rock Platform		EGI, 1999
TDRC 49								8			ONTSF Waste Rock Platform		EGI, 1999
TDRC 50								2.95			ONTSF Waste Rock Platform		EGI, 1999
TDRC 51								2.54			ONTSF Waste Rock Platform		EGI, 1999
NNTDNA-1			1.25		9.8	38.3	28.5	3.6	2.7	6.9	NNTSF Waste Rock Platform	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
NNTDNA-2			0.81		13.4	24.8	11.4	3.7	1.6	5.8	NNTSF Waste Rock Platform	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
NNTDNA-3			0.38		24.7	11.6	-13.1	8.5	0	0	NNTSF Waste Rock Platform	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
NNTDNA-4			0.61		40.3	18.7	-21.6	9.2	0	0	NNTSF Waste Rock Platform	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
NNTDNA-5			0.23		32.0	7.0	-25	8.8	0	0	NNTSF Waste Rock Platform	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
NNTDNA-6			1.19		12.4	36.4	24	3.8	1	3.7	NNTSF Waste Rock Platform	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
NNTDNA-7			0.57		16.6	17.5	0.9	6.9	0	0.2	NNTSF Waste Rock Platform	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
NNTDNA-8			1.21		13.0	37.1	24.1	3.7	1.2	4.1	NNTSF Waste Rock Platform	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
NNTDNA-9			1.23		12.0	37.7	25.7	4.4	0.2	2.3	NNTSF Waste Rock Platform	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
NNTDNA-10			0.85		14.4	26.0	11.6	4.6	0	1.6	NNTSF Waste Rock Platform	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
NNTDNA-11			0.93		14.0	28.5	14.5	3.8	0.7	2.5	NNTSF Waste Rock Platform	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
NNTDNA-12			1.46		13.4125	44.7125	31.3	3.3	2.1	4.6	NNTSF Waste Rock Platform	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
1A			1.03		54.9	31.5	-23.4				Porphyry Cover on Waste		SRK, 2000
1B			0.95		50.5	29	-21.5				Porphyry Cover on Waste		SRK, 2000
2A			0.48		52.3	14.5	-37.8				Porphyry Cover on Waste		SRK, 2000
2B			0.78		67.8	22.5	-45.3				Porphyry Cover on Waste		SRK, 2000
QC1A			0.27		54.2	8.5	-45.7				Porphyry Cover on Waste		SRK, 2000
QC1B			2		39.1	61	21.9				Porphyry Cover on Waste		SRK, 2000
3A			0.83		32.4	25.5	-6.9				Porphyry Cover on Waste		SRK, 2000
3B			0.71		31.8	31.5	-10.3				Porphyry Cover on Waste		SRK, 2000
QC2A			0.88		43.4	27	-16.4				Porphyry Cover on Waste		SRK, 2000
QC2B			0.68		51.5	21	-30.5				Porphyry Cover on Waste		SRK, 2000
4A			0.69		53.9	21	-32.9				Porphyry Cover on Waste		SRK, 2000
4B			0.6		55.1	18.5	-36.6				Porphyry Cover on Waste		SRK, 2000
5A			0.44		57.3	13.5	-43.8				Porphyry Cover on Waste		SRK, 2000
5B			0.4		72.4	12	-60.5				Porphyry Cover on Waste		SRK, 2000
6A			0.8		55.4	24.5	-30.9				Porphyry Cover on Waste		SRK, 2000
6B			0.82		55.1	25	-30.1				Porphyry Cover on Waste		SRK, 2000
7A			0.47		16	14.5	-1.5				Porphyry Cover on Waste		SRK, 2000
7B			0.9		41.8	30	-11.8				Porphyry Cover on Waste		SRK, 2000
8A			0.51		59.3	15.5	-43.8				Porphyry Cover on Waste		SRK, 2000
8B			1.56		45.8	47.5	1.7				Porphyry Cover on Waste		SRK, 2000
9A			0.74		34.5	22.5	-12				Porphyry Cover on Waste		SRK, 2000
9B			0.76		41.3	23.5	-17.8				Porphyry Cover on Waste		SRK, 2000
1C			2.63		44.8	80.5	35.7				Waste Rock		SRK, 2000
QC1C			2.21		37.6	67.5	29.9				Waste Rock		SRK, 2000
3C			3.67		39.9	112	72.1				Waste Rock		SRK, 2000
QC2C			2.84		39.6	87	47.4				Waste Rock		SRK, 2000
5C			0.55		0.05	17	17				Waste Rock		SRK, 2000
7C			2.71		31.5	83.0	51.5				Waste Rock		SRK, 2000
HL1	2652	6.9	1	0.7	5	30.6	25.6	4.5		2	Heap Leach	depth 0-10 cm, AP calculated as Total S * 30.625	CMLR, 2006
HL2	1922	5.8	0.46	0.32	4.3	14.1	9.8	4.8		1.8	Heap Leach	depth 50 cm, AP calculated as Total S * 30.625	CMLR, 2006
HL3	2259	6.4	1	0.68	4	30.6	26.6	3.2		7.7	Heap Leach	depth 30 cm, AP calculated as Total S * 30.625	CMLR, 2006
HL4	1256	5.2	0.88	0.69	1.9	27.0	25	4.7		2.1	Heap Leach	depth 200 cm (below liner), AP calculated as Total S * 30.625	CMLR, 2006
HL5	2418	7.7	1.3	0.92	5.7	39.8	34.1	4.8		1.4	Heap Leach	depth 30 cm (above liner), AP calculated as Total S * 30.625	CMLR, 2006
HL6	1365	5.7	0.55	0.33	3.6	16.8	13.2	5.9		0.7	Heap Leach	depth 60 cm (below liner), AP calculated as Total S * 30.625	CMLR, 2006
HL7	1791	7.8	1.15	0.96	6	35.2	29.2	7.3		0.05	Heap Leach	depth 20 cm (just above liner), AP calculated as Total S * 30.625	CMLR, 2006
HL8	660	7.2	0.02	<0.01	2.1	0.6	-1.5	6.8		0.4	Heap Leach	depth 20 cm (below liner), AP calculated as Total S * 30.625	CMLR, 2006
HL9	2343	8.1	1.28	0.96	7.1	39.2	32.1	7.4		0.05	Heap Leach	depth 10 cm, AP calculated as Total S * 30.625	CMLR, 2006
HL10	2740	7.7	1.59	1.27	8.7	48.7	39.6	6.6		2	Heap Leach	depth 10 cm, AP calculated as Total S * 30.625	CMLR, 2006
HL11	3007	7.5	1.62	1.35	4.4	49.6	45.2	6.1		1.7	Heap Leach	depth 0-100 cm, AP calculated as Total S * 30.625	CMLR, 2006
HL12	2085	7.2	1.51	1.31	3.9	46.2	42.3	7.9		0.05	Heap Leach	depth 200-300 cm, AP calculated as Total S * 30.625	CMLR, 2006
HL13	1807	8.9	1.04	0.81	10.3	31.9	21.5	6		3.2	Heap Leach	bottom of erosion gully, AP calculated as Total S * 30.625	CMLR, 2006
HL14	2552	7.8	1.46	1.09	5.1	44.7	39.6	4		2.4	Heap Leach	depth 25 cm, AP calculated as Total S * 30.625	CMLR, 2006
HL15	2489	7.8	2.08	1.5	4.8	63.7	58.8	2.8		14.9	Heap Leach	depth 50 cm, AP calculated as Total S * 30.625	CMLR, 2006
HL16	2480	8	1.11	0.76	7.7	34.0	26.3	8.4		0.05	Heap Leach	depth 25 cm, AP calculated as Total S * 30.625	CMLR, 2006
LEACHHPA			0.83		15.5	25.4	9.9	7.4	0	0	Heap Leach	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005

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Sample ID	EC (mS/cm)	paste pH	Total S (wt. %)	Sulphide S (wt%)	ANC (kg H2SO4/T)	AP (kg H2SO4/T)	NAPP	NAG pH	NAG (pH 4.5)	NAG (pH 7)	Rock type	Comment	Reference
LEACHHPB			1.2		14.0	36.8	22.8	7.4	0	0	Heap Leach	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
LEACHHPC			1.77		22.2	54.2	32	5.6	0	0.6	Heap Leach	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
LEACHHPD			1.52		16.6	46.6	30	3.6	1.5	5.2	Heap Leach	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
LEACHHPE			0.98		16.5	30.0	13.5	8.1	0	0	Heap Leach	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
LEACHHPF			1.57		16.6	48.1	31.5	3.3	3.3	7.2	Heap Leach	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
LEACHHPG			0.59		21.66875	18.06875	-3.6	7.5	0	0	Heap Leach	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
ONTD Perimeter	2730	8.4	4.9		25	150	125	2.4		27	Tailings	AP calculated as ANC + NAPP	EGI, 1999
ONTD Discharge	1080	9.1	4.9		24	150	126	2.3		32	Tailings	AP calculated as ANC + NAPP	EGI, 1999
STD Perimeter	5140	8.1	4.1		18	125	107	2.5		19	Tailings	AP calculated as ANC + NAPP	EGI, 1999
STD Centre	3280	8	2.2		16	67	51	2.5		20	Tailings	AP calculated as ANC + NAPP	EGI, 1999
ONTD 1A	2320	7.2	7.8		19	239	220	2.3		38	Tailings	AP calculated as ANC + NAPP	EGI, 1999
ONTD 1B	1380	8	5.4		25	165	140	2.4		24	Tailings	AP calculated as ANC + NAPP	EGI, 1999
ONTD 2A	1340	8.6	4		46	122	76	8.8		0	Tailings	AP calculated as ANC + NAPP	EGI, 1999
ONTD 2B	1320	8.5	4.4		38	135	97	8.5		0	Tailings	AP calculated as ANC + NAPP	EGI, 1999
ONTD 3A	1370	8.6	4.4		41	135	94	8.9		0	Tailings	AP calculated as ANC + NAPP	EGI, 1999
ONTD 3B	1250	8.6	4.9		52	150	98	8.7		0	Tailings	AP calculated as ANC + NAPP	EGI, 1999
ONTD 4A	1260	8.5	4.6		46	141	95	2.6		20	Tailings	AP calculated as ANC + NAPP	EGI, 1999
ONTD 4B	1040	8.6	4.7		48	144	96	8.6		0	Tailings	AP calculated as ANC + NAPP	EGI, 1999
ONTD 5A	1540	8.6	3.8		36	116	80	8.6		0	Tailings	AP calculated as ANC + NAPP	EGI, 1999
ONTD 5B	1080	8.5	4.8		47	145	98	2.5		27	Tailings	AP calculated as ANC + NAPP	EGI, 1999
ONTD Decant Pond	2410	8.8	1.8		51	54	3	8.6		0	Tailings	AP calculated as ANC + NAPP	EGI, 1999
T1 NAG								2.9			Tailings		EGI, 1999
T2 NAG								2.7			Tailings		EGI, 1999
T3 NAG								2.5			Tailings		EGI, 1999
T4 NAG								2			Tailings		EGI, 1999
T5 NAG								2.2			Tailings		EGI, 1999
T6 NAG								2.1			Tailings		EGI, 1999
T7 NAG								2.5			Tailings		EGI, 1999
T8 NAG								2			Tailings		EGI, 1999
T9 NAG								2			Tailings		EGI, 1999
T10 NAG								2.3			Tailings		EGI, 1999
1	730	7.77	3.85	3.83	11.1	117.9	106.8			66.2	Scats (Breccia)	NAPP based on sulphide S	Woodward-Clyde, 1993
2	900	8.08	2.85	2.82	52	87.3	35.3			0	Scats (Breccia)	NAPP based on sulphide S	Woodward-Clyde, 1993
3	810	7.76	2.96	2.94	10.7	90.7	79.9			54.3	Scats (Breccia)	NAPP based on sulphide S	Woodward-Clyde, 1993
6	620	8.15	3.28	3.26	16.3	100.5	84.1			48.8	Scats (Breccia)	NAPP based on sulphide S	Woodward-Clyde, 1993
4	750	7.99	2.93	2.91	20.9	89.7	68.8			35.1	Scats (Porphyry)	NAPP based on sulphide S	Woodward-Clyde, 1993
5	610	7.71	2.09	2.06	15.1	64	48.9			31.8	Scats (Porphyry)	NAPP based on sulphide S	Woodward-Clyde, 1993
1	698	7.8	1.9		19	58	39	2.4	20	29	Scats		URS, 2002
2	840	7.8	3		32	92	60	2.7	27	42	Scats		URS, 2002
3	1230	7.1	2		9	61	52	2.5	25	32	Scats		URS, 2002
4	1770	4.5	2.3		13	70	57	2.4	32	38	Scats		URS, 2002
5A	373	7.2	2.3		12	70	58	2.7	28	44	Scats		URS, 2002
5B	415	8.2	2.9		16	89	73	2.1	52	67	Scats		URS, 2002
6	424	7.7	2.5		12	77	65	2.2	38	50	Scats		URS, 2002
7	1220	5.8	2.1		4	64	60	2.6	26	40	Scats		URS, 2002
8	550	7.5	2.8		13	86	73	2.2	33	43	Scats		URS, 2002
9A	435	8.2	2.7		3	83	80	2.6	30	46	Scats		URS, 2002
9B	830	7.4	3		6	92	86	2.6	35	54	Scats		URS, 2002
11A	450	7.7	2.4		5	73	68	2.8	28	41	Scats		URS, 2002
11B	643	7	2.8		5	86	81	2.6	32	50	Scats		URS, 2002
12A	470	7.8	2.8		15	86	71	2.6	29	45	Scats		URS, 2002
12B	618	7.5	2.5		14	77	63	2.5	36	52	Scats		URS, 2002
13A	544	7.8	3		13	92	79	2.6	29	46	Scats		URS, 2002
13B	725	7.6	2.8		19	86	67	2.7	27	41	Scats		URS, 2002
1		9.2	3.0		9	91.2	82	2.5		59	Scats	paste pH 1:10 mix, Total S calculated as AP/30.625	Roseby, 2000
2		9.2	2.5		17.5	77.7	60	2.5		50.8	Scats	paste pH 1:10 mix, Total S calculated as AP/30.625	Roseby, 2000
3		9.1	2.9		11	88.7	77.5	2.5		64.3	Scats	paste pH 1:10 mix, Total S calculated as AP/30.625	Roseby, 2000
4		9.1	2.93877551		10.0	90.0	80	2.5		50.8	Scats	paste pH 1:10 mix, Total S calculated as AP/30.625	Roseby, 2000
PAFFP-1			0.66		10.3	20.2	9.9	4	0.4	11.9	Soil (PAF stockpile footprint)	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
PAFFP-2			1.24		10.9	38.0	27.1	3.9	0.4	6.4	Soil (PAF stockpile footprint)	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
PAFFP-3			0.83		12.4	25.4	13	4.4	0.1	5.2	Soil (PAF stockpile footprint)	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
PAFFP-4			0.79		13.9	24.2	10.3	4.2	0.2	4.9	Soil (PAF stockpile footprint)	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005
PAFFP-5			0.87		10.34375	26.64375	16.3	4.3	0.2	3.6	Soil (PAF stockpile footprint)	AP calculated as Total S * 30.625, ANC calculated as AP - NAPP	Otek, 2005

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Appendix B
Geochemical testwork data figures

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Figure B1 Paste pH values in Mt Leyshon materials

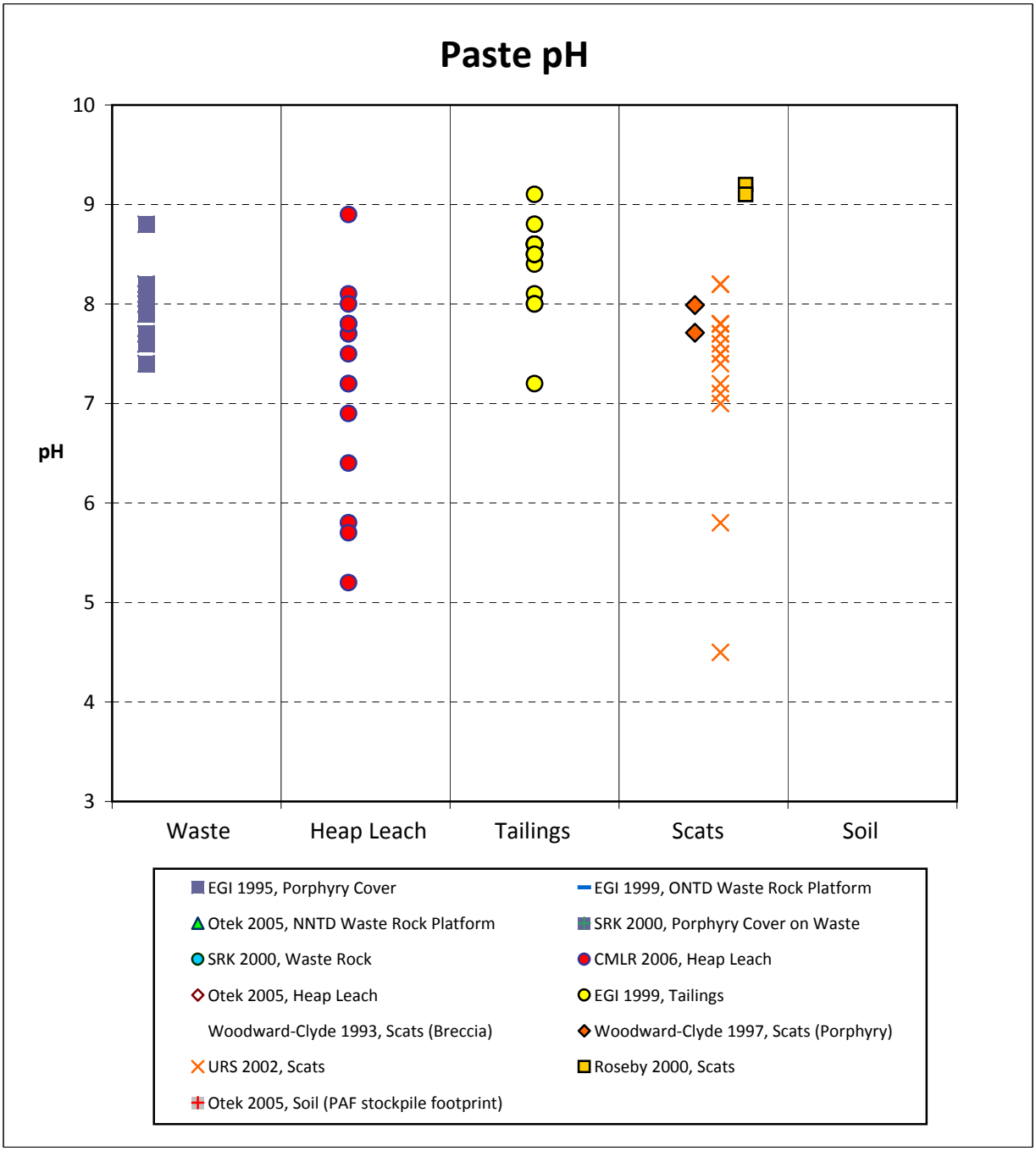

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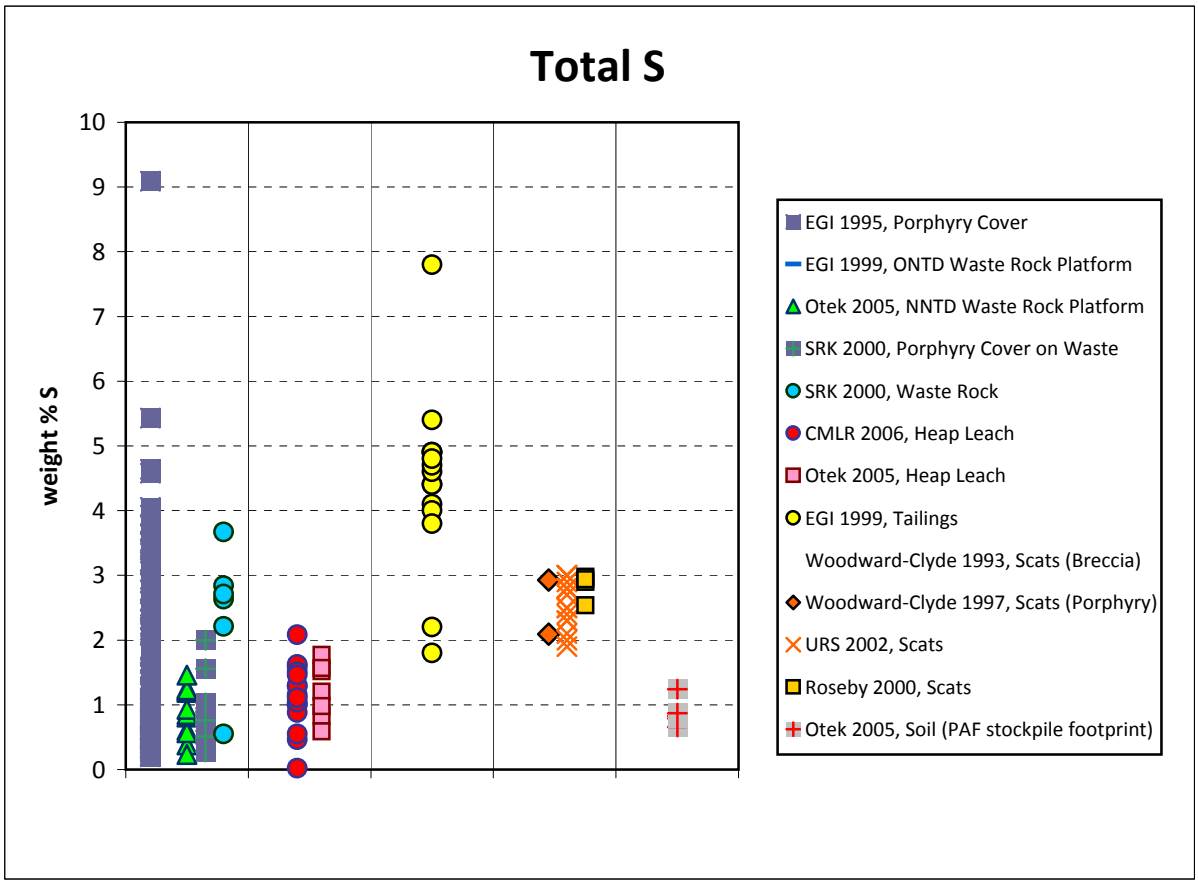
Figure B2 Total S concentrations and Acidification Potential (AP)



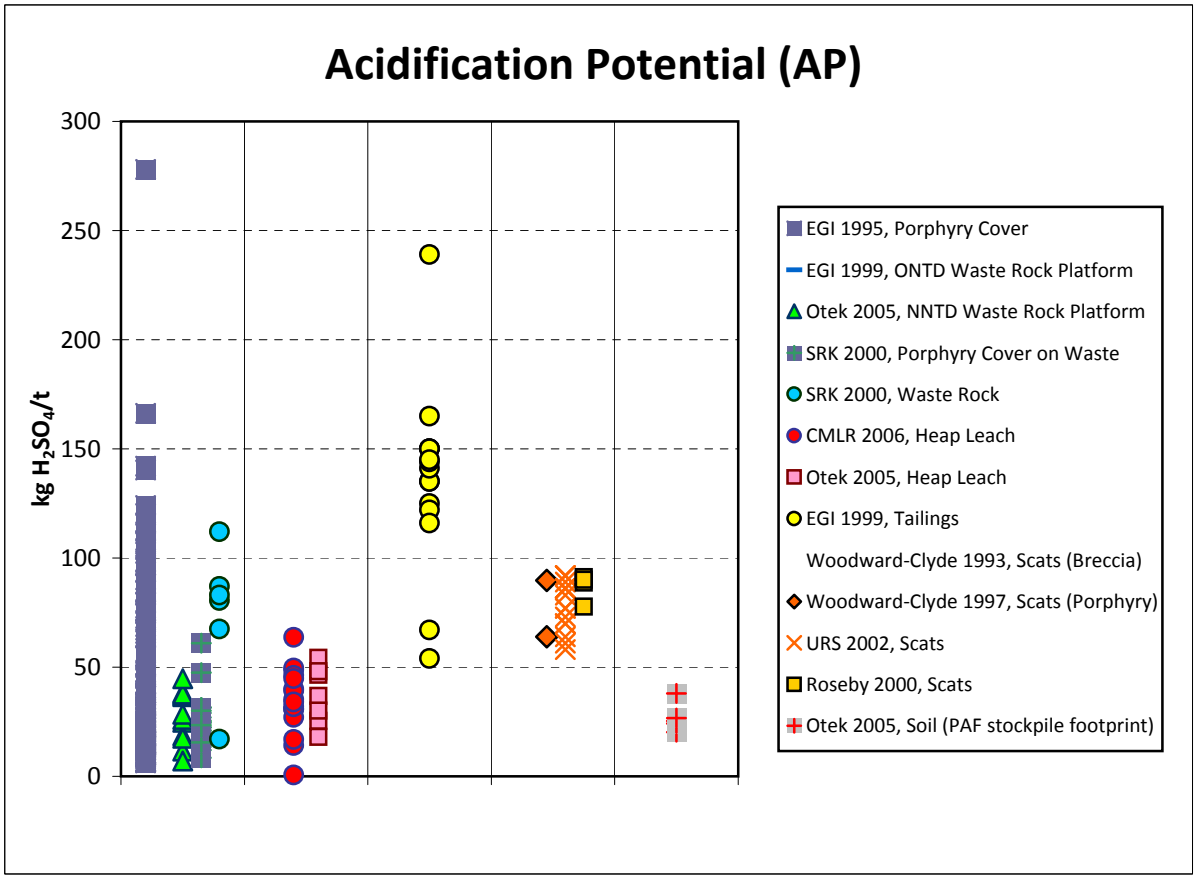


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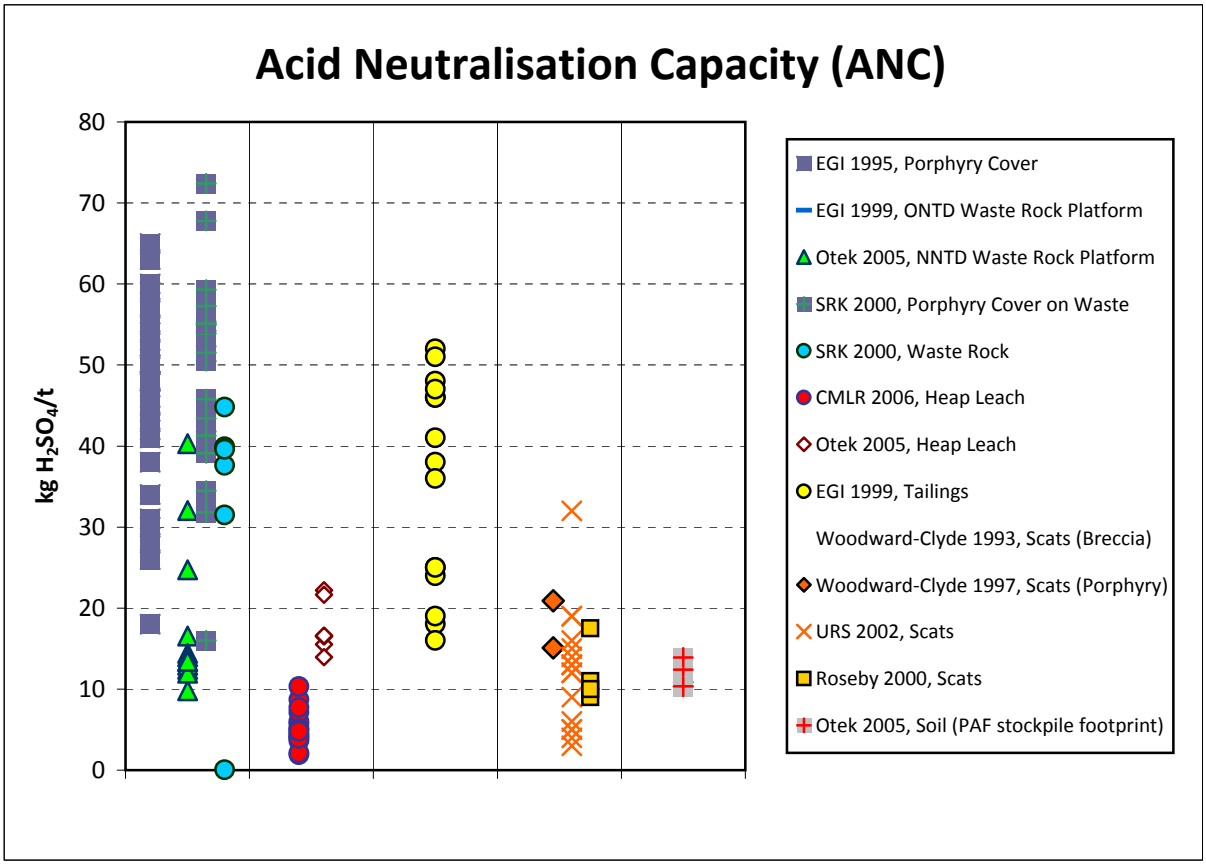
Figure B3 Acid Neutralisation Capacity (ANC) and Net Acid Production Potential (NAPP)



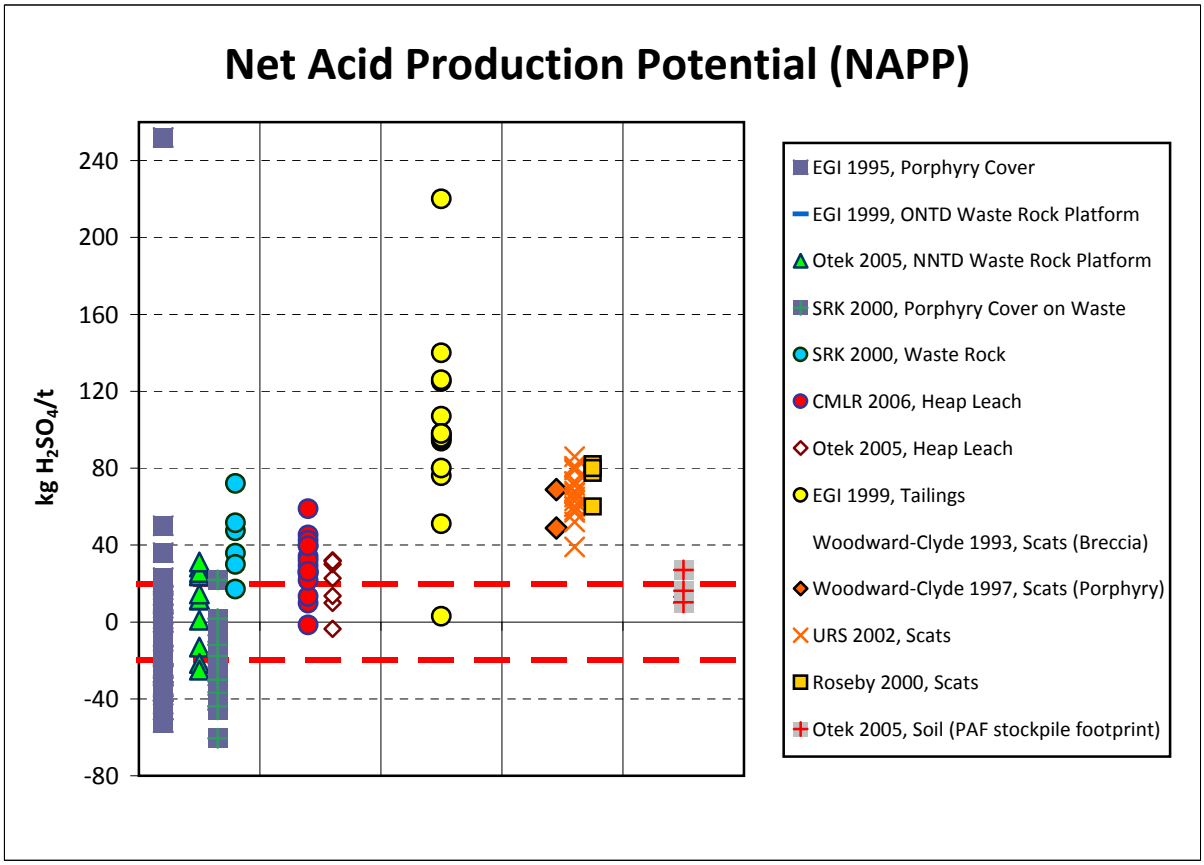


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Figure B4 Acid Neutralisation Capacity (ANC) and Acidification Potential (AP)

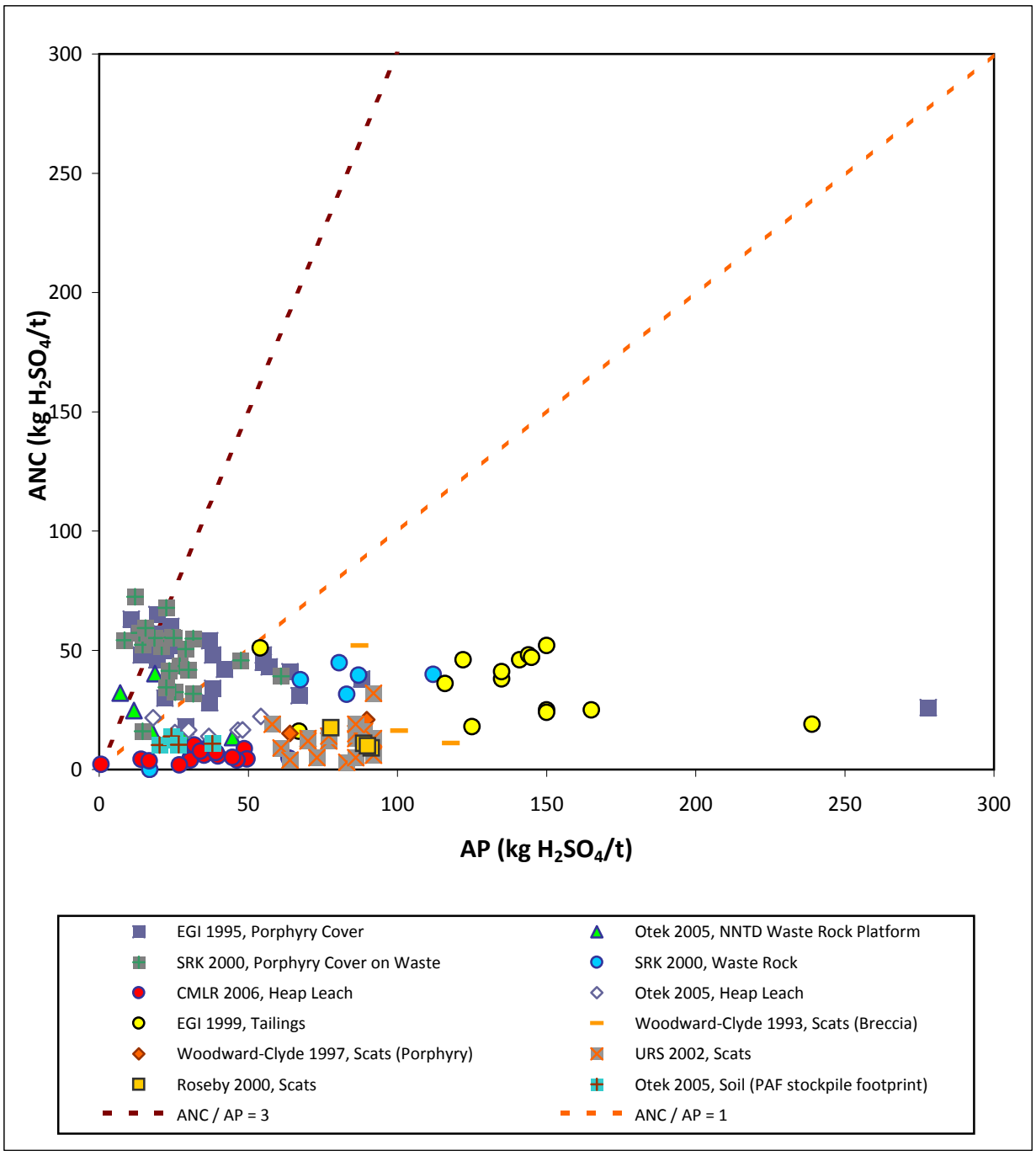

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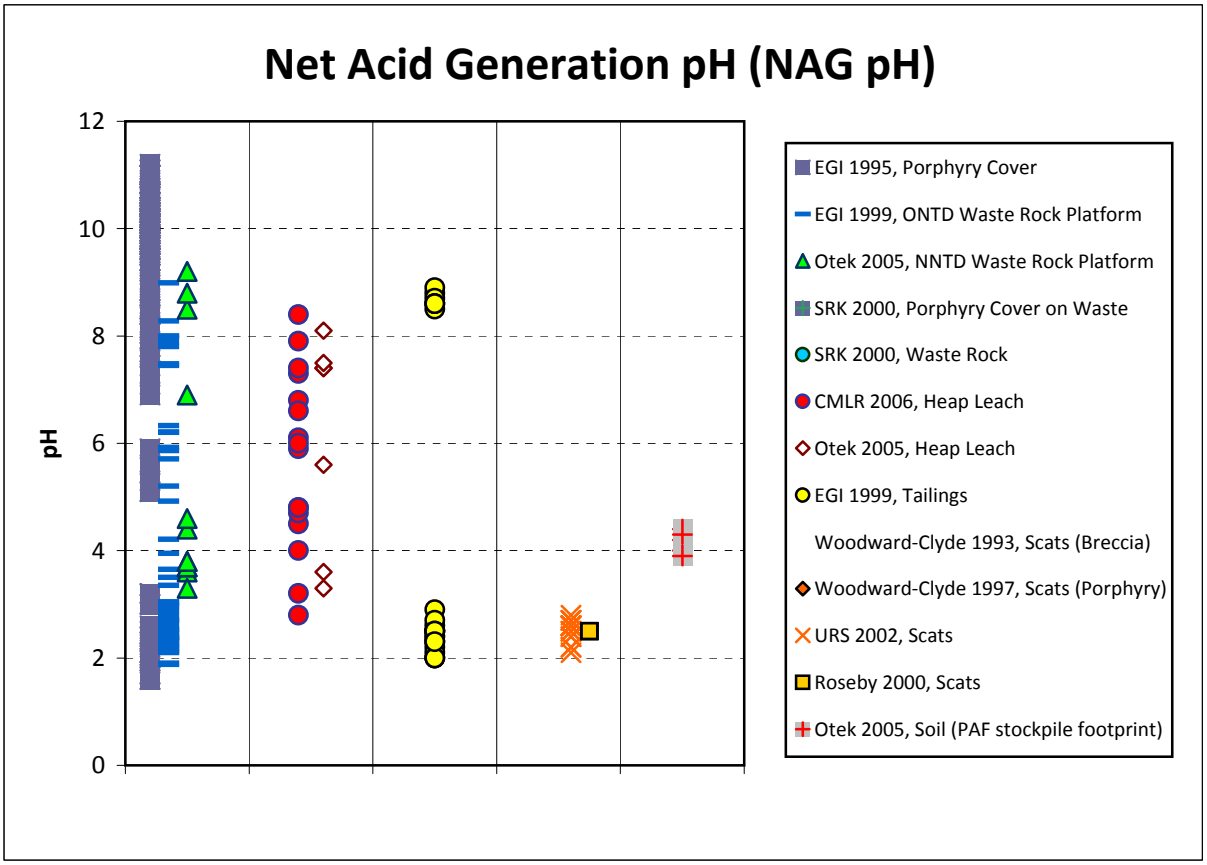
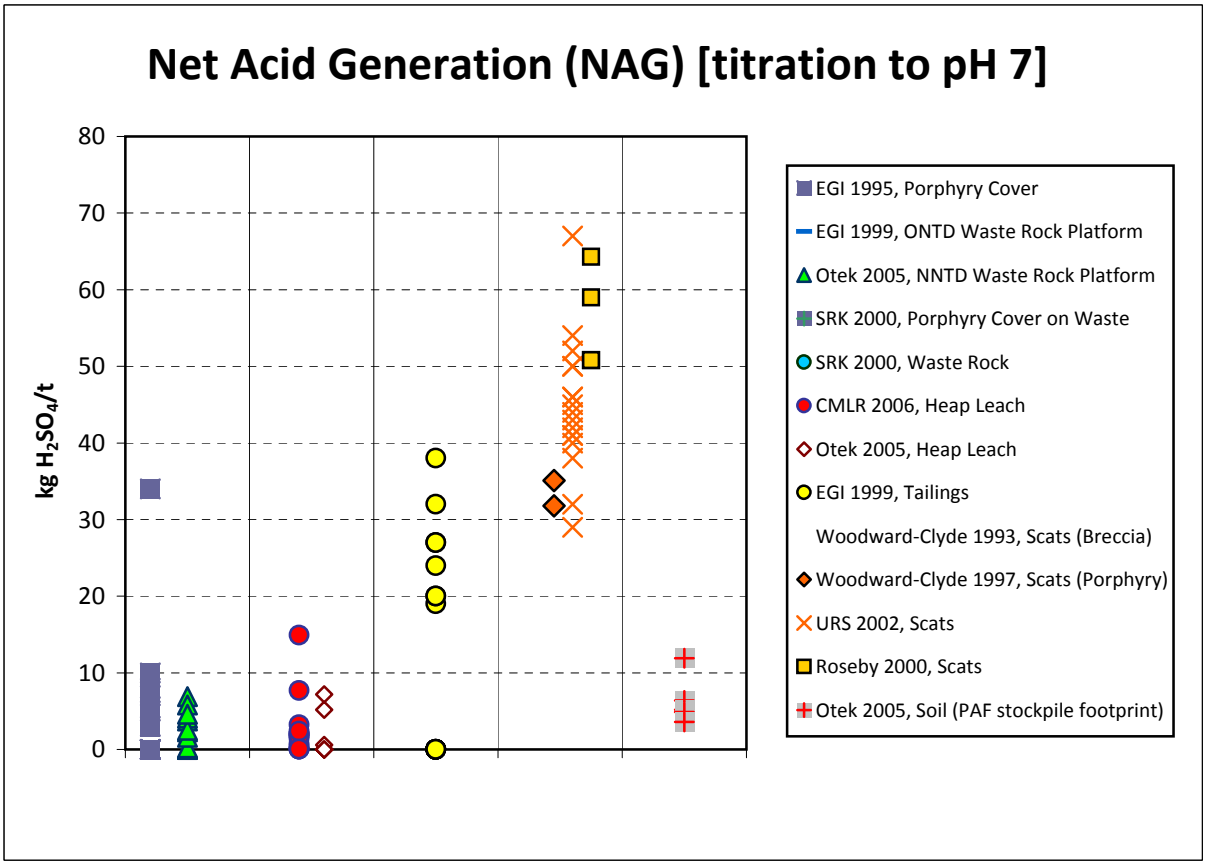
Figure B5 Net Acid Generation (NAG) Testwork Results





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Appendix C
Seepage chemistry figures

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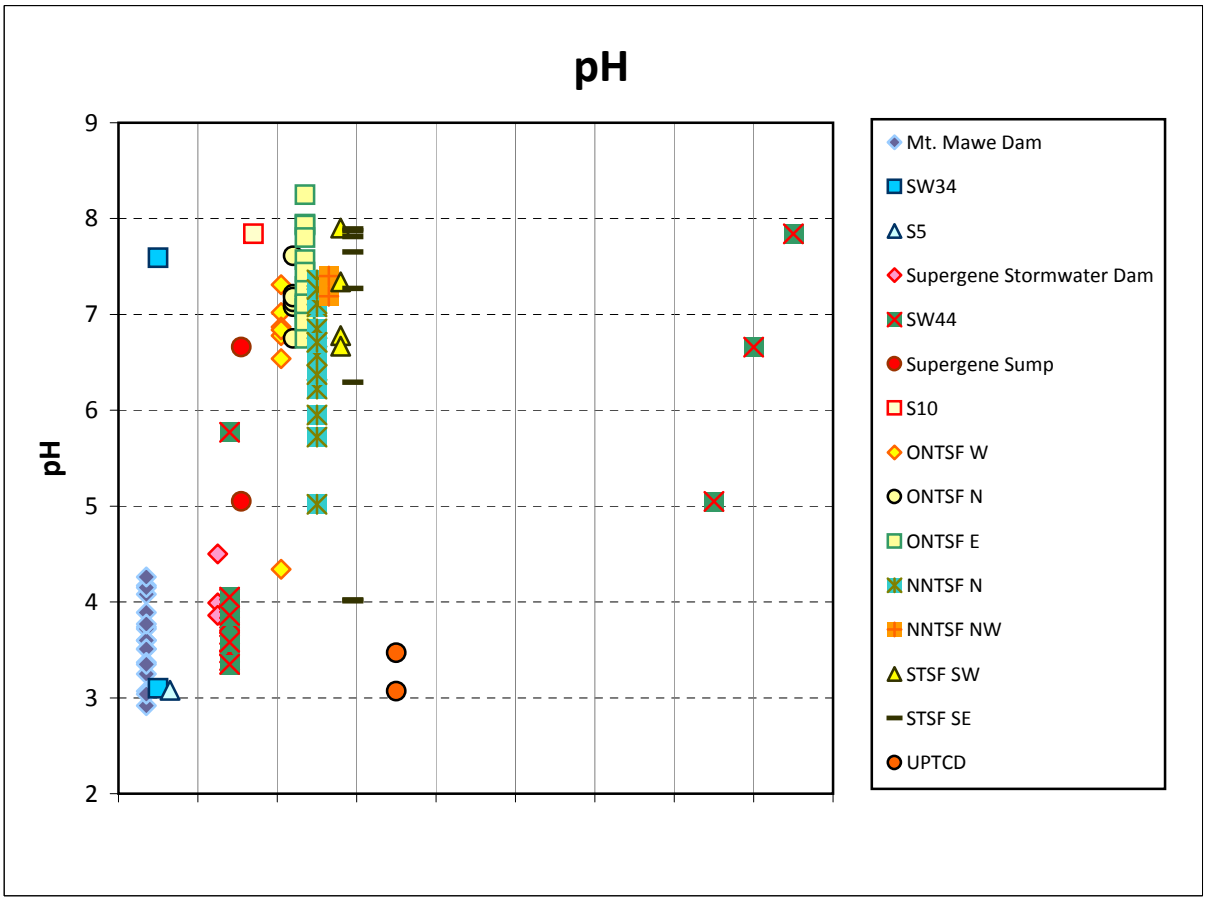
Figure C1 pH values and SO_4 concentrations in seepages and surface water associated with main Mt Leyshon material types



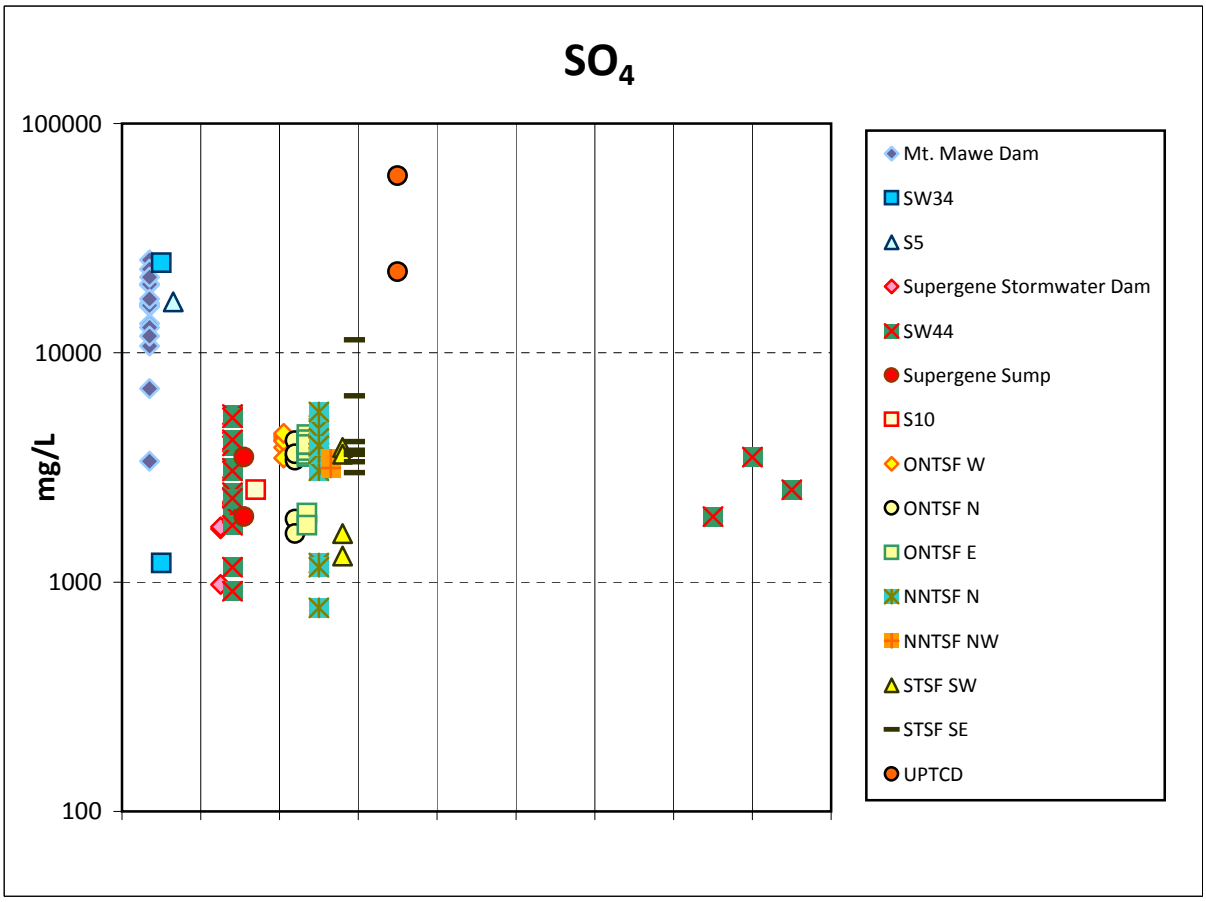


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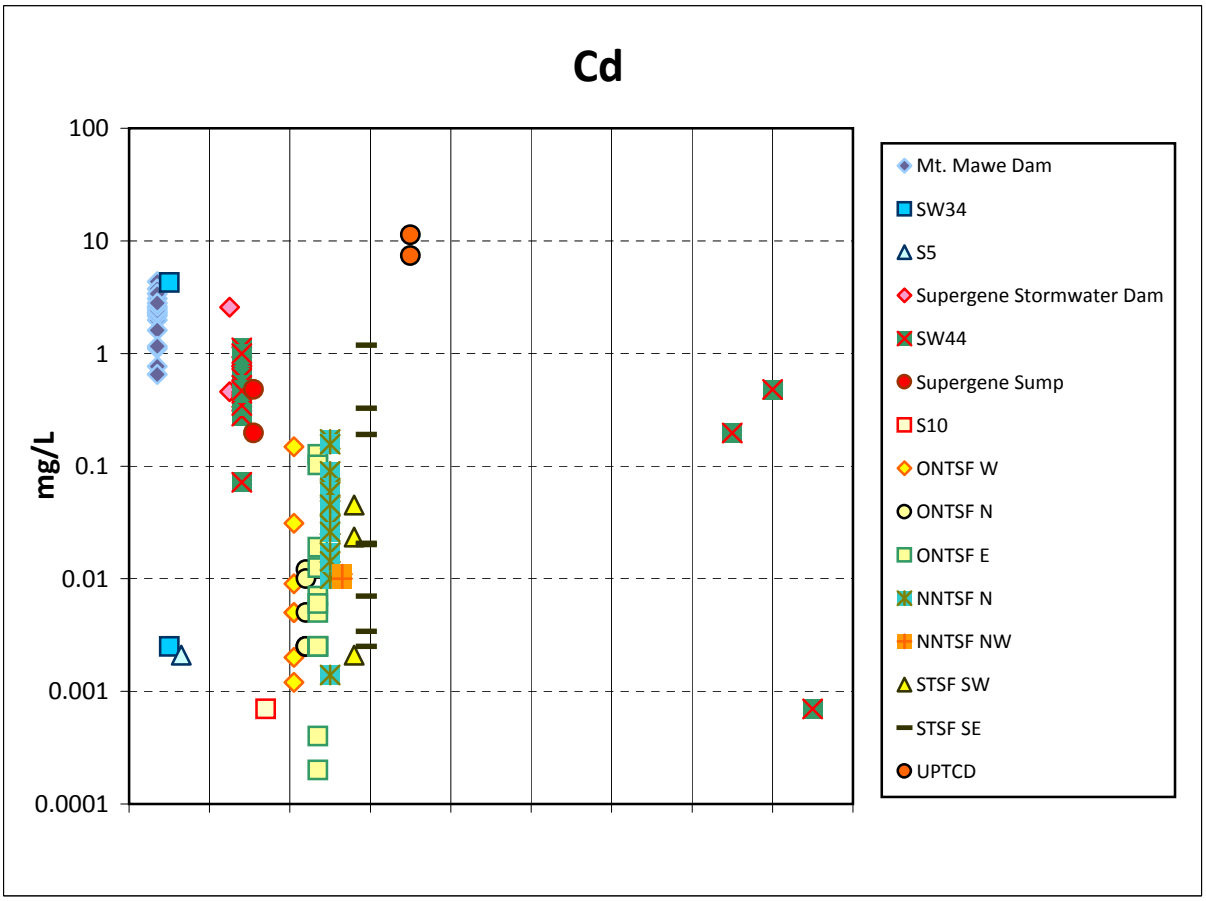
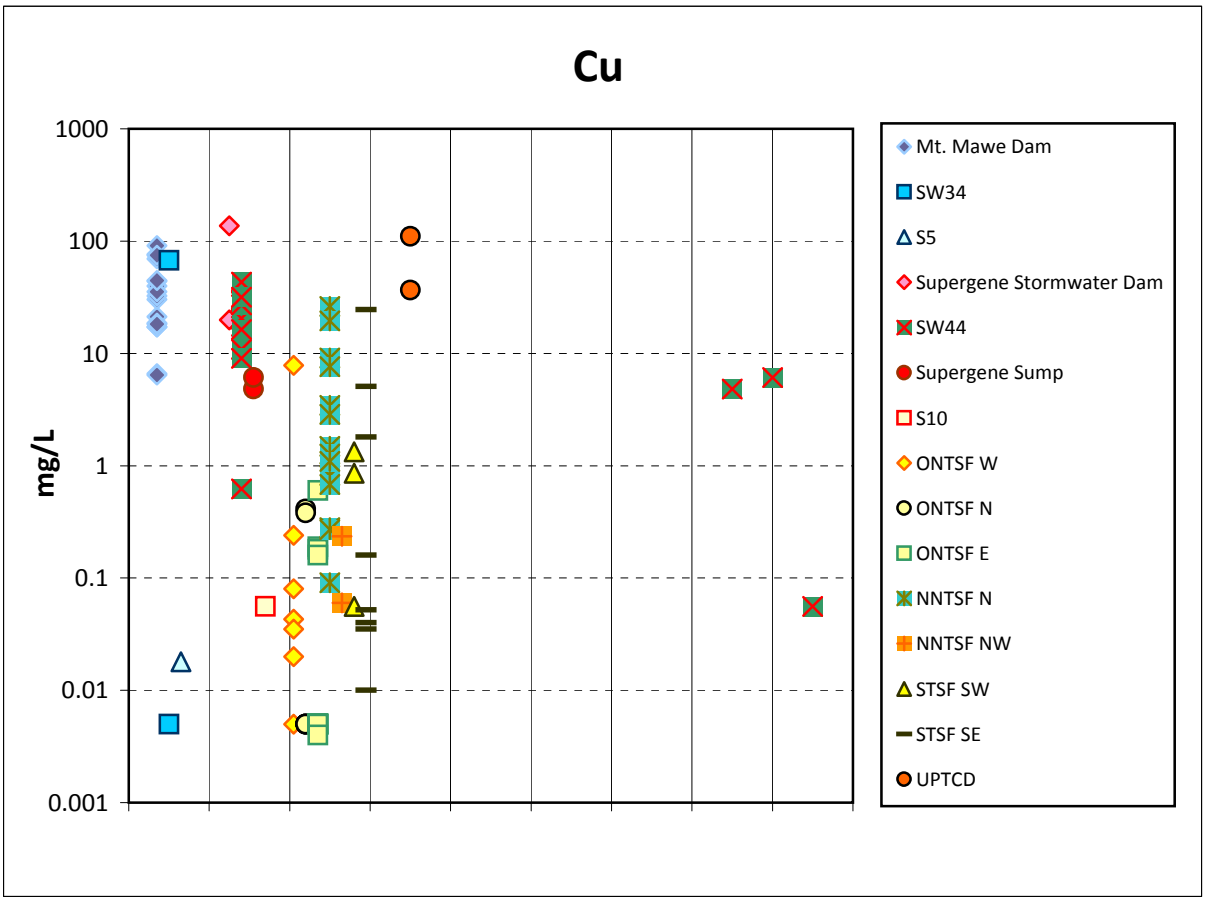
Figure C2 Cd and Cu concentrations in seepages and surface water associated with main Mt Leyshon material types





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WATER MANAGEMENT CONSULTANTS
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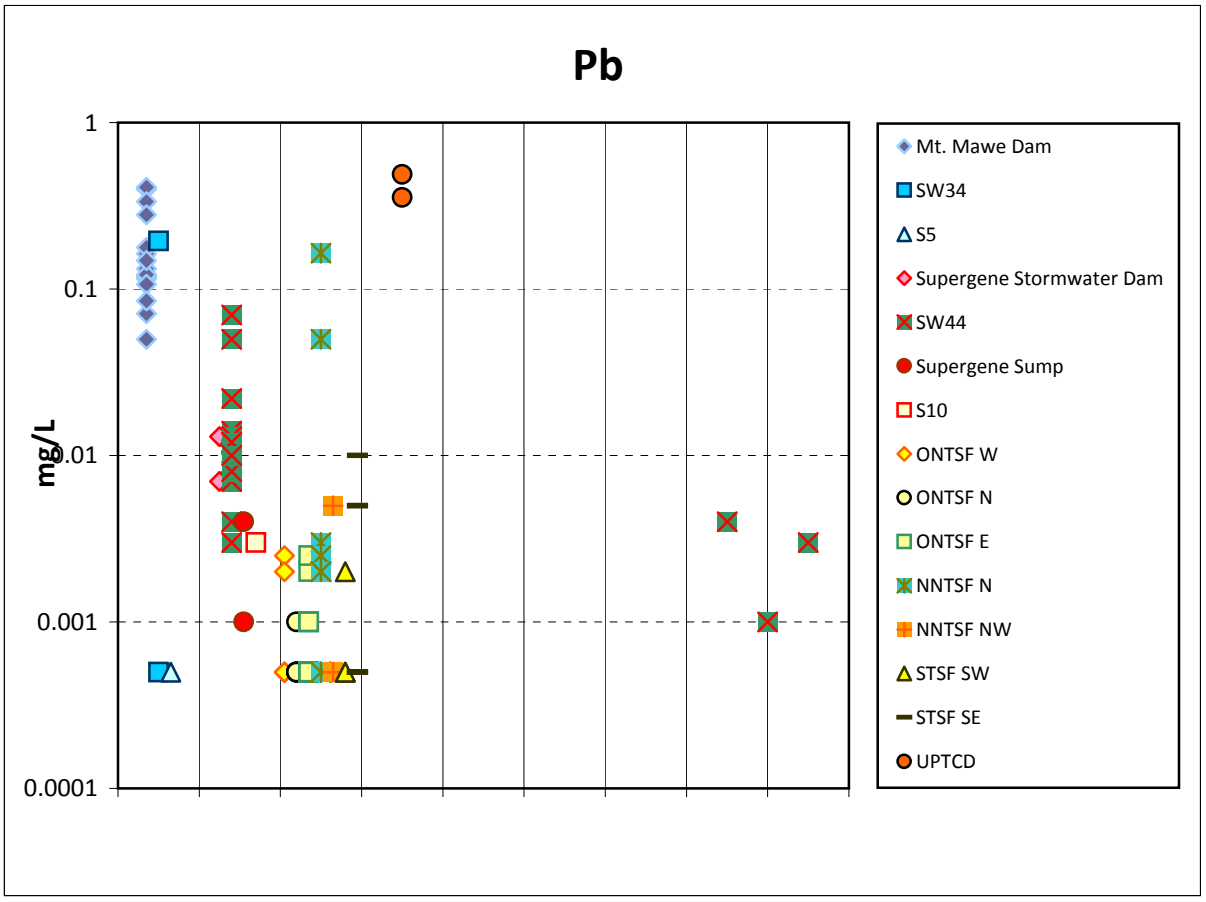
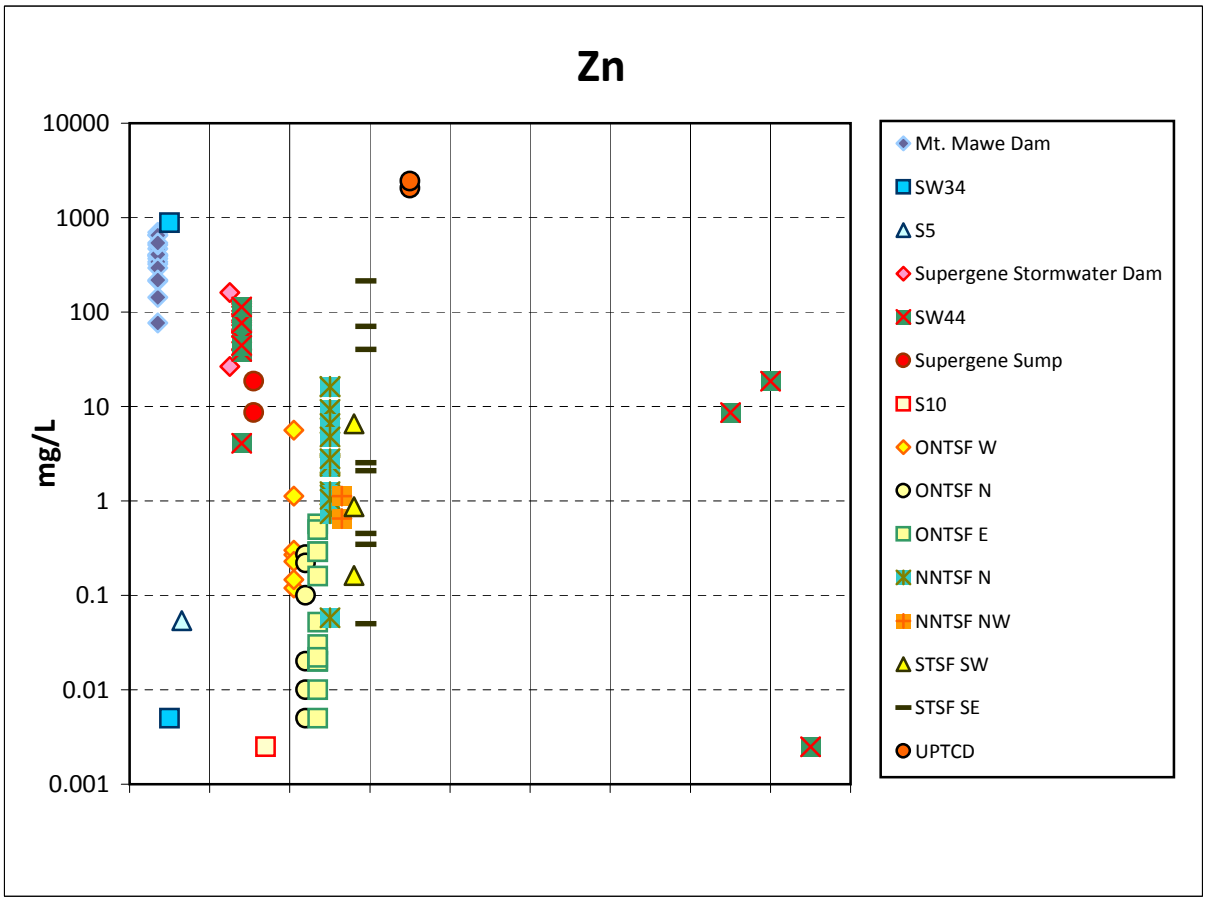
Figure C3 Pb and Zn concentrations in seepages and surface water associated with main Mt Leyshon material types





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WATER MANAGEMENT CONSULTANTS
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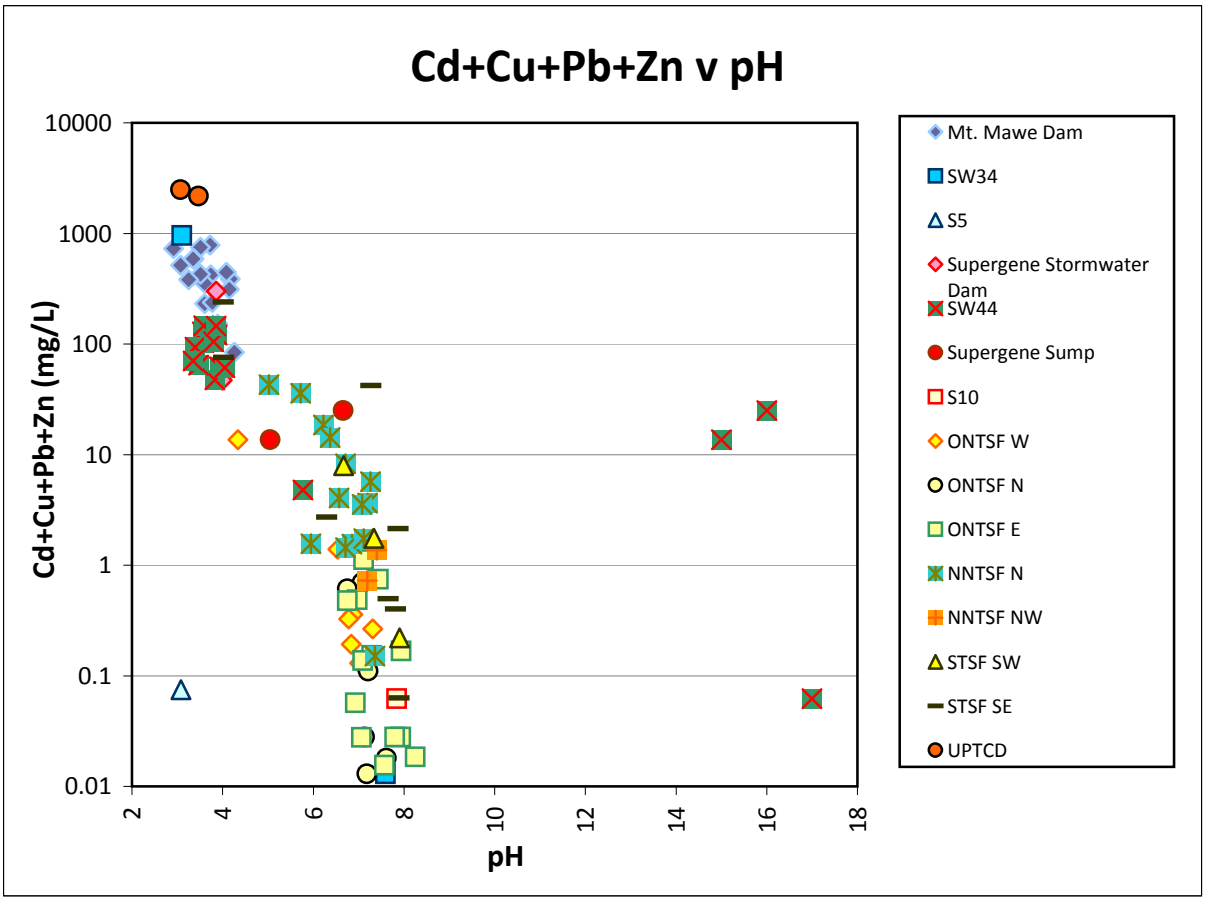
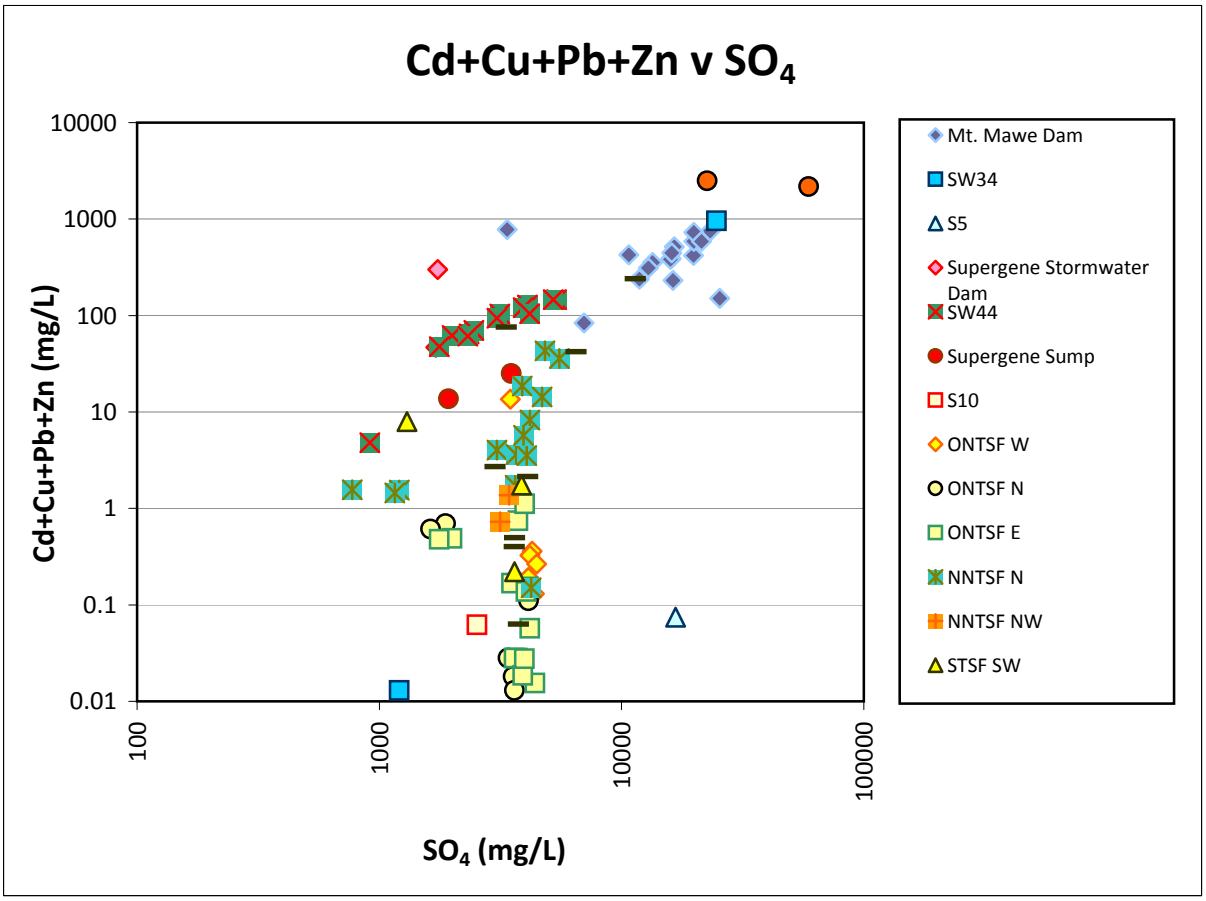
Figure C4 Variations in pH, SO_4 and selected metals concentrations in seepages and surface water





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Appendix M:
Material Testing Results for Northern Borrow Pit and Quarry

TropWATER TECHNICAL MEMO

QUARRY / BORROW MATERIAL ASSESSMENT FOR REHABILITATION WORKS AT MT LEYSHON

November 2021

Author: Shelley Templeman

1. BACKGROUND

Newmont Australia is proposing to use locally sourced quarry materials for ongoing rehabilitation works at the closed Mt Leyshon project. As part of their Environmental Authority (EPML00863713) amendment, there is a requirement to ensure the material is appropriate for the prescribed use.

2. SAMPLE SUMMARY

A total of nine separate sets of rock chip samples were collected by D. Young on 28th October 2021 (Figures 1-9). The collection site has been identified as an option for sourcing material to assist in erosion control and other rehabilitation for on-lease areas. Field notes indicate the potential for 3 to 4 different rock types based on visual observations (D. Young, *pers. comm.*).

3. ANALYSES

All samples were shipped to Environmental Analysis laboratory (EAL – Southern Cross University) on Monday 1st November. Requested analyses comprised:

- Acid Sulphate Rock Testing suite comprising Net Acid Producing Potential (NAPP), NAG pH and Net Acid Generation (NAG) (single addition peroxide acidity), Acid Neutralising Capacity (ANC-BT) and Reduced Inorganic Sulphur (S-CR) (combined in NAPP equation); and,
- Basic Metals Scan - Total Acid Extractable (ICPMS) including Aluminium, Arsenic, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Mercury, Nickel, Selenium, Silver and Zinc.

4. RESULTS SUMMARY

The analytical results for Acid Sulphate Potential and Basic Metals Scan are set out in Tables 1 & 2.

None of the submitted samples exhibited any acid forming potential (Table 1). Two samples had measurable Chromium Reducible Sulphur with both samples being considered to potentially have acid consuming potential. All samples had a level of acid neutralising capacity, with % $CaCO_3$ ranging from 0.08 (Sample7) to 10.04 (Sample 2).

Of the metals analysed, silver, cadmium, selenium, mercury and beryllium were all at or below the respective reporting limits (Table 2). Arsenic was just above the reporting limit for samples 1 and 8 and below reporting limits for all other samples.

Results for chromium, lead, nickel and zinc were all below ANZG (2018) sediment quality guidelines – low SQG-L) values, while copper just exceeded SQG-L for 2 samples. However, it is important to note these analyses were conducted as strong acid extraction on ground samples, and, as such are very conservative measures of potential for transfer into the receiving environment.

Manganese, iron and aluminium are consistent with the wider mineralogy / geology of the area (Morrison, 2007; Aspandiar et al 2003).

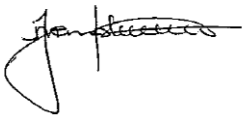
5. SUMMARY

The analyses undertaken on the supplied samples indicate no acid generating potential, and for all samples a level of acid neutralising capacity. The metals scan report low concentrations of most metals and a general mineralogy consistent with the wider area.

Based off this data, there is little risk of the material posing a contaminant risk to the wider receiving environment. It also offers an advantage of reduced biosecurity risk from introduced weed seeds due to the material being available within the existing lease area.

If you have any questions or queries regarding this assessment, please do not hesitate to contact me by email or telephone: Shelley.Templeman@jcu.edu.au or 0409636800

Regards



Shelley Templeman

REFERENCES

Aspandiar MF, Taylor G & Eggleton RA (2003). Charters Towers Region, Queensland. CRC LEME.

Morrison G (2007). Ore controls in the Mount Leyshon breccia-hosted gold deposit. EGRU-Breccia Symposium Field Guide 2007.

DRAFT

Table 1: Acid Sulphate Rock Testing Suite

RESULTS OF ACID SULFATE ROCK ANALYSIS

Sample No.	Moisture		Potential Sulfidic Acidity (Chromium Reducible Sulfur - CRS)		Total Sulfur		Acid Neutralising Capacity (ANC_{BT})		NAG pH	NAG Net Acidity to pH 7 (Net Acid Generation)	CLASSIFICATION (based on NAG pH and NAPP)	ANC/MPA RATIO	NAPP (Net Acid Producing Potential)	CLASSIFICATION (based on NAPP)
	(% moisture of total wet weight)	(g moisture / g of oven dry soil)	(% S_{cr})	(mol H^+/t)	%S	(mol H^+/t)	(% $CaCO_3$)	(mol H^+/t)		kg H_2SO_4/t	(ie. NAF, PAF, UC)	(as kg H2SO4/t) > 2 ideal	kg H_2SO_4/t (Based on total sulfur: does not include actual acidity)	*(i.e. 1- ACM; 2- NAF, 3- PAF-LC, 4- PAF)*
Method No.	**		(In-house method S20)		LECO CNS TruMac		(In-house method S14)		**	**	**	**	**	**
Sample 1	0.3	0.00	< 0.005	0	..	..	0.55	110	6.98	0.6	..	..	..	..
Sample 2	1.6	0.02	<0.005	0	..	..	10.04	2007	10.05	0.0	..	..	..	..
Sample 3	0.6	0.01	0.007	5	..	..	0.93	186	7.56	0.0	NAF	40.5	-9	ACM
Sample 4	0.3	0.00	< 0.005	0	..	..	0.27	53	6.48	3.1	..	..	..	..
Sample 5	0.5	0.00	< 0.005	0	..	..	0.97	194	8.44	0.0	..	..	..	..
Sample 6	1.4	0.01	< 0.005	0	..	..	1.08	215	8.00	0.0	..	..	..	..
Sample 7	0.2	0.00	0.007	4	..	..	0.08	15	6.23	5.8	NAF	3.6	-1	ACM
Sample 8	1.5	0.02	< 0.005	0	..	..	1.05	211	7.89	0.0	..	..	..	..
Sample 9	0.2	0.00	< 0.005	0	..	..	0.20	40	6.43	4.1	..	..	..	..

Notes:

1. All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)
2. Rock methods and classification from AMIRA international, May 2002. ARD Test Handbook, Project P387A Prediction and Kinetic Control of Acid Mine Drainage. Ian Walk Institute, Melbourne.
3. Soil Analytical procedures are sourced from Sullivan L, Ward N, Toppler N and Lancaster G. 2018. National acid sulfate soils guidance: national acid sulfate soils identification and laboratory methods manual, Department of Agriculture and Water Resources, Canberra, ACT. CC
4. Results at or below detection limits are replaced with '0' for calculation purposes.
5. Rock Classification = 1-ACM: acid consuming potential; 2-NAF: non-acid forming; 3-PAF-LC: potentially acid forming, low capacity (<5kg H2SO4/tonne); 4-PAF: potentially acid forming); UC = Uncertain.
6. Analysis conducted between sample arrival date and reporting date.
7. ** NATA accreditation does not cover the performance of this service.
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10. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer SCU.edu.au/eal/t&cs or on request).
11. Results relate only to the samples tested.
12. This report was issued on 04/11/2021.

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Table 2: Basic Metals Scan

RESULTS OF ROCK ANALYSIS - BASIC METAL SCAN

	Method	Detection Limits	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9
	Job No.		*M3082/1*	*M3082/2*	*M3082/3*	*M3082/4*	*M3082/5*	*M3082/6*	*M3082/7*	*M3082/8*	*M3082/9*
Silver (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Arsenic (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<2	2.7	<2	<2	<2	<2	<2	<2	2.5	<2
Lead (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<1	7.8	6.5	<1	4.9	1.1	2.1	2.7	2.2	3.2
Cadmium (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<2	3.9	1.4	8.6	0.9	4.3	14.3	0.8	31.3	23.7
Copper (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<1	6	23	54	1	7	69	<1	70	1
Manganese (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<1	271	251	309	82	719	377	23	573	18
Nickel (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<1	2.4	3.5	13.1	0.5	1.5	11.2	0.3	14.4	0.7
Selenium (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<1	20	19	29	8	53	33	2	52	2
Mercury (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Iron (%)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<0.005	1.56	1.20	2.31	0.70	3.13	2.67	0.39	3.51	0.33
Aluminium (%)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<0.005	0.51	0.86	1.73	0.28	1.34	1.52	0.21	1.94	0.20
Beryllium (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Boron (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<1	<1	3.9	2.3	<1	<1	3.0	1.3	1.2	<1
Cobalt (mg/kg)	1:3 Nitric/HCl digest - APHA 3125 ICPMS	<1	3.8	4.4	13.6	<1	7.9	15.2	<1	16.2	<1

Notes:

1. ppm = mg/Kg dried sample
2. All results as dry weight DW - samples were dried at 40oC for 24-48hrs prior to crushing and analysis.
3. Methods from Rayment and Lyons, Soil Chemical Methods - Australasia
4. Metals analysed by ICP-MS (Inductively Coupled Plasma - Mass Spectrometry)
5. Analysis conducted between sample arrival date and reporting date.
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Figure 1: Sample 1

Figure 2: Sample 2

Figure 3: Sample 3

Figure 4: Sample 4

Figure 5: Sample 5

Figure 6: Sample 6

Figure 7: Sample 8

Figure 8: Sample 9

GRAIN SIZE ANALYSIS (hydrometer and sieving techniques)

11 samples supplied by James Cook Univeristy on the 31 March 2022. Lab Job No. M7306.
Analysis requested by Michelle Tink. Your Job: J22-0083 Compost.
Aust. Centre for tropical Freshwater Research Level 2 ATSIP DB 145, JCU DOUGLAS QLD 4811

SAMPLE ID	Lab Code	MOISTURE CONTENT (% of water in sample)	GRAVEL > 2 mm (% of total oven-dry equivalent)	COARSE SAND 200-2000 µm (0.2-2.0 mm) (% of total oven-dry equivalent)	FINE SAND 100-200 µm (0.1-0.2 mm) (% of total oven-dry equivalent)	V. FINE SAND 20 - 100 µm (0.02-0.1 mm) (% of total oven-dry equivalent)	SILT 2-20 µm ISSS (% of total oven-dry equivalent)	CLAY < 2 µm (% of total oven-dry equivalent)	Total soil fractions (incl. Gravel)
J22-0083/1	M7306/1	2.6%	4.3%	28.3%	12.5%	27.4%	8.8%	18.7%	100.0%
J22-0083/2	M7306/2	2.8%	11.1%	46.9%	9.9%	17.6%	6.4%	8.1%	100.0%
J22-0083/3	M7306/3	2.7%	12.6%	57.7%	7.5%	15.9%	2.3%	3.9%	100.0%
J22-0083/4	M7306/4	4.2%	20.9%	44.9%	4.8%	14.5%	5.9%	9.0%	100.0%
J22-0083/5	M7306/5	8.4%	0.8%	21.4%	6.0%	13.1%	6.5%	52.2%	100.0%
J22-0083/6	M7306/6	4.0%	11.6%	48.4%	6.4%	13.1%	4.5%	15.9%	100.0%
J22-0083/7	M7306/7	4.0%	18.1%	48.8%	7.0%	11.0%	5.0%	10.1%	100.0%
J22-0083/8	M7306/8	11.0%	9.5%	33.5%	5.0%	12.9%	7.6%	31.5%	100.0%
J22-0083/9	M7306/9	2.8%	28.1%	45.0%	5.8%	11.7%	2.7%	6.9%	100.0%
J22-0083/10	M7306/10	3.2%	22.1%	42.3%	4.5%	14.4%	4.4%	12.3%	100.0%
J22-0083/11	M7306/11	2.3%	38.2%	41.9%	4.4%	8.3%	3.5%	3.7%	100.0%

Note:

1. The Hydrometer Analysis method was used to determine the percentage sand, silt and clay,

modified from SOP meth004 (California Dept of Pesticide Regulation), using method of Gee & Bauder (1986)," &

in Methods of Soil Analysis. Part 1 Agron. Monogr. 9 (2nd Ed). Klute, A., American Soc. of Agronomy Inc., Soil Sci. Soc. America Inc., Madison WI: 383-411.

2. The texture classification was based on the hydrometer results and the appropriate texture triangle.

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checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

GRAIN SIZE ANALYSIS (hydrometer and sieving techniques)

11 samples supplied by James Cook Univeristy on the 31 March 2022. Lab Job No. M7306.
Analysis requested by Michelle Tink. Your Job: J22-0083 Compost.
Aust. Centre for tropical Freshwater Research Level 2 ATSIP DB 145, JCU DOUGLAS QLD 4811

SAMPLE ID	Lab Code	MOISTURE CONTENT (% of water in sample)	COARSE SAND 200-2000 µm (0.2-2.0 mm) (% of total oven-dry equivalent)	FINE SAND 100-200 µm (0.1-0.2 mm) (% of total oven-dry equivalent)	V. FINE SAND 20 - 100 µm (0.02-0.1 mm) (% of total oven-dry equivalent)	SILT 2-20 µm ISSS (% of total oven-dry equivalent)	CLAY < 2 µm (% of total oven-dry equivalent)	Total soil fractions (<2mm)
J22-0083/1	M7306/1	2.6%	29.6%	13.0%	28.6%	9.2%	19.5%	100.0%
J22-0083/2	M7306/2	2.8%	52.8%	11.1%	19.8%	7.2%	9.1%	100.0%
J22-0083/3	M7306/3	2.7%	66.0%	8.6%	18.2%	2.7%	4.5%	100.0%
J22-0083/4	M7306/4	4.2%	56.8%	6.1%	18.3%	7.5%	11.4%	100.0%
J22-0083/5	M7306/5	8.4%	21.6%	6.1%	13.3%	6.5%	52.6%	100.0%
J22-0083/6	M7306/6	4.0%	54.8%	7.3%	14.8%	5.1%	18.0%	100.0%
J22-0083/7	M7306/7	4.0%	59.6%	8.6%	13.4%	6.1%	12.3%	100.0%
J22-0083/8	M7306/8	11.0%	37.0%	5.5%	14.3%	8.3%	34.8%	100.0%
J22-0083/9	M7306/9	2.8%	62.5%	8.0%	16.2%	3.7%	9.5%	100.0%
J22-0083/10	M7306/10	3.2%	54.3%	5.8%	18.5%	5.7%	15.8%	100.0%
J22-0083/11	M7306/11	2.3%	67.8%	7.1%	13.5%	5.7%	6.0%	100.0%

Note:

1. The Hydrometer Analysis method was used to determine the percentage sand, silt and clay,

modified from SOP meth004 (California Dept of Pesticide Regulation), using method of Gee & Bauder (1986)," &

in Methods of Soil Analysis. Part 1 Agron. Monogr. 9 (2nd Ed). Klute, A., American Soc. of Agronomy Inc., Soil Sci. Soc. America Inc., Madison WI: 383-411.

2. The texture classification was based on the hydrometer results and the appropriate texture triangle.

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checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

Use spinner to choose sample number

or enter the sample number here then choose Summary page

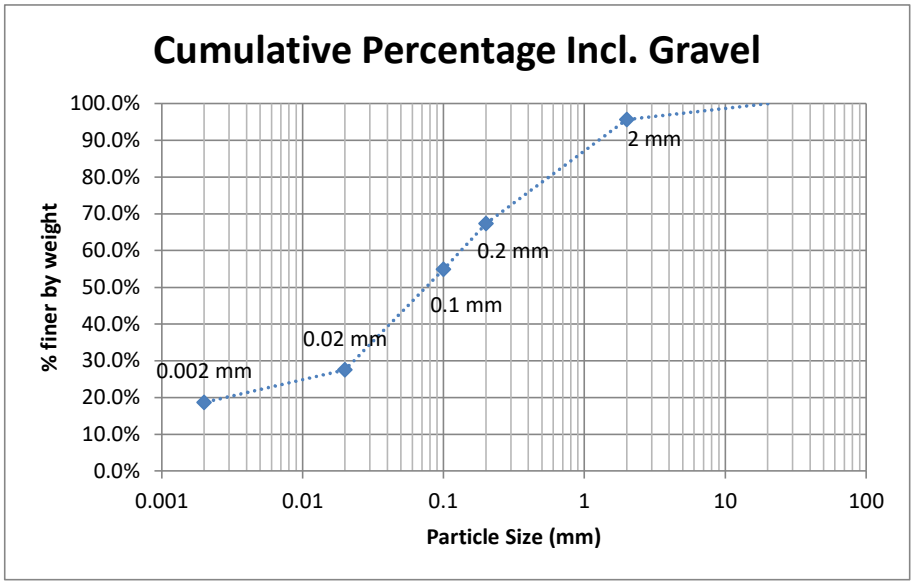
Incl. Gravel <2mm only

1

1

Cumulative Percentage Incl. Gravel

		1	2	3	4	5	6
	(% Very large)	% Gravel >2mm	%Coarse Sand	% Fine Sand	% V. Fine Sand	% Silt	% Clay
Fraction %	0.0%	**4.3%**	**28.3%**	**12.5%**	**27.4%**	**8.8%**	**18.7%**
Particle size (mm)	200	20	2	0.2	0.1	0.02	0.002
Cumulative percentage	100.0%	100.0%	95.7%	67.4%	54.9%	27.5%	18.7%



GRAIN SIZE ANALYSIS (sieving technique)

11 samples supplied by James Cook Univeristy on the 31 March 2022. Lab Job No. M7306.
Analysis requested by Michelle Tink. Your Job: J22-0083 Compost.
Aust. Centre for tropical Freshwater Research Level 2 ATSIP DB 145, JCU DOUGLAS QLD 4811

SAMPLE ID	Lab Code	> 2 mm Gravel	1–2 mm Very Coarse Sand	500 µm–1 mm Coarse Sand	250–500 µm Medium Sand	125–250 µm Fine Sand	63–125 µm Very Fine Sand	< 63 µm Mud (Silt/Clay)
J22-0083/1	M7306/1	37.2%	12.8%	11.5%	11.8%	11.0%	9.6%	6.0%
J22-0083/2	M7306/2	15.4%	17.7%	20.4%	16.4%	13.5%	9.0%	7.7%
J22-0083/3	M7306/3	25.0%	16.8%	18.7%	15.0%	11.2%	8.7%	4.7%
J22-0083/4	M7306/4	41.5%	17.9%	14.2%	9.7%	6.6%	4.9%	5.2%
J22-0083/5	M7306/5	17.1%	19.8%	23.8%	18.7%	11.5%	6.0%	3.1%
J22-0083/6	M7306/6	21.9%	21.9%	22.7%	16.4%	9.6%	5.0%	2.5%
J22-0083/7	M7306/7	22.8%	23.9%	20.8%	14.5%	9.2%	5.9%	3.0%
J22-0083/8	M7306/8	35.8%	23.7%	20.1%	11.5%	5.8%	2.5%	0.7%
J22-0083/9	M7306/9	44.3%	22.5%	13.5%	8.6%	5.4%	3.5%	2.1%
J22-0083/10	M7306/10	32.3%	23.3%	19.4%	11.7%	6.7%	4.0%	2.6%
J22-0083/11	M7306/11	41.5%	21.3%	14.6%	10.4%	6.3%	3.8%	2.1%

Note:

1. The Dry Sieving Analysis method was used for this grain size determination (Method of: Lewis and McConchie, 1994. Analytical Sedimentology. Chapman and Hall, USA.)
2. Analysis conducted between sample arrival date and reporting date.
3. .. Denotes not requested.
4. This report is not to be reproduced except in full.
5. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal or on request).
6. This report was issued on 21/04/2022.

Northern Borrow Pit Results - Final

	Job/Sample Label:	Sample 1 J22-0083/1	Sample 2 J22-0083/2	Sample 3 J22-0083/3	Sample 4 J22-0083/4	Sample 5 J22-0083/5	Sample 6 J22-0083/6	Sample 7 J22-0083/7
	Sample ID	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**
	Standard Applicable:	MRTS16 - FORM C	MRTS16 - FORM C	MRTS16 - FORM C	MRTS16 - FORM C	MRTS16 - FORM C	MRTS16 - FORM C	MRTS16 - FORM C
Parameter	**Method Reference**	**M7306/1**	**M7306/2**	**M7306/3**	**M7306/4**	**M7306/5**	**M7306/6**	**M7306/7**
Wet Bulk Density (t/m^3)	Note 2 - Clause 5.2	1.5	1.5	1.6	1.5	1.4	1.4	1.5
Bulk Density (t/m^3)	Note 2 - Clause 5.2	1.4	1.5	1.6	1.4	1.3	1.4	1.4
Organic Matter (%)	Calculation - Total Organic Carbon x 1.7	2.2	0.6	0.4	1.0	1.0	0.5	0.4
Wettability (mm)	Note 2 - Clause 5.4	26	27	29	28	24	26	27
pH	Note 2 - Clause 5.5	8.56	8.84	8.99	8.93	7.09	8.63	8.24
Electrical Conductivity (dS/m)	Note 2 - Clause 5.6	0.18	0.11	0.10	0.10	0.10	0.11	0.05
Phosphate Phosphorus (mg/kg P)	Note 2 - Clause 5.8	6.2	2.9	1.0	0.7	0.6	0.5	0.6
Permeability (cm/hr)	Note 2 - Clause 5.12	4	5	7	9	15	8	3
Texture (Texture Classification)	Note 2 - Clause 5.13	Sandy Clay Loam	Sandy Loam	Loamy Sand	Loamy Sand	Light Clay	Sandy Clay Loam	Sandy Loam
Large Particle - > 75mm Sieve (%)		Nil	20.2	Nil	Nil	Nil	Nil	Nil
Large Particle - > 50mm Sieve (%)	Note 2 - Clause 5.14	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Large Particle - > 20mm Sieve (%)		0.6	1.1	Nil	5.4	Nil	1.5	Nil
Water Repellence (Hydrophobicity) (Class No.)	Note 5 - Table 1	0	0	0	0	0	0	0
Water Drop Penetration Time (Sec)	Note 5 - Table 1	2.6	0.5	0.4	0.3	0.4	1.0	0.3
Dispersion - Emerson (Class No.)	Note 4 - Method 3.8.1	3	3	3	3	4	4	3
Total Organic Carbon (%)	Note 2 - Clause 5.3	1.3	0.3	0.3	0.6	0.6	0.3	0.2
Exchangeable Cation Method Used	Note 4	15C1	15C1	15C1	15C1	15B3	15C1	15C1
Exchangeable Calcium (meq/100g)		12.80	13.03	12.57	14.12	8.93	10.29	10.27
Exchangeable Magnesium (meq/100g)		1.45	0.69	0.84	0.74	3.89	2.98	2.80
Exchangeable Sodium (meq/100g)		0.17	0.13	0.14	0.09	0.08	0.12	0.12
Exchangeable Sodium (meq/100g) (Na Corrected)	Note 4							
Exchangeable Potassium (meq/100g)		0.59	0.07	0.12	0.09	0.32	0.15	0.08
Exchangeable Aluminium (meq/100g)		0.05	0.04	0.04	0.04	0.04	0.04	0.04
Effective Cation Exchange Capacity (meq/100g)	Note 4 - Method 15J1	15.06	13.97	13.71	15.08	13.26	13.56	13.30
Effective Cation Exchange Capacity (meq/100g) (Na Corrected)								
Exchangeable Sodium Percentage (%)	% Calculation	1.1	1.0	1.0	0.6	0.6	0.9	0.9
Exchangeable Sodium Percentage (%) (Na Corrected)								
Exchangeable Aluminium (%)	% Calculation	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Calcium/Magnesium Ratio	Calculation - Calcium/Magnesium	8.8	18.8	14.9	19.0	2.3	3.5	3.7
Chloride (mg/kg)	Note 4 - Method 5A	57.5	49.8	45.7	46.8	72.4	45.8	90.1
Extractable Sulfur (mg/kg)	Note 4 - Method 10B	6.6	7.1	5.6	1.5	7.8	3.3	0.4
Slaking (Class No.)	Note 6 - Table 1	1	2	1	1	2	2	1
Clouding (Dispersion) (Class No.)	Note 7 - Table 1	0	0	0	0	0	0	0

Notes:

1. All analysis is tested according to Technical Specification Appendix, MRTS16 Landscape and Revegetation Works 2014.
2. Indicative guidelines are based on those in AS4419:2003 for low density soils, organic soils, natural soils.
3. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
4. Refers to Soil Chemical Methods : Australasia - Rayment & Lyons, CSIRO 2011. When pH < 7.3 Method 15B3 When pH > 7.3 Method 15C1 When pH < 7.3 and EC > 0.3 Na Corrected..
5. Refers to MRTS16 Appendix - Test Method Q160 Determination of Water Repellency of a Soil.
6. Refers to MRTS16 Appendix - Test Method Q161 Field Dispersion Indicator Test of Soil - Slaking.
7. Refers to MRTS16 Appendix - Test Method Q162 Field Dispersion Indicator Test of Soil - Clouding.
8. Refers to AS1289.3.8.1 - Method of testing soils for engineering purposes.
9. Less than 5 mg/kg for very sensitive plants and <20 mg/kg for moderately sensitive plants and <100 mg/kg for non-sensitive plants.
10. All soils should be free from any living parts (seeds, bulbs, corms, vegetative propagules and the like).
11. Testing completed in a NATA accredited laboratory.
12. Analysis conducted between sample arrival date and reporting date.
13. This report is not to be reproduced except in full. Results only relate to the item tested.

Northern Borrow Pit Results - Final

	Job/Sample Label: Sample ID Standard Applicable:	Sample 8 J22-0083/8 **S8** MRTS16 - FORM C	Sample 9 J22-0083/9 **S9** MRTS16 - FORM C	Sample 10 J22-0083/10 **S10** MRTS16 - FORM C	Sample 11 J22-0083/11 **S11** MRTS16 - FORM C	***Guideline*** *MRTS16:2014* *FORM C* *(Sands and loamy sands)*	***Guideline*** *MRTS16:2014* *FORM C* *(Sandy loams to clay loams)*	***Guideline*** *MRTS16:2014* *FORM C* *(Sandy light clay to heavy clay)*
Parameter	**Method Reference**	**M7306/8**	**M7306/9**	**M7306/10**	**M7306/11**			
Wet Bulk Density (t/m^3)	Note 2 - Clause 5.2	1.2	1.6	1.5	1.6	..	..	..
Bulk Density (t/m^3)	Note 2 - Clause 5.2	1.0	1.5	1.5	1.6	*> 0.7*	*> 0.7*	*> 0.7*
Organic Matter (%)	Calculation - Total Organic Carbon x 1.7	0.8	0.4	0.4	0.4	*3 - 10*	*3 - 10*	*3 - 10*
Wettability (mm)	Note 2 - Clause 5.4	23	25	25	30	*5 - 150*	*5 - 150*	*5 - 150*
pH	Note 2 - Clause 5.5	8.20	8.59	7.70	7.88	*5.5 - 7.5*	*5.5 - 7.5*	*5.5 - 7.5*
Electrical Conductivity (dS/m)	Note 2 - Clause 5.6	0.15	0.10	0.02	0.02	*< 1.2*	*< 1.2*	*< 1.2*
Phosphate Phosphorus (mg/kg P)	Note 2 - Clause 5.8	0.5	0.5	0.5	0.9	*see note 9*	*see note 9*	*see note 9*
Permeability (cm/hr)	Note 2 - Clause 5.12	4	52	18	83	*2 - 35*	*2 - 35*	*2 - 35*
Texture (Texture Classification)	Note 2 - Clause 5.13	Sandy Clay	Sandy Loam	Sandy Loam	Loamy Sand	..	..	..
Large Particle - > 75mm Sieve (%)		Nil	Nil	Nil	Nil	*Nil*	*Nil*	*Nil*
Large Particle - > 50mm Sieve (%)	Note 2 - Clause 5.14	Nil	Nil	Nil	Nil	*Nil*	*Nil*	*Nil*
Large Particle - > 20mm Sieve (%)		Nil	Nil	Nil	Nil	*Nil*	*Nil*	*Nil*
Water Repellence (Hydrophobicity) (Class No.)	Note 5 - Table 1	0	0	0	0	*Class 0 or 1*	*Class 0 or 1*	*Class 0 or 1*
Water Drop Penetration Time (Sec)	Note 5 - Table 1	0.3	0.3	0.3	0.3	..	..	..
Dispersion - Emerson (Class No.)	Note 4 - Method 3.8.1	4	3	4	3	*Class 3 - 8*	*Class 3 - 8*	*Class 3 - 8*
Total Organic Carbon (%)	Note 2 - Clause 5.3	0.5	0.2	0.3	0.3	*≥ 0.5*	*≥ 0.5*	*≥ 0.5*
Exchangeable Cation Method Used	Note 4	15C1	15C1	15C1	15C1	..	..	..
Exchangeable Calcium (meq/100g)		11.54	7.96	7.37	5.59	*≥ 2*	*≥ 5*	*≥ 5*
Exchangeable Magnesium (meq/100g)		3.48	2.43	2.80	1.96	*> 0.6*	*> 1.0*	*> 1.0*
Exchangeable Sodium (meq/100g)		0.11	0.07	0.05	0.02	..	..	..
Exchangeable Sodium (meq/100g) (Na Corrected)	Note 4					..	..	..
Exchangeable Potassium (meq/100g)		0.20	0.06	0.08	0.03	*> 0.2*	*> 0.4*	*> 0.4*
Exchangeable Aluminium (meq/100g)		0.04	0.04	0.04	0.04	..	..	..
Effective Cation Exchange Capacity (meq/100g)	Note 4 - Method 15J1	15.38	10.56	10.33	7.65	*> 5*	*> 10*	*> 10*
Effective Cation Exchange Capacity (meq/100g) (Na Corrected)						*> 5*	*> 10*	*> 10*
Exchangeable Sodium Percentage (%)	% Calculation	0.7	0.7	0.5	0.3	*< 6*	*< 15*	*< 15*
Exchangeable Sodium Percentage (%) (Na Corrected)						*< 6*	*< 15*	*< 15*
Exchangeable Aluminium (%)	% Calculation	0.3	0.4	0.4	0.5	*< 25*	*< 40*	*< 40*
Calcium/Magnesium Ratio	Calculation - Calcium/Magnesium	3.3	3.3	2.6	2.9	*2 - 10*	*2 - 10*	*2 - 10*
Chloride (mg/kg)	Note 4 - Method 5A	29.9	41.0	239.4	233.7	*< 900*	*< 900*	*< 900*
Extractable Sulfur (mg/kg)	Note 4 - Method 10B	1.6	1.0	0.4	1.2	*< 100*	*< 100*	*< 100*
Slaking (Class No.)	Note 6 - Table 1	1	2	1	1	*Class 0 - 2*	*Class 0 - 2*	*Class 0 - 2*
Clouding (Dispersion) (Class No.)	Note 7 - Table 1	0	0	0	0	*Class 0 - 1*	*Class 0 - 1*	*Class 0 - 1*

Notes:

1. All analysis is tested according to Technical Specification Appendix, MRTS16 Landscape and Revegetation Works 2014.
2. Indicative guidelines are based on those in AS4419:2003 for low density soils, organic soils, natural soils.
3. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
4. Refers to Soil Chemical Methods : Australasia - Rayment & Lyons, CSIRO 2011. When pH < 7.3 Method 15B3 When pH > 7.3 M
EC > 0.3 Na Corrected..
5. Refers to MRTS16 Appendix - Test Method Q160 Determination of Water Repellency of a Soil.
6. Refers to MRTS16 Appendix - Test Method Q161 Field Dispersion Indicator Test of Soil - Slaking.
7. Refers to MRTS16 Appendix - Test Method Q162 Field Dispersion Indicator Test of Soil - Clouding.
8. Refers to AS1289.3.8.1 - Method of testing soils for engineering purposes.
9. Less than 5 mg/kg for very sensitive plants and <20 mg/kg for moderately sensitive plants and <100 mg/kg for non-sensitive plan
10. All soils should be free from any living parts (seeds, bulbs, corms, vegetative propagules and the like).
11. Testing completed in a NATA accredited laboratory.
12. Analysis conducted between sample arrival date and reporting date.
13. This report is not to be reproduced except in full. Results only relate to the item tested.

Northern Borrow Pit Results - Final

		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
	Job/Sample Label:	J22-0083/1	J22-0083/2	J22-0083/3	J22-0083/4	J22-0083/5	J22-0083/6	J22-0083/7
	Sample ID	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**
	Test Applicable:	SS-PACK-004	SS-PACK-004	SS-PACK-004	SS-PACK-004	SS-PACK-004	SS-PACK-004	SS-PACK-004
Parameter	**Method Reference**	**M7306/1**	**M7306/2**	**M7306/3**	**M7306/4**	**M7306/5**	**M7306/6**	**M7306/7**
Total Zinc (mg/kg)	Rayment & Lyons 2011 - 17C1 Aqua Regia Total Metals	43.0	42.7	46.4	74.3	20.3	30.9	53.7
Total Manganese (mg/kg)		4,449	3,782	4,076	5,365	3,502	3,386	4,915
Total Iron (mg/kg)		409,232	321,257	345,577	296,299	474,789	290,167	404,682
Total Copper (mg/kg)		96.6	178	143	45.1	39.9	47.7	77.9
Total Boron (mg/kg)		<5	<5	<5	<5	<5	<5	<5
Total Aluminium (mg/kg)		200,255	214,143	233,772	291,497	313,203	172,148	209,939
Total Cobalt (mg/kg)	Rayment & Lyons 2011 - 17C1 Aqua Regia Total Metals	17.7	17.0	19.9	16.2	14.6	13.3	19.5
Total Selenium (mg/kg)		<1	<1	<1	<1	<1	<1	<1
Total Cadmium (mg/kg)	Rayment & Lyons 2011 - 17C1 Aqua Regia Total Heavy Metals	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Lead (mg/kg)		7.73	2.63	2.63	10.8	9.15	5.34	5.82
Total Arsenic (mg/kg)		4.42	2.17	2.17	7.30	3.27	<2	2.31
Total Chromium (mg/kg)		73.8	36.7	42.2	19.6	31.4	21.0	22.3
Total Nickel (mg/kg)		18.4	19.5	22.3	15.8	12.7	12.1	17.2
Total Mercury (mg/kg)		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Silver (mg/kg)		<1	<1	<1	<1	<1	<1	<1

* < LOR Less than limit of reporting. *ND* Not detected. *NA* Not applicable. *NR* Not required.

Notes:

1. All analysis is dry weight – Samples reported on an oven dried basis at 105˚C (testing conducted on finely ground sample dried at 40˚C).
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. Indicative guidelines are based on those in AS4454:2012 for a composted product.
4. Total Acid Extractable Nutrients indicate a store of nutrients.
6. Conversions for 1 mg/kg = 1 ppm; 1 % = 10,000 ppm
7. Conversions to kg/ha = mg/kg x 2.24
8. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
9. Testing completed in a NATA accredited laboratory.
10. Analysis conducted between sample arrival date and reporting date.
11. This report is not to be reproduced except in full. Results only relate to the item tested.

Northern Borrow Pit Results - Final

		Sample 8	Sample 9	Sample 10	Sample 11	
	Job/Sample Label:	J22-0083/8	J22-0083/9	J22-0083/10	J22-0083/11	Guideline
	Sample ID	**S8**	**S9**	**S10**	**S11**	AS4454:2012
	Test Applicable:	SS-PACK-004	SS-PACK-004	SS-PACK-004	SS-PACK-004	Composted Product
Parameter	**Method Reference**	**M7306/8**	**M7306/9**	**M7306/10**	**M7306/11**	
Total Zinc (mg/kg)	Rayment & Lyons 2011 - 17C1 Aqua Regia Total Metals	31.9	39.5	37.7	48.6	**< 300 Zn**
Total Manganese (mg/kg)		4,326	3,462	3,445	4,000	..
Total Iron (mg/kg)		422,375	300,456	282,052	313,378	..
Total Copper (mg/kg)		57.6	62.4	56.3	80.1	**< 150 Cu**
Total Boron (mg/kg)		<5	<5	<5	<5	**< 100 B**
Total Aluminium (mg/kg)		293,419	187,320	165,656	160,604	..
Total Cobalt (mg/kg)	Rayment & Lyons 2011 - 17C1 Aqua Regia Total Metals	16.4	14.9	13.9	16.6	..
Total Selenium (mg/kg)		<1	<1	<1	<1	**< 5 Se**
Total Cadmium (mg/kg)	Rayment & Lyons 2011 - 17C1 Aqua Regia Total Heavy Metals	<0.5	<0.5	<0.5	<0.5	**< 1 Cd**
Total Lead (mg/kg)		9.58	6.89	4.91	4.71	**< 150 Pb**
Total Arsenic (mg/kg)		3.39	3.24	3.37	3.26	**< 20 As**
Total Chromium (mg/kg)		29.2	20.2	22.2	29.2	**< 100 Cr**
Total Nickel (mg/kg)		14.4	13.9	12.3	14.9	**< 60 Ni**
Total Mercury (mg/kg)		<0.1	<0.1	<0.1	<0.1	**< 1 Hg**
Total Silver (mg/kg)		<1	<1	<1	<1	..

* < LOR Less than limit of reporting. *ND* Not detected. *NA* Not applicable. *NR* Not required.

Notes:

1. All analysis is dry weight – Samples reported on an oven dried basis at 105˚C (testing conducted on finely ground sample
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. Indicative guidelines are based on those in AS4454:2012 for a composted product.
4. Total Acid Extractable Nutrients indicate a store of nutrients.
6. Conversions for 1 mg/kg = 1 ppm; 1 % = 10,000 ppm
7. Conversions to kg/ha = mg/kg x 2.24
8. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
9. Testing completed in a NATA accredited laboratory.
10. Analysis conducted between sample arrival date and reporting date.
11. This report is not to be reproduced except in full. Results only relate to the item tested.

RESULTS OF SOIL ANALYSIS

11 samples supplied by James Cook Univeristy on the 31 March 2022. Lab Job No. M7306.
Analysis requested by Michelle Tink. Your Job: J22-0083 Compost.
Aust. Centre for tropical Freshwater Research Level 2 ATSIP DB 145, JCU DOUGLAS QLD 4811

	Method	Sample 1 J22-0083/1	Sample 2 J22-0083/2	Sample 3 J22-0083/3	Sample 4 J22-0083/4	Sample 5 J22-0083/5	Sample 6 J22-0083/6	Sample 7 J22-0083/7	Sample 8 J22-0083/8	Sample 9 J22-0083/9	Sample 10 J22-0083/10	Sample 11 J22-0083/11
	Job No.	*M7306/1*	*M7306/2*	*M7306/3*	*M7306/4*	*M7306/5*	*M7306/6*	*M7306/7*	*M7306/8*	*M7306/9*	*M7306/10*	*M7306/11*
Emerson Dispersion Class	*Emerson Aggregate Test (EAT)*	3	3	3	3	4	4	3	4	3	4	3
Total Organic Carbon (%C)	*HCL treatment- LECO Analyser*	1.31	0.34	0.26	0.63	0.64	0.28	0.25	0.51	0.23	0.26	0.25
Organic Matter (%)	*** Calculation*	2.25	0.58	0.44	1.08	1.10	0.47	0.42	0.87	0.40	0.44	0.44
K Factor	*Revised Universal Soil Loss Equation (RUSLE)*	0.043	0.042	0.036	0.036	0.025	0.032	0.034	0.032	0.038	0.037	0.033

Notes:

1. All results as dry weight DW - samples were dried at 40 °C for 24-48 h prior to crushing and analysis.
2. Methods from Rayment and Lyons, Soil Chemical Methods - Australasia.
3. K Factor determined for RUSLE; Organic matter calculation as per RUSLE; K Factor determined using client provided information for structure and permeability.
4. Analysis conducted between sample arrival date and reporting date.
5. ** NATA accreditation does not cover the performance of this service.
6. .. Denotes not requested.
7. This report is not to be reproduced except in full.
8. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal or on request).
9. Results relate only to the samples tested.
10. This report was issued on 21/04/2022. Reissued on the 26/04/2022.

NATA
WORLD RECOGNISED ACCREDITATION
Accreditation No. 14960
Accredited for compliance with ISO/IEC 17025 - Testing

checked: .....
Graham Lancaster
Laboratory Manager

MEMORANDUM

Project:	Mt Leyshon ERC – RFI Response	**Date:**	11 May 2022
To:	Newmont	**From:**	Colin Schiller
ATT:	Glen Ware	**CC:**	Andrew Vitale, Tegan Ireland, Claire Sotiriadis
Subject:	Mt Leyshon ERC RFI Response – Material Re-use for Growth Media		

OVERVIEW

This memorandum has been prepared in response to the request for information (RFI) received from the Department of Science (DES) on the Mt Leyshon Mine Estimated Rehabilitation Cost (ERC) decision application, specifically the RFI item related to the quantity and quality of topsoil available from the Northern Borrow Pit at the Mt Leyshon Mine:

"The application supporting material at section 12 and in Tables 12.1 and 12.2 describes volumes of topsoil estimated to be required for use in outstanding rehabilitation and proposed to be sourced from the Northern Borrow Pit. The application supporting material does not comment on the viability of the Northern Borrow pit topsoil material to support vegetation. Please provide further information regarding the assessment completed to understand the available quantities and quality of topsoil material at the site. If appropriate, propose additional costs in the ERC calculator to source local topsoil material and import to the site".

The following sections discuss recent soil sampling and analysis of material from the Northern Borrow Pit, and the ability of the material to support vegetation growth and the attainment of a self-sustaining grazing post-mining land use at the Mt Leyshon Mine.

SAMPLING METHODOLOGY

TropWATER was engaged by Newmont in 2022 to collect and coordinate testing of soil samples from the Northern Borrow Pit area. Eleven soil samples were collected on 22nd March 2022 from the seven test pits shown in Figure 1 and described in Table 1. Due to cultural heritage restrictions, the test pits had to be located next to the existing access track through the Northern Borrow Pit.

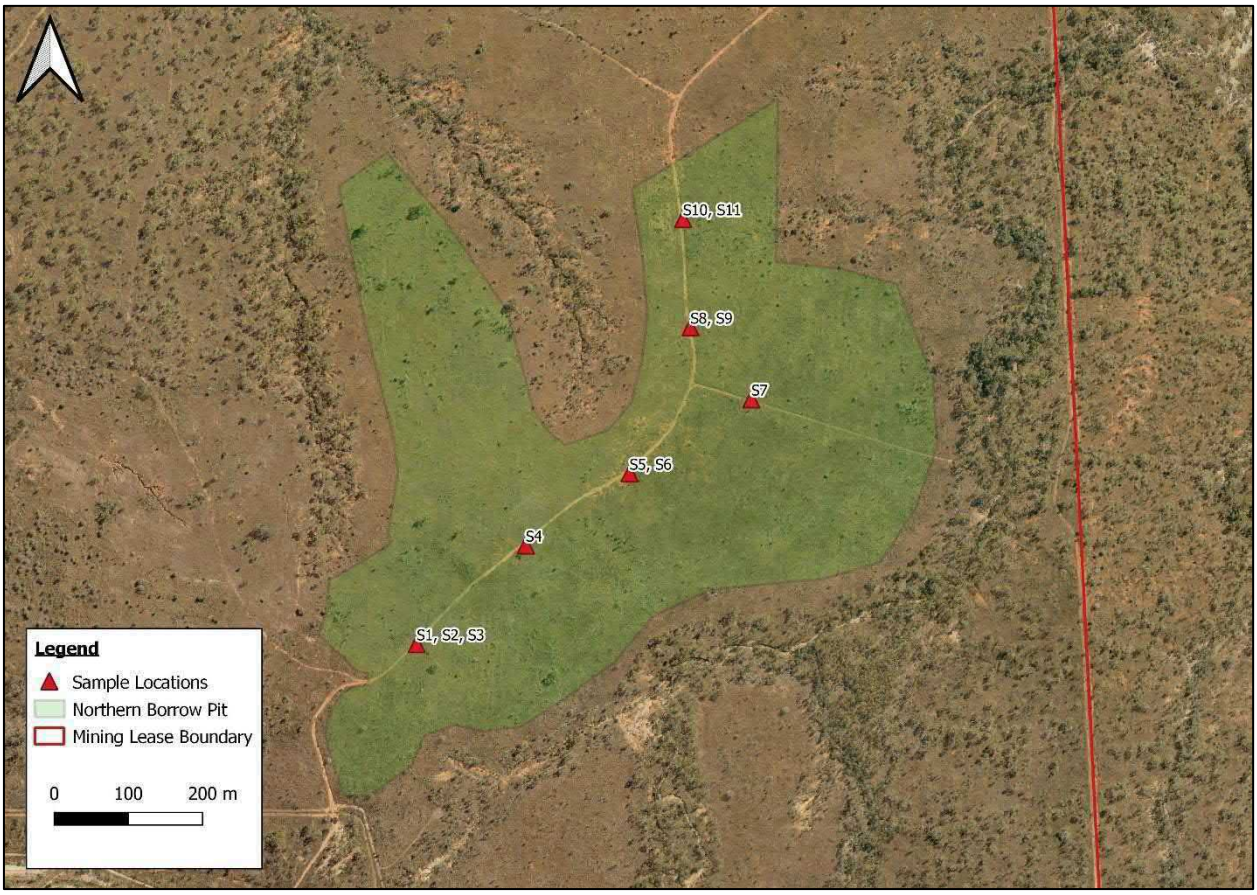


Figure 1: Soil Sampling Locations

Table 1: Summary of Soil Sampling Locations

Test Pit Number	Sample Number	Sample Depth (mm)	Brief Field Description of Soil
1	S1	200-250	Reddish clayey material
1	S2	300-350	Light grey clayey fines
1	S3	2300	Decomposed granite
2	S4	1000	250-300 mm topsoil over decomposed granite and clayey fines
3	S5	0-150	0-750mm of red clay ochre
3	S6	1100-1300	Highly decomposed reddish granite
5	S7	2200-2400	Reddish decomposed granite with clayey sand
6	S8	0-200	Red ochre layer
6	S9	1200-1400	Pinkish red decomposed granite
7	S10	500-1100	Pinkish red decomposed granite

Photos showing the typical condition of test pits 4 and 5 are shown in Figure 2.

These test pits were comprised of approximately 200 – 250 mm of reddish clay topsoil overlying a white-grey material interpreted as highly-to-completely weathered decomposed granitic rock. Pit 5 included two horizons in the white-grey material.

Excavated soil from the upper horizon (300 – 350 mm thick) was characterised by clayey fines with fewer coarse fragments than the lower horizon which contained more sand and gravel fragments. Clay 'smears' were visible in excavated face.

Pit 4 did not exhibit any strong variation through the white-grey material which was generally similar to the lower horizon in Pit 5.

Both pits were terminated at shallower depth than target (2.1 m depth in Pit 4 and 2.3 m depth in Pit 5) as digging became increasingly hard.

Figure 2: Photos Showing the Typical Condition of Test Pits 4 and 5

Photos showing the typical condition of the remainder of the test pits are shown in Figure 3.

These test pits were comprised of an upper horizon of dark ochre coloured blocky 'clay' (700 – 800 mm) overlying red decomposed granitic rock.

Clay 'smears' were visible in the excavated face and a relatively high clay content was inferred.

Excavated soil from the lower horizon typically presented as a clayey sand that has some structure when wetted, but crumbles easily. The material was generally easier to dig than the white-grey material in Pits 4 and 5, although refusal was reached at <2.5 m in most of the pits.

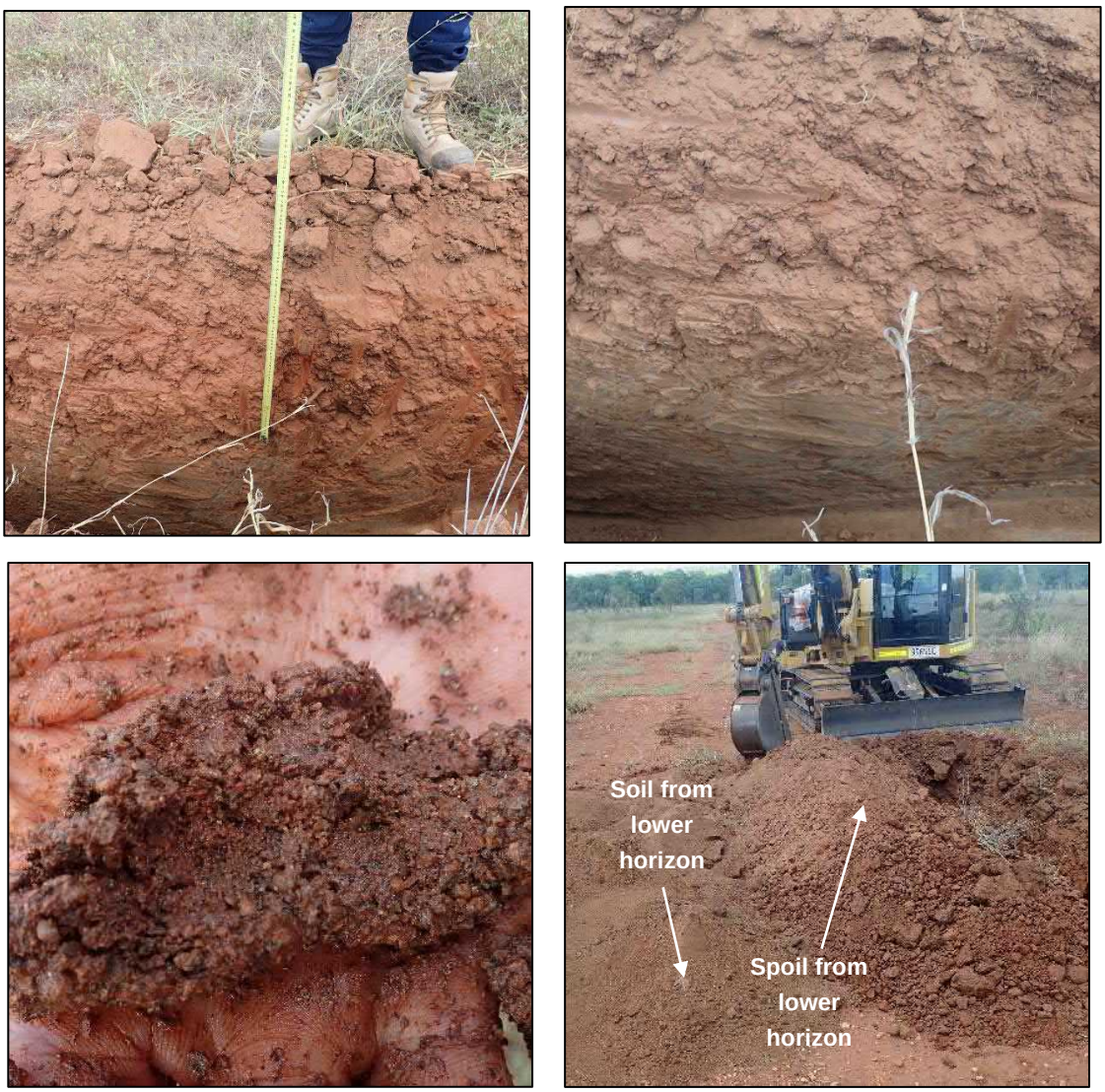


Figure 3: Photos Showing the Typical Condition of the Remainder of the Test Pits

ANALYSES

The soil samples were sent to Environmental Analysis Laboratory (EAL – Southern Cross University) on 25th March 2022 where the soil samples were tested for:

- Wet bulk density;
- Bulk density;
- Organic matter;
- Wettability
- pH
- Electrical conductivity;
- Phosphate Phosphorous
- Permeability
- Texture
- Particle size
- Water repellence;
- Emerson Class;
- Total Organic Carbon;
- Exchangeable cations (Ca, Mg, Na, K, Al)
- Effective Cation Exchange Capacity
- Exchangeable sodium percentage;
- Exchangeable Aluminium
- Calcium/Magnesium Ratio;
- Chloride;
- Extractable Sulfur;
- Slaking; and
- Clouding.

RESULTS

The full soil sampling results are attached. The results show/indicate that:

- The pH of three of the samples fall within the acceptable range of 6.0 to 8.0 for pasture grasses, whilst the pH of the remaining three samples can be modified with amelioration to reduce to below pH 8.0.
- The phosphate levels in all samples are low and will need to be increased with a slow release phosphate fertiliser such as diammonium phosphate (DAP).
- The permeability and texture of all of the samples is within the acceptable range for pasture grasses.
- The Emerson classes are within the acceptable range for pasture grasses within seven samples and will require amelioration with gypsum for the remaining samples.
- The organic carbon is moderate to low in all samples and will require the addition of a composted manure/compost, microbial stimulant, hydromulch or seaweed extract to improve the water holding capacity, nutrient retention and nutrient release capacity.
- The Calcium/Magnesium ratio exceeds 2:1 in all samples, conforming with the requirements for pasture grasses.
- The exchangeable Aluminium levels are beneath the levels considered to retard plant growth.
- The exchangeable Sodium levels are well below the 6% set at the Australian Standard for Sodicity.
- The Chloride levels are significantly below the Australian Standard for Salinity.

Based on analysis of the results, all samples are suitable for use as a growth medium with the recommended amelioration (Table 24) to support a sustainable grazing post-mining land use at the Mt Leyshon Mine.

Based on the soil sampling results, material from the Northern Borrow Pit is suitable to the depths tested for use as a growth medium with the recommended amelioration (refer to Table 2) to support vegetation growth and the attainment of a self-sustaining grazing post-mining land use at the Mt Leyshon Mine.

Table 2 Amelioration and Nutrient Requirements for Pasture

	Product	Rate/Ha	1	2	3	4	5	6	7	8	9	10	11
Amelioration	Gypsum	tonne/ha	5	5	5	5	0	5	5	5	5	0	0
Fertiliser	DAP	kg/ha	150	150	150	150	150	150	150	150	150	150	150
	Zinc Sulfate	kg/ha	10	10	10	10	5	10	10	10	10	5	5
Organic Matter		Tonne/ha	20	40	40	20	20	40	40	40	40	40	40

The recommended technique for applying gypsum and organic matter is via a mechanical spreader to the surface of the material prior to stripping (after vegetation removal). Mixing will occur as the material is excavated and relocated to either stockpiling or direct to the areas requiring rehabilitation.

The recommended technique for applying fertiliser is by mechanical spinner to the final rehabilitated surface prior to seed application (if dry spun) or included into the hydromulch blend if using hydromulch to stabilise the final rehabilitated surface. If the soils are mixed during extraction and relocation, then it is recommended that fertiliser application is simplified to a combination blend.

CONCLUSION

Material from the Northern Borrow Pit is suitable, to the depths tested and with the recommended amelioration, for use as a growth medium to support vegetation growth and the attainment of a self-sustaining grazing post-mining land use at the Mt Leyshon Mine.

DISCLAIMER

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Appendix N:
Scats Stockpile Rehabilitation Design Reports

Memo

To:	Glen Ware
From:	Mike Russell
cc:	
Date:	23rd December 2021
Subject:	**Mt Leyshon Scats Stockpile – Rehabilitation Design and Cost Estimate**

Introduction

Newmont Australia requested DumpSolver to undertake a design and cost estimate for the rehabilitation of the Scats Stockpile at their Mt Leyshon mine site. Rehabilitation work is complete on most of the mine site, with the Scats Stockpile being the only major structure remaining in its as-constructed form.

The Scats Stockpile consists of approximately 5.86 Mm^3 of reject material from the processing plant, covering 23.92 Ha. The characteristics of the Scats Stockpile material includes:

- Very hard, relatively uniform ~20 – 30mm size crushed rock, with negligible smaller size fraction.
- They are present as three parallel and joined stockpiles deposited using an advancing conveyor system.
- Potentially Acid Forming (PAF) material, well-blended within the stockpile.

The Scats Stockpile has remained unrehabilitated primarily because of the insitu gold resource. The location of the Scats Stockpiles is:

- Into the eastern side and of a valley that runs South to North.
- The surface water catchment above the Scats Stockpile does not drain any substantially disturbed areas and is therefore considered clean and suitable for direct discharge from the leases. A diversion drain for this water has been constructed on the western side of the valley.
- The stockpiles' slopes remain at the angle of repose (~33°). The upper surfaces of each stockpile are generally flat but irregular.
- In several sections, the toe of the stockpile directly abuts the diversion drain giving little expansion room for the rehabilitated toe.
- Currently, no cover or water diversion structures are present on the Scats Stockpile, which means that all direct rainfall percolates through and exits at the toe of the stockpile at the lower northern end, where it is collected and returned to the pit. The collection and pumping system is temporary in that it isn't acceptable for relinquishment.
- The configuration of the conveyor system used to deposit the scats on the stockpile means that the northern end is lower than the southern end by several metres.

Basis of Design for the Rehabilitated Scats Stockpile

The specification for the rehabilitation design includes:

- A maximum rehabilitated outer slope of 15°. The 15° final slope selection is considered

conservative, reflecting the potential difficulty of reshaping the scats (uniform material size fraction with negligible fines present) and the need for a stable water-shedding final outer surface. The surface stability is enhanced using a good vegetation cover, which is more achievable at a shallower slope. It is beneficial to trial the final slope constructability and subsequent stability for several seasons ahead of the main construction.

- The toe of the rehabilitated scats is constrained to at least 5m laterally from the clean water diversion drain. The use of this standoff is intended to provide room for the landform cover system, toe drain and sediment control. Optimally these structures would be spread over a wider lateral extent. However, the very constrained location makes this challenging to achieve. An evaluation may determine that the clean water drain should be relocated further to the west and/or it's eastern embankment strengthened.
- The proximity of the Scats Stockpile to the clean water drain has required a reasonably complex staged approach for landform reshaping. The aim is to maintain efficient earthmoving within the confined footprint. The practical implication of this is to maximise the use of down-dip dozing and minimise truck and shovel haulage. While presented as individual stages, it is stressed that parts of stages should be undertaken concurrently to maintain efficient operation.

Earthmoving Stage 1 – Reshaping the Western Face

The primary aim of Stage 1 is to create the final 15° profile on the western face.

Figure 1 - Current Scats Stockpile

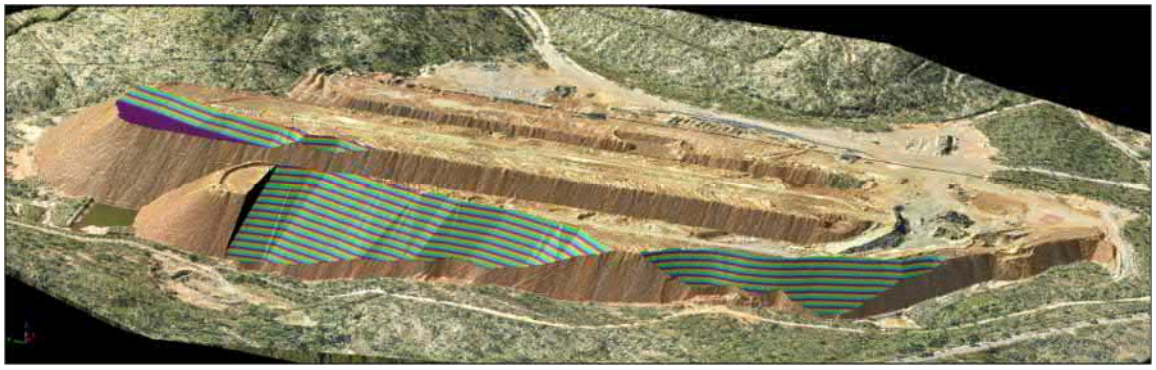

Figure 2 - Slope Cut Requirement

There are three areas of the western slope where the toe constraint requires the relocation of significant scats volume. Figure 2 shows these areas, with two relating to cutting back the western finger and the third being on the central finger. The limited excavation on the central finger can be deferred to Stage 3 if

this is considered beneficial.

The volumes of cut from each area is shown in Table 1 below.

Volume	Load and Haul Only	Doze , then Load and Haul	Total
Western Face - North	14,398	177,336	191,734
Western Face - South	8,304	27,555	35,859
Central Finger	24,075	-	24,075
Total	46,777	204,891	251,668

Table 1 - Stage 1 Cut Volumes

To reduce the volume of material hauled from the toe of the stockpile, the top 3m of each cut on the western face is excavated and directly hauled laterally. The 3m limit is arbitrary and depends on the contractor's selected equipment and ability to operate in a confined area. All of the central finger cut is excavated and hauled laterally.

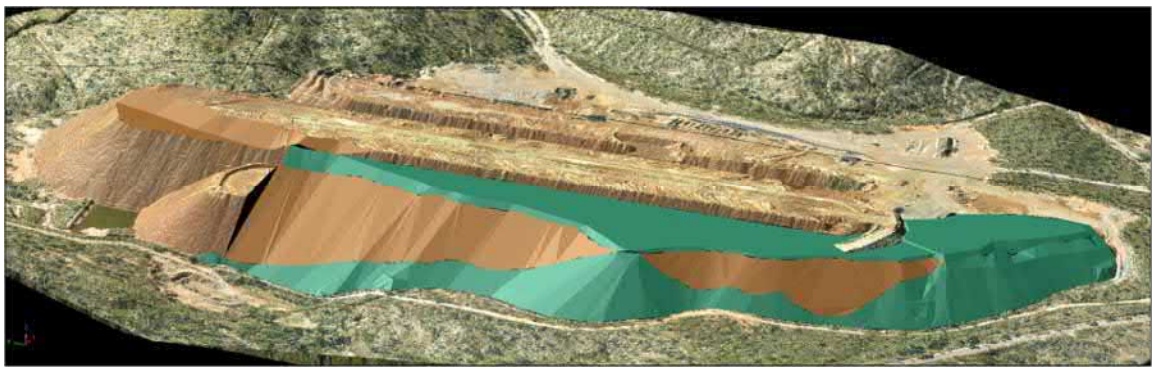

Figure 3 - Landform Post Stage 1

Figure 3 shows the final surface from Stage 1. There are two main areas of deposition for the 205 km^3 of excavated scats being:

- The Western Face The northern and southern cut areas generate a significant volume of scats reporting at the toe of the dump (205 km^3). Figure 4 shows the two western face crest areas in red that generate excess material at the toe. The remaining crest areas, shown in blue, have insufficient material present and require additional material to be dumped at the crest or on the floor below if access is available. Approximately 175 km^3 of material needs is hauled out from the western toe, with 123 km^3 required for the fill of the face.
- Surcharge on the Western Finger While the western face fill can take, in total, about 60% of scats generated in Stage 1, the remaining material, some 99 km^3, is to be placed on top of the western finger and in the gully between the western and central fingers. The final elevation is 389RL, with a small portion at the southern end being half a metre higher. The increase in total elevation of the western finger is acceptable because it directly assists in forming the scats upper surface that falls towards the east (see Stage 4).

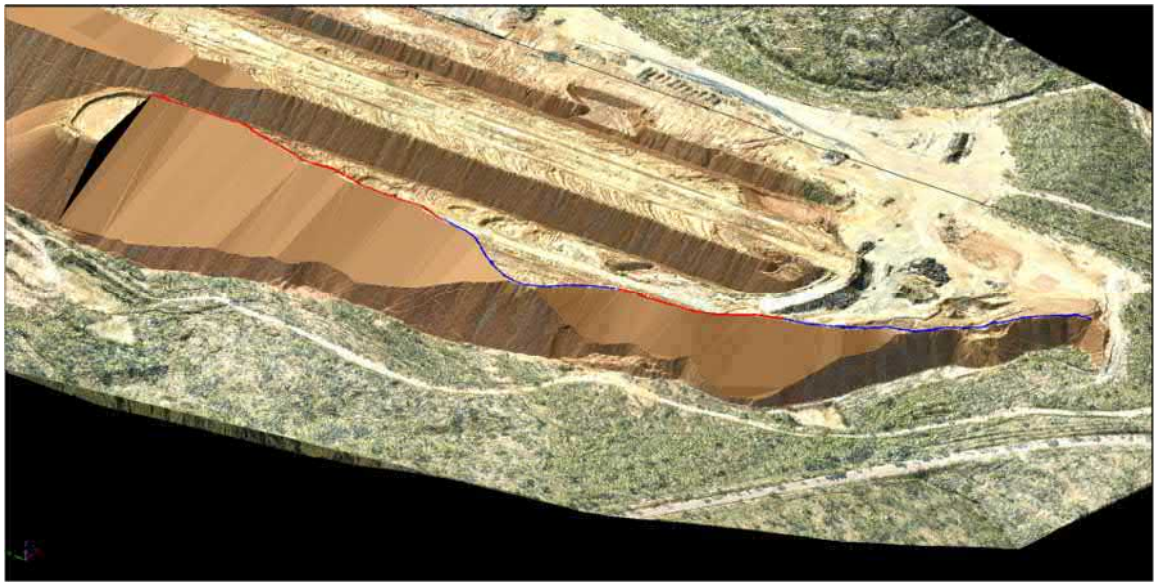

Figure 4 - Crestline Identification of Areas of Excess and Insufficient Fill

Detailed section by section analysis highlights where surplus scats are present at the toe and where additional material is required to form the final 15° slope.

Cost Estimate Stage 1

Tasks	Volume (m3)	Fleet	Fleet Hrs	Cost ($k)	Unit Cost ($/m3)
Doze Prep for Haulage	225,380	Kom D375	589	281	1.25
Load and Haul Scats into Position	251,668	Small	952	1,428	5.67
Face Dozing	127,002	Kom D375	386	184	1.45
Doze Scats into Place	98,844	D8	305	110	1.11
Total	251,668			1,722	6.84

Table 2 – Estimate of the Direct Cost, Stage 1

DumpSolver has estimated the direct costs associated with the Stage 1 works, as shown in Table 2 above. The various tasks are divided into four activities:

- Preparation for Haulage The consists of the dozing work to move surplus material on the western face down to the toe of the dump, ready for haulage away. This dozing results in reshaping the western face to its planned 15°, but this is not the main task.
- Load and Haul Scats Scats are excavated and hauled from two general areas along the toe of the western face. A minor amount, 47 km^3, is excavated and hauled from the top 3m accessible from the finger's upper surface, reducing the total haulage requirement. The majority of the scats, 205 km^3, is present at the toe of the western face. The majority of excavated scats are dumped on the western face to fill the indents in the western face. This is a conservative approach, and local optimisation of material movement may reduce cost.
- Face Dozing The final reshaping of the western face to 15°.
- Scats Placement Where scats are dumped onto the western finger, additional dozing is required to provide a trafficable surface.

Earthmoving Stage 2 – Reshape the Northern End of the Western Finger

Concurrently with part of the work during Stage 1 (northern end), there is the need to reshape the northern end of the western finger and establish the base of the rehabilitated landform.

The maximum northward extent of the rehabilitated Scats Stockpiles was considered. The upper sump (directly north of the western finger toe) was determined to have no long-term significance. However, while the earthworks are underway and for some time afterwards, it would be useful to maintain the main sump at the toe of the central scats finger. To prevent inundation of the toe of the final landform, the toe position of the Scats Stockpile was limited to above the general waterline, i.e. south of the existing pond.

Stage 2 consists of removing scats from the western finger to the post-rehabilitation 15° slope and relocating these northward to form the base of the stockpile. The before and after view of this work is shown in Figure 5 and Figure 6 below.

Figure 5 - Northern End of the Landform at the Nominal End of Stage 1

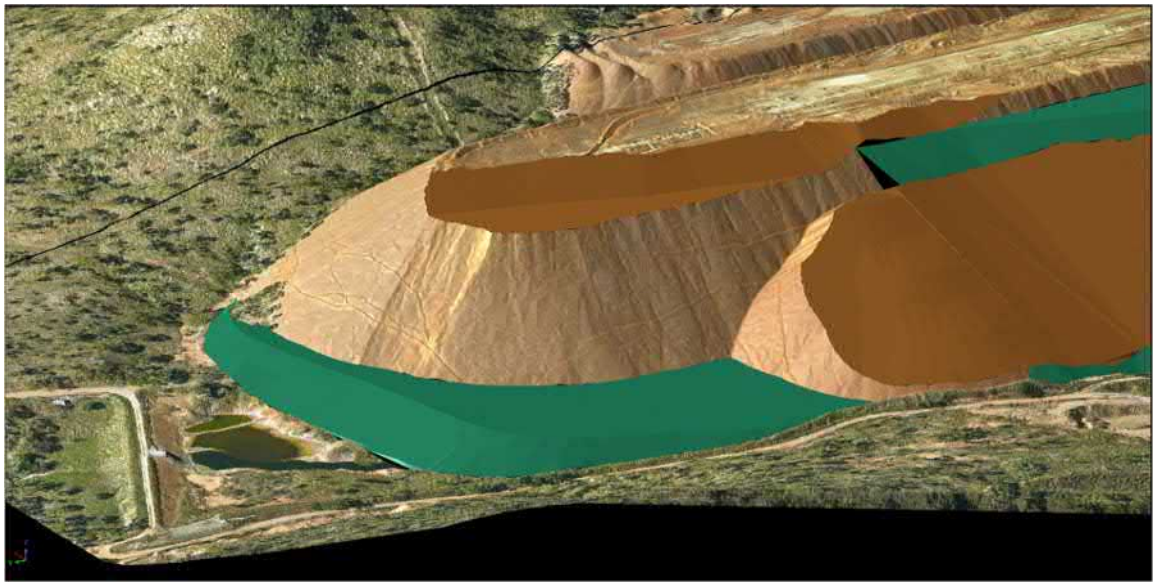

Figure 6 - North End of the Landform Post Stage 2

Of note with the earthworks is:

- A total of 62 km^3 is mined from the northern end and placed as the extended landform's base. The final elevation of the extended stockpile base is 348rl.
- While some of the scats can be dozed into their final position directly, for costing purposes, it has been assumed that all scats are hauled into position with 40t ADT and spread by dozer.

Cost Estimate – Stage 2

Table 3 summarises the direct cost of relocating the northern end of the western finger and forming the base of the extended landform.

Tasks	Volume (m3)	Fleet	Fleet Hrs	Cost ($k)	Unit Cost ($/m3)
Doze Prep for Haulage	62,152	Kom D375	259	123	1.59
Load and Haul Scats into Position	62,152	Small	235	249	4.01
Doze Scats into Place	62,152	D8	191	69	1.11
Total	62,152			441	7.10

Table 3 – Estimate of the Direct Cost, Stage 2

Earthmoving – Stage 3 Reshaping the Northern End of the Central Finger

Stage 3 consists of reshaping the northern end of the central scats finger. The controlled northern extent of the toe, as defined during Stage 2, requires that this is done in two parts:

- Firstly, remove the upper flitches of the north end of the central scats finger down to the 385.5rl (approximately 6.5m below the current elevation). This ties in with the initial work done on the central finger during Stage 1. It amounts to 12.8 km^3 of scats hauled with a 40t ADT type fleet and dumped in the northern end of the gully between the central and eastern fingers. It is a simple haulage task done on the level.
- Secondly, the remaining material, 130.7 km^3, is dozed down into its final position, creating the final slope of 15°. This balanced cut to fill relocation is achieved with a Komatsu D375, or equivalent, dozer dozing efficiently down dip.

After Stage 3, the main earthworks on the northern end of the scats stockpile is complete.

Figure 7 and Figure 8 show the landform at the end of Stages 2 and 3, respectively.

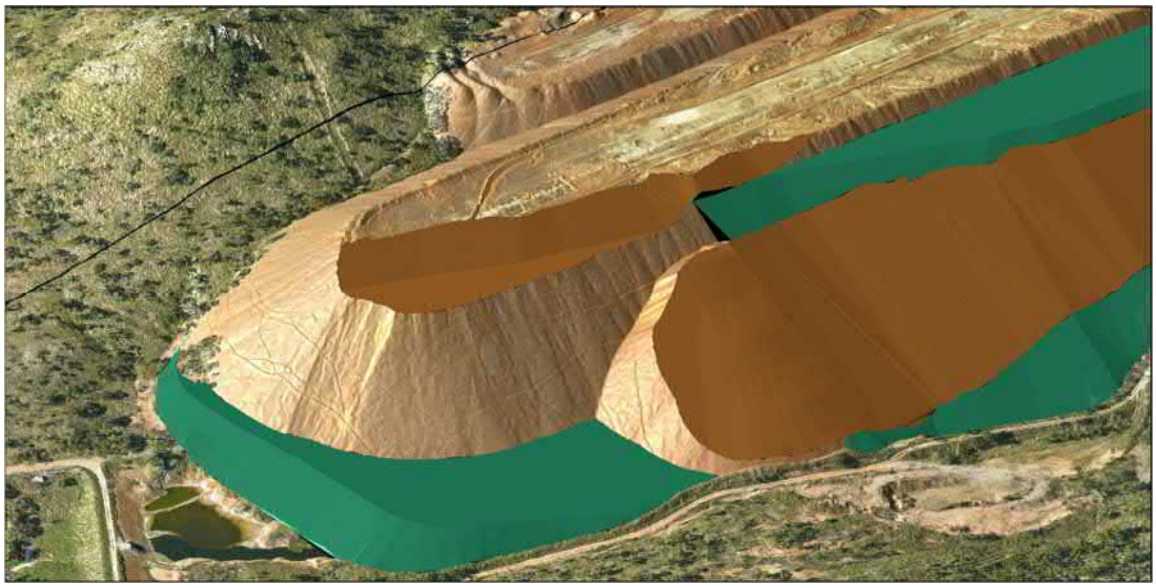

Figure 7 - Northern End of Landform at the End of Stage 2

Figure 8 - Landform Post Stage 3

Cost Estimate – Stage 3

Tasks	Volume (m3)	Fleet	Fleet Hrs	Cost ($k)	Unit Cost ($/m3)
Load and Haul Scats	12,777	Small	48	51	4.01
Doze Scats into Place	12,777	D8	42	15	1.18
Doze Down Central Finger	130,689	Kom D375	600	286	1.75
Total	143,466			352	2.46

Table 4 – Estimate of the Direct Cost, Stage 3

Table 4 summarises the direct cost of relocating the central finger scats into position.

As noted above, while the works are shown as separate stages, there is either the logic or need to integrate some parts of the stages together either for practical purposes or to reduce the overall cost of the rehabilitation works. A case in point is the potential to integrate Stages 2 and 3, whereby all material (with the exception of the unloading of the central finger above the 385.5rl), the two stages "down dip" dozing can be combined to reduce/eliminate the need for the more costly, load and haul component.

Earthmoving Stage 4 – Reprofiling the Upper Surface of Scats Stockpile

The central scats finger was built approximately 5m higher than the two fingers on either side. To minimise the volume of surface runoff on the main slopes that reports to the toe of the dump, it was decided to flatten the upper surface creating a gradual fall to the east. This direction was chosen as it gives an excellent opportunity to handle the runoff, controlling any sediments present.

A series of 45 east-west sections, generally 15m apart, were laid onto the topography along the length of the Scats Stockpile. These sections included the material dumped on the top surface during Stages 1 and 3. Based on creating a shedding top surface, several designs were tried to balance the cut to fill volumes. The criteria were used in the development of the final upper surface, including:

- Western Limit and Slope Work during Stage 1 developed the final western slope at its maximum extent. This formed a hard limit for Stage 4, meaning that while the slope could be extended upward, at 15°, it could not be extended further westward.
- The Upper Surface The upper surface should slope towards the east. While the slope isn't necessarily precisely defined, it was considered that due to an HDPE liner's presence, it should be shallow, over this reasonably large area. For the design, this slope was set at a fall of 1:100 (0.6°).
- Limit the Eastern Extent of the Scats Stockpile As a general statement, it is desirable to minimise the expansion of the scats footprint beyond its eastern limit.

The original intent of the design was to have a greater slope and to taper this onto the natural topography to the east. This was possible in the southern end, where there wasn't a central finger. However, this was not practical for the remainder, so the top surface was flattened and the dump extent limited on the eastern side using a short 12° slope off the dump.

Images of the landform before and after the Stage 4 work are shown in Figure 9 and Figure 10 below.

An evaluation was made as to the most efficient manner of creating the modified surface, either load and haul or dozing. It was determined that dozing was the most cost-effective solution.

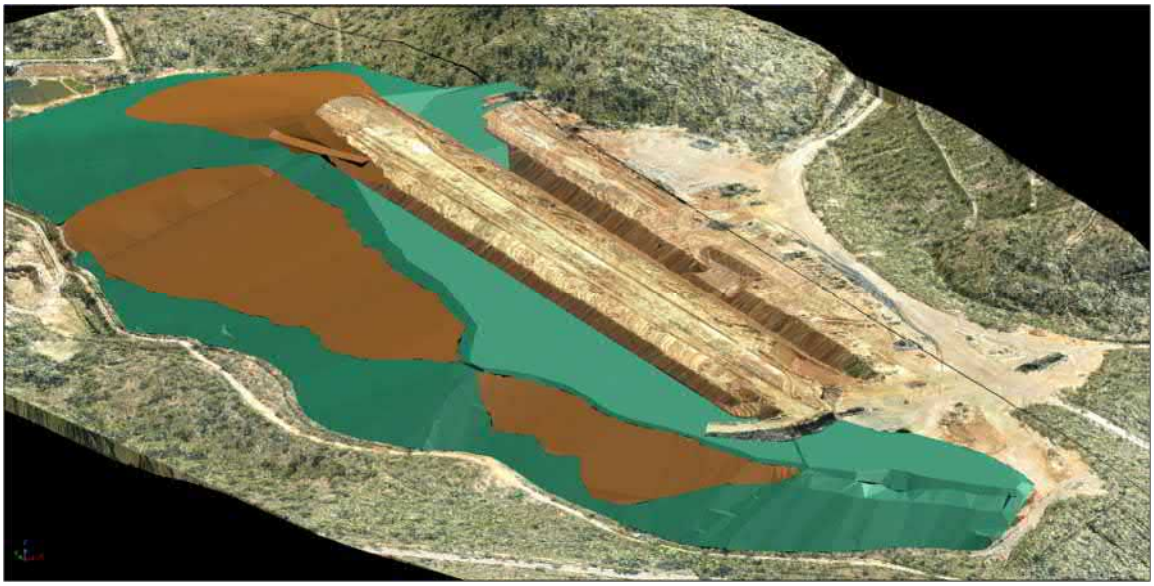

Figure 9 - Landform Post Stage 4

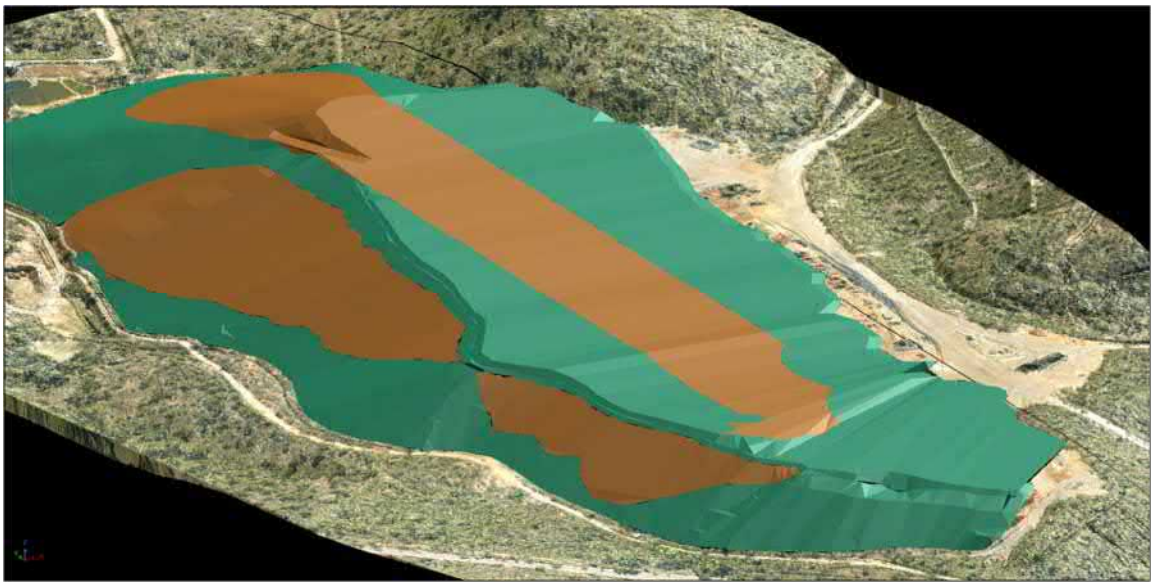

Figure 10 - Landform Post Stage 4 Post work on the Top Surface

Cost Estimate – Stage 4

Tasks	Volume (m3)	Fleet	Fleet Hrs	Cost ($k)	Unit Cost ($/m3)
Lateral Dozing	170,215	Kom D375	915	436	2.56
Total	-	0.00	-	436	-

Table 5 - Estimate of the Direct Cost, Stage 4

Stage 5 – Cover System for the Scats Landform

The capping of the reprofiled Scats Stockpile has three tasks, namely:

- Preparation and Installation of an HDPE Liner An HDPE liner will be installed over the entire scats footprint, slopes and flat surfaces. The uniform size fraction of the scats suggests that reasonably limited preparation work is required ahead of installing the line. An allowance has been made for grading and compacting the surface, though the compaction may be replaced with the importation of a fine-grained layer.
- Cover System A 0.5m thick layer of armouring/growth medium is installed over all surfaces. Care is required to maintain the liner's integrity during Installation and the constructability of a cover layer on a 15° slope.
- Hydromulch Based on the successful use of hydromulch for Mt Leyshon's Roche Hill remediation in 2017, provision has been made for the full hydromulching of the scats stockpile. It may be preferable to revert to conventional seeding over the "flat" top surface (~12Ha) with a reduction in total cost.

Cost Estimate – Stage 5

Tasks	Volume (m3)	Fleet	Fleet Hrs	Cost ($k)	Unit Cost ($/m3)
Prep and Instalation of Liner	-	-	-	6,157	
Load and Haul Cover	131,820	Small	498	1,138	8.63
Doze Cover into Place	131,820	D8	747	331	2.51
Hydromulch	-	-	-	360	
General Surface Dozing	-	D8	120	43	
Total		-	-	8,030	-

Table 6 - Estimate of Direct Costs, Stage 5

It is noted that the HDPE liner and its installation make up a significant portion of the total cost for Scats Stockpile rehabilitation. For this reason, it is recommended that further evaluation be undertaken, including obtaining indicative installation requirements and costs.

As noted elsewhere, the surface water runoff from the top surface of the Scats Stockpile moves to the east. Further, minor design work is required to control and handle this runoff appropriately.

Total Direct Cost of the Scats Stopile Rehabilitation

Based on the work noted above, the estimated direct costs are $10.98M.

Basis of the Estimate

A detailed and volumetrically balanced rehabilitation design was developed ahead of the cost estimation. It reflected the necessary physical constraints to any design and the mining equipment required. As noted above, the tasks have a level of complexity, but it is considered executable by a competent mining or rehabilitation contractor.

The cost estimate was developed from first principles for each specific task. Essentially this is made up of the following components:

- Evaluation of the Design Effectively developing a detailed understanding of the individual tasks, including the volumes to be moved, the relocation distances and any other physical attributes that specify the equipment or equipment fleet required.
- Contractor Wet Hire Rates Based upon either quoted equipment hire rates or recent work in a

similarly remote locations, the direct wet hire rate is estimated. It is inclusive of:

- The equipment hiring rate per direct operating hour.
- The operating labour cost (if not included in the above) includes direct salary and overheads.
- Fuel (if not included in the above) based upon the equipment duty cycle.

Not included, at this stage, is supervision, owner costs and sited base costs (e.g. accommodation, messing and flights, etc.) or contingency which may be applied later.

Of note is that the cost is developed per direct operating hour, which is the number of hours available to undertake the task and excludes such items as safety meeting, crib, refuelling, transit to the workplace, equipment maintenance, etc.

- Equipment Productivity For each task, the productivity of the individual pieces of equipment per direct operating hour was estimated. It considers such factors as equipment size and speed as well as "on the job" factors such as distances, slopes, material types, etc. The derivation of equipment productivity has been used for the majority of tasks and includes an allowance for various production efficiencies, including operator experience. It assumes that the equipment will be operated efficiently but for a "day shift only" type operation. This was selected to ensure that care and close supervision are required, like most rehabilitation projects.

Thus the estimated cost was developed for a robust logical base rather than using generic per hectare rates.

Mike Russell
Director
DumpSolver Pty Ltd
mike@dumpsolver.com.au

MEMORANDUM

Project:	M13000_024	**Date:**	28 July 2022
To:	Newmont	**From:**	Engeny
ATT:	Glen Ware	**CC:**	N/A
Subject:	Scats Stockpile Rehabilitation Design		

INTRODUCTION

This memorandum is a standalone document that is intended to be read in conjunction with the Mt Leyshon Mine Progressive Rehabilitation and Closure Plan (PRCP). This memorandum details the proposed rehabilitation design for the Scats Stockpile at the Mt Leyshon Mine.

OVERVIEW OF THE SCATS STOCKPILE

As shown in Figure 1, the Scats Stockpile is the only major landform at the Mt Leyshon Mine that has not been rehabilitated. It covers an area of approximately 30 ha and consists of approximately 5.86 Mm^3 (9.8 Mt) of scats (ore grade material that entered the mill during CIP processing operations but was found to be unusually hard and was therefore rejected from the crushing circuit). The scats were deposited using an advancing conveyor system into three elongated 'fingers'. The outer surface of the fingers is at the natural angle of repose (approximately 33º). The top surface of the fingers is currently generally flat but irregular, with the northern end being several meters lower than the southern end.

A clean water diversion drain has been constructed on the western side of the Scats Stockpile to divert clean runoff from the south around the Scats Stockpile and Plum Tree Creek Dam and into Plum Tree Creek. In some locations, the toe of the Scats Stockpile is in close proximity to the clean water diversion drain, which prevents any further expansion of the stockpile footprint to the west for the final landform design of the Scats Stockpile.

Figure 1: Scats Stockpile

A material characterisation study of the scats was carried out in 1993 (Woodward Clyde, 1993). The main findings from the study were as follows:

- Relatively uniform particle size (~20 – 30 mm) with negligible fines content.
- Average total sulphur content of 3%.
- The portion of total sulphur being in the reactive form of pyrite was higher in the scats than in the tailings and waste rock samples tested.
- NAPP defined from the various static tests was typically in the range 30 – 100 kg H_2SO_4/t confirming that the scats would be acid generating if all the component minerals were to be weathered and released.
- Digestion of scats samples followed by multi-element composition analyses indicated elevated average concentrations of copper (278 mg/kg), manganese (2,880 mg/kg) and zinc (793 mg/kg).
- Operation of the leach columns for 8 weeks provided leachate samples with pH between 3.3 and 4.0 with elevated concentrations of sulphate, copper and zinc.

SCATS STOCKPILE REHABILITATION DESIGN

A range of rehabilitation designs for the Scats Stockpile have been investigated during the post-closure phase of the site, including processing the scats, disposing of the scats into the open-cut pit, covering the Scats Stockpile (full or partial cover) and maintaining the Scats Stockpile as it currently stands. Most recently, a rehabilitation design for the Scats Stockpile was developed by DumpSolver (who was responsible for the rehabilitation designs for the Roche Hill Rehabilitation Project which Newmont executed in 2017) in December 2021 (this design proposed a HDPE liner system which has since been superseded by a more robust Bituminous Geotextile Membrane liner system as described in this Memo). Key aspects of the final landform design for the Scats Stockpile are summarised below.

BASIS OF DESIGN

The basis of design for the Scats Stockpile rehabilitation design is as follows:

- A maximum outer slope of 15º:
  - A 15º outer slope is considered to be conservative, reflecting the potential difficulty of reshaping the scats (due to their uniform particle size and negligible fines content) and the need to achieve a stable, water-shedding final landform. Vegetation coverage enhances surface stability, which is easier to achieve on shallower slopes. It is anticipated that the constructability and subsequent stability of the outer slope will be trialled for several wet seasons prior to construction.
- A minimum distance between the toe of the rehabilitated landform and the clean water diversion drain to the west of the Scats Stockpile of 5 m:
  - This minimum distance is intended to provide room for the cover system, toe drain and sediment control. Optimally, these features would be spread over a larger lateral extent. However, the very constrained location of the Scats Stockpile makes this challenging to achieve. Further design work and investigations may determine that the clean water diversion drain to the west of the Scats Stockpile should be relocated further to the west (this will be difficult to achieve due to steep topography) and/or the eastern embankment of the clean water diversion drain should be strengthened.

RE-PROFILING STAGES

The proximity of the Scats Stockpile to the clean water diversion drain has resulted in a relatively complex, staged approach to re-profiling the Scats Stockpile. While presented as four discrete re-profiling stages, some stages or parts of stages will be undertaken concurrently (e.g. Stages 2 and 3) to maximise the use of down-dip dozing and eliminate/reduce the need for more costly truck and shovel haulage whilst preserving the surface water management system objectives.

RE-PROFILING STAGE 1 (FIGURE 2)

The aim of Stage 1 is to create an outer slope of 15º on the western face of the Scats Stockpile. This involves shifting a significant volume of scats from the western and central fingers. The scats will be placed on the western face, on top of the western finger, and in the gully between the western and central fingers. This will increase the elevation of the western finger, which is acceptable because it will assist in creating a top surface that falls towards the east (i.e. no valleys or depressions).

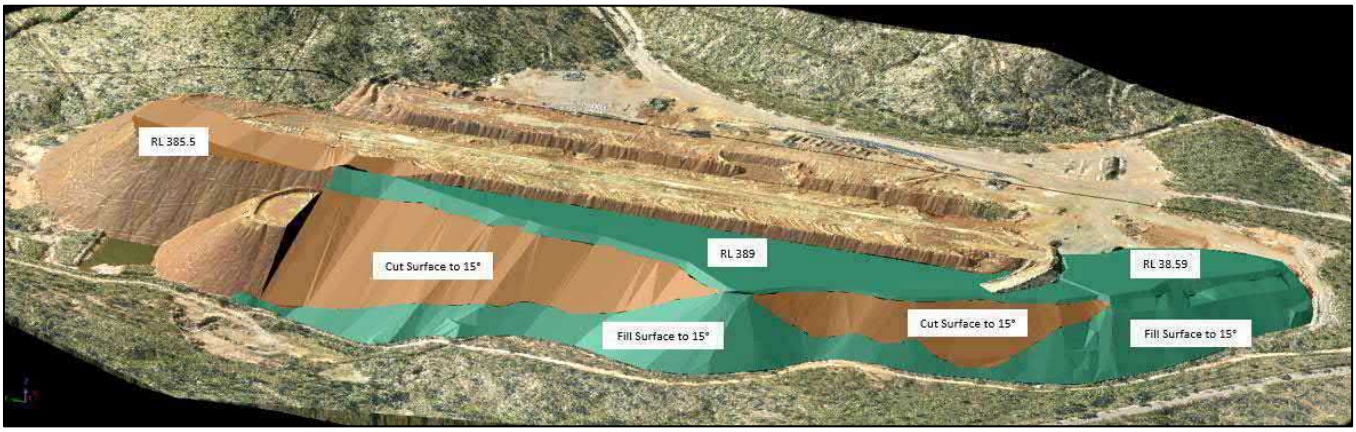

Figure 2: Scats Stockpile Re-Profiling Stage 1

RE-PROFILING STAGE 2 (FIGURE 3)

The aim of Stage 2 is to create an outer slope of 15º on the northern ends of the western and central fingers. This involves shifting scats from the western finger and placing it to the north of the western and central fingers. The Upper Plum Tree Creek Dam will be fully subsumed by the re-profiled landform (current dam is already partly infilled by the stockpiles); however, the Plum Tree Creek Dam will remain in place during rehabilitation and for some time afterwards to capture any seepage and to act as a sediment basin for the steeper western and northern batters of the Scats Stockpile final landform during vegetation establishment. Water quality in the Plum Tree Creek Dam will be monitored to ensure that the rehabilitated Scats Stockpile is trending towards achieving a stable condition.

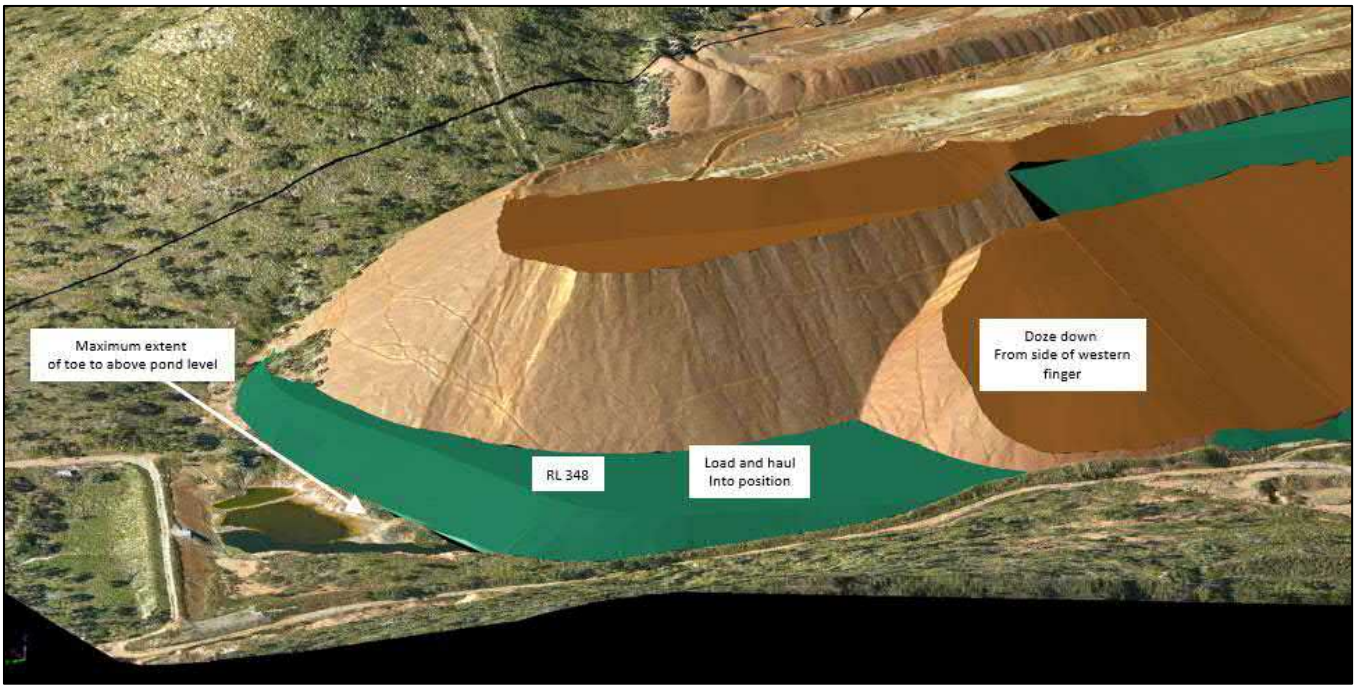

Figure 3: Scats Stockpile Re-Profiling Stage 2

RE-PROFILING STAGE 3 (FIGURE 4)

The aim of Stage 3 is to create an outer slope of 15º around the entire northern end of the central finger. This involves shifting scats from the top of the central finger and placing it around the northern end of the central finger. As stated above, Stages 2 and 3 may be undertaken concurrently to maximise the use of down-dip dozing and eliminate/reduce the need for more costly truck and shovel haulage.

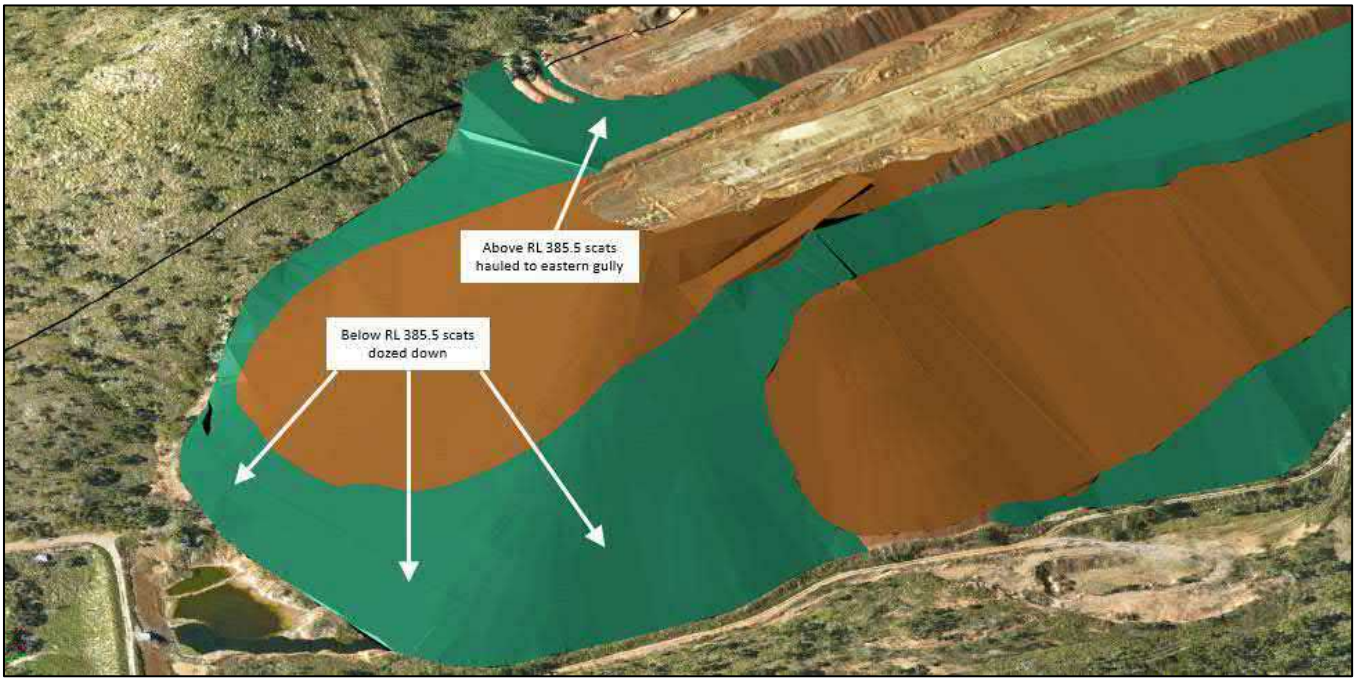

Figure 4: Scats Stockpile Re-Profiling Stage 3

RE-PROFILING STAGE 4 (FIGURE 5)

The aim of Stage 4 is to flatten the top surface of the Scats Stockpile and create a gradual fall to the east of 1% (0.6º). At the very southern end of the Scats Stockpile, the final landform will tie-in to the natural topography in the east. This wasn't possible for the remainder of the Scats Stockpile, so a 12º slope of the eastern face of the Scats Stockpile will be constructed, although to a much lower height/shorter slope than the western and northern batters of the landform.

Stage 4 will remove the 'fingers and valleys' profile from the Scats Stockpile landform.

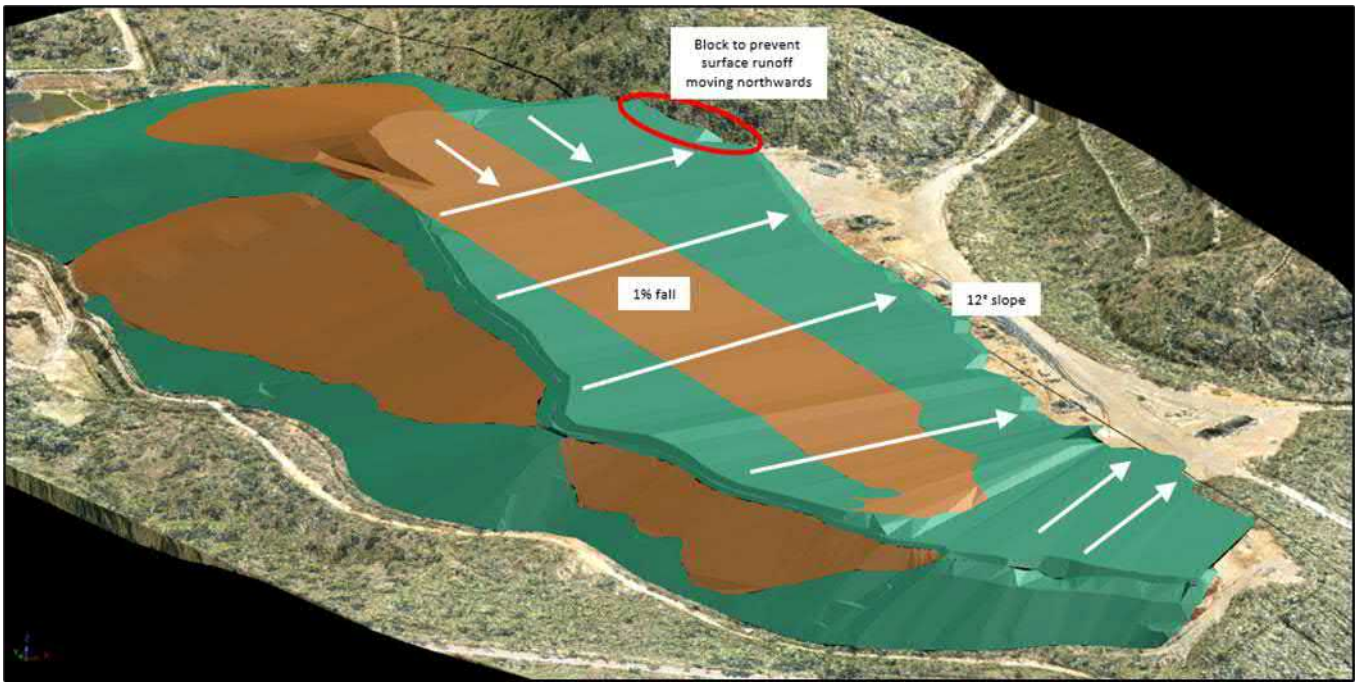

Figure 5: Stats Stockpile Re-Profiling Stage 4

Figure 6 shows the direction of surface water drainage flows off the Scats Stockpile surface at the completion of Stage 4. Surface water drainage on the rehabilitated landform will occur by way of sheet flow down the vegetated surfaces of the landform, with constructed drainage channels around the perimeter of the landform. The Plum Tree Creek Dam will be retained at the northern end of the landform to collect any seepage water and to act as a sediment dam for the steeper western and northern batters of the landform. The rehabilitated Scats Stockpile landform will be a free-draining surface.

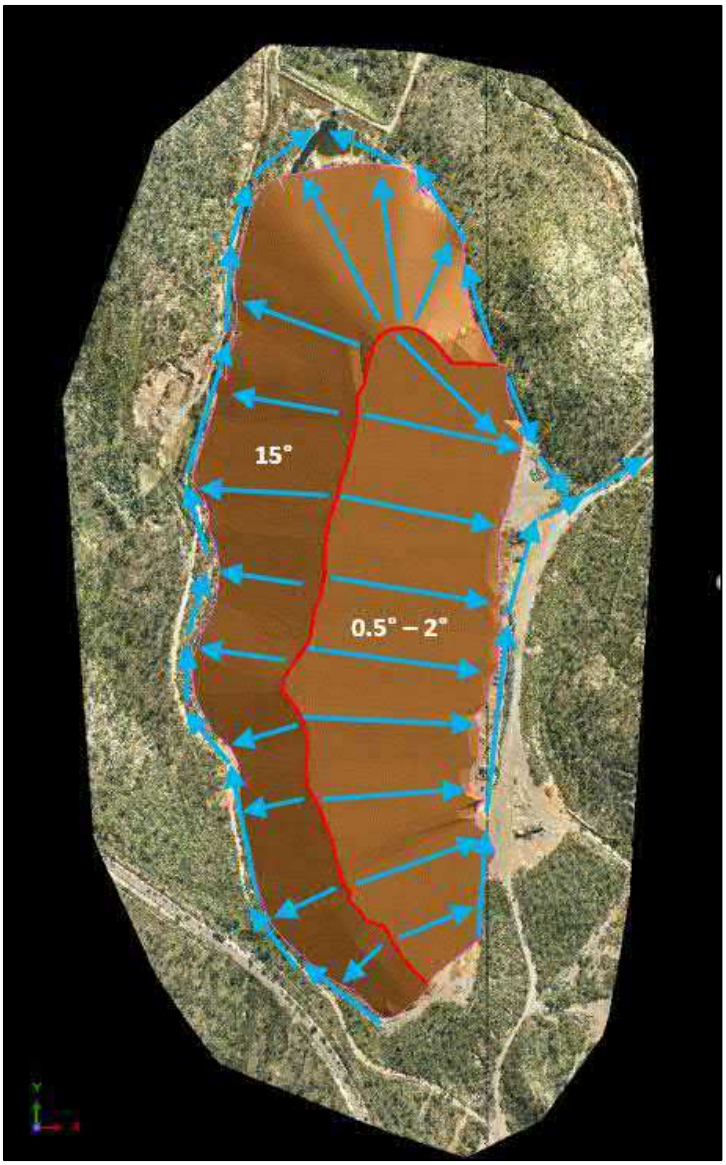

Figure 6: Scats Stockpile Drainage

COVER SYSTEM DESIGN

The cover system for the rehabilitated Scats Stockpile will comprise:

- Bituminous geotextile membrane (BGM) liner – A BGM liner will be installed over the entire re-profiled Scats Stockpile. The uniform particle size of the scats suggests that limited preparation (e.g. grading and compaction) will be required prior to installing the liner.
  - A BGM is a composite material, typically consisting of non-woven geotextile and glass fleece or polyester layers impregnated with and encapsulated in elastomeric bitumen, with a sand textured surface on one side (lower side) for enhanced friction contact with the subgrade and an anti-piercing/root barrier layer on the other side (upper side). The geotextiles dictate the mechanical properties of the BGM, while the elastomeric bitumen provides waterproofing, chemical resistance and protection from ageing.
  - A nominal 5 mm thick BGM liner (Teranap 531 or similar) is considered suitable for the Scats Stockpile rehabilitation.

- BGM liners are suitable for installation on rough subgrades such as the Scats Stockpile.
- Care will be taken when unloading and installing the BGM liner to prevent deformation of or damage to the BGM liner.

- Growth media – A 0.5 m thick layer of growth media will be installed over the BGM liner. When placing topsoil on the western and northern slopes of the landform, care will be taken to maintain the integrity of the BGM liner.
- Hydromulch – Based on the successful use of hydromulch during the Roche Hill Rehabilitation Project in 2017, hydromulch may also be applied to the rehabilitated Scats Stockpile. The benefits of applying hydromulch are to bind the surface media to provide erosion resistance and to establish cover quickly.

A capillary break layer is not expected to be required as the likelihood of the Scats Stockpile being able to support any capillary action would be very low due to the very coarse nature and uniform particle size of the scats (particle size of ~20 – 30 mm with low fines content).

EROSIONAL STABILITY ASSESSMENT

An erosional stability assessment of the rehabilitated Scats Stockpile landform has been completed using the Revised Universal Soil Loss Equation (RUSLE), an empirical-based modelling approach that predicts the long-term average annual rate of soil erosion.

The RUSLE can be expressed as follows:

$$A = R \times K \times LS \times C \times P$$

Where:

- A = estimated average soil loss in tonnes per hectare per year;
- R = rainfall-runoff erosivity factor;
- K = soil erodibility factor;
- LS = slope length and steepness factor;
- C = cover-management factor; and
- P = support practice factor.

The following sections describe the derivation of each of these factors for the rehabilitated Scats Stockpile landform, as well as the recently (2017) rehabilitated Roche Hill landform which, due its rehabilitation success (rehabilitation monitoring results indicate that the Roche Hill landform has been erosionally stable since the initial establishment of a moderate vegetation cover on the rehabilitated landform), has been used as a benchmark for an acceptable rate of soil erosion loss from a stable landform at the Mt Leyshon Mine.

R FACTOR

The R factor for the Scats Stockpile and Roche Hill landform was sourced from the CSIRO R Factor DEM file (Viscarra Rossel, et al.) which mapped all landforms at the Mt Leyshon Mine as having an R factor of 3346.

K FACTOR

Growth media needed for rehabilitation of the Scats Stockpile will be sourced from the Northern Borrow Pit. Material from the Northern Borrow Pit was sampled and analysed in March 2022 (Engeny, 2022), returning an average K factor of 0.035. Amelioration is expected to alter the chemical and structural properties of the material won from the borrow pit and reduce the average K factor by approximately 0.005. Therefore, a K factor of 0.030 was adopted for the Scats Stockpile.

Material from on-site borrow pits in the general vicinity of the proposed Northern Borrow Pit was used to rehabilitate the heavily eroded Roche Hill landform in 2017. It is understood that this material was not ameliorated prior to use, therefore a K factor of 0.035 was adopted for Roche Hill.

LS FACTOR

LS factors for the Scats Stockpile and Roche Hill landform were derived using spatial data (refer to Figure 7 and Table 1). LS factors were derived for four different locations on the Scats Stockpile final landform, representing the range of slope gradients and lengths, and therefore soil erosion rates, that may be encountered on the rehabilitated Scats Stockpile landform (and Roche Hill).

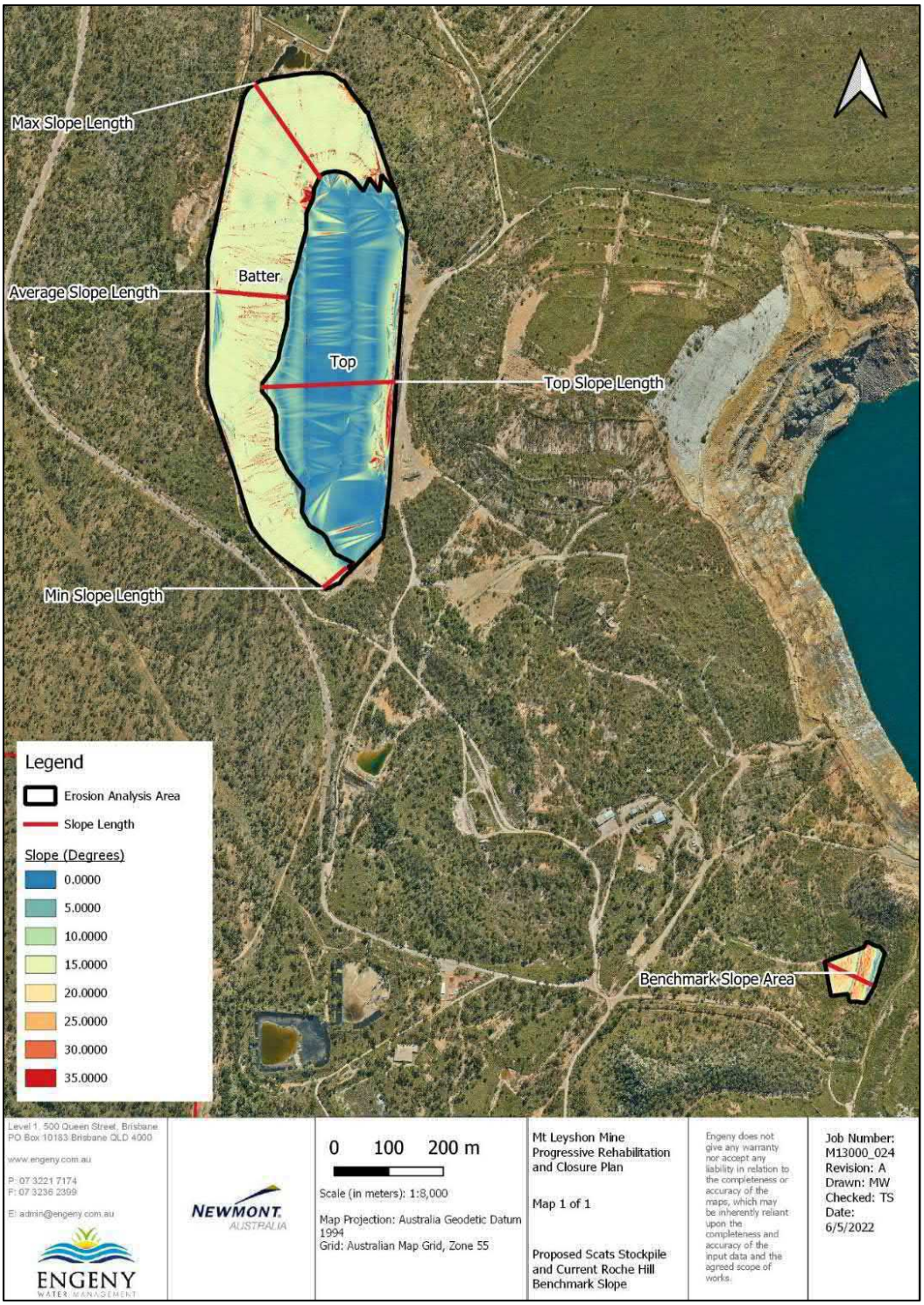

Figure 7: Areas on the Scats Stockpile Final Landform for which LS Factors Were Derived

Table 1: LS Factors for Different Areas on the Scats Stockpile and Roche Hill

Area on Scats Stockpile	Slope Steepness	Slope Length	Corresponding LS Factor
Scats Stockpile – Top Maximum	10% (equivalent to 6º)	260m	4.03

Scats Stockpile – Batter Maximum	27% (equivalent to 15º)	210m	18.45
Scats Stockpile – Batter Minimum	27% (equivalent to 15º)	55m	9.44
Scats Stockpile – Batter Average	27% (equivalent to 15º)	130m	15.52
Roche Hill	34% (equivalent to 19º)	100m	19.20

C FACTOR

Vegetation coverage on the Roche Hill landform was analysed using the Catchments and Creeks Visual Cover Estimation Template (Catchments and Creeks, 2010). A summary of the analysis is provided in Table 2. Vegetation coverage was approximately 60% when the landform was first considered to be 'stable' in terms of erosion in 2019. Recent photographs show that vegetation coverage has increased to 90%. Similar vegetation establishment trends are expected on the Scats Stockpile based on the proposed application of hydromulch (consistent with Roche Hill). Therefore, for the purpose of the erosional stability assessment, a range of C factors corresponding to vegetation coverages between 50% and 90% were adopted to demonstrate the reduction in soil erosion with increasing vegetation coverage. The C factors were obtained from the IECA Erosion and Sediment Control Guidelines (IECA, 2008).

Table 2: Vegetation Coverage on the Roche Hill Landforms and Corresponding C Factors

Year	Rehabilitation Status	Landform Condition	Photos	Vegetation Coverage	Corresponding C Factor
2017	Prior to vegetation establishment	Not Stable		<2%	-
2019	During vegetation establishment	Stable		60%	0.1
2021	Vegetation established	Stable		80%	0.025
2022	Vegetation established	Stable		90%	0.01

P FACTOR

The cover system for the Scats Stockpile will include a 0.5 m thick layer of growth media with light ripping on the contour consistent with best practical soil conservation. The Roche Hill landform was rehabilitated in a similar manner. As such, a P factor of 0.8 was adopted for the Scats Stockpile and Roche Hill landform.

GUIDELINE/LITERATURE VALUES FOR ACCEPTABLE SOIL LOSS FROM REHABILITATION LANDFORMS

For the purpose of benchmarking for the predicted rate of soil erosion from the Scats Stockpile final landform against other successfully rehabilitated landforms and 'acceptable' rates of soil erosion for a stable landform, a brief literature review was undertaken which found that published 'acceptable' rates of soil erosion vary considerably. For instance:

- Historically, Environmental Management Overview Strategies (EMOSs) have included conditions requiring mines to target soil loss rates from rehabilitated landforms of between 12 t/ha/yr and 14 t/ha/yr (Welsh, R, Garillp, & Gillespie, 1994).
- The *Soil Conservation Measures Design Manual for Queensland* (Carey & Barry, 2004) nominates approximately 12.5 t/ha/yr as an acceptable soil loss rate.
- IECA (IECA, 2008) considers landforms to have a 'Very Low' erosion hazard rating if the average soil loss is below 150 t/ha/yr.

EROSIONAL STABILITY ASSESSMENT RESULTS

The results of the erosional stability assessment for the Scats Stockpile final landform are presented in Figure 8.

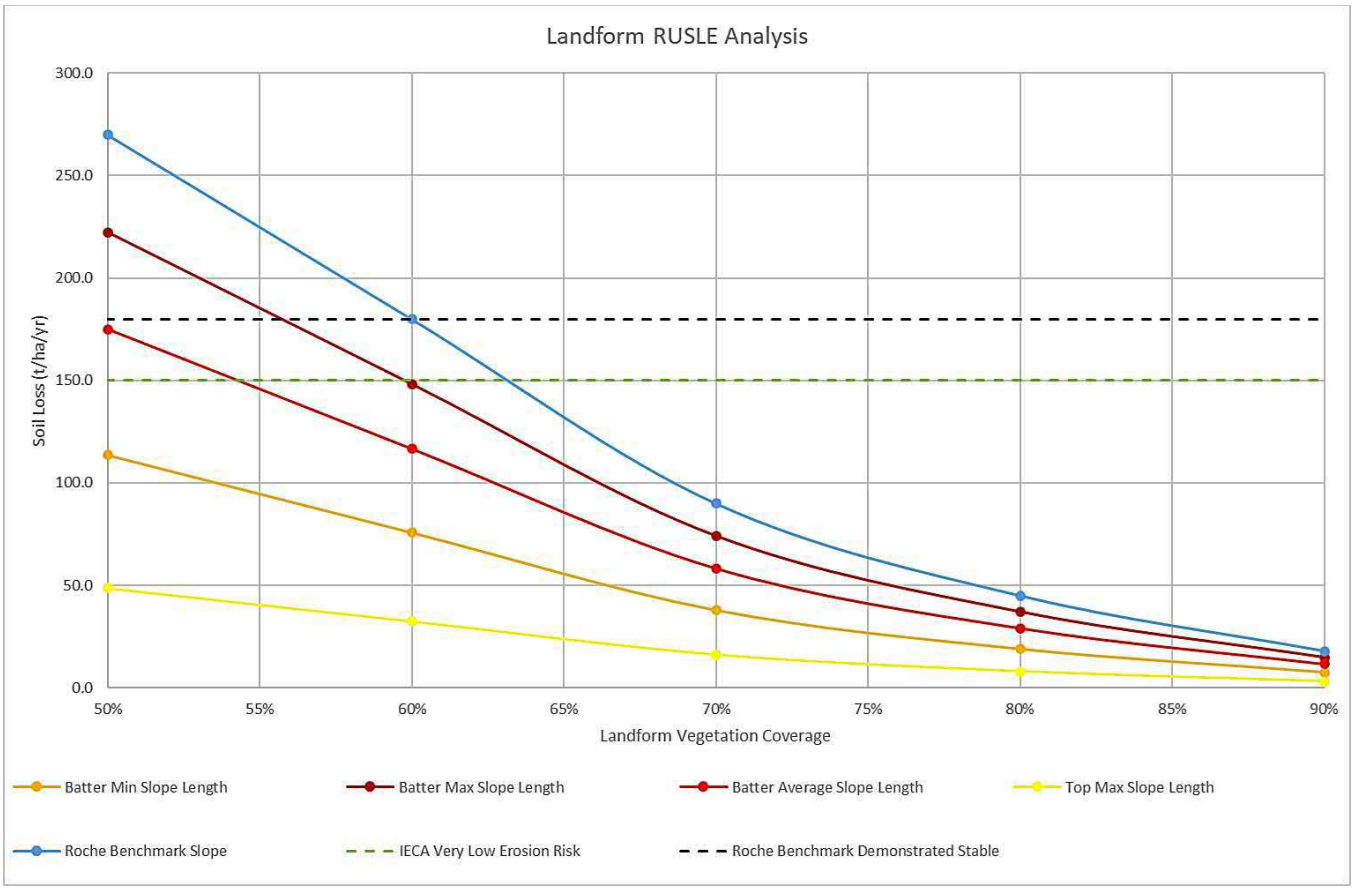

Figure 8: Results of the Erosional Stability Assessment for the Scats Stockpile Final Landform

The results show that:

- The top of the Scats Stockpile final landform represents the lowest risk of erosion – lower than the Roche Hill landform and lower than the IECA threshold for 'very low' erosion hazard landforms. The predicted rate of soil loss from the top of the Scats Stockpile once 90% vegetation coverage is achieved is approximately 3.2 t/ha/yr.
- The batters of the Scats Stockpile also present a relatively low risk of erosion – lower than the Roche Hill landform, and lower than the IECA threshold for 'very low' erosion hazard landforms once 60% vegetation coverage on the steepest areas of the batters has been achieved. The predicted rate of soil loss from the batters once 90% vegetation coverage is achieved ranges from 7.6 t/ha/yr on the shallow slopes and 14.8 t/ha/yr on the steep slopes.

The rate of soil erosion from all areas on the rehabilitated Scats Stockpile final landform is predicted to be less than the IECA threshold for 'very low' erosion hazard landforms once 60% vegetation coverage has been achieved. Considering that growth media for the Scats Stockpile rehabilitation will be sourced from a similar area to where growth media was sourced for Roche Hill, it is expected that 60% vegetation coverage on the Scats Stockpile will be achieved in a similar timeframe to Roche Hill (approximately two years). This timeframe has been factored in the PRCP schedule.

GEOTECHNICAL STABILITY ASSESSMENT

Since the existing Scats Stockpile has been observed over time to be geotechnically stable (i.e. no slumping or slope failures of the side batter slopes) at the angle of repose of the scats material (approximately 33º), the proposed maximum batter slopes for the final landform (15º) will also be geotechnically stable.

Interface friction (i.e. the ability of the growth media to 'hang' on to the BGM liner without sliding off) was considered when selecting the liner for the Scats Stockpile rehabilitation. Based on experience and existing testing of similar materials and information provided by the BGM manufacturer (Geofabrics Australia), the interface friction between a clayey soil growth media such as the material that will be sourced from the Northern Borrow Pit and a BGM liner is approximately 23.5º (i.e. the growth media is highly likely to slide off the BGM liner if the slope angle is greater than 23.5º). As the reprofiled Scats Stockpile will have a maximum outer slope of 15º, there is a low risk of the growth media siding off the BGM liner (Factor of Safety (FoS) >1.5).

POST-MINING LAND USE

The post-mining land use for the rehabilitated Scats Stockpile is grazing. Grazing will take the form of light grazing in accessible areas (i.e. on the top of the rehabilitated Scats Stockpile). This is consistent with the pre-mining topography and surrounding land which contains steeper areas which are not suited to grazing.

DISCLAIMER

This memo has been prepared on behalf of and for the exclusive use of Newmont and is subject to and issued in accordance with Newmont instruction to Engeny Water Management (Engeny). The content of this memo was based on previous information and studies supplied by Newmont

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Appendix O:
Updated Assessment of Mt Leyshon Groundwater Chemistry for 2022

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1 June 2022

Re: Updated assessment of Mt Leyshon groundwater chemistry for 2022

Dear Glen,

As requested, please find following an updated assessment of the site wide hydrochemistry of the shallow groundwater system at the Mt Leyshon mine which has been completed using site wide sampling data collected in April 2022.

1 INTRODUCTION

The Mt Leyshon site is an open pit gold mine located 24 km south of Charters Towers, which has been closed since 2002. Mt Leyshon commenced operations in September 1986. It produced gold and silver, initially as a heap leach operation of oxide ore, and then via carbon in pulp processing of primary un-oxidised ore in 1989. Open pit mining ceased due to depletion of the ore body in early 2001 after which mill feed was sourced from low grade stockpiles which were processed until March 2002. Maintenance and rehabilitation of the site is being undertaken by Newmont Landco Pty Ltd (Newmont).

Facilities constructed during the mining period included three Tailings Storage Facilities (TSFs), three Waste Rock Storage Facilities (WRSFs) and a Scats Stockpile. With the exception of the Scats Stockpile all of these facilities have been rehabilitated with covers, drainage channels have been constructed to remove runoff and vegetation has been established. Seepage emerging from the bases of the facilities in the locations of surface water drainages is captured in containment structures and pumped to the lake in the open pit. However investigations during mining and closure have identified that some facility seepage enters the shallow groundwater system and migrates into the receiving environment.

A detailed characterisation of the shallow groundwater system was undertaken from 2009 to 2012 (SWS, 2012). Subsequently a numerical groundwater model was constructed to simulate sulphate transport within the groundwater system and to predict the future extent of groundwater influenced by the mine facilities (SWS, 2013). The Groundwater Management Plan for Mt Leyshon was compiled in 2013 (GMP, see BDH, 2017a), and noted that in combination the groundwater investigations and modelling indicated that if the facility covers continued to perform at the same level, long term changes in the extent of groundwater influenced by the mine facilities would be restricted to a modelled migration of around one to two km along Schreibers Creek to the northeast of the mine and around one to two km along One Mile Creek and Two Mile Creek to the southeast of the mine. A key outcome of the model was that the long term extent of sulphate remained within Newmont controlled land. The model predicted that under average precipitation conditions, sulphate concentrations would stabilise or even decrease after 2012 in many locations.

The GMP implemented a routine groundwater monitoring regime sampling selected monitoring bores in key locations every three months and this regime has been formalised within the Environmental Authority (EA). The rationale for the selection of monitored bores and the classification of the bores was as follows:

- Background bores. Two bores are located upgradient of the mine facilities and are sampled to identify background regional trends in groundwater chemistry.
- Interpretation bores. Interpretation bores are located close to the mine facilities and within areas of known mine influence on groundwater. They are intended to provide early warning of any change in the rate or hydrochemistry of seepage from the rehabilitated mine facilities.
- Compliance bores. Compliance bores are located distant from the mine facilities and in the downgradient receiving environment. They measure the combined influences of seepage which occurred during the operating period and seepage occurring in closure. The compliance locations were selected to confirm the model predictions of future seepage migration in the receiving environment, and include locations within the modelled expansion zones to the northeast and southeast of the mine.

Monitoring data collected from the bores specified in the EA have been reviewed annually from 2014 to 2022 and it has been concluded that the observed changes in groundwater conditions match the existing conceptual and numerical models of the shallow groundwater system.

Five years after completion of the numerical groundwater model in 2013 Newmont collected groundwater samples from all accessible bores (in June 2017) and compared the observed conditions in 2017 with the model predictions (BDH, 2017b). The review concluded that:

- The stabilisation of sulphate concentrations after 2012 was occurring in many locations as predicted by the model.
- The model predictions continued to be an appropriate approach to defining future average sulphate concentrations in groundwater.
- The influence of the mine facilities in the receiving environment continued to be restricted to sulphate and Co.
- There was no requirement to modify the monitoring regime described in the GMP or to update the model.

Now that ten years have elapsed since completion of the numerical groundwater model, Newmont collected a further set of groundwater samples from all accessible bores in April 2022, and have requested BDH review the data to determine whether the conclusions from the 2017 review remain valid. The results of the analysis are summarised in this report.

2 SUMMARY OF HYDROGEOLOGY AND NUMERICAL MODEL

Hydrogeological investigations undertaken at the Mt Leyshon mine during the mining and closure period include both shallow and deep electrical geophysical surveys over a distance of more than 15 km, installation of 10 deep investigation holes to depths of up to 300 m with vibrating wire piezometer (VWP) sensors installed, installation of 58 shallow monitoring bores, investigation of 35 existing monitoring bores, and subsequent monitoring of all these installations which are identified in Figure 1. Interpretation of these investigations and monitoring was described in the GMP.

The GMP noted that the shallow groundwater system comprises the weathered and fractured zone at the upper basement surface, typically encountered between 5 metres below ground level (mBGL) and 25 mBGL. This system is recharged by a combination of natural rainfall infiltration and residual seepage from the rehabilitated mine facilities. Groundwater flow directions are radially away from the mine area, following similar directions to the intermittent streams draining the mine facilities. Discharge from the shallow groundwater system occurs seasonally to the streambeds in the surface water system, and the shallow groundwater system is the primary pathway by which seepage from the rehabilitated mine facilities migrates into the receiving environment.

A numerical groundwater model of the shallow groundwater system was constructed using the code FEFLOW in 2013 and was based on data collected to 2012. The properties assigned to the model were initially derived from the extensive field investigations and were subsequently refined during calibration of the model to the observed data. The model was calibrated to observations of groundwater elevations and groundwater sulphate concentrations made during operations (1989 to 2002) and during closure (2002 to 2012). The primary objective of the modelling was to define the maximum future extent of sulphate in groundwater in the receiving groundwater environment, and in particular to confirm that the extent would remain within land controlled by Newmont under all possible future conditions. Consistent with this primary objective, model construction and calibration were focussed on observed responses in the receiving environment, with less detail applied in the locations of the mine facilities. Key aspects of the model during the construction and calibration process were:

- Due the progressive nature of cover installation, and taking account of the modelling objectives, an average uniform infiltration rate was applied to each of the mine facilities. A single average infiltration rate was applied in the model for each facility, which represents the average of conditions in the early 1990s (wholly uncovered), the late 1990s (partially covered), and the closure period (fully covered with vegetation progressively increasing from 2002 to 2012).
- In order to match the observed changes in groundwater elevations and groundwater chemistry during operations and closure, the calibrated average seepage rates from the facilities in the period 1990 to 2012 were 1.7% of precipitation at the NNTSF and the ONTSF, and 0.7% of precipitation at the EWRSF and the STSF. The concentration of sulphate in seepage was calibrated to be 3,500 mg/L at the STSF, 20,000 mg/L at the Scats Stockpile and 5,000 mg/l at all other facilities.
- These calibrated values do not reflect infiltration through the cover and the groundwater model can not be used to quantify the current rates of infiltration through the covers. Infiltration through the covers may 1) reach the base of the facility by vertical flow and flow horizontally into the downgradient containment dam as seepage to subsequently be pumped to the lake in the open pit; 2) infiltrate through the original ground surface below the facility, enter the saturated zone within the groundwater system and flow into the receiving groundwater environment; or 3) follow other pathways into the receiving environment. The model calibrated values discussed above reflect an average for component 2 of cover infiltration over the operating, closure and post closure periods.
- These calibration parameters resulted in a good fit to the average groundwater elevations and sulphate concentrations in the receiving groundwater system from 1989 to 2012.

A key outcome from the model predictions was that if the facility covers continued to perform at the same average level assumed in the model, under average rainfall conditions the maximum future extent of sulphate concentration was unlikely to change a great deal from the extent observed in 2012. In two areas (to the northeast and southeast) continued migration away from the facilities was predicted, resulting in an additional extent of around 1 km to 2 km in the very long term in these locations. The maximum extent of sulphate in groundwater was concluded to be within Newmont controlled land.

The prediction of limited future expansion of the zone of elevated sulphate in groundwater under average conditions in the model resulted from a combination of hydrogeological factors, including:

- As the area of influence increases, the total volume of groundwater in the system to accommodate the fixed sulphate load increases rapidly.
- As the area of influence increases, the proportion of the area which is exposed to good quality natural groundwater recharge significantly increases.
- The more the area of influence extends, the more creek systems it covers, which provides more potential locations for the model to remove sulphate from the groundwater system by discharging it to surface water on a seasonal basis.
- The extent of the sulphate influenced zone in 2012 reflected higher than average rainfall conditions over preceding years. The basecase predictive model assumed a return to average rainfall conditions, and so there was an immediate recession in groundwater elevations and sulphate concentrations in the early part of the predictive period.

Monitoring data collected between completion of the model 2013 and the site wide sampling conducted in April 2022 are reviewed in the following sections to investigate whether these predictions remain valid.

3 OBJECTIVES OF 2022 UPDATED ASSESSMENT

The objectives defined by Newmont for the updated assessment of groundwater chemistry are discussed as follows:

- In many monitoring locations, observed sulphate concentrations had been steadily rising up to the year 2012, but in these locations the model predicted that concentrations would subsequently stabilise or even reduce in future years. The 2017 groundwater chemistry assessment concluded that this prediction was valid. The 2022 groundwater chemistry assessment is intended to investigate whether this prediction continues to be valid.
- The GMP reviewed groundwater chemistry and concluded that sulphate was the primary constituent of concern for migration into the receiving environment, along with Co migration downgradient of tailings facilities. It was noted that due to the groundwater in the shallow groundwater system retaining significant alkalinity, the pH remained high and the mobility of most metals was limited. The site wide snapshot of groundwater chemistry collected in April 2022 was intended to binvestigate whether these conclusions remain valid, and whether there may have been any significant changes in groundwater pH or metals concentrations close to the mine facilities.

4 REVIEW OF APRIL 2022 HYDROCHEMICAL DATA

Sampling

The site wide groundwater sampling was undertaken in April 2022. Sampling was attempted at all monitoring bores which remain accessible (a few have been grouted and decommissioned during the closure period). Most of the very shallow bores (screened around 5 m deep in alluvial sediments) which were installed in 2012 to investigate near surface conditions were dry and were not sampled. This is consistent with the conceptual hydrogeological model which defines the groundwater transmission pathway to be in the weathered and fractured bedrock underlying the alluvial sediments.

A few deeper bores screened in weathered and fractured bedrock which could be sampled in 2017 were found to be blocked by tree roots in 2022 and could not be sampled. These bores were:

- NMLMB27
- NMLMB31
- NMLMB41
- NMLMB42
- NMLMB48
- NMLMB9

Newmont plan to attempt to rehabilitate these bores to regain access for the routine measurement of groundwater depths and for one-off sampling events as required.

All other bores were sampled by placing a pump in the screened section of casing, and pumping at low rates until field hydrochemical readings had stabilised (i.e. following the micropurging technique). Groundwater samples were then collected, filtered and preserved as necessary and sent to ALS for analysis.

Data Quality
All results of the April 2022 laboratory analyses are tabulated in Appendix A. Based on quality checks these data are considered appropriate for interpretation. These quality checks comprised:

- The calculation of ion balances, all of which were within or close to 5%.
- Comparing TDS calculated by summing major ions against TDS measured by evaporation in the laboratory, which didn't identify any anomalies.
- Comparing field and laboratory measurements of pH and EC which demonstrated consistent relationships.
- Comparing laboratory and field measured EC against TDS concentrations which did not identify any anomalies.
- Comparing total metals concentrations against filterable concentrations. In a number of cases the filterable concentration was slightly higher than the total concentration (as highlighted in Appendix A), but the differences were within the experimental variation of the methods. In many of the samples, total Sn was below the detection limit, while filterable Sn was reported to be in the range 0.001 mg/L to 0.009 mg/L, which suggests low level Sn contamination has been introduced during the field filtering of the groundwater samples.

Shallow groundwater system hydrochemistry
Groundwater chemistry data for the samples collected in April 2022 are tabulated in Appendix A. The bores have been classified in Table A1 according to their locations (upgradient or downgradient of mine facilities) and have been grouped according to the facility they are located closest to, which allows common hydrochemical trends in localised areas to be identified. The classification of the bore in the EA is also included for reference (background, compliance or interpretation).

Appendix B re-presents the April 2022 laboratory results for analytes which are included in the EA. As a convenient means of identifying analytes that are potentially elevated, groundwater chemistry at every bore has been compared against the trigger levels and contaminant limits for groundwater set in the EA, although clearly these limits only apply at the bores defined as compliance points. In each case, where applicable, hardness adjusted limits have been calculated for filterable metals to compare against the measured concentrations.

The complete hydrochemical data in Table A1 and the highlighted instances of elevated concentrations in Table B1 confirm the interpretation of groundwater chemistry presented in the GMP, which interpreted that:

- The bores which are not located downgradient of mine facilities confirm that background sulphate concentrations and metals concentrations are low, pH is in the range 7.7 to 8.2, total alkalinity is around 500 mg/L as $CaCO_3$ and EC reaches 1,700 uS/cm due to the naturally elevated alkalinity.
- Groundwater pH is comparable with background in all downgradient locations and remains unaffected by seepage influences.
- Sulphate concentrations continue to be elevated in many locations downgradient of all of the mine facilities and are the dominant change in groundwater chemistry associated with facility seepage. The highest sulphate concentration in April 2022 (19,000 mg/L) was measured at NMLMB16 immediately downgradient of the EWRSF and the Mt Mawe Dam. The Mt Mawe Dam collects seepage which typically contains around 30,000 mg/L sulphate.
- Filterable Co concentrations are consistently and regionally elevated in groundwater downgradient of the NNTSF, ONTSF and STSF, but are low downgradient of the EWRSF.
- Filterable As may be elevated in discrete locations very close to mine facilities, including at MLM28 and NMLMB6 below the EWRSF, and at MLM44 below the STSF, but is not consistently regionally elevated and is indicated not to be mobile in the receiving environment.
- Filterable U may be elevated in discrete locations very close to mine facilities, including at MLM28 and NMLMB6 below the EWRSF, but is not consistently regionally elevated and in most locations the U concentrations are consistent with the background influence of the granites hosting the shallow groundwater system.
- Other filterable metals concentrations are generally low, consistent with the alkaline groundwater pH.
- Cyanide concentrations are at or below the detection limit in all monitoring bores.

Current extent of Co in groundwater

During annual groundwater monitoring reviews it has been noted that filterable Co concentrations display short term variation which can be correlated across bores in each sampling event, and which appears to relate to background controls on the amount of Co which exists in filterable form. Total Co concentrations tend to follow more consistent long term trends. Total Co concentrations have therefore been used to define the current extent of Co in groundwater in Figure 2. The extent of total Co in 2012 interpreted in the GMP, and the extent defined by the 2017 sampling are also illustrated. There has been little change in the extent of Co in groundwater from 2012 to 2022, other than a small increase of the extent below Schreibers Creek to the northeast of the NNTSF, where total Co at NMLMB29 has risen from 0.003 mg/L in 2012 to 0.013 mg/L in 2022.

Current extent of sulphate in groundwater

The GMP presented contours defining the extent of groundwater containing more than 500 mg/L and 1,000 mg/L sulphate in the shallow groundwater system. These contours were interpreted from a site wide groundwater sampling snapshot conducted in 2012. The site wide sampling undertaken in June 2017 and in April 2022 have been interpreted in the same manner to generate updated contours. Figures 3 and 4 illustrate that between 2012 and 2022, there have been only minor changes in the extent of sulphate in groundwater, consistent with the model predictions that concentrations in most locations are approaching equilibrium. At NMLMB26 to the north of the NNTSF, sulphate concentrations decreased in 2017 and increased in 2022 compared to 2012 (Figure 4), which results from the influences of recharge pulses and seepage pulses originating in the operating period. Locations where the extent of sulphate has increased by a small amount from 2012 to 2022 in Figures 3 and 4 are:

- To the north of the New North Tailings Storage Facility (NNTSF) near Clarke Creek. This change reflects recovery of the groundwater system from a large recharge event in 2008, which resulted in the 2012 sulphate concentrations being relatively low.
- To the northeast of the NNTSF along Schreibers Creek. Sulphate concentrations have increased at NMLMB9 and NMLMB28 and sulphate extends further in this part of the groundwater system in 2022 compared to 2012 and 2017. This response is consistent with the model predictions that sulphate would continue to increase during the initial closure period at NMLMB28 and NMLMB9.
- To the southeast of the EWRSF along One Mile Creek, where sulphate concentrations have increased at NMLMB37 and NMLMB5. This is consistent with the model predictions that sulphate would continue to increase at these bores in the initial closure period.

5 REVIEW OF MODEL PREDICTIONS

Observed vs modelled sulphate trends

The numerical groundwater model provided predictions of future groundwater chemistry under a range of scenarios, including different precipitation conditions. Scenario 1 corresponded to the facility covers continuing to perform at the same level, the sulphate concentration of seepage from the facilities remaining constant at 5,000 mg/L, and average precipitation conditions (658 mm/year). Scenario 5 adopted the same facility assumptions under wet conditions (1,200 mm/year), while Scenario 6 adopted the same facility assumptions under dry conditions (277 mm/year). Figure 5 illustrates precipitation conditions at Mt Leyshon since 2012 as measured at the Automated Weather Station (AWS) located in the middle of the mine. In the period 2012 to 2022 actual precipitation has been between the values assumed in Scenarios 1 and 6, and has clearly been closest to the average conditions in Scenario 1.

Appendix C compares the groundwater sulphate concentrations predicted by both Scenario 1 and Scenario 6 against monitoring data collected since 2012. Every monitoring bore screened in the shallow groundwater system which could be accessed for the April 2022 sampling is included in the plots. For each bore the observed sulphate concentrations measured from 1989 to 2012 that were used for model calibration are also presented for reference. The model was calibrated to regional sulphate trends and average conditions. As a result during the calibration period at some bores there may be observed changes in sulphate concentration due to localised influences which were not attempted to be replicated in the model results during model construction and calibration.

On a regional basis, the monitoring data collected since 2012 and plotted in Appendix A provide a good fit to the model predictions, with trends observed since 2012 generally being between those predicted for Scenarios 1 and 6. In areas where the sulphate concentration was predicted by the model to stabilise or reduce after 2012, these responses are consistently validated by the sampling in June 2017 and April 2022. Figure 6 provides examples of locations where the rising sulphate trends in the calibration period are confirmed to have stabilised by the subsequent monitoring data.

Locations where the April 2022 data indicate long term rising trends are present in sulphate concentrations are:

- NMLMB3, NMLMB38 and NMLMB39 located downgradient of the STSF (see Figures C10 and C13). These rising trends result from the migration of sulphate entering the groundwater system in the operating period, and remain consistent with the model predictions, which indicate that stabilisation of sulphate concentrations will occur in the near future.

- NMLMB28 and NMLMB29 downgradient of the NNTSF (see Figure C9). These rising trends result from the migration of sulphate entering the groundwater system in the operating period, and remain consistent with the model predictions, which indicate that stabilisation of sulphate concentrations will occur in the near future.
- NMLMB5 located southeast of the EWRSF (see Figure C15). This rising trend results from a combination of recovery from a recharge event in 2008, and the migration of sulphate entering the groundwater system in the operating period. The observed trends are consistent with the model representation of average concentrations in this location, which predicts stabilisation of concentrations in the near future.
- NMLMB40 located to the west of the SWRSF (Figure C14). The rising trend is consistent with the model predictions which reflect the delayed migration of seepage due to relatively lower hydraulic conductivity conditions assumed in this location. The basecase model predicts stabilisation of sulphate conditions in this location will be achieved around 2030.

As with the calibration model results, the model predictions are based on regional average conditions, and there will be locations or periods where localised effects cause the actual sulphate trends to depart from those modelled. Figure 7 provides examples of locations where sulphate concentrations have been significantly higher than predicted by the model. MLM28 is located at the toe of the Eastern Waste Rock Storage Facility (EWRSF). Following a very large precipitation event on 15 January 2008, groundwater sulphate concentrations in this location rose from 1,500 mg/L to 15,000 mg/L over a seven month period. The groundwater chemistry changes are interpreted to reflect a localised pulse of seepage emanating from the EWRSF. The updated monitoring data illustrate that this pulse decayed from 2012 to 2017 with groundwater sulphate concentrations returning to close to the modelled value. These responses at MLM28 illustrate that the model correctly reflects the long term average conditions, but may not replicate localised or short term trends resulting from local effects.

The other locations where observed sulphate concentrations depart most significantly from the model predictions are at NMLMB15D and NMLMB16 plotted in Figure 7. Figure 1 illustrates that these bores are located downgradient of the EWRSF, and are in locations similar to MLM28. The increasing sulphate concentrations at these locations likely reflect the same seepage pulse from the EWRSF which occurred in 2008. As a result of the bores being 100 m to 200 m from the EWRSF, and due to the low sulphate migration velocity within the shallow groundwater system, it has taken several years for the sulphate concentrations to rise, but as demonstrated at MLM28, in the long term the concentrations are expected to reduce and the observed values will return the modelled average trends.

Figure 8 illustrates two bores where sulphate concentrations have been significantly lower than predicted by the model. NMLMB2 is located close to Clarke Creek while NMLMB4 is located close to Puddler Creek. Following the large precipitation event in 2008, both these bores showed a significant decrease in sulphate concentrations, which lasted for several years before concentrations started to recover towards the model predicted values. In each case this response is attributed to localised high rates of natural recharge associated with flooding in the precipitation event. While the model does not replicate the specific effects of this individual event at these bores, the long term average trends in the observed data provide a good match to the model indicating the average recharge rate applied in the model is appropriate.

Current sulphate extent compared to model

The GMP presented contours for the model predicted position of the 1,000 mg/L sulphate contour for prediction year 2022. Figure 9 compares the actual sulphate extent in 2022 with the model predicted extent in 2022 under the basecase model assumptions. The observed data confirm that the general shapes and locations of the model contours are consistent with the actual distributions, and also that the model is highly conservative, in that to the northeast and southeast, the model predicts significantly more sulphate migration in 2022 than has been observed. The over prediction of the current sulphate extent may result from the model assumed seepage infiltration rates reflecting both operating and covered conditions, while the observed responses are now more driven by the closed conditions.

6 CONCLUSIONS AND RECOMMENDATIONS

An updated assessment of the hydrochemistry of the shallow groundwater system has been completed using routine monitoring data, in conjunction with site wide snapshots of groundwater chemistry provided by sampling every accessible bore in June 2017 and in April 2022. The hydrochemical data have been compared against the characterisation included in the GMP and against the predictions of sulphate concentrations provided by the numerical groundwater model.

The recent data confirm that the numerical groundwater model continues to provide a good representation of the average regional trends in sulphate concentrations. The model predicted that under average precipitation conditions, sulphate concentrations would stabilise or even decrease after 2012 in many locations. The recent data confirm that these trends are being observed in the shallow groundwater system where they were predicted. Rising sulphate trends are evident to the northeast and southeast of the mine facilities, which are consistent with the model predictions, and are predicted to stabilise in the near future. There have been only small changes in the extent of sulphate in the shallow groundwater system between 2012 and 2022, and the areas where the extent has increased are consistent with the model predictions. The numerical model has therefore been further validated by the recent monitoring data, and the existing model predictions remain the most appropriate means of defining the long term potential extent of sulphate in groundwater. However it should be noted that the model predictions reflect the maximum future extent of sulphate, as the model over predicts the sulphate extent in 2022.

The validated model predicts that if the seepage rates at the base of each facility remain at the calibrated level, under average precipitation conditions the maximum future extent of sulphate concentration is unlikely to change a great deal from the extent currently observed. In two areas (to the northeast and southeast) continued migration away from the facilities is predicted, but this is limited to about an additional 1 km to 2 km to the east over a 200 year period.

There have been no significant changes in the pH and metals concentrations in groundwater in areas close to seepage sources, and the analytes which are consistently and regionally elevated continue to be sulphate and Co. The extent of Co in groundwater is much less than for sulphate, despite these analytes having a common source, due to Co being affected by geochemical attenuation. The pH of downgradient groundwater is consistent with upgradient locations and continues to be unimpacted by facility seepage.

It is concluded that:

- If the facility covers are maintained in their current configuration, there will be limited expansion of the area of influence of the mine facilities on groundwater chemistry in the long term (in the next 200 years) and the extent will remain within Newmont controlled land.

- There have been no significant changes in the pH and metals concentrations in the groundwater system from 2012 to 2022 and the analytes which are consistently and regionally elevated downgradient of the mine facilities continue to be sulphate and Co.
- The existing compliance bores which are nominated for routine sampling in the EA include locations within the modelled sulphate expansion along Schreibers Creek, One Mile Creek and Two Mile Creek and are therefore suitably located to identify any changes in the extent of facility influences.
- No changes are recommended for the routine groundwater sampling regime for the Mt Leyshon mine as described in the GMP and defined in the EA.

Please contact me if you would like any further details of the discussion of current and future groundwater chemistry at the Mt Leyshon mine.

Yours sincerely

Simon Barrett
Principal
Big Dog Hydrogeology Pty Ltd
ABN 158 858 087

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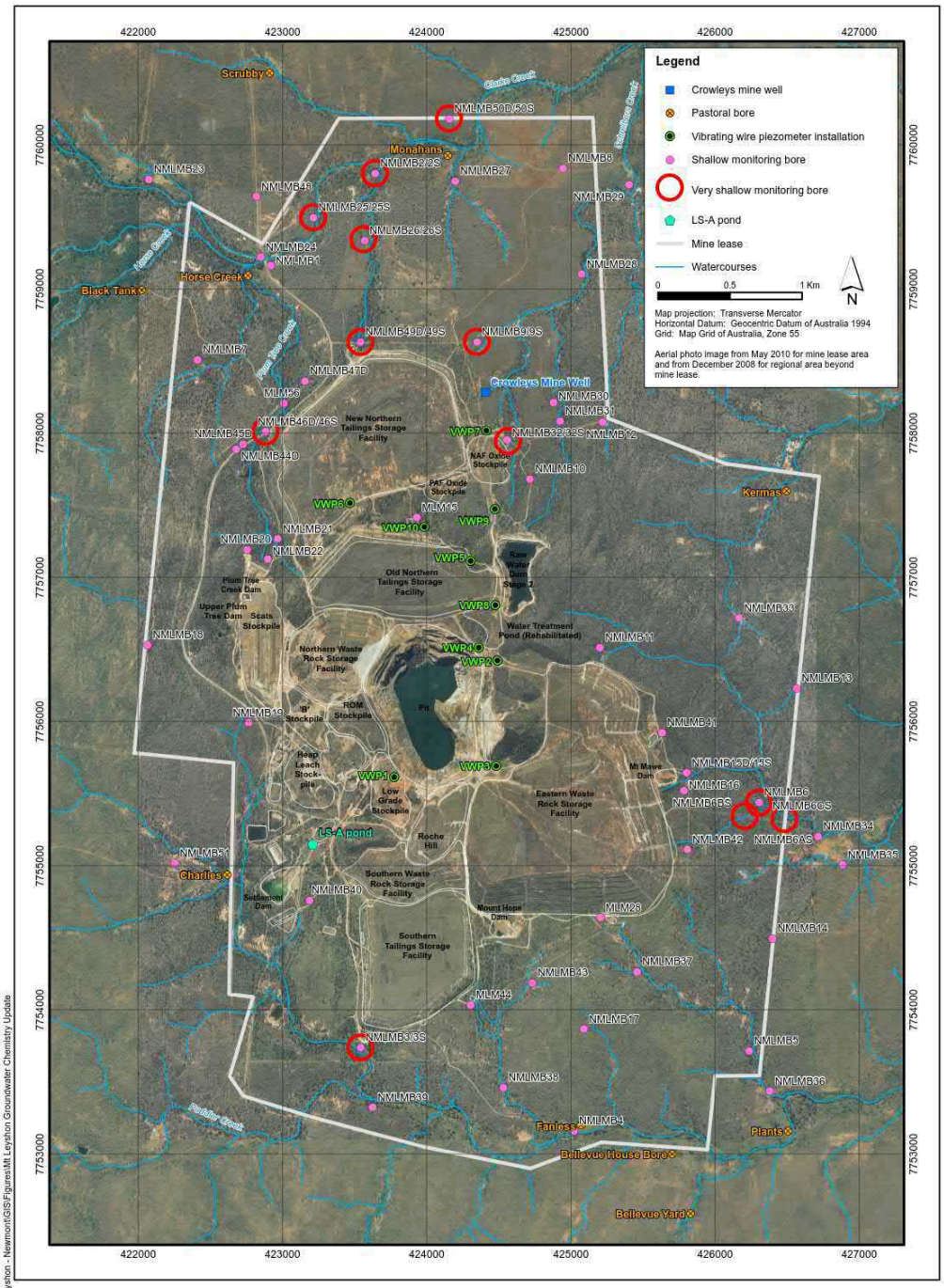
FIGURES



BIG DOG HYDROGEOLOGY	**Groundwater monitoring locations**	**Figure 1**
		Date: June 2022
		Report: Mt Leyshon Groundwater Chemistry Update

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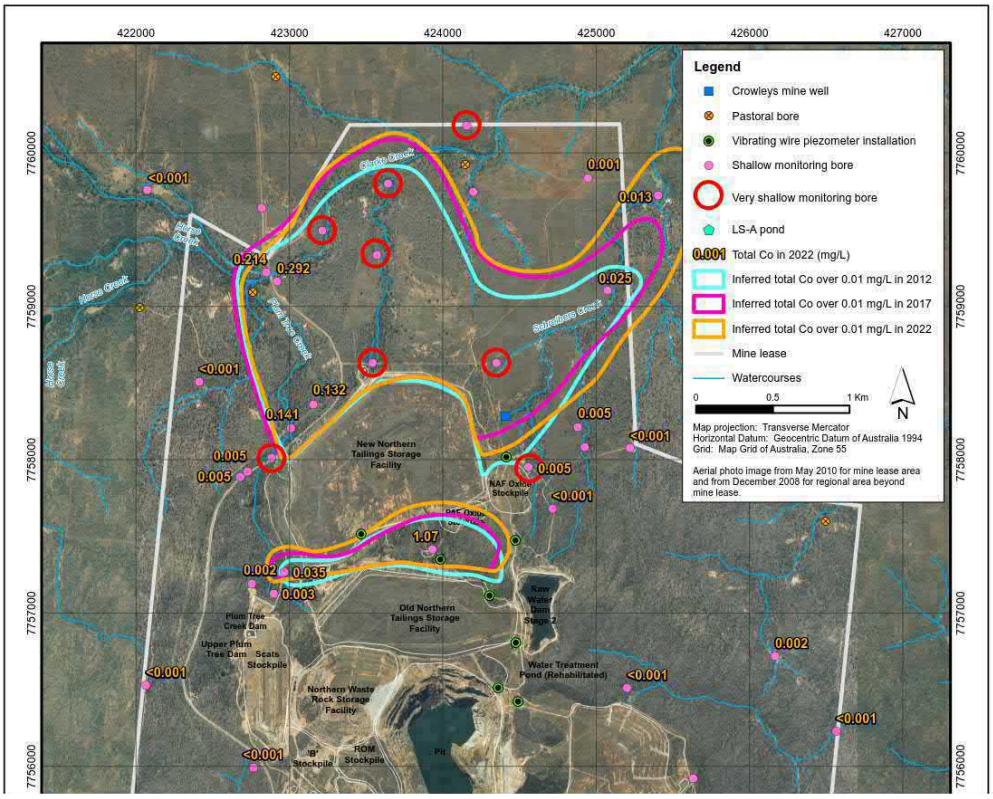
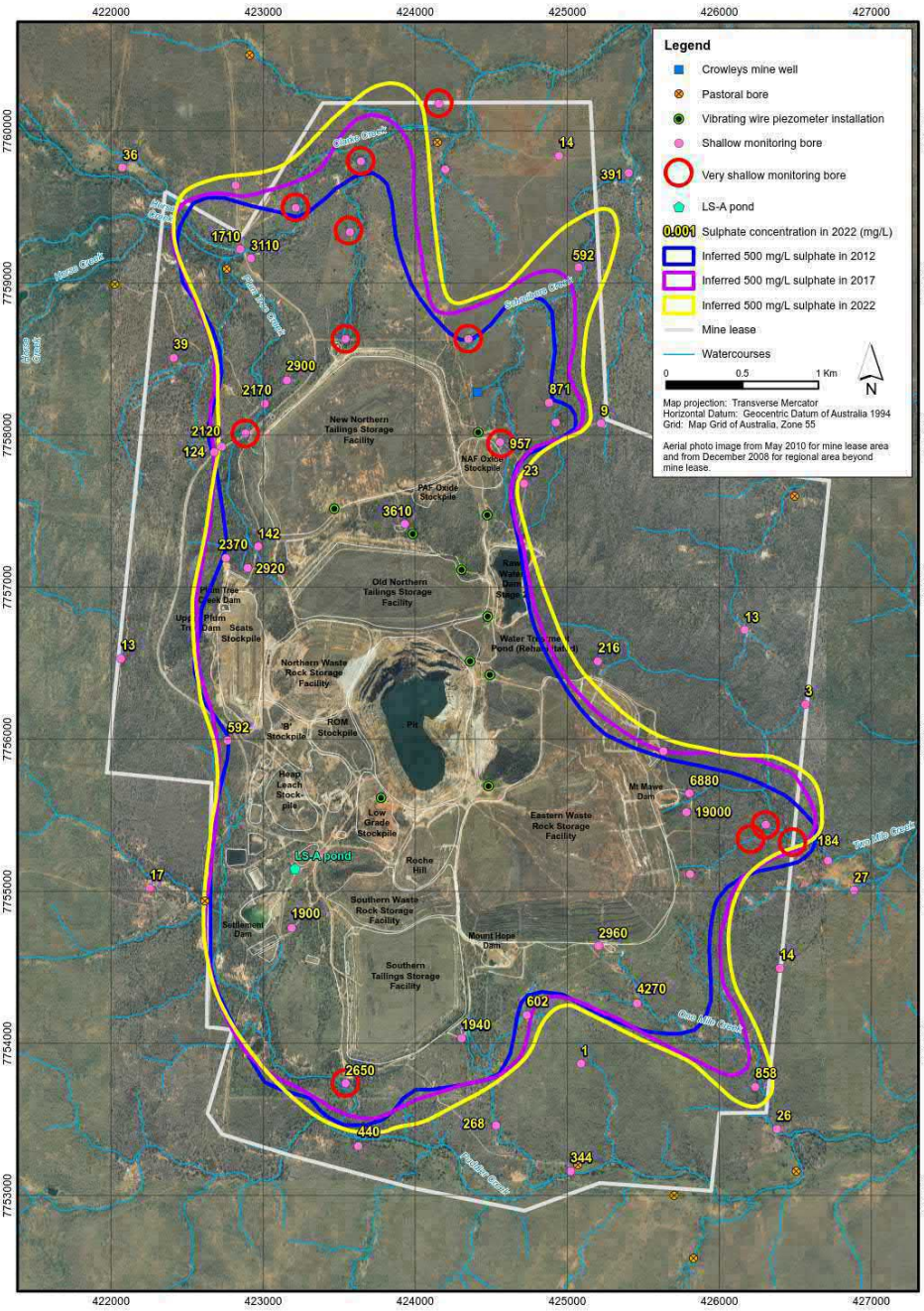

422000
423000
424000
425000
426000
427000
7760000
7759000
7758000
7757000
7756000
Legend
Crowleys mine well
Pastoral bore
Vibrating wire piezometer installation
Shallow monitoring bore
Very shallow monitoring bore
LS-A pond
0.001 Total Co in 2022 (mg/L)
Inferred total Co over 0.01 mg/L in 2012
Inferred total Co over 0.01 mg/L in 2017
Inferred total Co over 0.01 mg/L in 2022
Mine lease
Watercourses
0
0.5
1 Km
N
Map projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55
Aerial photo image from May 2010 for mine lease area and from December 2006 for regional area beyond mine lease.
<0.001
0.001
0.013
0.214
0.292
0.025
<0.001
0.132
0.141
0.005
<0.001
0.005
0.005
0.005
<0.001
1.07
0.002
0.035
0.003
0.002
<0.001
<0.001
<0.001
<0.001
New Northern Tailings Storage Facility
NAF Oxide Stockpile
Old Northern Tailings Storage Facility
Raw Water Dam Stage 2
Plum Tree Creek Dam
Upper Plum Tree Dam
Seats Stockpile
Water Treatment Pond (Rehabilitated)
Northern Waste Rock Storage Facility
'B' Stockpile
ROM Stockpile
Pit
Clarke Creek
Hawes Creek
Sandalwood Creek



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BIG DOG HYDROGEOLOGY

Inferred extent of sulphate above 500 mg/L in groundwater

Figure 3

Date: June 2022

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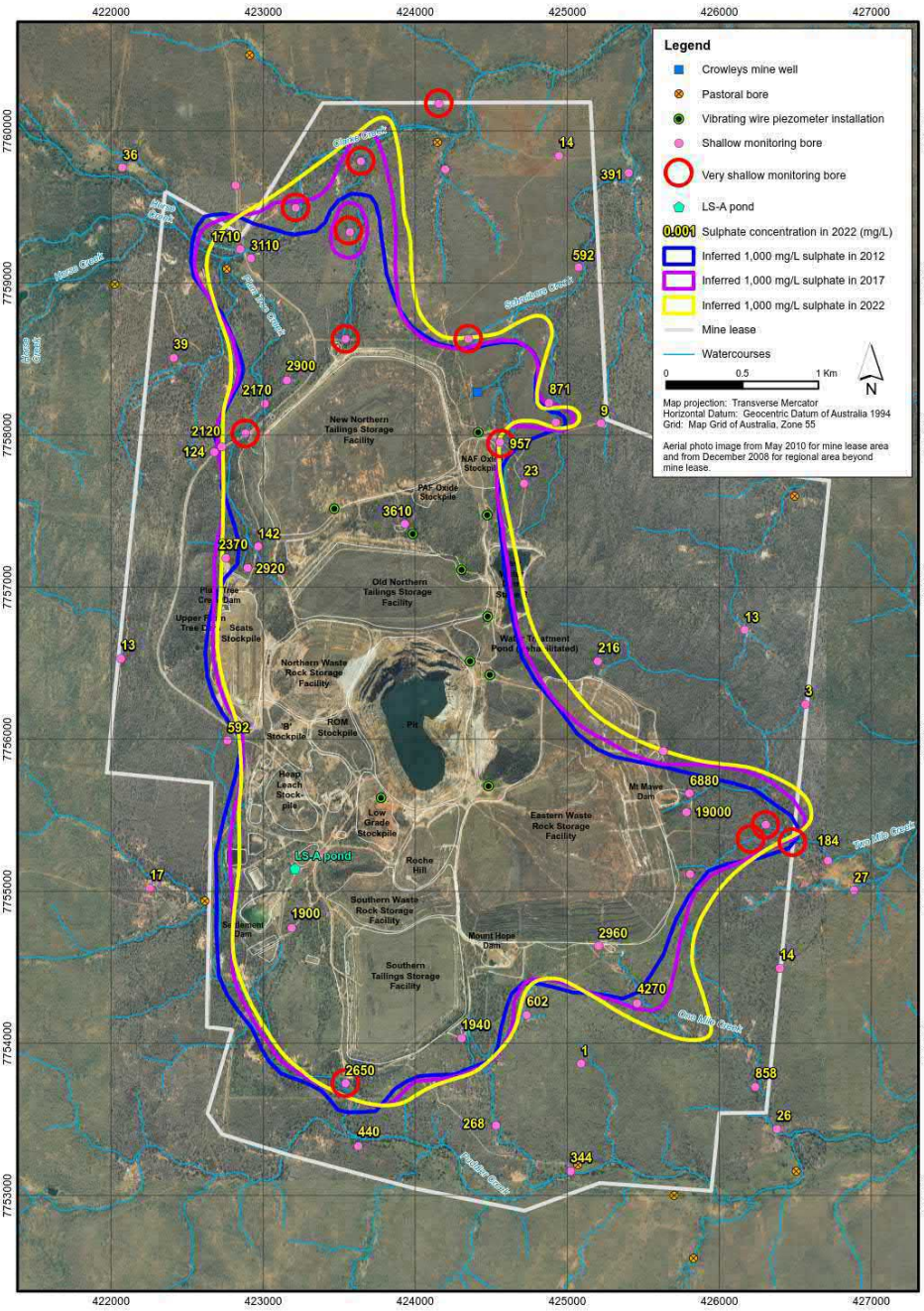

BIG DOG HYDROGEOLOGY

Inferred extent of sulphate above 1,000 mg/L in groundwater

Figure 4

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update

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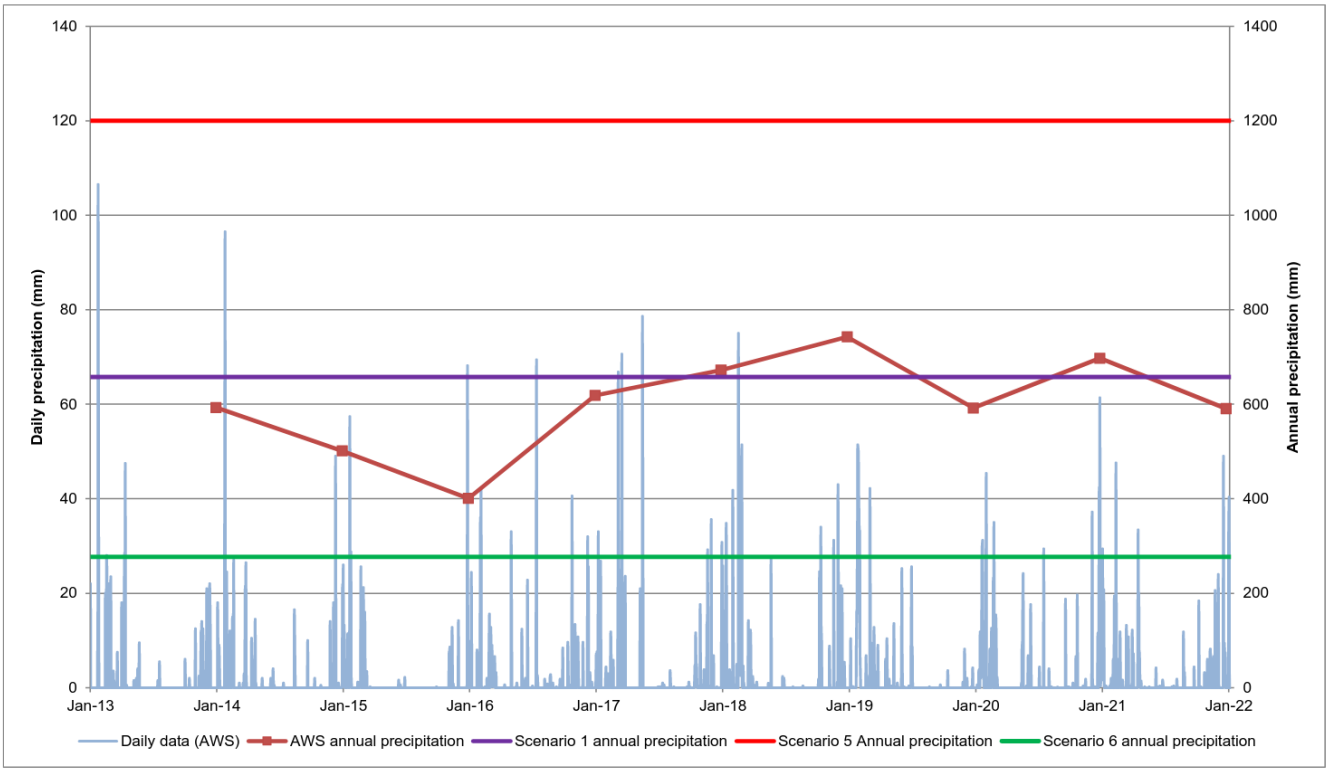

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BIG DOG HYDROGEOLOGY

Precipitation conditions

Figure 5

Date: June 2022

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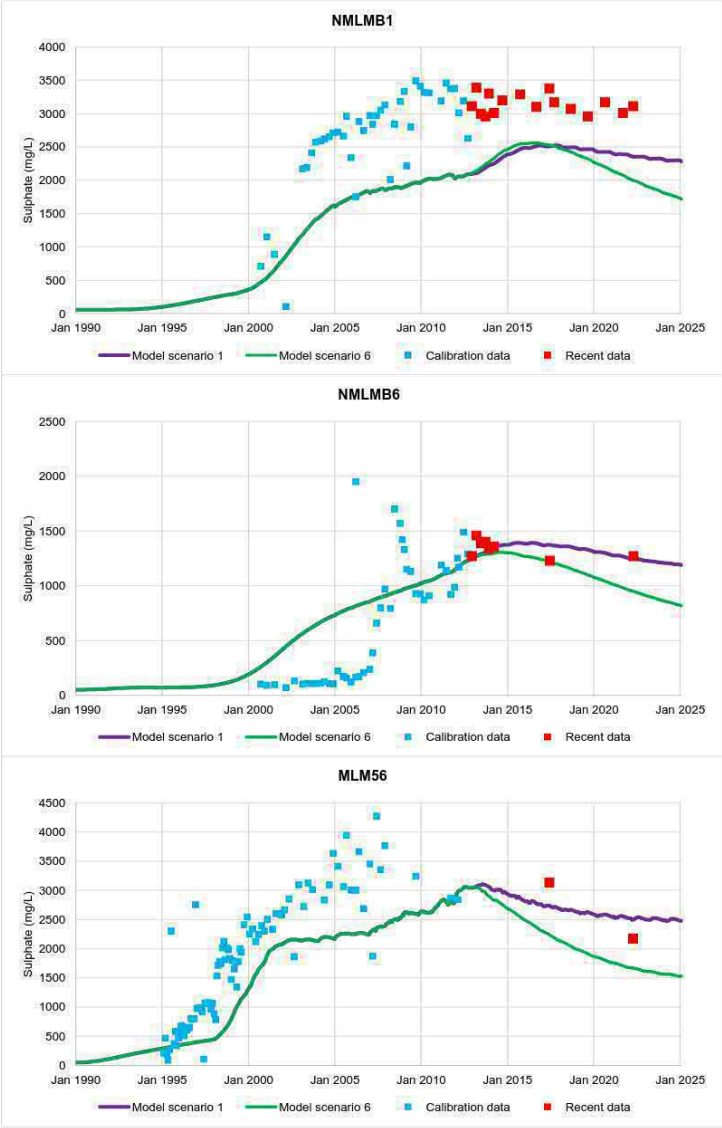

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BIG DOG HYDROGEOLOGY

Sulphate stabilisation responses

Figure 6

Date: June 2022

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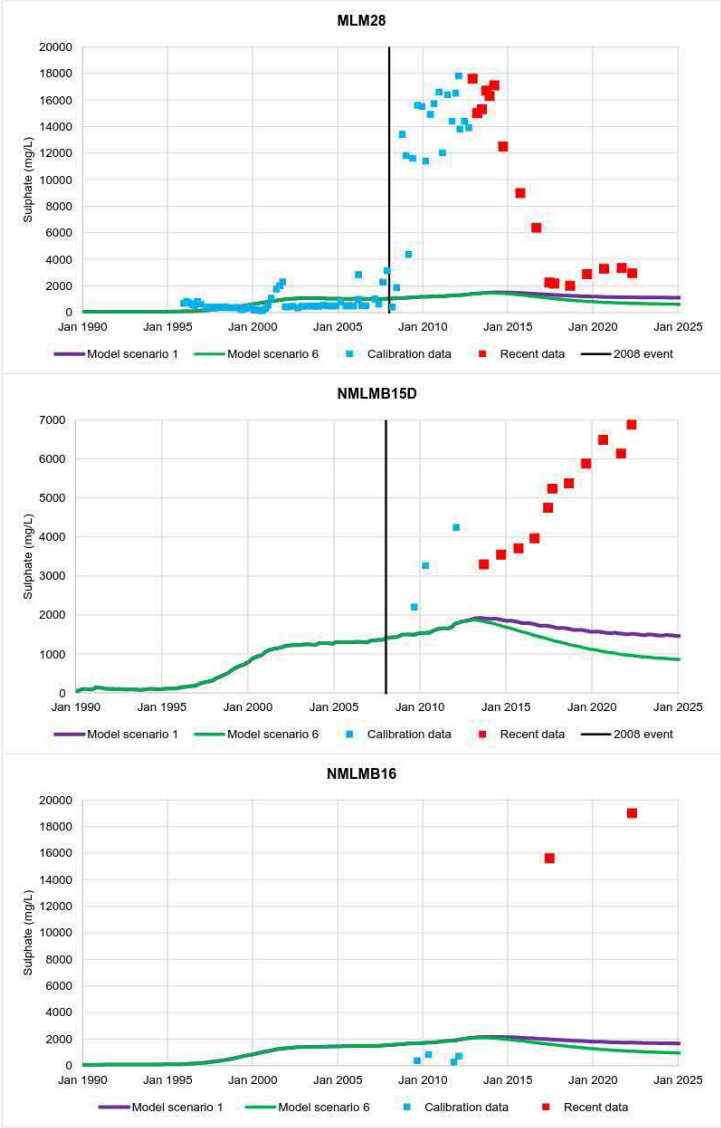

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BIG DOG HYDROGEOLOGY

Seepage pulse responses

Figure 7

Date: June 2022

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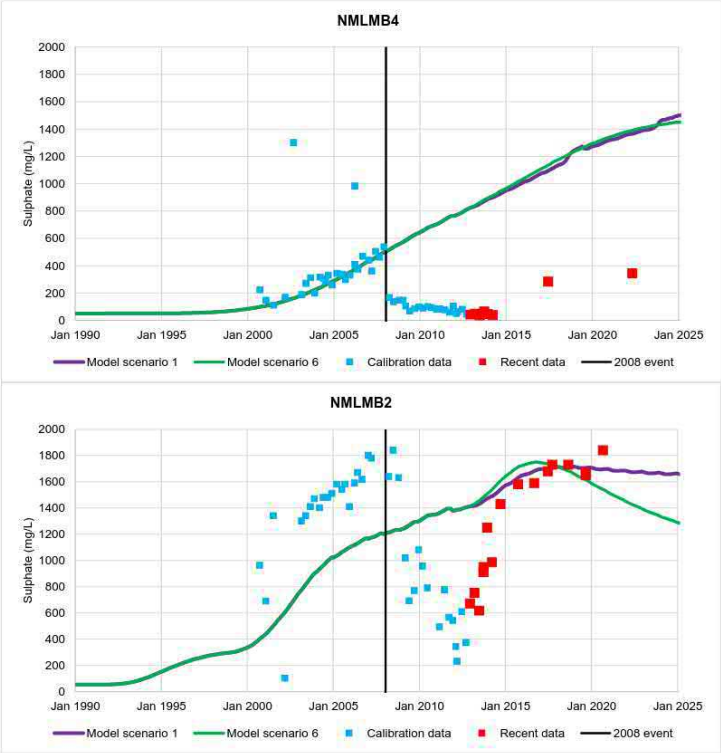

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BIG DOG HYDROGEOLOGY

Recharge responses

Figure 8

Date: June 2022

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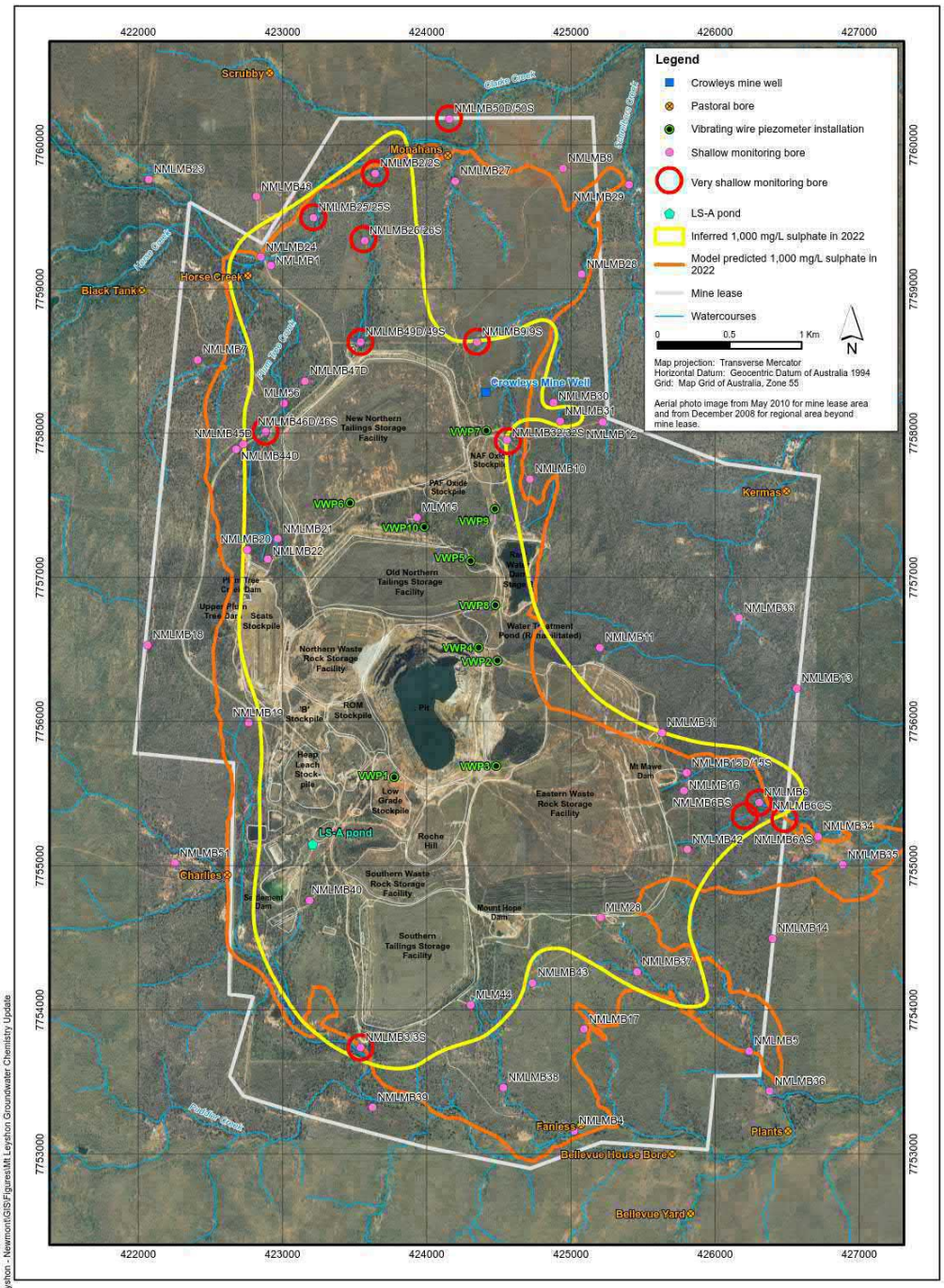

BIG DOG HYDROGEOLOGY	**Comparison of 2022 sulphate concentrations against model**	**Figure 9**
		Date: June 2022
		Report: Mt Leyshon Groundwater Chemistry Update

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APPENDIX A
GROUNDWATER CHEMISTRY APRIL 2022

Table A1 Groundwater Hydrochemical Data April 2022

Source Facility		None	None	None	None	EWRSF	EWRSF	EWRSF	EWRSF	EWRSF	EWRSF	EWRSF	EWRSF	EWRSF
EA Classification		Background	Background	None	None	Compliance	Compliance	Interpretation	Interpretation	None	None	None	None	None
Site		NMLMB23	NMLMB51	NMLMB13	NMLMB33	NMLMB34	NMLMB5	MLM28	NMLMB15D	NMLMB11	NMLMB14	NMLMB16	NMLMB17	NMLMB35
Date and time		29-Mar-22	29-Mar-22	27-Apr-22	27-Apr-22	30-Mar-22	19-Apr-22	29-Apr-22	28-Apr-22	28-Apr-22	28-Apr-22	28-Apr-22	29-Apr-22	28-Apr-22
Parameter	**Unit**													
Physical characteristics														
Electrical Conductivity	uS/cm	1,670	1,530	1,080	1,140	2,200	3,770	6,120	10,300	1,610	2,540	19,300	2,490	3,750
pH		8.18	7.7	8.03	7.99	7.81	8.06	8.14	7.88	8.01	8.44	7.84	8.12	8.05
Total Dissolved Solids	mg/L	926	844	628	682	1,280	2,620	5,610	11,800	934	1,460	29,400	1,380	2,260
Total Suspended Solids	mg/L	<5	<5	28	<5	<5	6	6	27	<5	56	12	20	8
Total hardness	mg/L as $CaCO_3$	456	497	425	339	666	1,447	3,509	6,144	461	661	21,030	653	715
Major ions														
Calcium	mg/L	87	77	96	37	82	161	215	433	74	52	510	80	62
Magnesium	mg/L	58	74	45	60	112	254	722	1230	67	129	4800	110	136
Sodium	mg/L	176	166	95	146	269	383	504	1020	179	352	1020	342	589
Potassium	mg/L	1	1	3	<1	1	3	<1	9	3	4	5	4	3
Sulphate	mg/L	36	17	3	13	184	858	2,960	6,880	216	14	19,000	1	27
Chloride	mg/L	282	113	43	15	182	431	325	369	109	347	465	332	676
Hydroxide Alkalinity	mg/L as $CaCO_3$	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity	mg/L as $CaCO_3$	<1	<1	<1	<1	<1	<1	<1	<1	<1	209	<1	<1	<1
Bicarbonate Alkalinity	mg/L as $CaCO_3$	453	651	548	623	776	646	685	699	533	713	1260	875	1190
Total Alkalinity	mg/L as $CaCO_3$	453	651	548	623	776	646	685	699	533	921	1260	875	1190
Metals														
Aluminium total	mg/L	0.04	0.06	0.18	0.03	0.02	0.08	0.04	0.22	0.03	1.88	<0.05	0.05	0.26
Aluminium filterable	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01
Arsenic total	mg/L	0.002	0.002	0.006	0.004	0.012	0.012	0.027	0.017	0.004	0.003	<0.005	0.017	0.005
Arsenic filterable	mg/L	0.002	0.002	0.004	0.004	0.012	0.012	0.026	0.017	0.003	0.002	**0.006**	0.013	0.004
Barium total	mg/L	0.135	0.026	0.428	0.099	0.102	0.06	0.026	0.023	0.085	0.146	0.029	0.061	0.468
Barium filterable	mg/L	0.122	0.025	0.362	0.094	0.096	0.056	0.025	0.02	0.079	0.127	0.027	0.06	0.42
Cadmium total	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	<0.0001
Cadmium filterable	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	<0.0001
Chromium total	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.005	0.003	<0.001
Chromium filterable	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.001	<0.001
Copper total	mg/L	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.001	0.001	<0.001	0.006	<0.005	0.002	0.003
Copper filterable	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.001	<0.001
Cobalt total	mg/L	<0.001	<0.001	<0.001	0.002	<0.001	0.001	<0.001	0.003	<0.001	0.002	<0.005	0.002	<0.001
Cobalt filterable	mg/L	<0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	0.002	<0.001	<0.001	<0.005	<0.001	<0.001
Iron total	mg/L	0.06	0.1	11.4	0.09	<0.05	1.23	1.69	9.58	0.16	2.3	1.02	10.2	0.64
Iron filterable	mg/L	<0.05	<0.05	6.39	<0.05	<0.05	1.09	1.56	8.64	<0.05	0.05	0.96	9.07	<0.05
Lead total	mg/L	<0.001	<0.001	0.002	<0.001	0.002	<0.001	<0.001	<0.001	0.001	0.008	<0.005	<0.001	<0.001
Lead filterable	mg/L	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.001	<0.001
Manganese total	mg/L	0.187	0.08	0.207	0.075	0.006	0.162	0.301	0.472	0.1	0.14	1.65	0.523	0.037
Manganese filterable	mg/L	0.029	0.073	0.131	0.068	0.005	0.159	0.274	0.413	0.002	0.114	1.62	0.476	0.023
Molybdenum total	mg/L	0.002	0.005	0.012	0.021	0.003	0.002	0.002	0.013	0.006	0.003	<0.005	0.008	0.003
Molybdenum filterable	mg/L	0.002	0.004	0.01	0.018	0.003	0.002	0.002	0.011	0.005	0.003	<0.005	0.006	0.003
Nickel total	mg/L	0.002	<0.001	0.002	0.002	<0.001	0.013	0.001	0.002	0.002	0.003	<0.005	0.004	0.002
Nickel filterable	mg/L	0.001	<0.001	<0.001	0.002	**0.001**	0.007	0.001	0.002	0.002	<0.001	<0.005	0.002	0.001
Selenium total	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01
Selenium filterable	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01
Strontium total	mg/L	0.921	0.7	0.633	0.548	1.12	2.76	4.48	7.77	1.74	0.998	13.3	1.03	1.4
Strontium filterable	mg/L	0.831	0.616	0.593	0.526	1.02	**3**	4.61	7.82	1.87	0.97	**15.8**	**1.07**	1.38
Tin total	mg/L	<0.001	0.002	<0.001	<0.001	0.002	0.007	<0.001	<0.001	<0.001	<0.001	0.016	<0.001	<0.001
Tin filterable	mg/L	<0.001	<0.001	**0.003**	**0.004**	<0.001	<0.001	**0.003**	**0.005**	**0.004**	0.002	<0.005	**0.002**	**0.004**
Uranium total	mg/L	0.007	0.006	0.003	0.009	0.009	0.007	0.016	0.036	0.012	0.012	0.012	0.002	0.015
Uranium filterable	mg/L	0.007	0.005	0.002	0.008	0.009	0.007	0.015	0.033	0.011	0.01	0.012	0.002	0.014
Zinc total	mg/L	0.006	<0.005	0.013	0.012	0.007	0.171	0.005	0.015	0.009	0.018	<0.026	0.011	0.02
Zinc filterable	mg/L	**0.007**	**0.005**	<0.005	0.007	0.006	0.114	<0.005	0.009	0.007	0.007	**0.033**	<0.005	0.007
Cyanide														
Free Cyanide	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WAD Cyanide	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004

Bold values Anomalous, filterable exceeds total

Table A1 Groundwater Hydrochemical Data April 2022

Source Facility		EWRSF	EWRSF	EWRSF	EWRSF	NNTSF	NNTSF	NNTSF	NNTSF	NNTSF	NNTSF	NNTSF	NNTSF	NNTSF
EA Classification		**None**	**None**	**None**	**None**	**Compliance**	**Compliance**	**Interpretation**	**Interpretation**	**Interpretation**	**None**	**None**	**None**	**None**
Site		**NMLMB36**	**NMLMB37**	**NMLMB43**	**NMLMB6**	**NMLMB28**	**NMLMB7**	**NMLMB1**	**NMLMB2**	**NMLMB47D**	**MLM56**	**NMLMB21**	**NMLMB24**	**NMLMB25**
Date and time		**28-Apr-22**	**29-Apr-22**	**29-Apr-22**	**27-Apr-22**	**30-Mar-22**	**29-Mar-22**	**21-Apr-22**	**22-Apr-22**	**20-Apr-22**	**20-Apr-22**	**20-Apr-22**	**21-Apr-22**	**21-Apr-22**
Parameter	**Unit**													
Physical characteristics														
Electrical Conductivity	uS/cm	1,250	7,370	2,950	4,740	2,390	1,530	6,170	5,260	5,510	4,430	1,630	4,610	5,400
pH		8.42	8.13	8.11	7.89	7.91	7.85	7.74	7.95	7.52	7.56	7.78	7.81	7.78
Total Dissolved Solids	mg/L	766	7,140	1,930	3,360	1,640	852	5,560	4,780	4,960	4,190	936	3,470	4,860
Total Suspended Solids	mg/L	<5	11	10	22	<5	<5	9	332	6	6	<5	6	<5
Total hardness	mg/L as $CaCO_3$	252	4,276	993	1,281	824	447	2,734	1,962	2,314	1,940	616	1,708	2,689
Major ions														
Calcium	mg/L	20	412	124	111	134	80	396	311	462	439	90	282	579
Magnesium	mg/L	49	789	166	244	119	60	424	288	282	205	95	244	302
Sodium	mg/L	198	702	338	686	243	173	684	620	605	448	160	516	427
Potassium	mg/L	<1	5	<1	4	2	1	4	7	2	2	4	2	4
Sulphate	mg/L	26	4,270	602	1,270	592	39	3,110	2,290	2,900	2,170	142	1,710	2,720
Chloride	mg/L	47	287	300	348	186	181	312	313	157	120	82	355	310
Hydroxide Alkalinity	mg/L as $CaCO_3$	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity	mg/L as $CaCO_3$	51	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L as $CaCO_3$	481	748	646	1100	440	486	572	485	365	431	685	524	408
Total Alkalinity	mg/L as $CaCO_3$	533	748	646	1100	440	486	572	485	365	431	685	524	408
Metals														
Aluminium total	mg/L	0.02	0.1	0.51	0.16	0.02	0.02	0.06	6.23	0.07	0.06	0.05	0.06	0.02
Aluminium filterable	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic total	mg/L	0.014	0.01	0.004	0.014	0.003	0.003	0.004	0.005	0.001	<0.001	0.002	0.005	0.002
Arsenic filterable	mg/L	0.014	0.009	0.003	0.012	0.003	0.003	0.004	0.003	0.001	<0.001	0.001	0.004	0.001
Barium total	mg/L	0.041	0.031	0.026	0.053	0.079	0.011	0.024	0.174	0.022	0.04	0.196	0.043	0.039
Barium filterable	mg/L	0.04	0.029	0.024	0.048	0.064	0.01	0.022	0.026	0.017	0.036	0.179	0.025	0.029
Cadmium total	mg/L	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0003	<0.0001	<0.0001	<0.0001	0.0008
Cadmium filterable	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	<0.0001	<0.0001	0.0003
Chromium total	mg/L	<0.001	<0.001	0.002	0.001	<0.001	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium filterable	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.002**	<0.001	<0.001	<0.001
Copper total	mg/L	<0.001	<0.001	0.003	0.003	0.002	<0.001	<0.001	0.011	0.002	<0.001	<0.001	0.001	0.001
Copper filterable	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt total	mg/L	<0.001	0.007	0.004	<0.001	0.025	<0.001	0.292	0.091	0.132	0.141	0.035	0.214	0.062
Cobalt filterable	mg/L	<0.001	0.006	0.004	<0.001	**0.028**	<0.001	0.261	0.079	0.116	0.125	0.031	0.181	0.054
Iron total	mg/L	<0.05	4.9	1.6	1.48	<0.05	0.12	1.58	7.08	0.16	0.43	0.48	0.49	0.61
Iron filterable	mg/L	<0.05	2.23	0.89	0.65	<0.05	<0.05	1.52	0.22	<0.05	0.24	<0.05	0.06	0.05
Lead total	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	<0.001	0.002	0.001	<0.001	<0.001
Lead filterable	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese total	mg/L	0.012	0.649	0.098	0.196	0.004	0.026	0.25	0.192	2.17	0.397	0.058	2.15	0.896
Manganese filterable	mg/L	0.006	0.583	0.086	0.175	0.001	0.022	**0.268**	0.122	2.04	0.416	0.044	1.15	0.686
Molybdenum total	mg/L	0.006	0.005	0.003	0.008	0.004	0.01	0.003	0.028	0.01	<0.001	0.006	0.006	0.003
Molybdenum filterable	mg/L	0.006	0.004	0.003	0.007	0.003	0.009	0.003	0.028	0.009	**0.001**	0.006	0.006	0.003
Nickel total	mg/L	<0.001	0.002	0.001	0.002	<0.001	<0.001	0.005	0.004	0.006	0.007	<0.001	0.006	0.003
Nickel filterable	mg/L	<0.001	0.002	<0.001	0.002	<0.001	<0.001	0.005	0.002	0.006	0.007	**0.001**	0.005	0.003
Selenium total	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium filterable	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium total	mg/L	0.532	6.45	1.66	2.44	1.61	0.991	4.57	3.96	2.42	1.63	0.994	2.97	3.3
Strontium filterable	mg/L	0.494	**6.73**	1.75	2.35	1.53	0.89	**4.62**	3.79	2.27	1.56	0.94	2.82	3.15
Tin total	mg/L	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin filterable	mg/L	**0.001**	**0.004**	**0.006**	**0.006**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium total	mg/L	0.002	0.021	0.01	0.019	0.004	0.012	0.018	0.026	0.003	0.008	0.079	0.011	0.017
Uranium filterable	mg/L	0.002	0.019	0.009	0.017	0.004	0.012	0.018	0.023	0.003	0.007	0.074	0.011	0.016
Zinc total	mg/L	0.028	0.016	0.013	0.037	0.007	0.01	0.148	0.056	0.326	0.198	0.073	0.081	0.064
Zinc filterable	mg/L	<0.005	0.011	0.007	0.012	0.006	0.008	0.018	0.029	0.138	0.01	**0.075**	0.072	0.06
Cyanide														
Free Cyanide	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WAD Cyanide	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004

Bold values Anomalous, filterable exceeds total

Table A1 Groundwater Hydrochemical Data April 2022

Source Facility		NNTSF	NNTSF	NNTSF	NNTSF	NNTSF	NNTSF	NNTSF	NNTSF	ONTSF	ONTSF	ONTSF	ONTSF	ONTSF
EA Classification		None	None	None	None	None	None	None	None	Interpretation	None	None	None	None
Site		NMLMB26	NMLMB29	NMLMB44D	NMLMB45D	NMLMB46D	NMLMB49D	NMLMB50D	NMLMB8	NMLMB32	MLM15	NMLMB10	NMLMB12	NMLMB30
Date and time		22-Apr-22	21-Apr-22	20-Apr-22	20-Apr-22	20-Apr-22	21-Apr-22	22-Apr-22	21-Apr-22	28-Apr-22	3-May-22	28-Apr-22	27-Apr-22	22-Apr-22
Parameter	**Unit**													
Physical characteristics														
Electrical Conductivity	uS/cm	4,910	2,540	1,760	4,160	3,670	5,610	1,250	1,430	2,390	7,380	1,150	1,050	2,380
pH		8.03	8.02	7.82	7.49	7.59	7.69	8.1	7.97	7.91	7.73	8.07	8.03	8.04
Total Dissolved Solids	mg/L	4,140	1,640	1,030	3,990	3,180	5,280	722	864	1,950	6,570	732	682	1,800
Total Suspended Solids	mg/L	<5	<5	7	<5	<5	22	<5	<5	<5	12	10	<5	11
Total hardness	mg/L as $CaCO_3$	1,622	754	531	2,200	1,605	2,218	300	368	1,125	2,309	478	388	957
Major ions														
Calcium	mg/L	211	104	79	487	356	453	41	60	274	468	99	86	187
Magnesium	mg/L	266	120	81	239	174	264	48	53	107	277	56	42	119
Sodium	mg/L	651	314	219	300	342	655	180	207	159	1040	92	116	226
Potassium	mg/L	5	2	3	2	2	2	4	2	<1	5	2	<1	<1
Sulphate	mg/L	2,290	397	124	2,120	1,610	3,000	9	14	957	3,610	23	9	871
Chloride	mg/L	159	282	123	65	61	114	62	93	39	329	52	37	41
Hydroxide Alkalinity	mg/L as $CaCO_3$	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity	mg/L as $CaCO_3$	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L as $CaCO_3$	423	625	681	513	513	384	596	660	403	366	526	580	507
Total Alkalinity	mg/L as $CaCO_3$	423	625	681	513	513	384	596	660	403	366	526	580	507
Metals														
Aluminium total	mg/L	0.05	0.01	0.02	0.06	<0.01	0.03	0.05	0.16	<0.01	0.02	0.02	0.02	0.22
Aluminium filterable	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic total	mg/L	0.002	0.005	0.01	<0.001	0.001	0.025	0.004	0.002	<0.001	0.007	0.012	0.001	0.004
Arsenic filterable	mg/L	0.001	0.005	0.005	**0.001**	0.001	0.003	0.004	0.002	<0.001	0.007	0.003	0.001	0.002
Barium total	mg/L	0.035	0.032	0.244	0.03	0.023	0.043	0.086	0.107	0.022	0.024	0.407	0.142	0.094
Barium filterable	mg/L	0.033	0.03	0.21	0.026	0.021	0.025	0.079	0.096	0.022	0.024	0.384	0.127	0.087
Cadmium total	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cadmium filterable	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium total	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium filterable	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper total	mg/L	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.001	<0.001	0.004	<0.001	0.001
Copper filterable	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt total	mg/L	0.04	0.013	0.005	0.005	0.008	0.016	<0.001	0.001	0.005	1.07	<0.001	<0.001	0.005
Cobalt filterable	mg/L	0.035	0.012	0.003	0.004	0.007	0.01	<0.001	<0.001	0.004	1.02	<0.001	<0.001	0.003
Iron total	mg/L	0.64	0.06	1.92	0.13	<0.05	6.31	0.12	0.34	0.05	3.42	2.53	<0.05	0.8
Iron filterable	mg/L	0.05	<0.05	0.47	<0.05	<0.05	0.52	<0.05	<0.05	<0.05	2.85	0.27	<0.05	<0.05
Lead total	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	<0.001	0.001	<0.001	<0.001	0.028	<0.001	<0.001
Lead filterable	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese total	mg/L	0.022	0.034	1.05	0.108	0.067	6.18	0.04	0.074	0.073	21.8	0.378	0.001	0.129
Manganese filterable	mg/L	0.016	**0.035**	0.955	**0.11**	**0.069**	5.4	0.01	0.041	0.021	23.3	0.311	<0.001	0.063
Molybdenum total	mg/L	0.028	0.005	0.005	0.004	0.002	0.044	0.005	0.004	0.003	0.062	0.002	0.001	0.004
Molybdenum filterable	mg/L	0.026	0.004	0.005	0.004	0.002	0.039	0.005	0.004	0.003	0.053	0.002	0.001	0.004
Nickel total	mg/L	0.002	0.001	0.006	0.004	0.003	0.009	0.007	0.004	0.003	0.014	0.002	0.002	0.001
Nickel filterable	mg/L	0.004	**0.002**	0.006	0.003	0.002	0.008	0.007	**0.009**	0.002	0.013	0.001	0.002	0.001
Selenium total	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium filterable	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium total	mg/L	2.68	1.35	1.57	2	1.23	3.79	0.713	0.836	0.778	1.92	0.616	0.554	1.35
Strontium filterable	mg/L	2.52	1.29	1.51	1.91	1.16	3.59	0.673	0.802	**0.794**	1.95	**0.628**	0.49	1.3
Tin total	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin filterable	mg/L	**0.009**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.004**	0.005	**0.002**	**0.003**	<0.001
Uranium total	mg/L	0.012	0.009	0.007	0.012	0.014	0.004	0.014	0.015	0.004	0.002	0.008	0.004	0.004
Uranium filterable	mg/L	0.012	0.008	0.006	0.011	0.013	0.004	0.012	0.014	0.003	0.001	0.008	0.003	0.004
Zinc total	mg/L	0.007	0.015	0.066	0.178	0.178	0.046	<0.005	0.011	0.013	0.009	0.011	0.01	0.011
Zinc filterable	mg/L	**0.009**	**0.016**	0.059	0.15	0.158	0.045	**0.006**	**0.017**	0.01	<0.005	0.007	0.008	0.011
Cyanide														
Free Cyanide	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WAD Cyanide	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004

Bold values Anomalous, filterable exceeds total

Table A1 Groundwater Hydrochemical Data April 2022

Source Facility		Scats	Scats	Scats	Scats	STSF	STSF	STSF	STSF	STSF	STSF	SWRSF
EA Classification		Compliance	Interpretation	None	None	Compliance	Compliance	Interpretation	Interpretation	None	None	Interpretation
Site		NMLMB18	NMLMB22	NMLMB19	NMLMB20	NMLMB38	NMLMB39	NMLMB3	NMLMB3S	MLM44	NMLMB4	NMLMB40
Date and time		29-Mar-22	19-Apr-22	20-Apr-22	19-Apr-22	29-Mar-22	29-Mar-22	27-Apr-22	27-Apr-22	29-Apr-22	3-May-22	21-Apr-22
Parameter	**Unit**											
Physical characteristics												
Electrical Conductivity	uS/cm	1,170	5,020	1,920	4,230	2,350	4,000	4,920	12,700	5,340	2,970	4,280
pH		7.55	7.25	7.78	7.22	7.85	7.7	7.83	7.77	7.97	7.98	7.53
Total Dissolved Solids	mg/L	668	5,080	1,380	4,380	1,390	2,330	4,460	13,900	4,270	1,750	3,930
Total Suspended Solids	mg/L	<5	<5	<5	<5	<5	6	25	8	62	272	<5
Total hardness	mg/L as $CaCO_3$	420	3,043	922	2,657	556	1,191	2,689	7,879	2,595	756	2,221
Major ions												
Calcium	mg/L	94	543	168	665	76	172	368	452	413	100	433
Magnesium	mg/L	45	410	122	242	89	185	430	1640	380	123	277
Sodium	mg/L	98	276	118	192	341	454	327	1230	444	359	253
Potassium	mg/L	1	2	3	2	1	2	2	<1	6	2	7
Sulphate	mg/L	13	2,920	592	2,370	268	440	2,650	7,930	1,940	344	1,900
Chloride	mg/L	32	35	31	10	243	687	309	819	526	358	251
Hydroxide Alkalinity	mg/L as $CaCO_3$	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity	mg/L as $CaCO_3$	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L as $CaCO_3$	578	592	466	558	654	813	449	574	711	661	500
Total Alkalinity	mg/L as $CaCO_3$	578	592	466	558	654	813	449	574	711	661	500
Metals												
Aluminium total	mg/L	<0.01	<0.01	0.01	<0.01	0.02	<0.01	0.15	0.07	4.4	5.85	0.02
Aluminium filterable	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic total	mg/L	0.001	<0.001	0.025	<0.001	0.005	0.007	0.004	0.012	0.088	0.011	<0.001
Arsenic filterable	mg/L	0.001	<0.001	0.016	<0.001	0.005	0.007	0.004	0.011	0.086	0.01	<0.001
Barium total	mg/L	0.022	0.027	0.021	0.055	0.05	0.252	0.021	0.038	0.079	0.12	0.011
Barium filterable	mg/L	0.02	0.024	0.02	0.051	0.047	0.244	0.018	0.034	0.056	0.068	0.009
Cadmium total	mg/L	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001
Cadmium filterable	mg/L	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	**0.0001**
Chromium total	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.014	<0.001
Chromium filterable	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper total	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.012	0.002	0.001
Copper filterable	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt total	mg/L	<0.001	0.003	<0.001	0.002	0.029	0.031	0.391	0.503	0.618	0.012	0.006
Cobalt filterable	mg/L	<0.001	0.002	<0.001	<0.001	**0.033**	0.031	0.338	0.442	0.58	0.005	0.004
Iron total	mg/L	0.18	0.21	0.72	<0.05	0.8	3.31	8.34	1.58	8.82	9.9	0.67
Iron filterable	mg/L	0.13	<0.05	<0.05	<0.05	0.71	3.14	7.21	1.2	0.06	0.51	<0.05
Lead total	mg/L	<0.001	<0.001	0.005	0.002	<0.001	<0.001	<0.001	<0.001	0.048	0.003	<0.001
Lead filterable	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese total	mg/L	0.057	2.99	0.104	0.23	0.17	0.536	0.223	1.09	0.897	0.293	0.734
Manganese filterable	mg/L	0.052	2.97	0.003	**0.232**	0.158	0.5	0.189	0.958	0.804	0.165	0.708
Molybdenum total	mg/L	0.001	0.002	0.002	0.002	0.005	0.005	0.002	0.003	0.001	0.012	0.002
Molybdenum filterable	mg/L	**0.002**	0.002	0.002	0.002	0.005	0.004	0.001	0.003	0.001	0.011	0.002
Nickel total	mg/L	0.001	0.002	0.004	0.004	<0.001	0.001	0.008	0.018	0.009	0.01	0.006
Nickel filterable	mg/L	<0.001	0.002	**0.005**	0.004	<0.001	<0.001	0.007	0.016	0.004	<0.001	0.005
Selenium total	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium filterable	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium total	mg/L	0.409	2.05	0.851	2.22	1.02	2	4.23	13.6	2.44	1.53	3.05
Strontium filterable	mg/L	0.348	1.93	0.812	2.18	0.932	1.9	4.14	13.2	**2.62**	1.47	2.86
Tin total	mg/L	0.001	<0.001	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Tin filterable	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.002**	**0.005**	**0.004**	**0.003**	<0.001
Uranium total	mg/L	0.003	0.012	0.01	0.008	0.006	0.029	0.004	0.015	<0.001	0.007	0.006
Uranium filterable	mg/L	0.002	0.011	0.01	0.008	0.005	0.027	0.004	0.014	<0.001	0.006	0.005
Zinc total	mg/L	0.027	0.484	0.105	0.35	0.007	<0.005	0.03	0.011	0.05	0.033	0.142
Zinc filterable	mg/L	0.013	0.292	0.101	0.31	**0.01**	**0.006**	0.017	0.005	<0.005	0.011	0.133
Cyanide												
Free Cyanide	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WAD Cyanide	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004

Bold values Anomalous, filterable exceeds total

APPENDIX B
APRIL 2022 GROUNDWATER CHEMISTRY COMPARED AGAINST EA LIMITS

Table B1
April 2022 Hydrochemistry Compared to EA Limits

Location Type				Upgradient	Upgradient	Upgradient	Upgradient	Downgradient	Downgradient	Downgradient
Source Facility				**None**	**None**	**None**	**None**	**EWRSF**	**EWRSF**	**EWRSF**
EA Classification				**Background**	**Background**	**None**	**None**	**Compliance**	**Compliance**	**Interpretation**
Site				**NMLMB23**	**NMLMB51**	**NMLMB13**	**NMLMB33**	**NMLMB34**	**NMLMB5**	**MLM28**
Date and time				**29-Mar-22**	**29-Mar-22**	**27-Apr-22**	**27-Apr-22**	**30-Mar-22**	**19-Apr-22**	**29-Apr-22**
Parameter	**Unit**	**Sched C - Table 13 Contaminant Limit**	**Sched C - Table 13 Trigger level**							
EC	uS/cm	TBD	TBD	1,670	1,530	1,080	1,140	2,200	3,770	6,120
pH		TBD	TBD	8.18	7.7	8.03	7.99	7.81	8.06	8.14
Sulphate	mg/L	1000	TBD	36	17	3	13	184	858	2,960
Total hardness	mg/L as $CaCO_3$	NA	NA	456	497	425	339	666	1,447	3,509
Aluminium total	mg/L	5	NA	0.04	0.06	0.18	0.03	0.02	0.08	0.04
Aluminium filterable	mg/L	NA	0.055	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic total	mg/L	0.5	NA	0.002	0.002	0.006	0.004	0.012	0.012	0.027
Arsenic filterable	mg/L	NA	0.013	0.002	0.002	0.004	0.004	0.012	0.012	0.026
Cadmium total	mg/L	0.01	NA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cadmium filterable	mg/L	NA	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium total	mg/L	1	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium filterable	mg/L	NA	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt total	mg/L	1	NA	<0.001	<0.001	<0.001	0.002	<0.001	0.001	<0.001
Cobalt filterable	mg/L	NA	0.0028	<0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001
Copper total	mg/L	1	NA	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.001
Copper filterable	mg/L	NA	0.0014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead total	mg/L	0.1	NA	<0.001	<0.001	0.002	<0.001	0.002	<0.001	<0.001
Lead filterable	mg/L	NA	0.0034	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Nickel total	mg/L	1	NA	0.002	<0.001	0.002	0.002	<0.001	0.013	0.001
Nickel filterable	mg/L	NA	0.011	0.001	<0.001	<0.001	0.002	0.001	0.007	0.001
Zinc total	mg/L	20	NA	0.006	<0.005	0.013	0.012	0.007	0.171	0.005
Zinc filterable	mg/L	NA	0.008	0.007	0.005	<0.005	0.007	0.006	0.114	<0.005
Free Cyanide	mg/L	0.22	0.007	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WAD Cyanide	mg/L	NA	NA	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Hardness corrected limits										
Cadmium filterable	mg/L			0.0020	0.0020	0.0020	0.0017	0.0020	0.0020	0.0020
Chromium filterable	mg/L			0.0084	0.0084	0.0084	0.0073	0.0084	0.0084	0.0084
Copper filterable	mg/L			0.0127	0.0127	0.0127	0.0110	0.0127	0.0127	0.0127
Lead filterable	mg/L			0.0912	0.0912	0.0912	0.0740	0.0912	0.0912	0.0912
Nickel filterable	mg/L			0.0994	0.0994	0.0994	0.0865	0.0994	0.0994	0.0994
Zinc filterable	mg/L			0.0723	0.0723	0.0723	0.0629	0.0723	0.0723	0.0723

NOTES

TBD To be determined
NA Not applicable
Higher concentration than contaminant limit
Higher concentration than trigger level
Suspect result, filterable exceeds total

Table B1
April 2022 Hydrochemistry Compared to EA Limits

Location Type				Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient
Source Facility				**EWRSF**	**EWRSF**	**EWRSF**	**EWRSF**	**EWRSF**	**EWRSF**	**EWRSF**
EA Classification				**Interpretation**	**None**	**None**	**None**	**None**	**None**	**None**
Site				**NMLMB15D**	**NMLMB11**	**NMLMB14**	**NMLMB16**	**NMLMB17**	**NMLMB35**	**NMLMB36**
Date and time				**28-Apr-22**	**28-Apr-22**	**28-Apr-22**	**28-Apr-22**	**29-Apr-22**	**28-Apr-22**	**28-Apr-22**
Parameter	**Unit**	**Sched C - Table 13 Contaminant Limit**	**Sched C - Table 13 Trigger level**							
EC	uS/cm	TBD	TBD	10,300	1,610	2,540	19,300	2,490	3,750	1,250
pH		TBD	TBD	7.88	8.01	8.44	7.84	8.12	8.05	8.42
Sulphate	mg/L	1000	TBD	6,880	216	14	19,000	1	27	26
Total hardness	mg/L as $CaCO_3$	NA	NA	6,144	461	661	21,030	653	715	252
Aluminium total	mg/L	5	NA	0.22	0.03	1.88	<0.05	0.05	0.26	0.02
Aluminium filterable	mg/L	NA	0.055	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01
Arsenic total	mg/L	0.5	NA	0.017	0.004	0.003	<0.005	0.017	0.005	0.014
Arsenic filterable	mg/L	NA	0.013	0.017	0.003	0.002	0.006	0.013	0.004	0.014
Cadmium total	mg/L	0.01	NA	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	<0.0001	<0.0001
Cadmium filterable	mg/L	NA	0.0002	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	<0.0001	<0.0001
Chromium total	mg/L	1	NA	<0.001	<0.001	0.004	<0.005	0.003	<0.001	<0.001
Chromium filterable	mg/L	NA	0.001	<0.001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001
Cobalt total	mg/L	1	NA	0.003	<0.001	0.002	<0.005	0.002	<0.001	<0.001
Cobalt filterable	mg/L	NA	0.0028	0.002	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001
Copper total	mg/L	1	NA	0.001	<0.001	0.006	<0.005	0.002	0.003	<0.001
Copper filterable	mg/L	NA	0.0014	<0.001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001
Lead total	mg/L	0.1	NA	<0.001	0.001	0.008	<0.005	<0.001	<0.001	<0.001
Lead filterable	mg/L	NA	0.0034	<0.001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001
Nickel total	mg/L	1	NA	0.002	0.002	0.003	<0.005	0.004	0.002	<0.001
Nickel filterable	mg/L	NA	0.011	0.002	0.002	<0.001	<0.005	0.002	0.001	<0.001
Zinc total	mg/L	20	NA	0.015	0.009	0.018	<0.026	0.011	0.02	0.028
Zinc filterable	mg/L	NA	0.008	0.009	0.007	0.007	0.033	<0.005	0.007	<0.005
Free Cyanide	mg/L	0.22	0.007	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WAD Cyanide	mg/L	NA	NA	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Hardness corrected limits										
Cadmium filterable	mg/L			0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0013
Chromium filterable	mg/L			0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0057
Copper filterable	mg/L			0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0085
Lead filterable	mg/L			0.0912	0.0912	0.0912	0.0912	0.0912	0.0912	0.0506
Nickel filterable	mg/L			0.0994	0.0994	0.0994	0.0994	0.0994	0.0994	0.0671
Zinc filterable	mg/L			0.0723	0.0723	0.0723	0.0723	0.0723	0.0723	0.0488

NOTES

TBD To be determined
NA Not applicable
Higher concentration than contaminant limit
Higher concentration than trigger level
Suspect result, filterable exceeds total

Table B1
April 2022 Hydrochemistry Compared to EA Limits

Location Type				Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient
Source Facility				**EWRSF**	**EWRSF**	**EWRSF**	**NNTSF**	**NNTSF**	**NNTSF**	**NNTSF**
EA Classification				**None**	**None**	**None**	**Compliance**	**Compliance**	**Interpretation**	**Interpretation**
Site				**NMLMB37**	**NMLMB43**	**NMLMB6**	**NMLMB28**	**NMLMB7**	**NMLMB1**	**NMLMB2**
Date and time				**29-Apr-22**	**29-Apr-22**	**27-Apr-22**	**30-Mar-22**	**29-Mar-22**	**21-Apr-22**	**22-Apr-22**
Parameter	**Unit**	**Sched C - Table 13 Contaminant Limit**	**Sched C - Table 13 Trigger level**							
EC	uS/cm	TBD	TBD	7,370	2,950	4,740	2,390	1,530	6,170	5,260
pH		TBD	TBD	8.13	8.11	7.89	7.91	7.85	7.74	7.95
Sulphate	mg/L	1000	TBD	4,270	602	1,270	592	39	3,110	2,290
Total hardness	mg/L as $CaCO_3$	NA	NA	4,276	993	1,281	824	447	2,734	1,962
Aluminium total	mg/L	5	NA	0.1	0.51	0.16	0.02	0.02	0.06	6.23
Aluminium filterable	mg/L	NA	0.055	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic total	mg/L	0.5	NA	0.01	0.004	0.014	0.003	0.003	0.004	0.005
Arsenic filterable	mg/L	NA	0.013	0.009	0.003	0.012	0.003	0.003	0.004	0.003
Cadmium total	mg/L	0.01	NA	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0001
Cadmium filterable	mg/L	NA	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium total	mg/L	1	NA	<0.001	0.002	0.001	<0.001	<0.001	<0.001	0.004
Chromium filterable	mg/L	NA	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt total	mg/L	1	NA	0.007	0.004	<0.001	0.025	<0.001	0.292	0.091
Cobalt filterable	mg/L	NA	0.0028	0.006	0.004	<0.001	0.028	<0.001	0.261	0.079
Copper total	mg/L	1	NA	<0.001	0.003	0.003	0.002	<0.001	<0.001	0.011
Copper filterable	mg/L	NA	0.0014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead total	mg/L	0.1	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.009
Lead filterable	mg/L	NA	0.0034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel total	mg/L	1	NA	0.002	0.001	0.002	<0.001	<0.001	0.005	0.004
Nickel filterable	mg/L	NA	0.011	0.002	<0.001	0.002	<0.001	<0.001	0.005	0.002
Zinc total	mg/L	20	NA	0.016	0.013	0.037	0.007	0.01	0.148	0.056
Zinc filterable	mg/L	NA	0.008	0.011	0.007	0.012	0.006	0.008	0.018	0.029
Free Cyanide	mg/L	0.22	0.007	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WAD Cyanide	mg/L	NA	NA	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Hardness corrected limits										
Cadmium filterable	mg/L			0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Chromium filterable	mg/L			0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084
Copper filterable	mg/L			0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127
Lead filterable	mg/L			0.0912	0.0912	0.0912	0.0912	0.0912	0.0912	0.0912
Nickel filterable	mg/L			0.0994	0.0994	0.0994	0.0994	0.0994	0.0994	0.0994
Zinc filterable	mg/L			0.0723	0.0723	0.0723	0.0723	0.0723	0.0723	0.0723

NOTES

TBD To be determined
NA Not applicable
Higher concentration than contaminant limit
Higher concentration than trigger level
Suspect result, filterable exceeds total

Table B1
April 2022 Hydrochemistry Compared to EA Limits

Location Type				Downgradient	Downgradient	Downgradient	Duplicate	Downgradient	Downgradient	Downgradient
Source Facility				**NNTSF**	**NNTSF**	**NNTSF**	**NNTSF**	**NNTSF**	**NNTSF**	**NNTSF**
EA Classification				**Interpretation**	**None**	**None**	**None**	**None**	**None**	**None**
Site				**NMLMB47D**	**MLM56**	**NMLMB21**	**NMLMB24**	**NMLMB25**	**NMLMB26**	**NMLMB29**
Date and time				**20-Apr-22**	**20-Apr-22**	**20-Apr-22**	**21-Apr-22**	**21-Apr-22**	**22-Apr-22**	**21-Apr-22**
Parameter	**Unit**	**Sched C - Table 13 Contaminant Limit**	**Sched C - Table 13 Trigger level**							
EC	uS/cm	TBD	TBD	5,510	4,430	1,630	4,610	5,400	4,910	2,540
pH		TBD	TBD	7.52	7.56	7.78	7.81	7.78	8.03	8.02
Sulphate	mg/L	1000	TBD	2,900	2,170	142	1,710	2,720	2,290	397
Total hardness	mg/L as $CaCO_3$	NA	NA	2,314	1,940	616	1,708	2,689	1,622	754
Aluminium total	mg/L	5	NA	0.07	0.06	0.05	0.06	0.02	0.05	0.01
Aluminium filterable	mg/L	NA	0.055	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic total	mg/L	0.5	NA	0.001	<0.001	0.002	0.005	0.002	0.002	0.005
Arsenic filterable	mg/L	NA	0.013	0.001	<0.001	0.001	0.004	0.001	0.001	0.005
Cadmium total	mg/L	0.01	NA	0.0003	<0.0001	<0.0001	<0.0001	0.0008	<0.0001	<0.0001
Cadmium filterable	mg/L	NA	0.0002	0.0003	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	<0.0001
Chromium total	mg/L	1	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium filterable	mg/L	NA	0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt total	mg/L	1	NA	0.132	0.141	0.035	0.214	0.062	0.04	0.013
Cobalt filterable	mg/L	NA	0.0028	0.116	0.125	0.031	0.181	0.054	0.035	0.012
Copper total	mg/L	1	NA	0.002	<0.001	<0.001	0.001	0.001	0.002	<0.001
Copper filterable	mg/L	NA	0.0014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead total	mg/L	0.1	NA	<0.001	0.002	0.001	<0.001	<0.001	<0.001	<0.001
Lead filterable	mg/L	NA	0.0034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel total	mg/L	1	NA	0.006	0.007	<0.001	0.006	0.003	0.002	0.001
Nickel filterable	mg/L	NA	0.011	0.006	0.007	0.001	0.005	0.003	0.004	0.002
Zinc total	mg/L	20	NA	0.326	0.198	0.073	0.081	0.064	0.007	0.015
Zinc filterable	mg/L	NA	0.008	0.138	0.01	0.075	0.072	0.06	0.009	0.016
Free Cyanide	mg/L	0.22	0.007	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WAD Cyanide	mg/L	NA	NA	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Hardness corrected limits										
Cadmium filterable	mg/L			0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Chromium filterable	mg/L			0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084
Copper filterable	mg/L			0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127
Lead filterable	mg/L			0.0912	0.0912	0.0912	0.0912	0.0912	0.0912	0.0912
Nickel filterable	mg/L			0.0994	0.0994	0.0994	0.0994	0.0994	0.0994	0.0994
Zinc filterable	mg/L			0.0723	0.0723	0.0723	0.0723	0.0723	0.0723	0.0723

NOTES

TBD To be determined
NA Not applicable
Higher concentration than contaminant limit
Higher concentration than trigger level
Suspect result, filterable exceeds total

Table B1
April 2022 Hydrochemistry Compared to EA Limits

Location Type				Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient
Source Facility				**NNTSF**	**NNTSF**	**NNTSF**	**NNTSF**	**NNTSF**	**NNTSF**	**ONTSF**
EA Classification				**None**	**None**	**None**	**None**	**None**	**None**	**Interpretation**
Site				**NMLMB44D**	**NMLMB45D**	**NMLMB46D**	**NMLMB49D**	**NMLMB50D**	**NMLMB8**	**NMLMB32**
Date and time				**20-Apr-22**	**20-Apr-22**	**20-Apr-22**	**21-Apr-22**	**22-Apr-22**	**21-Apr-22**	**28-Apr-22**
Parameter	**Unit**	**Sched C - Table 13 Contaminant Limit**	**Sched C - Table 13 Trigger level**							
EC	uS/cm	TBD	TBD	1,760	4,160	3,670	5,610	1,250	1,430	2,390
pH		TBD	TBD	7.82	7.49	7.59	7.69	8.1	7.97	7.91
Sulphate	mg/L	1000	TBD	124	2,120	1,610	3,000	9	14	957
Total hardness	mg/L as $CaCO_3$	NA	NA	531	2,200	1,605	2,218	300	368	1,125
Aluminium total	mg/L	5	NA	0.02	0.06	<0.01	0.03	0.05	0.16	<0.01
Aluminium filterable	mg/L	NA	0.055	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic total	mg/L	0.5	NA	0.01	<0.001	0.001	0.025	0.004	0.002	<0.001
Arsenic filterable	mg/L	NA	0.013	0.005	0.001	0.001	0.003	0.004	0.002	<0.001
Cadmium total	mg/L	0.01	NA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cadmium filterable	mg/L	NA	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium total	mg/L	1	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium filterable	mg/L	NA	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt total	mg/L	1	NA	0.005	0.005	0.008	0.016	<0.001	0.001	0.005
Cobalt filterable	mg/L	NA	0.0028	0.003	0.004	0.007	0.01	<0.001	<0.001	0.004
Copper total	mg/L	1	NA	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.001
Copper filterable	mg/L	NA	0.0014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead total	mg/L	0.1	NA	<0.001	<0.001	<0.001	0.008	<0.001	0.001	<0.001
Lead filterable	mg/L	NA	0.0034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel total	mg/L	1	NA	0.006	0.004	0.003	0.009	0.007	0.004	0.003
Nickel filterable	mg/L	NA	0.011	0.006	0.003	0.002	0.008	0.007	0.009	0.002
Zinc total	mg/L	20	NA	0.066	0.178	0.178	0.046	<0.005	0.011	0.013
Zinc filterable	mg/L	NA	0.008	0.059	0.15	0.158	0.045	0.006	0.017	0.01
Free Cyanide	mg/L	0.22	0.007	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WAD Cyanide	mg/L	NA	NA	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Hardness corrected limits										
Cadmium filterable	mg/L			0.0020	0.0020	0.0020	0.0020	0.0016	0.0019	0.0020
Chromium filterable	mg/L			0.0084	0.0084	0.0084	0.0084	0.0066	0.0078	0.0084
Copper filterable	mg/L			0.0127	0.0127	0.0127	0.0127	0.0099	0.0118	0.0127
Lead filterable	mg/L			0.0912	0.0912	0.0912	0.0912	0.0633	0.0821	0.0912
Nickel filterable	mg/L			0.0994	0.0994	0.0994	0.0994	0.0779	0.0926	0.0994
Zinc filterable	mg/L			0.0723	0.0723	0.0723	0.0723	0.0566	0.0674	0.0723

NOTES

TBD To be determined
NA Not applicable
Higher concentration than contaminant limit
Higher concentration than trigger level
Suspect result, filterable exceeds total

Table B1
April 2022 Hydrochemistry Compared to EA Limits

Location Type				Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient
Source Facility				**ONTSF**	**ONTSF**	**ONTSF**	**ONTSF**	**Scats**	**Scats**	**Scats**
EA Classification				**None**	**None**	**None**	**None**	**Compliance**	**Interpretation**	**None**
Site				**MLM15**	**NMLMB10**	**NMLMB12**	**NMLMB30**	**NMLMB18**	**NMLMB22**	**NMLMB19**
Date and time				**3-May-22**	**28-Apr-22**	**27-Apr-22**	**22-Apr-22**	**29-Mar-22**	**19-Apr-22**	**20-Apr-22**
Parameter	**Unit**	**Sched C - Table 13 Contaminant Limit**	**Sched C - Table 13 Trigger level**							
EC	uS/cm	TBD	TBD	7,380	1,150	1,050	2,380	1,170	5,020	1,920
pH		TBD	TBD	7.73	8.07	8.03	8.04	7.55	7.25	7.78
Sulphate	mg/L	1000	TBD	3,610	23	9	871	13	2,920	592
Total hardness	mg/L as $CaCO_3$	NA	NA	2,309	478	388	957	420	3,043	922
Aluminium total	mg/L	5	NA	0.02	0.02	0.02	0.22	<0.01	<0.01	0.01
Aluminium filterable	mg/L	NA	0.055	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic total	mg/L	0.5	NA	0.007	0.012	0.001	0.004	0.001	<0.001	0.025
Arsenic filterable	mg/L	NA	0.013	0.007	0.003	0.001	0.002	0.001	<0.001	0.016
Cadmium total	mg/L	0.01	NA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cadmium filterable	mg/L	NA	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium total	mg/L	1	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium filterable	mg/L	NA	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt total	mg/L	1	NA	1.07	<0.001	<0.001	0.005	<0.001	0.003	<0.001
Cobalt filterable	mg/L	NA	0.0028	1.02	<0.001	<0.001	0.003	<0.001	0.002	<0.001
Copper total	mg/L	1	NA	<0.001	0.004	<0.001	0.001	<0.001	<0.001	<0.001
Copper filterable	mg/L	NA	0.0014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead total	mg/L	0.1	NA	<0.001	0.028	<0.001	<0.001	<0.001	<0.001	0.005
Lead filterable	mg/L	NA	0.0034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel total	mg/L	1	NA	0.014	0.002	0.002	0.001	0.001	0.002	0.004
Nickel filterable	mg/L	NA	0.011	0.013	0.001	0.002	0.001	<0.001	0.002	0.005
Zinc total	mg/L	20	NA	0.009	0.011	0.01	0.011	0.027	0.484	0.105
Zinc filterable	mg/L	NA	0.008	<0.005	0.007	0.008	0.011	0.013	0.292	0.101
Free Cyanide	mg/L	0.22	0.007	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WAD Cyanide	mg/L	NA	NA	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Hardness corrected limits										
Cadmium filterable	mg/L			0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Chromium filterable	mg/L			0.0084	0.0084	0.0082	0.0084	0.0084	0.0084	0.0084
Copper filterable	mg/L			0.0127	0.0127	0.0123	0.0127	0.0127	0.0127	0.0127
Lead filterable	mg/L			0.0912	0.0912	0.0877	0.0912	0.0912	0.0912	0.0912
Nickel filterable	mg/L			0.0994	0.0994	0.0968	0.0994	0.0994	0.0994	0.0994
Zinc filterable	mg/L			0.0723	0.0723	0.0704	0.0723	0.0723	0.0723	0.0723

NOTES

TBD To be determined
NA Not applicable
Higher concentration than contaminant limit
Higher concentration than trigger level
Suspect result, filterable exceeds total

Table B1
April 2022 Hydrochemistry Compared to EA Limits

Location Type				Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient
Source Facility				**Scats**	**STSF**	**STSF**	**STSF**	**STSF**	**STSF**	**STSF**
EA Classification				**None**	**Compliance**	**Compliance**	**Interpretation**	**Interpretation**	**None**	**None**
Site				**NMLMB20**	**NMLMB38**	**NMLMB39**	**NMLMB3**	**NMLMB3S**	**MLM44**	**NMLMB4**
Date and time				**19-Apr-22**	**29-Mar-22**	**29-Mar-22**	**27-Apr-22**	**27-Apr-22**	**29-Apr-22**	**3-May-22**
Parameter	**Unit**	**Sched C - Table 13 Contaminant Limit**	**Sched C - Table 13 Trigger level**							
EC	uS/cm	TBD	TBD	4,230	2,350	4,000	4,920	12,700	5,340	2,970
pH		TBD	TBD	7.22	7.85	7.7	7.83	7.77	7.97	7.98
Sulphate	mg/L	1000	TBD	2,370	268	440	2,650	7,930	1,940	344
Total hardness	mg/L as $CaCO_3$	NA	NA	2,657	556	1,191	2,689	7,879	2,595	756
Aluminium total	mg/L	5	NA	<0.01	0.02	<0.01	0.15	0.07	4.4	5.85
Aluminium filterable	mg/L	NA	0.055	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic total	mg/L	0.5	NA	<0.001	0.005	0.007	0.004	0.012	0.088	0.011
Arsenic filterable	mg/L	NA	0.013	<0.001	0.005	0.007	0.004	0.011	0.086	0.01
Cadmium total	mg/L	0.01	NA	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001
Cadmium filterable	mg/L	NA	0.0002	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium total	mg/L	1	NA	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.014
Chromium filterable	mg/L	NA	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt total	mg/L	1	NA	0.002	0.029	0.031	0.391	0.503	0.618	0.012
Cobalt filterable	mg/L	NA	0.0028	<0.001	0.033	0.031	0.338	0.442	0.58	0.005
Copper total	mg/L	1	NA	<0.001	<0.001	<0.001	0.001	<0.001	0.012	0.002
Copper filterable	mg/L	NA	0.0014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead total	mg/L	0.1	NA	0.002	<0.001	<0.001	<0.001	<0.001	0.048	0.003
Lead filterable	mg/L	NA	0.0034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel total	mg/L	1	NA	0.004	<0.001	0.001	0.008	0.018	0.009	0.01
Nickel filterable	mg/L	NA	0.011	0.004	<0.001	<0.001	0.007	0.016	0.004	<0.001
Zinc total	mg/L	20	NA	0.35	0.007	<0.005	0.03	0.011	0.05	0.033
Zinc filterable	mg/L	NA	0.008	0.31	0.01	0.006	0.017	0.005	<0.005	0.011
Free Cyanide	mg/L	0.22	0.007	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
WAD Cyanide	mg/L	NA	NA	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Hardness corrected limits										
Cadmium filterable	mg/L			0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Chromium filterable	mg/L			0.0084	0.0084	0.0084	0.0084	0.0084	0.0084	0.0084
Copper filterable	mg/L			0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127
Lead filterable	mg/L			0.0912	0.0912	0.0912	0.0912	0.0912	0.0912	0.0912
Nickel filterable	mg/L			0.0994	0.0994	0.0994	0.0994	0.0994	0.0994	0.0994
Zinc filterable	mg/L			0.0723	0.0723	0.0723	0.0723	0.0723	0.0723	0.0723

NOTES

TBD To be determined
NA Not applicable
Higher concentration than contaminant limit
Higher concentration than trigger level
Suspect result, filterable exceeds total

Table B1
April 2022 Hydrochemistry Compared to EA Limits

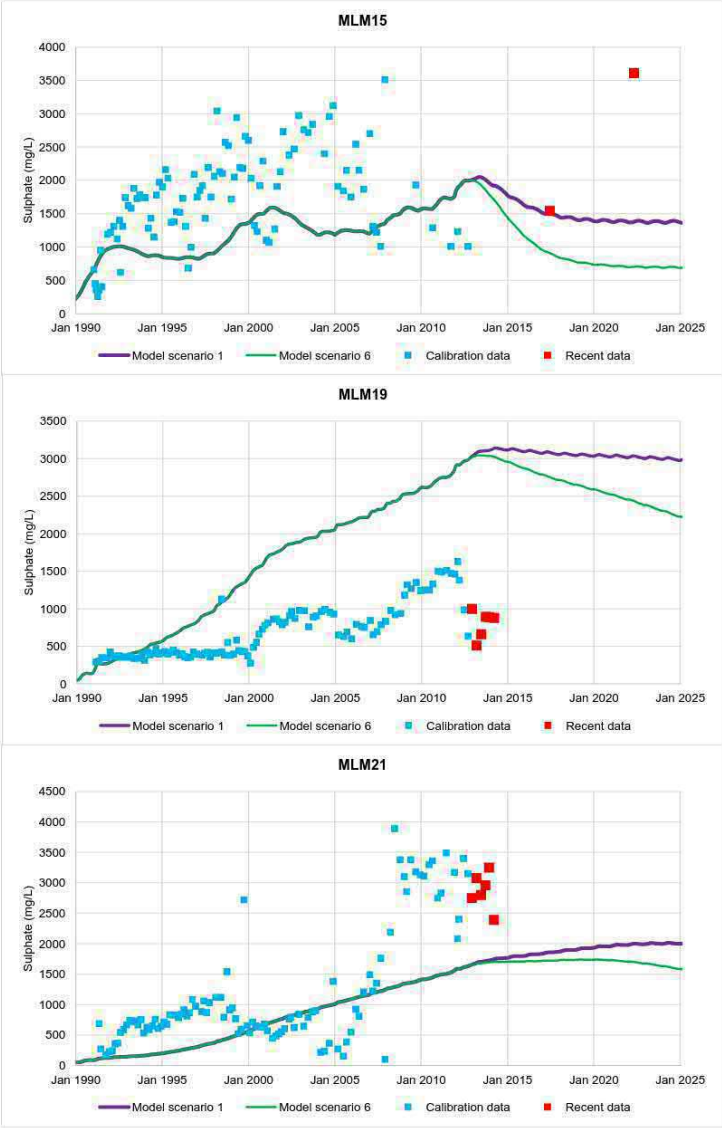
Location Type	**Downgradient**
Source Facility	**SWRSF**
EA Classification	**Interpretation**
Site	**NMLMB40**
Date and time	**21-Apr-22**

Parameter	**Unit**	**Sched C - Table 13 Contaminant Limit**	**Sched C - Table 13 Trigger level**	
EC	uS/cm	TBD	TBD	4,280
pH		TBD	TBD	7.53
Sulphate	mg/L	1000	TBD	1,900
Total hardness	mg/L as $CaCO_3$	NA	NA	2,221
Aluminium total	mg/L	5	NA	0.02
Aluminium filterable	mg/L	NA	0.055	<0.01
Arsenic total	mg/L	0.5	NA	<0.001
Arsenic filterable	mg/L	NA	0.013	<0.001
Cadmium total	mg/L	0.01	NA	<0.0001
Cadmium filterable	mg/L	NA	0.0002	0.0001
Chromium total	mg/L	1	NA	<0.001
Chromium filterable	mg/L	NA	0.001	<0.001
Cobalt total	mg/L	1	NA	0.006
Cobalt filterable	mg/L	NA	0.0028	0.004
Copper total	mg/L	1	NA	0.001
Copper filterable	mg/L	NA	0.0014	<0.001
Lead total	mg/L	0.1	NA	<0.001
Lead filterable	mg/L	NA	0.0034	<0.001
Nickel total	mg/L	1	NA	0.006
Nickel filterable	mg/L	NA	0.011	0.005
Zinc total	mg/L	20	NA	0.142
Zinc filterable	mg/L	NA	0.008	0.133
Free Cyanide	mg/L	0.22	0.007	<0.004
WAD Cyanide	mg/L	NA	NA	<0.004
Hardness corrected limits				
Cadmium filterable	mg/L			0.0020
Chromium filterable	mg/L			0.0084
Copper filterable	mg/L			0.0127
Lead filterable	mg/L			0.0912
Nickel filterable	mg/L			0.0994
Zinc filterable	mg/L			0.0723

NOTES

TBD To be determined
NA Not applicable
Higher concentration than contaminant limit
Higher concentration than trigger level
Suspect result, filterable exceeds total

APPENDIX C
MODELLED AND OBSERVED GROUNDWATER SULPHATE TRENDS



C:\Users\Simon\Documents\BDH Projects\Mt Leyshon\Mt Leyshon groundwater chemistry update

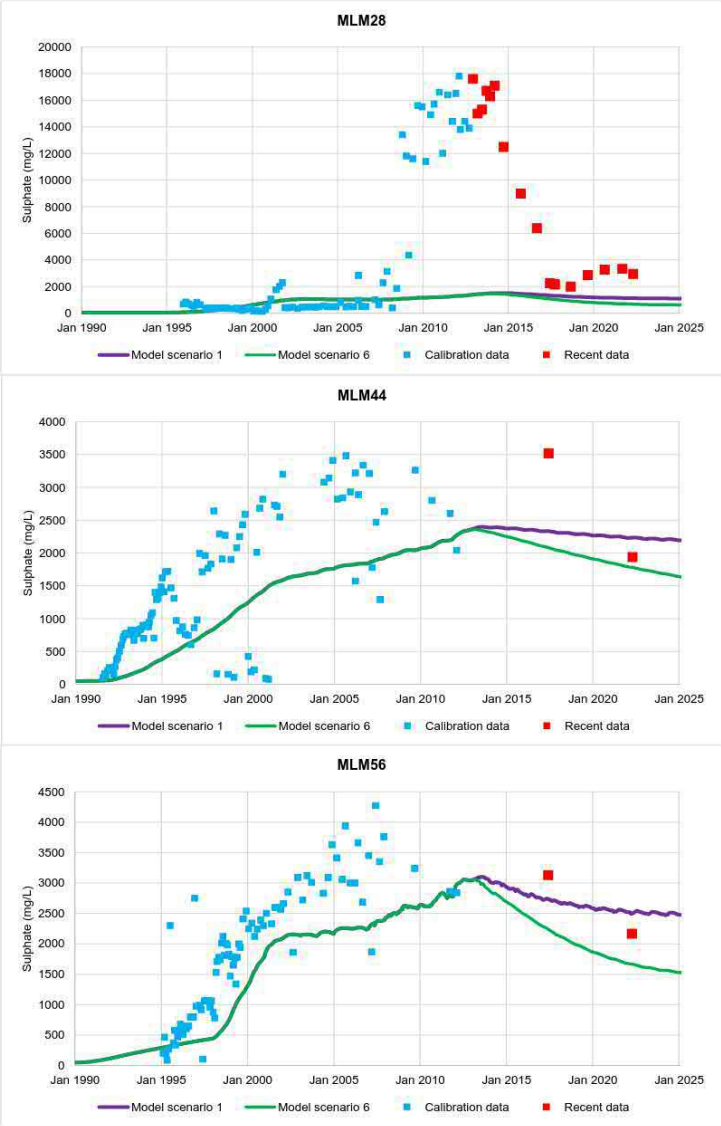
BIG DOG HYDROGEOLOGY

Modelled and observed sulphate trends part 1

Figure C1

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update



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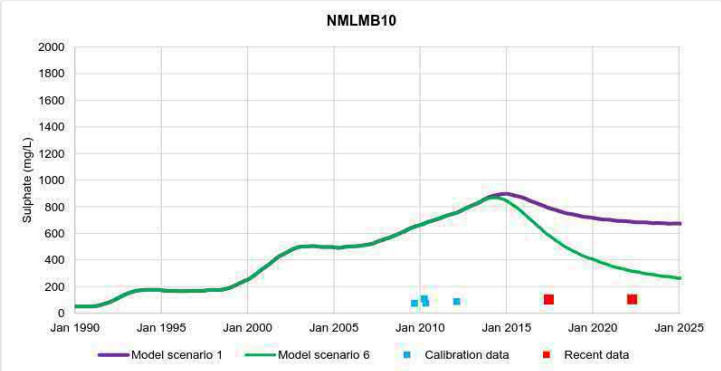
BIG DOG HYDROGEOLOGY

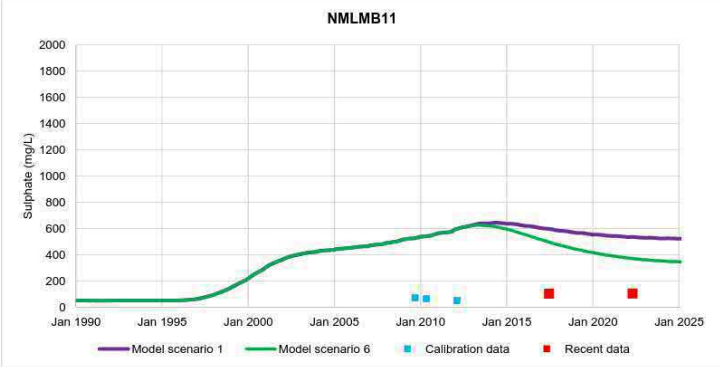
Modelled and observed sulphate trends part 2

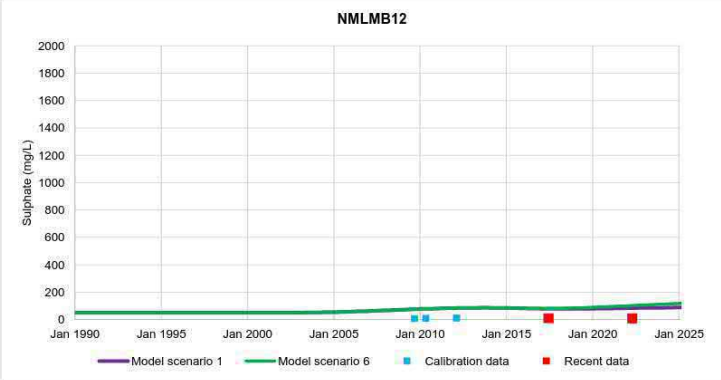
Figure C2

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update







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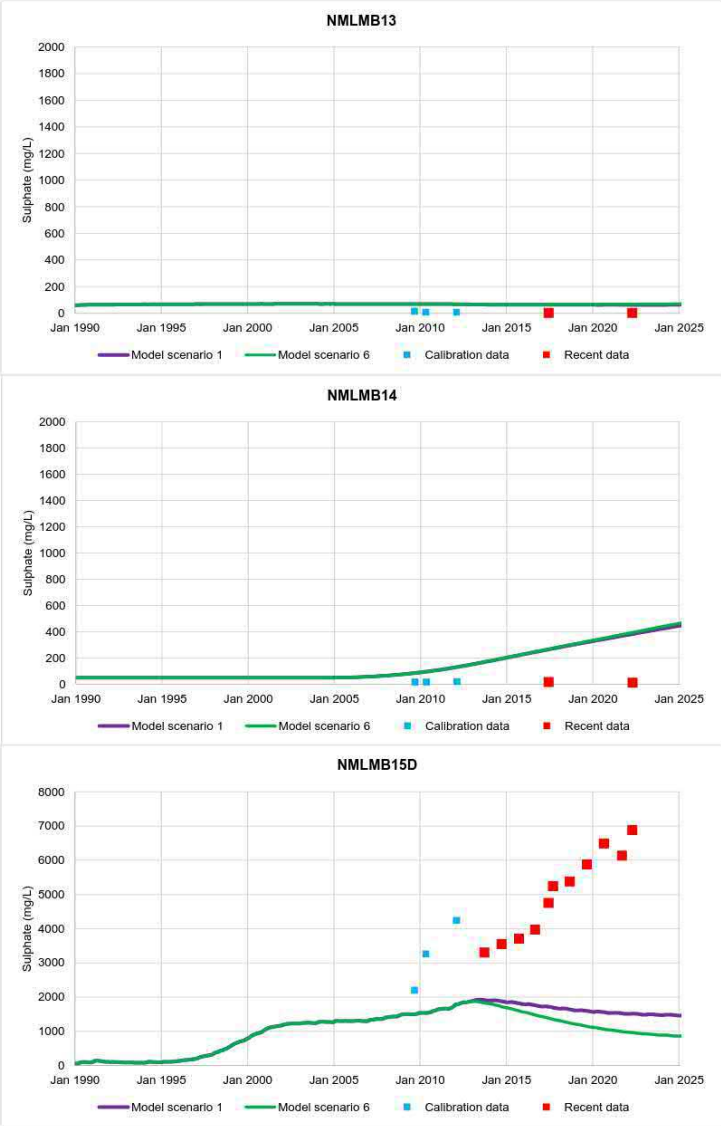
BIG DOG HYDROGEOLOGY

Modelled and observed sulphate trends part 3

Figure C3

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update



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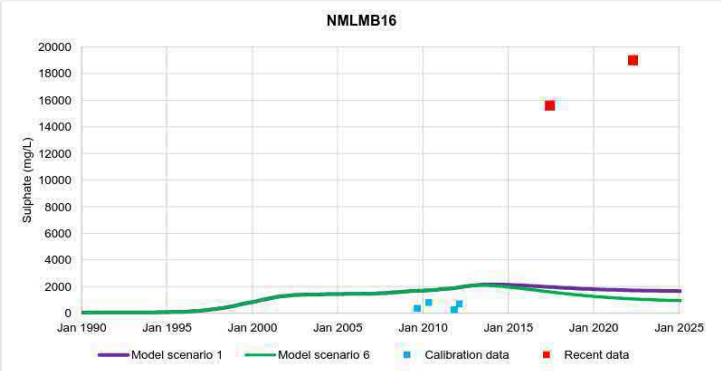
BIG DOG HYDROGEOLOGY

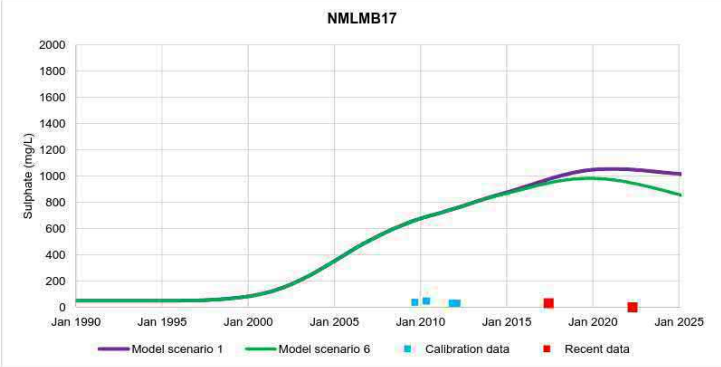
Modelled and observed sulphate trends part 4

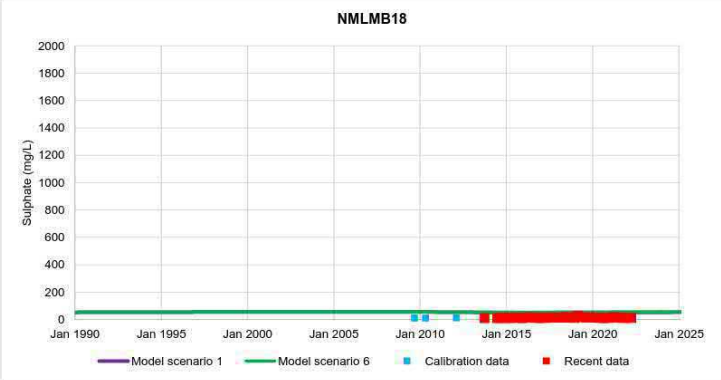
Figure C4

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update







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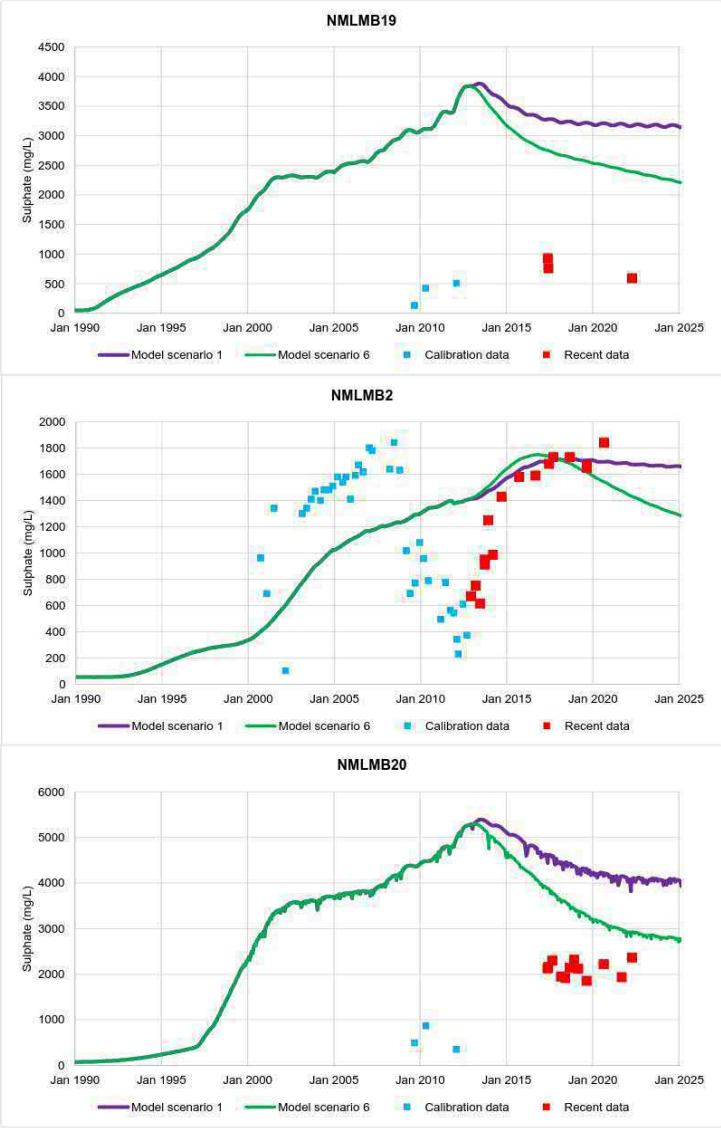
BIG DOG HYDROGEOLOGY

Modelled and observed sulphate trends part 5

Figure C5

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update



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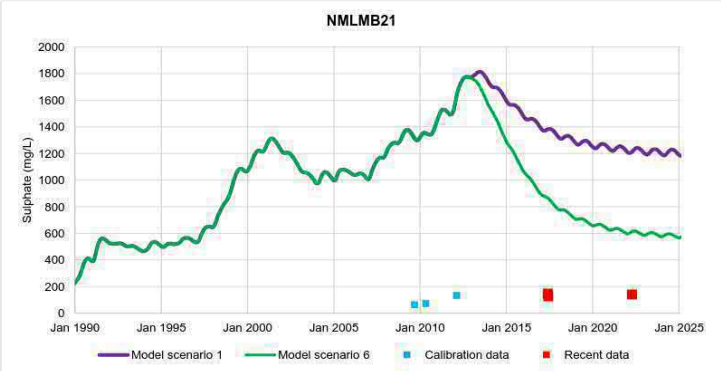
BIG DOG HYDROGEOLOGY

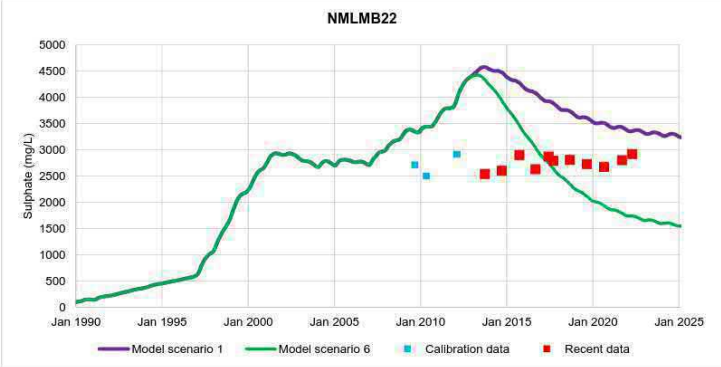
Modelled and observed sulphate trends part 6

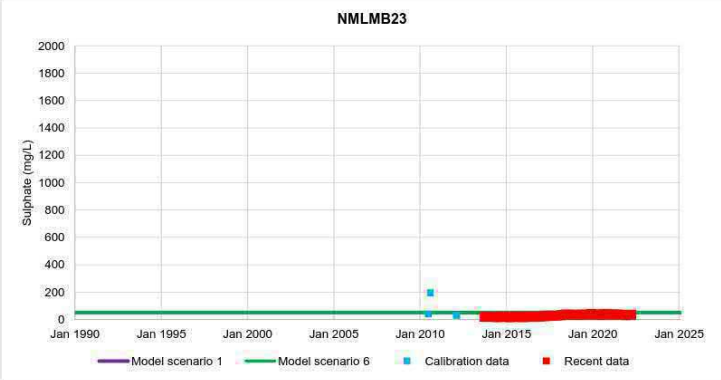
Figure C6

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update







BIG DOG HYDROGEOLOGY

Modelled and observed sulphate trends part 7

Figure C7

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update

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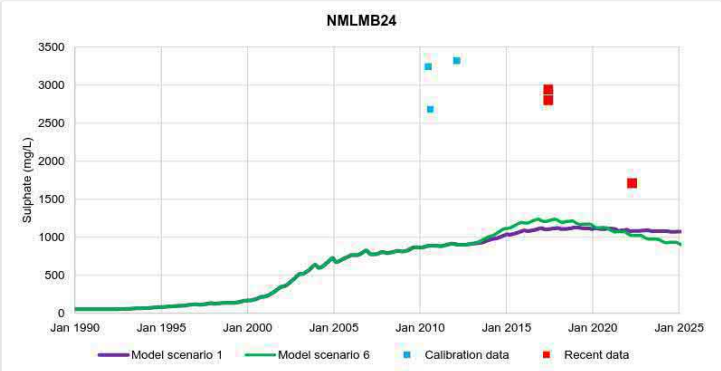

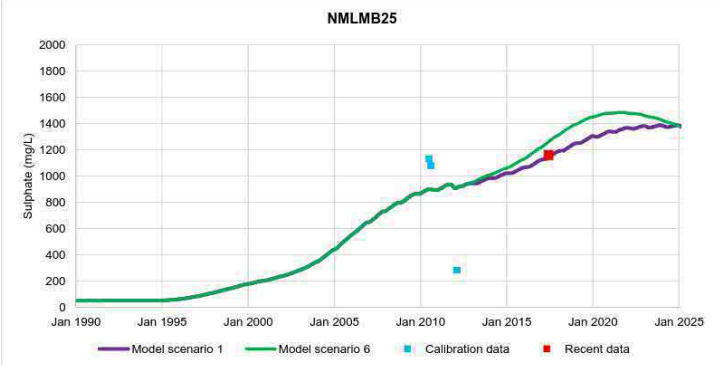

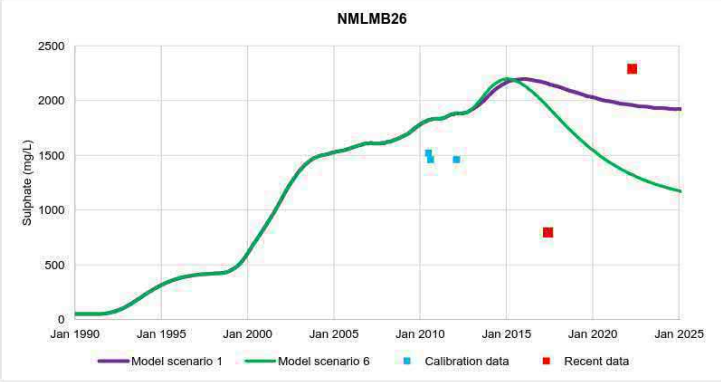

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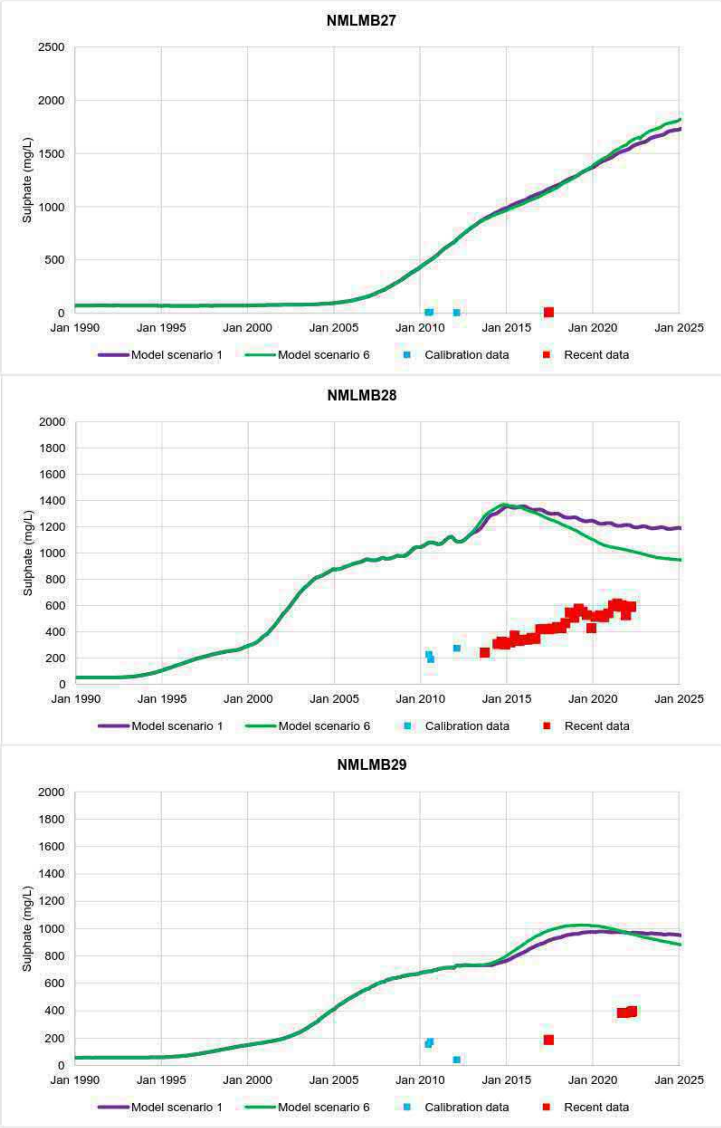
BIG DOG HYDROGEOLOGY	**Modelled and observed sulphate trends part 8**	**Figure C8**
		Date: June 2022
		Report: Mt Leyshon Groundwater Chemistry Update



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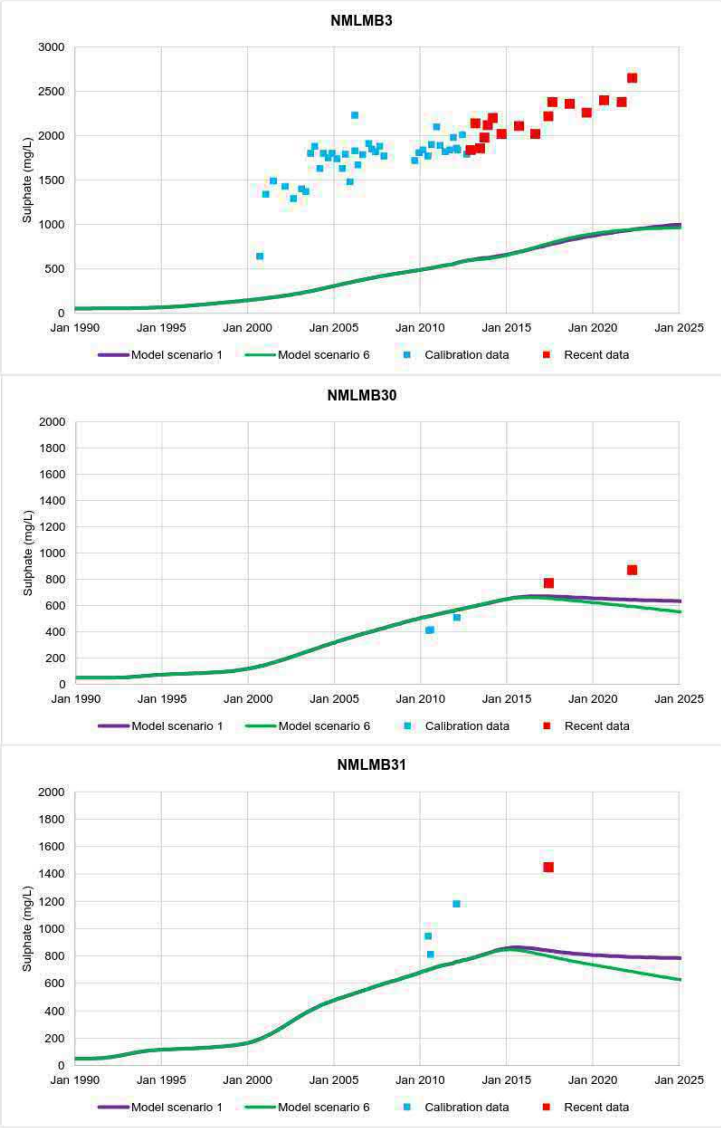
BIG DOG HYDROGEOLOGY

Modelled and observed sulphate trends part 9

Figure C9

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update



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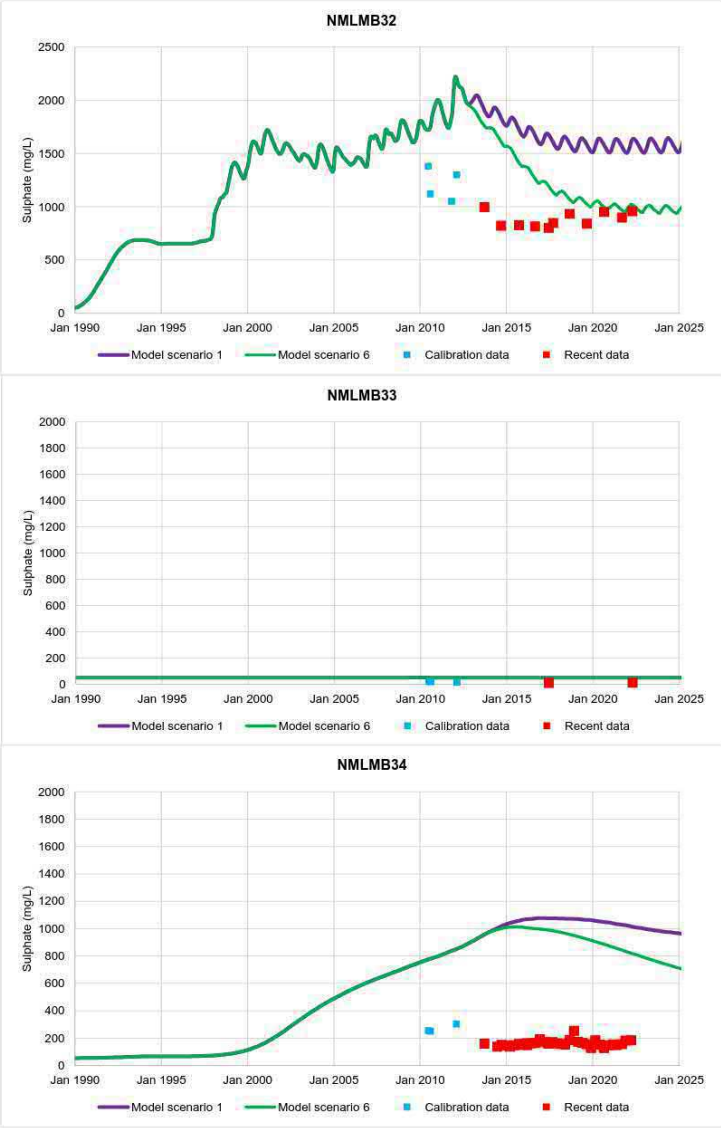
BIG DOG HYDROGEOLOGY

Modelled and observed sulphate trends part 10

Figure C10

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update



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BIG DOG HYDROGEOLOGY

Modelled and observed sulphate trends part 11

Figure C11

Date: June 2022

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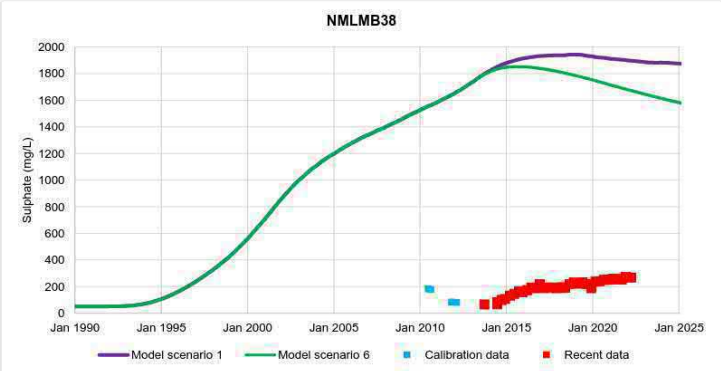
BIG DOG HYDROGEOLOGY

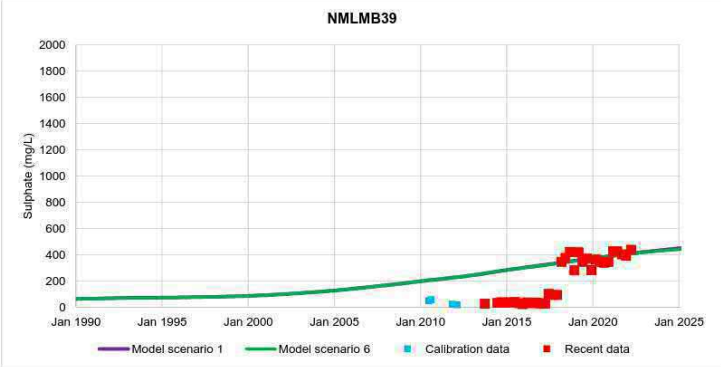
Modelled and observed sulphate trends part 12

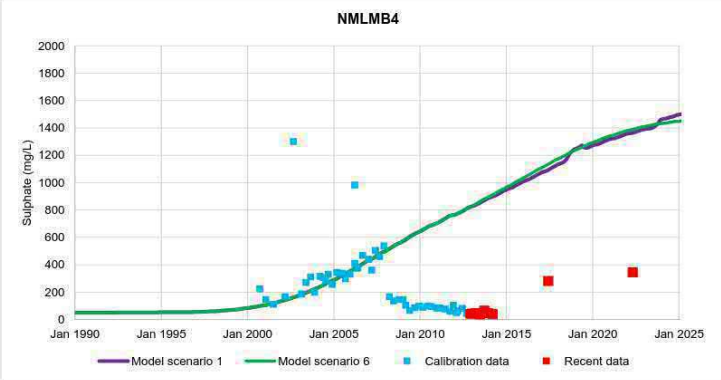
Figure C12

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update







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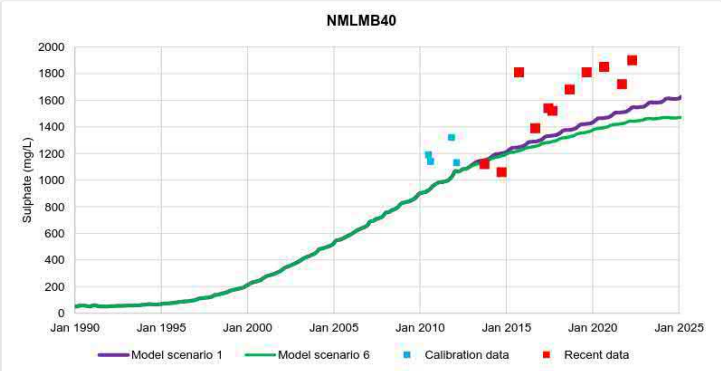
BIG DOG HYDROGEOLOGY

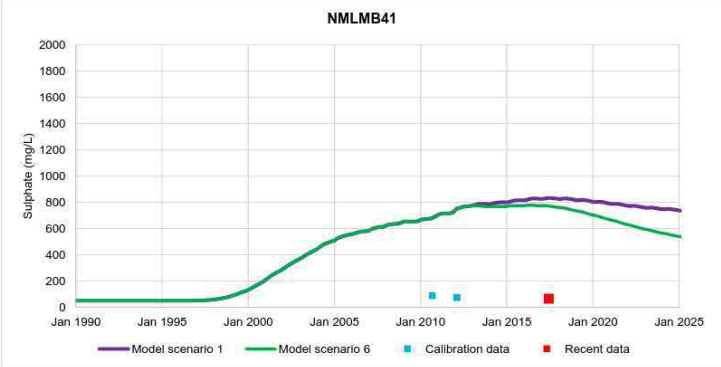
Modelled and observed sulphate trends part 13

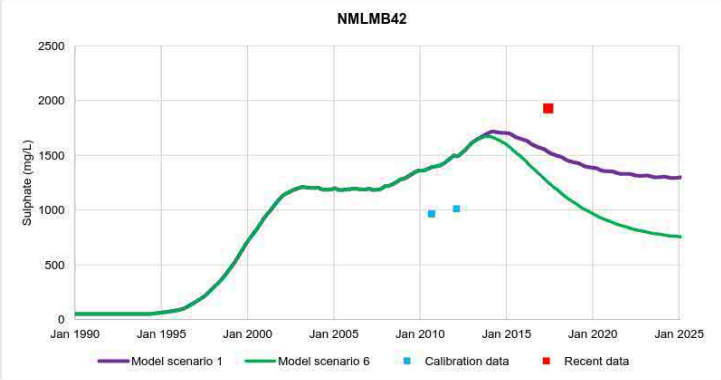
Figure C13

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update







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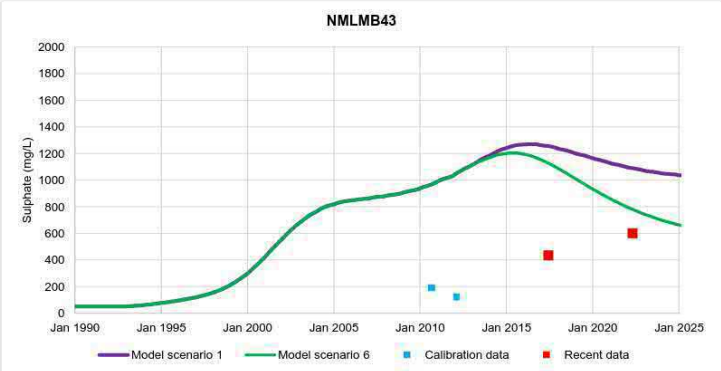
BIG DOG HYDROGEOLOGY

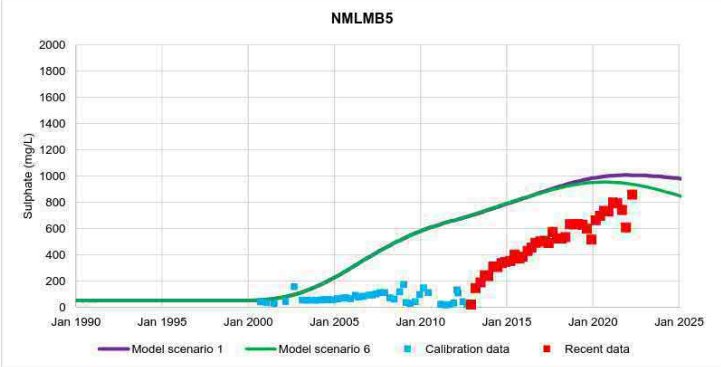
Modelled and observed sulphate trends part 14

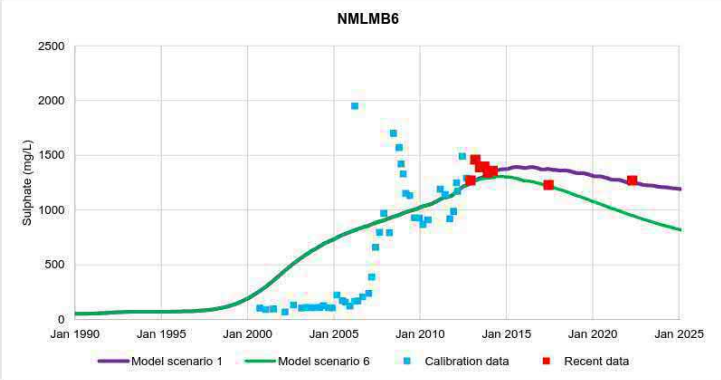
Figure C14

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update







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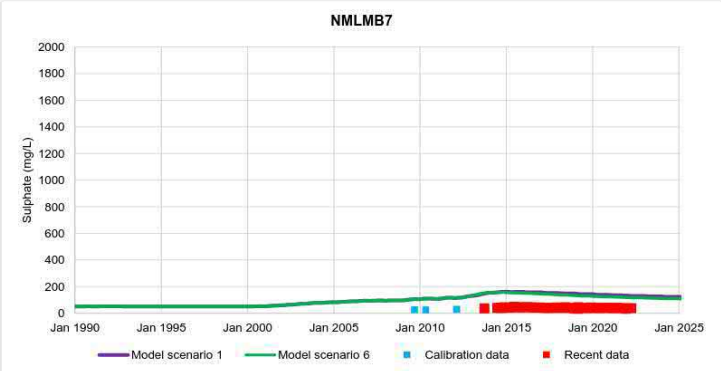
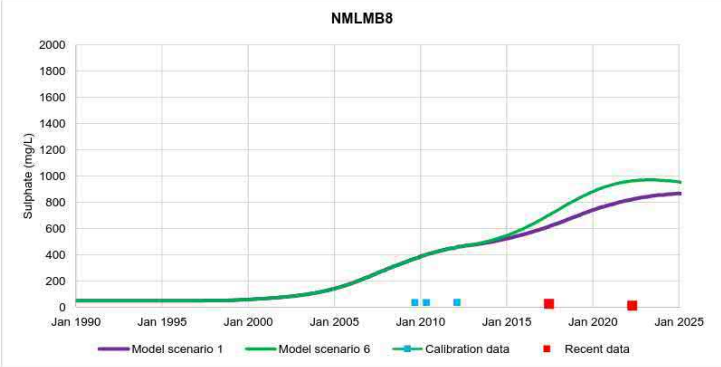
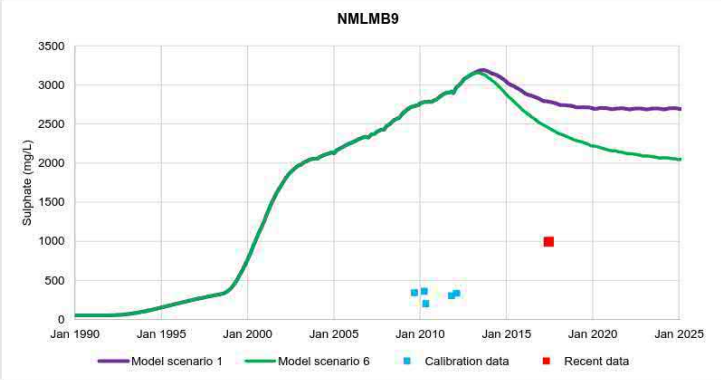
BIG DOG HYDROGEOLOGY	**Modelled and observed sulphate trends part 15**	**Figure C15**
		Date: June 2022
		Report: Mt Leyshon Groundwater Chemistry Update







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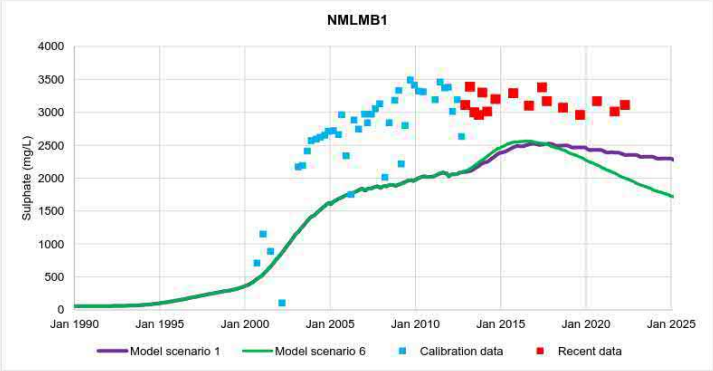
BIG DOG HYDROGEOLOGY	**Modelled and observed sulphate trends part 16**	**Figure C16**
		Date: June 2022
		Report: Mt Leyshon Groundwater Chemistry Update



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BIG DOG HYDROGEOLOGY

Modelled and observed sulphate trends part 17

Figure C17

Date: June 2022

Report: Mt Leyshon Groundwater Chemistry Update

Appendix P:
Big Dog Hydrogeology Report on Cover Performance Influence on Receiving Environment

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Mr Glen Ware
Principal Advisor Legacy Sites
Newmont Australia Pty Ltd
388 Hay St
Subiaco, WA 6008

1 July 2022

Re: Discussion of the influence of Mt Leyshon Mine cover performance on the receiving environment – Rev 2 final

Dear Glen,

As requested, we have undertaken a technical review of the groundwater monitoring and modelling data available for groundwater at the Mt Leyshon Mine and used these as inputs to discuss the current and future performance of the covers on the closed and rehabilitated mine facilities in terms of protecting the receiving environment.

1 INTRODUCTION

The Mt Leyshon site is an open pit gold mine located 24 km south of Charters Towers, which has been in closure since 2002. During operations three waste rock storage facilities (WRSFs) and three tailings storage facilities (TSFs) were utilised, and were progressively rehabilitated during the operating and closure periods. The Old North TSF (ONTSF) was the first facility to be commissioned in January 1989, with the other facilities commissioned between 1989 and 1997, and the New North TSF (NNTSF) was the last facility to be commissioned in June 1997. As a result of the progressive rehabilitation approach, partial covers were first constructed in 1992, with construction continuing through the operating and closure periods, and with all covers completed by 2002. The last covers to be physically placed were the Southern TSF (STSF) in 2002, the NNTSF in 2002 and the eastern side of the Eastern WRSF (EWRSF) in 2001 after which revegetation of each facility was undertaken.

During the post closure monitoring and maintenance phase at the Mt Leyshon Mine, Newmont Australia (Newmont) have undertaken a range of design studies to develop closure provisioning costs. To assist with these studies, Newmont require an assessment of current cover performance, and the implications to the receiving environment of the current and future cover performance.

This document discusses the operational and post closure groundwater monitoring and modelling results and uses these results to assess the implications for the receiving environment related to cover performance.

2 NUMERICAL GROUNDWATER AND SULPHATE TRANSPORT MODEL

Testing and modelling of the performance of cover designs for the Mt Leyshon Mine facilities was undertaken during the operating period from 1996. The investigations represented leading industry standard technology at that time, and included the construction of lysimeters within the WRSFs, installation and monitoring of probe holes to measure oxygen content in pore spaces, and numerical modelling of oxygen flow, sulphide oxidation and water infiltration through the facilities. The investigations were crucial to the testing and refinement of cover designs during operations. However these studies are of limited value in defining cover performance in closure as:

1. Most of the investigations were completed on the cover design provided in the original EMOS (300 mm of compacted heap leach material). The monitoring indicated this design was not effective in reducing infiltration of water and oxygen, and the cover design was subsequently upgraded to require 800 mm of compacted porphyry waste rock. Much of the testing therefore is not representative of the covers as finally constructed.
2. Probe holes and lysimeters represent point observations which are difficult to extrapolate over the full footprint of the facility due to the variable nature of materials stored in the facilities.
3. Lysimeters measure the rate of infiltration into the top of the facility, which is not necessarily the same as the combined rates of discharge reaching the receiving groundwater and surface water environment.
4. Infiltration conditions are inevitably altered by the construction and installation of the monitoring equipment.

Seepage from the Mt Leyshon Mine facilities has influenced the receiving groundwater environment, and is primarily evident in changes in groundwater sulphate concentrations. Monitoring of changes in groundwater conditions therefore provides a large scale indication of the total influence of infiltration through covers and component of infiltration which subsequently reports as seepage to groundwater from the mine facilities. Conclusions drawn from changes in groundwater conditions are considered more representative of the cumulative influences of seepage on the receiving environment than conclusions drawn from localised testing within the facilities. The groundwater model described below which was calibrated to the observed groundwater responses therefore provides a valuable tool for predicting future groundwater responses to cover performance, and hence implications for the distant receiving environment.

The receiving environment at the Mt Leyshon Mine comprises the shallow groundwater system which occurs within weathered and fractured granite between 5 m below ground level (mBGL) and 25 mBGL. Although baseline groundwater chemistry was not measured prior to mining, background groundwater sulphate concentrations within this system are expected to be around 40 mg/L. The shallow groundwater system receives natural recharge occurring in the wet season and seepage from the mine facilities. Discharge occurs as downgradient throughflow into the receiving groundwater environment and as discharge to surface water intermittent streams downgradient of the mine. Discharge of groundwater to the surface water environment is a natural condition for the shallow groundwater system, with the locations and rates of discharge being naturally variable in response to climate conditions. The shallow groundwater system, and interactions with the surface water system are well understood from geophysical surveys, from the installation and monitoring of more than 100 investigation bores, and from monitoring of the surface water receiving environment undertaken as part of the Receiving Environment Monitoring Program (REMP).

In 2013 a numerical model of groundwater flow and sulphate transport was constructed to simulate the shallow groundwater system, including the interactions between the mine facilities and the shallow groundwater system, and the interactions between the shallow groundwater system and the surface water environment (SWS, 2013). The model was calibrated to 33,507 observations of groundwater elevations and 1,483 observations of groundwater sulphate concentrations made during operations (1989 to 2002) and during closure (2002 to 2012). The primary objective of the modelling was to define the maximum future extent of sulphate in groundwater in the receiving groundwater environment, and in particular to confirm that the extent would remain within land controlled by Newmont under all possible future conditions. Consistent with this primary objective, model construction and calibration were focussed on observed responses in the receiving environment, with less detail applied in the locations of the mine facilities. A conservative approach was adopted for the mine facilities in which seepage rates were calibrated to the average of operational conditions and closure conditions, whereas future behaviour will be controlled by the closed conditions with covers in place over the facilities. Key aspects of the model during the construction and calibration process were:

- The model was constructed using the FEFLOW code and simulates both groundwater elevations and groundwater sulphate concentrations. Rates of discharge of both groundwater and sulphate to intermittent surface water streams are explicitly simulated.
- Due the progressive nature of cover installation, and taking account of the modelling objectives, an average uniform infiltration rate was applied to each of the mine facilities. A single average infiltration rate was applied in the model for each facility, which represented the average of conditions in the early 1990s (wholly uncovered), the late 1990s (partially covered), and the closure period (fully covered with vegetation progressively increasing from 2002 to 2012).
- In order to match the observed changes in groundwater elevations and groundwater chemistry during operations and closure, the calibrated average seepage rates from the facilities in the period 1990 to 2012 were 1.7% of precipitation at the NNTSF and the ONTSF, and 0.7% of precipitation at the EWRSF and the STSF. The average concentration of sulphate in seepage was calibrated to be 3,500 mg/L at the STSF, 20,000 mg/L at the Scats Stockpile and 5,000 mg/l at all other facilities.
- These calibrated values do not represent infiltration through the covers and the groundwater model can not be used to quantify the current rates of infiltration through the covers. Infiltration through the covers which is not subsequently removed by evapotranspiration may 1) reach the base of the facility by vertical flow and subsequently flow horizontally into the downgradient containment dam as seepage to be pumped to the lake in the open pit; 2) infiltrate through the original ground surface below the facility, enter the saturated zone within the groundwater system and flow into the receiving groundwater environment; or 3) potentially follow other pathways into the receiving environment. The model calibrated values discussed above (0.7% to 1.7% of precipitation) reflect an average for component 2 of cover infiltration over the whole of the operating (uncovered), closure (covered) and post closure (covered and vegetated) periods.
- These calibration parameters for the component of cover infiltration reaching the groundwater system and for the long term average sulphate concentration of seepage resulted in a good fit to the average groundwater elevations and sulphate concentrations in the receiving groundwater system from 1989 to 2012.

3 BASECASE AND ALTERNATIVE MODEL PREDICTIONS

The calibrated model was subsequently employed to predict groundwater conditions for the 200 year period from 2012 to 2212. This prediction period is significantly longer than the period of available calibration data, which reduces confidence in long term predictions of absolute sulphate concentrations, however the model predictions remain valid for comparing the relative influences of different management options.

For the basecase predictive model, it was assumed that precipitation patterns would be close to average, that the concentration of sulphate in seepage from the mine facilities would remain constant, and that the rate of seepage from the facilities would remain constant. The basecase predictions are therefore expected to be conservative, as the calibrated facility seepage rates reflect both uncovered and covered conditions, while the predictive period comprises only covered conditions. This conservative approach was consistent with the primary modelling objective, which was to define the maximum future extent of sulphate in groundwater in the receiving environment.

The basecase model predictions are reproduced in Figure 1 which illustrates the predicted future extent of the 500 mg/L sulphate contour between the years 2012 and 2212. The model predicted that there would be little increase in the future extent of groundwater containing more than 500 mg/L sulphate, other than in the northeast where it was predicted to migrate a further 500 m beyond the mine lease boundary towards Clarke Creek, and in the southeast where it was predicted to migrate a further 1,500 m beyond the mine lease boundary towards Two Mile Creek. All of these locations are within land controlled by Newmont, with access to groundwater for stock watering or other agricultural uses also controlled by Newmont.

The basecase model predictions of limited future migration of sulphate in groundwater resulted from the initial rapid migration of sulphate being driven by the uncovered facilities in the operating period, and from the model predicting equilibrium conditions would be reached in closure. In these closure equilibrium conditions the residual flux of sulphate leaving the rehabilitated mine facilities is matched by the discharge of sulphate into the receiving groundwater and surface water environments. Figure 2 summarises the migration of groundwater sulphate concentrations in the operating period, which identifies that sulphate in groundwater had reached the northern and southern mine lease boundaries by the year 2000, and was therefore driven by the operating and partially covered facilities, rather than by the performance of the covers in closure.

Alternative case predictions were also completed using the model, which investigated the implications of lower than average precipitation conditions, higher than average precipitation conditions, and changes in the rate or chemistry of seepage leaving the closed and rehabilitated mine facilities. Model Scenario 2 applied the same assumptions as the basecase model, but assumed that the rate of seepage from every facility was reduced by 50% at the start of the predictive period in 2012.

The assumed 50% reduction in seepage rates was not based on an assessment of the changes which would result from the placement of industry best practice covers on the mine facilities. Such an assessment could not be undertaken because:

1. The current rate of infiltration through the covers is unknown and is not quantified from the model which is calibrated to the rate of seepage entering the groundwater system at the base of each facility.

2. The controls and the relationship between the rate of infiltration through the cover, and the subsequent division into the rate of seepage into the containment dams and the rate of seepage into the groundwater system are unknown,
3. The model has been calibrated to the average seepage rate in both operations and closure and does not specifically model changes in the performance of each facility following installation of the covers or changes in performance associated with the establishment of vegetation on the covers.

The assumed 50% reduction in seepage was a nominal value which was intended to be employed to compare the relative influence of assumptions regarding seepage rates on future groundwater conditions compared to the other model assumptions including climate conditions. A key conclusion in the modelling report was that if seepage rates from the facilities into groundwater were 50% less than assumed in the basecase model, the future peak sulphate concentrations in the receiving environment would be reduced, but there would be only a modest reduction in the areal extent of sulphate in groundwater by the year 2212 (SWS, 2013).

4 UPDATED MODEL VALIDATION

Routine three monthly or annual groundwater sampling is undertaken in selected background, interpretation and compliance bores as described in the Groundwater Management Plan and in the Environmental Authority (EA) and these monitoring data indicate that the conceptual model developed for the shallow groundwater system remains valid. The numerical model of groundwater flow and sulphate transport constructed using monitoring data collected to 2012 predicted that in many locations groundwater sulphate concentrations would stabilise soon after 2012, including in locations which are not routinely sampled. In order to test the validity of these predictions, Newmont undertook site wide groundwater sampling programs in June 2017 and in April 2022, during which all accessible monitoring bores were sampled to allow actual changes in groundwater conditions from 2012 to 2022 to be compared against the conceptual hydrogeological model and the numerical model predictions. A detailed review was undertaken of the 2017 and 2022 sampling results, which included comparing model predicted sulphate concentrations against the observed data for the period 2012 to 2022 at all bores (BDH, 2022a).

There have been no significant changes in the pH and metals concentrations in groundwater in areas close to seepage sources from 2012 to 2022, and the analytes which are consistently and regionally elevated continue to be sulphate and Co. The pH of downgradient groundwater is consistent with upgradient locations and continues to be unimpacted by facility seepage.

The extent of Co in groundwater in the receiving environment is summarised in Figure 3, based on total Co concentrations measured in 2012, 2017 and 2022. Total Co is used in preference to filterable Co, as filterable Co is subject to short term variation resulting from changes in the portion of Co which is in filterable form (BDH, 2022b). There has been little change in the extent of Co in groundwater from 2012 to 2022, other than a small expansion into the receiving environment below Schreibers Creek. The sampling results validate the adopted modelling approach of simulating sulphate concentrations as the primary analyte of concern due to sulphate having the greatest mobility in the receiving environment. Co is subject to geochemical attenuation and the extent in the receiving environment is therefore much less than for sulphate. Modelling sulphate extent therefore defines the maximum extent of mine facility influence in the receiving environment.

The model predicted that under average precipitation conditions, sulphate concentrations would stabilise or even decrease after 2012 in many locations. The detailed review of data collected from 2012 to 2022 confirmed that these trends are being observed in the shallow groundwater system where they were predicted. Figure 4 provides examples of bores where stabilisation of sulphate conditions has occurred following the model construction in 2013. The stabilisation of sulphate concentrations at NMLMB1 was already understood as it is included in routine annual sampling. Bores NMLMB6 and MLM56 are not routinely sampled, and Figure 4 illustrates the value of the site wide sampling programs undertaken in 2017 and 2022 in validating the model predictions.

In 2022 rising sulphate trends are evident to the northeast and southeast of the mine facilities, which are consistent with the model predictions, reflecting the arrival in the distant receiving environment of seepage generated during operations and closure, and the model predicts these sulphate concentrations will stabilise in the near future, as they have in other locations in the receiving environment.

Figures 5 and 6 compare the extent of sulphate at 500 mg/L and at 1,000 mg/L in the receiving environment. The data presented are:

1. The inferred extent based on site wide monitoring data available in 2012 at the time of model calibration.
2. The extent inferred from the site wide groundwater sampling undertaken in 2017.
3. The extent inferred from the site wide sampling in 2022.
4. The predicted extent in the year 2022, derived from the basecase model which assumes average precipitation conditions and uniform seepage rates and chemistry from all mine facilities.

Precipitation conditions in the period 2012 to 2022 are summarised in Figure 7. It is evident that the climate prevailing in that period falls between model Scenario 1 (basecase, average precipitation) and model Scenario 6 (below average precipitation) and is much closer to Scenario 1. The basecase model results are therefore presented in Figures 5 and 6.

There have been only small changes in the observed inferred extent of sulphate in the shallow groundwater system between 2012 and 2022, and the locations where the extent has increased (along Clarke Creek, Schreibers Creek and One Mile Creek) are consistent with the model predictions. The numerical model has therefore been validated by the recent monitoring data, and the existing model predictions remain the most appropriate means of defining the long term potential extent of sulphate in groundwater in the receiving environment. However it should be noted that the model predictions reflect the maximum future extent of sulphate, as in Figures 5 and 6 the model significantly over predicts the sulphate extent in 2022.

The model predictions presented in Figure 1 which reflect an equilibrium between residual seepage from the mine facilities and discharge to the receiving environment are therefore confirmed to be valid, as the 2017 and 2022 sampling confirm that equilibrium conditions are becoming established, but the predictions in Figure 1 are expected to over predict the extent of sulphate in the receiving environment. The over prediction of sulphate extent may result from the model assumed seepage infiltration rates reflecting both operating and covered conditions at the mine facilities, while the observed responses are now more driven by the closed conditions for the mine facilities.

5 CURRENT MINE INFLUENCES ON THE RECEIVING ENVIRONMENT

The influences of the closed and rehabilitated Mt Leyshon Mine facilities on the receiving environment, and mitigation and monitoring of these influences are described in:

- The Groundwater Management Plan (referred to as the GMP, first compiled in 2013 and most recently updated in BDH, 2017).
- The Sulphate Management Plan (referred to as the SMP, BDH 2013).
- Annual reviews of groundwater monitoring data, the most recent of which presented monitoring data to the end of 2021 (BDH, 2022b).
- Investigations into exceedances of EA trigger levels for surface water chemistry, the most recent of which was completed in March 2022 (BDH, 2022c).
- Annual monitoring and assessment of the receiving environment via the REMP, the most recent of which was compiled in April 2022 (TropWater, 2022a).
- An updated assessment of sulphate influences on the receiving environment compiled by TropWater as a supporting technical reference for this report (TropWater 2022b).

Potential pathways for contaminant migration into the receiving environment were described in the GMP with respect to the conceptual model reproduced in Figure 8. These pathways were described as:

- If the Acid Rock Drainage (ARD) forming materials in the WRSFs and TSFs are not fully covered solutes may be carried by runoff into the receiving environment.
- If the zone of impacted groundwater which continues to have neutral pH but to have elevated TDS and sulphate concentrations were to reach locations where groundwater is abstracted for use, the ability to use that groundwater for stock watering may be compromised.
- If the zone of impacted groundwater which continues to have neutral pH but demonstrates total Co concentrations above 0.05 mg/L were to reach locations where groundwater is abstracted for use, the ability to use that groundwater for crop irrigation could be compromised.
- If impacted groundwater should discharge into the receiving streams downgradient of the site, the TDS, sulphate or Co concentrations could potentially cause environmental harm to aquatic organisms in the surface water systems.
- If phreatophytic vegetation is present in the environment, which has roots in the permanently saturated zone below the water table, the migration of groundwater with elevated TDS and sulphate into this zone could potentially cause stress to that vegetation.

The current (2022) influence of each of these pathways to the receiving environment is discussed in the following sections.

Current runoff from ARD material

All of the surface water monitoring data and REMP assessments indicate that surface water quality contains low concentrations of solutes in high flow conditions, when runoff is the primary contribution, and relatively higher concentrations of solutes in low flow conditions, when groundwater is a significant contribution (TropWater, 2022b). This confirms that the covers are achieving their primary objective, which is to ensure that runoff from the closed and rehabilitated mine facilities does not make contact with ARD material and is suitable for direct discharge to the receiving surface water environment.

Current abstraction of groundwater with elevated TDS and sulphate

The current (2022) extent of groundwater with elevated sulphate and TDS concentrations can best be characterised using the inferred extent of groundwater containing more than 500 mg/L sulphate in Figure 5. The default sulphate limit for stock watering is 1,000 mg/L, and use of the 500 mg/L contour is a conservative approach which allows for uncertainty regarding the interpolation between the bores. All of the land overlying the 500 mg/L contour comprises the mine lease and pastoral properties owned by Newmont. These pastoral properties are leased out by Newmont for agistment, and the agistment agreements all contain clauses which preclude the use of groundwater from within these areas. The only existing pastoral bores within the 500 mg/L contour are Horse Creek Bore and Charlies Bore. Charlies Bore located to the west of the mine area has been abandoned. Horse Creek Bore is located northwest of the NNTSF, within property owned by Newmont, and access to this bore by stock is prevented by Newmont. There is therefore currently no potential for groundwater harm to occur via stock watering.

Current abstraction of groundwater with elevated Co

The current (2022) extent of groundwater with elevated Co concentrations can best be characterised using the inferred extent of groundwater containing more than 0.01 mg/L total Co in Figure 3. The default total Co limit for cropping is 0.05 mg/L, and use of the 0.01 mg/L boundary is a conservative approach which allows for uncertainty regarding the interpolation between the bores. All of the land overlying the 0.01 mg/L contour comprises the mine lease and pastoral properties owned by Newmont. These pastoral properties are leased out by Newmont for agistment, and the agistment agreements all contain clauses which preclude the use of groundwater from within these areas. The only existing pastoral bore within the 0.01 mg/L contour is the Horse Creek Bore located northwest of the NNTSF, and access to this bore is prevented by Newmont. There is therefore currently no potential for groundwater harm to occur via use of groundwater with elevated Co for crop irrigation.

Current discharge of groundwater to the receiving surface water environment

Discharge of groundwater from the shallow groundwater system into the receiving surface water environment occurs naturally in periods when the groundwater elevation approaches the stream bed, and in locations where vertical pathways are present in the shallow alluvial sediments and weathered bedrock. Locations where the groundwater elevation approaches the streambed can be identified by contouring groundwater depths measured in monitoring bores. Figure 9 presents mapped groundwater depths in March 2021 and identifies potential for groundwater discharge to be currently occurring in portions of all of Clarke Creek, Schreibers Creek, Two Mile Creek and Puddler Creek. Figure 10 provides a similar interpretation for March 2013 when groundwater elevations were higher. It is evident that under the full range of current conditions potential discharge zones may occur along much of Plumtree Creek, Clarke Creek, Puddler Creek, Schreibers Creek and Two Mile Creek.

The hydrochemical investigations presented in the SMP, the investigations into surface water environmental harm, and the monitoring described in the REMP identify that in low flow conditions the influence of groundwater discharge can be discerned in the hydrochemistry of the receiving surface water environment. The SMP noted that based on data available to 2012 discharge of groundwater into the surface water systems had resulted in discernible changes in downgradient surface water sulphate concentrations within Clarke Creek, Two Mile Creek, Puddler Creek, Seventy Mile Creek and the Broughton River, while there had been no discernible change in sulphate concentrations in the Burdekin River due to the Mt Leyshon Mine facilities.

A detailed assessment of the current influence of sulphate in surface water on the health of the receiving environment (TropWater, 2022b) is summarised as follows:

- TSS and EC data were used to identify high flow samples with hydrochemistry dominated by runoff and to remove them from the analyses, in order to characterise ambient conditions.
- Upgradient surface water monitoring stations (located both upgradient of the mineralised province associated with the mine and upgradient of the mine facilities) indicated ambient sulphate concentrations to have median of 6 mg/L.
- Based on data collected from 2010 to 2022, compliance surface water monitoring locations located near the mine lease boundary on Clarke Creek, Two Mile Creek and Puddler Creek, which are all downgradient of the influence of the mine facilities, and downgradient of groundwater discharge zones inferred from Figures 9 and 10, indicated median sulphate concentrations to be in the range 217 mg/L to 646 mg/L. The predominant source of the sulphate observed in surface water at the lease boundary is inferred to be groundwater discharge.
- Based on observed groundwater depths and on calculated infiltration deficit, the surface water monitoring from 2010 to 2022 includes periods of inferred high groundwater discharge (2010 to 2012) and periods of low groundwater discharge (from 2014 to 2022).
- An analysis of receiving surface water monitoring using data from 2017 to 2022 (low groundwater discharge conditions) indicates that current sulphate concentrations are relatively lower, with median sulphate concentrations at the lease boundary calculated to be in the range 22 mg/L to 145 mg/L.
- Based on comparisons between 1) major ion concentrations in surface water; 2) site specific quantitative measures of receiving environment health (SIGNAL, taxa richness, diversity); and 3) published data on sulphate toxicity, sulphate in surface water at concentrations up to the range 545 mg/L to 1186 mg/L would not be expected to cause effects in the site specific receiving environment conditions.
- This conclusion is supported by site specific AUSRIVAS band scores measured from 2013 to 2021 which have shown no indication of impairment on the macroinvertebrate community at sulphate concentrations ranging from as low as 7 mg/L to as high as 1,900 mg/L.
- Sustained sulphate concentrations in the potential impairment range (545 mg/L to 1,186 mg/L) range are not occurring in the surface water receiving environment under current conditions, as confirmed by more than a decade of closure monitoring, undertaken during a range of climate conditions.
- The covers on the mine facilities, as currently performing, are therefore not causing harm associated with the discharge of groundwater to the surface water environment.

Phreatophytic vegetation

Vegetation species such as Red-Barked Bloodwood (Corymbia erythrophloia) and Narrow-leaved Ironbark (Eucalyptus crebra) trees are present in the terrestrial environment within the area defined by contour describing locations where groundwater sulphate concentrations exceed 500 mg/L in Figure 5. These species are expected to be phreatophytic. The available research suggests that vegetation can be impaired due to elevated sulphate concentrations in groundwater, however these conclusions generally relate to acid sulphate soils where anoxic conditions are present, whereas the Mt Leyshon soils are alkaline and are not permanently waterlogged. The published research also indicates that the influence of sulphate varies widely with vegetation species, and with contributing factors which include soil pH and ratios of Ca to Mg. It is therefore not possible to suggest a limit for the groundwater sulphate concentration which would potentially influence phreatophytic vegetation.

However monitoring of vegetation health in the riparian environment both within and outside of the zone of elevated groundwater sulphate in Figure 5 is undertaken as part of the REMP. In addition, leaf tissue geochemistry is measured and compared against soil geochemistry. The vegetation monitoring in the REMP has identified that the primary stress on vegetation is caused by changes in groundwater depth, as evidenced by major ion ratios, rather than changes in groundwater chemistry. No significant difference in vegetation health has been identified within and outside the sulphate contours in Figure 5. It is therefore concluded that the current changes in groundwater chemistry downgradient of the Mt Leyshon mine are not causing harm to phreatophytic vegetation.

6 FUTURE MINE INFLUENCES ON THE RECEIVING ENVIRONMENT

Potential pathways for the future migration of contaminants into the receiving environment will remain consistent with those described in the GMP, illustrated in Figure 8, and summarised in Section 5 above. The potential for incremental future changes in influences on the receiving environment via each pathway are discussed in the following sections.

Future runoff from ARD material

The covers on the closed and rehabilitated Mt Leyshon Mine facilities are routinely inspected, and erosion repairs and revegetation are undertaken as required and as described in closure planning documentation. It has been concluded that environmental harm due to ARD runoff is not currently occurring, and there is no reason to anticipate any change in this condition in future.

Future abstraction of groundwater with elevated TDS and sulphate

The maximum future extent of groundwater with elevated sulphate and TDS concentrations can best be characterised using the modelled extent of groundwater containing more than 500 mg/L sulphate in the year 2212 presented in Figure 1. Due to the conservative nature of the model this is considered to reflect a maximum extent under all realistic future conditions.

All of the land overlying the 500 mg/L contour predicted for 2212 comprises the mine lease and pastoral properties owned by Newmont. These pastoral properties are leased out by Newmont for agistment, and future agistment agreements will all contain clauses which preclude the use of groundwater from within these areas. The existing pastoral bores located within the modelled future 500 mg/L contour are Fanless Bore which has been decommissioned and backfilled, Charlies Bore which has been abandoned, Horse Creek Bore, Monahans Bore, and Latan House Bore. Access to these bores will be prevented by Newmont in future land use agreements. There is therefore no potential for future groundwater harm to occur via stock watering.

Future abstraction of groundwater with elevated Co

The future extent of Co in groundwater can not be accurately modelled, as Co is subject to geochemical attenuation during groundwater flow, controlled by complexing reactions and interactions with the host rocks. The proportion of Co which is in dissolved form and hence bioavailable is also highly variable in response to subtle changes in background groundwater chemistry. However it is identified that that there has been very little change in extent from 2012 to 2022, and it can be confidently assumed that the extent of Co in groundwater will always be less than the extent of sulphate in groundwater (given that sulphate is derived from the same seepage sources and is not subject to geochemical attenuation). The management controls preventing future access to groundwater containing elevated sulphate will therefore also be effective in preventing future access to groundwater with elevated Co.

Future discharge of groundwater to the receiving surface water environment

Discharge of groundwater from the shallow groundwater system into the receiving surface water environment occurs naturally, and is expected to occur in future, although the long term hydrological conditions can not easily be predicted (in terms of whether groundwater discharge may increase or decrease in future on average compared to current conditions).

Figures 11 to 13 provide predicted sulphate future concentrations for bores in locations where expansion of sulphate in groundwater is predicted (NMLMB8, NMLMB28 and NMLMB29 along Schreibers Creek, NMLMB6, NMLMB34 and NMLMB35 along Two Mile Creek, and NMLMB37, NMLMB5 and NMLMB36 along One Mile Creek). The basecase model predicted sulphate concentrations for these bores are considered to be an upper estimate, given the conservative nature of the model. The model indicates that the current sulphate concentrations which are in the range 30 mg/L to 1,500 mg/L will reach around 1,000 mg/L and then stabilise in future. These future sulphate concentrations are consistent with the currently observed range of groundwater sulphate concentrations closer to the mine facilities.

It is anticipated that future concentrations of sulphate in surface water will be primarily controlled by the long term climate and hydrologic conditions, which govern the contribution of groundwater discharge to the ambient surface water hydrochemistry. Given that the monitoring data available to define the receiving environment include high groundwater discharge conditions (around 2012) and low groundwater discharge conditions (around 2021), it is anticipated that the future influence of sulphate on the receiving surface water environment will remain within the range currently observed. As discussed above the current monitoring supports that sulphate entering the receiving surface water environment is not causing harm. It is therefore anticipated that the long term future discharge of sulphate to surface water will not cause environmental harm.

Future influence on phreatophytic vegetation

The numerical model predicts that future peak groundwater sulphate and TDS concentrations will be largely consistent with the currently observed concentrations, but that the extent of elevated concentrations will increase in some locations. Given that the REMP monitoring described in Section 5 has not identified any impairment of vegetation in response to the current groundwater chemistry, no impairment is expected to occur associated with the future groundwater chemistry.

7 CONCLUSIONS

A numerical model of groundwater flow and sulphate transport was constructed in 2013 to simulate long term conditions in the shallow groundwater system in the receiving environment at the Mt Leyshon Mine. The model does not simulate infiltration through the covers on the closed and rehabilitated facilities at the Mt Leyshon Mine and the performance of the covers has not been quantified. The model simulates the rate of seepage entering the groundwater system below each facility, averaged over the period 1990 to 2012. Routine sampling of selected monitoring bores has been undertaken since 2013 and in 2017 and in 2022 all monitoring bores were re-sampled. All of these sampling results have confirmed the predictions of the model.

The model predicted that under average precipitation conditions, sulphate concentrations would stabilise or even decrease after 2012 in many locations. The detailed review of data collected from 2012 to 2022 confirmed that these trends are being observed in the shallow groundwater system where they were predicted. In 2022 rising sulphate trends are evident to the northeast and southeast of the mine facilities, which are consistent with the model predictions, reflecting the arrival in the distant receiving environment of seepage generated during operations, and the model predicts these sulphate concentrations will stabilise in the near future, as they have in other locations in the receiving environment.

There have been only small changes in the measured and inferred extent of sulphate in the shallow groundwater system between 2012 and 2022, and the locations where the extent has increased (along Clarke Creek, Schreibers Creek and One Mile Creek) are consistent with the model predictions. The numerical model has therefore been validated by the recent monitoring data, and the existing model predictions remain the most appropriate means of defining the long term potential extent of sulphate in groundwater in the receiving environment. However it should be noted that the model predictions reflect the maximum future extent of sulphate, as the model over significantly over predicts the sulphate extent in 2022.

A range of groundwater and surface water investigations and monitoring have been undertaken to characterise the influence of the Mt Leyshon Mine facilities on the receiving groundwater and surface water environments. Current changes in groundwater chemistry comprise elevated Co concentrations downgradient of the closed TSFs, and elevated sulphate concentrations downgradient of the WRSFs and TSFs.

The available monitoring data indicate that the covers are meeting their primary objective of preventing contact with ARD material and ensuring that runoff is of suitable quality for direct discharge. Seepage into groundwater during operations and residual seepage into groundwater in closure have caused increased sulphate and Co concentrations in the groundwater receiving environment. No environmental harm is occurring associated with abstraction of groundwater as Newmont prevent access to the locations where sulphate and Co are elevated in groundwater. Monitoring undertaken for the REMP identifies no environmental harm to vegetation is occurring due to the changes in groundwater chemistry. The shallow groundwater system naturally discharges into the receiving surface water system. The influence of mine influenced groundwater can be discerned in the hydrochemistry of surface water flows, however these changes in hydrochemistry are not causing harm to the aquatic ecosystem and the receiving environment is capable of assimilating solutes in groundwater discharge. Therefore while the current performance of the covers in preventing infiltration has not been quantified, the performance of the covers is sufficient to prevent environmental harm under the current conditions.

In many locations sulphate concentrations in groundwater have stabilised and will change little in future. In the locations of Scheibers Creek, Two Mile Creek and One Mile Creek groundwater sulphate concentrations are rising, and are responding to pulses of seepage originating in the operating and closure periods. The model predicts that sulphate concentrations in these locations will stabilise in the near future, as they have in locations closer to the mine facilities. The future extent of groundwater containing elevated sulphate remains within Newmont controlled land and no harm associated with groundwater abstraction will occur in future. The influence of groundwater discharge on sulphate concentrations in surface water in future is expected to be controlled more by long term climate and hydrological conditions than by groundwater sulphate conditions. The current monitoring indicates that there is no harm associated with groundwater discharge, and the current monitoring spans a large range in climate conditions. The future influence of groundwater discharge is therefore expected to remain within the assimilative capacity of the receiving environment.

It is therefore concluded that residual seepage from the Mt Leyshon Mine facilities driven by the performance of the covers is not currently causing environmental harm, and is not expected to cause environmental harm in the long term future.

Please contact me if you would like any further details of the review groundwater monitoring and modelling and the discussion of cover performance at the Mt Leyshon Mine.

Yours sincerely

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Big Dog Hydrogeology Pty Ltd
ABN 158 858 087

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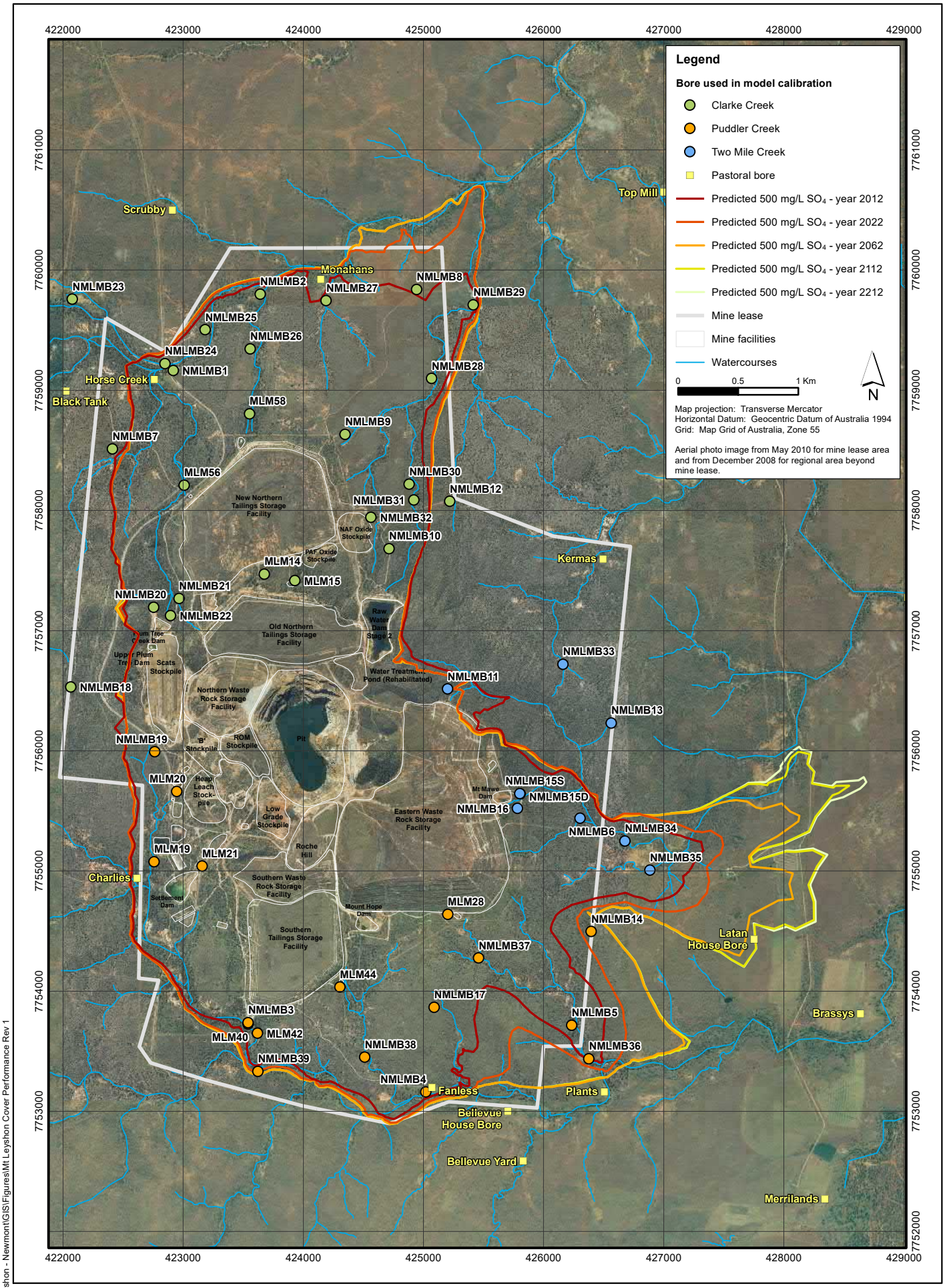
FIGURES



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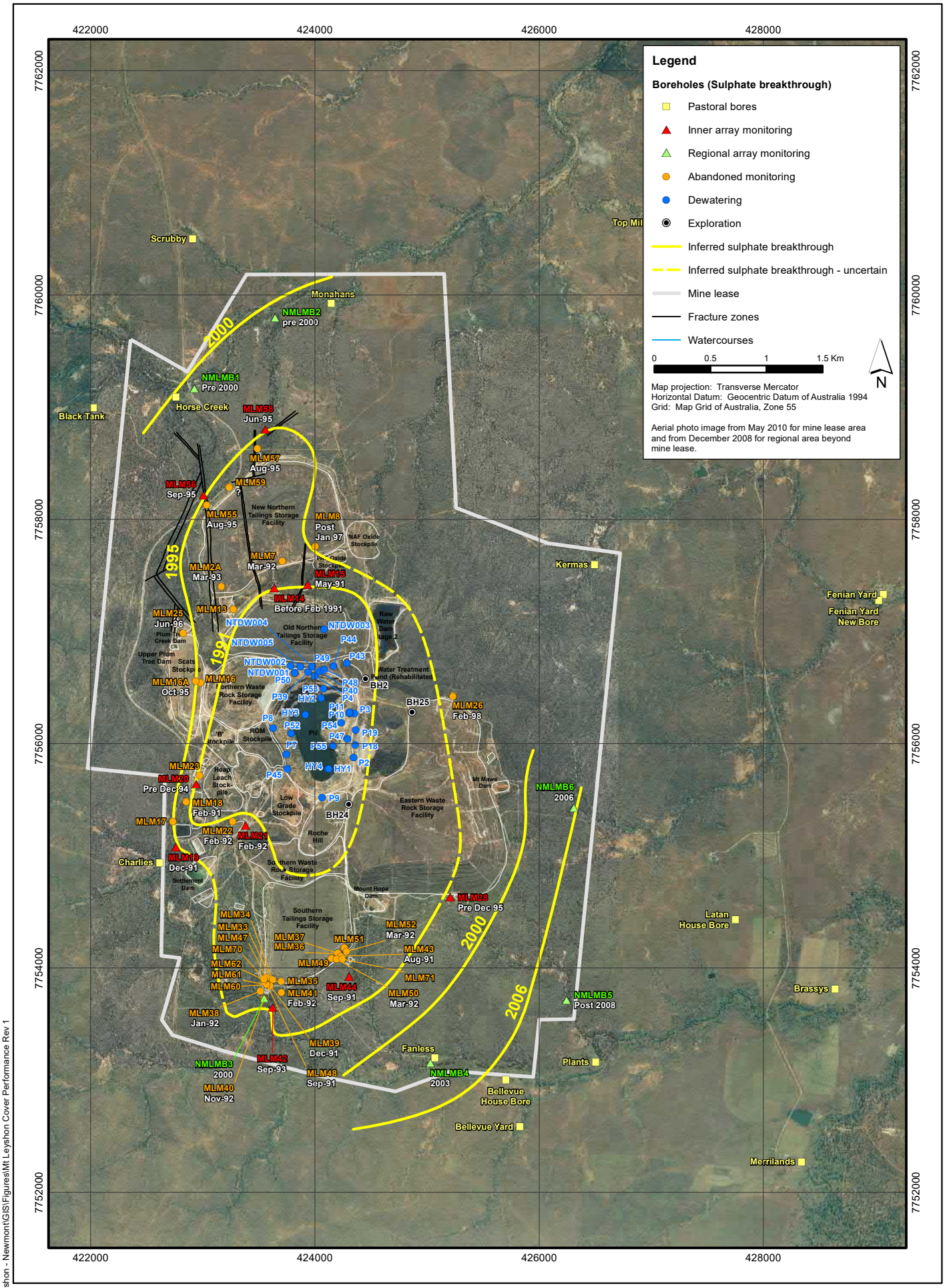
BIG DOG HYDROGEOLOGY

Basecase model predictions for 500 mg/L sulphate contour

Figure 1

Date: June 2022

Report: Mt Leyshon Cover Performance Rev 1



BIG DOG HYDROGEOLOGY

Operational migration of sulphate in groundwater

Figure 2

Date: June 2022

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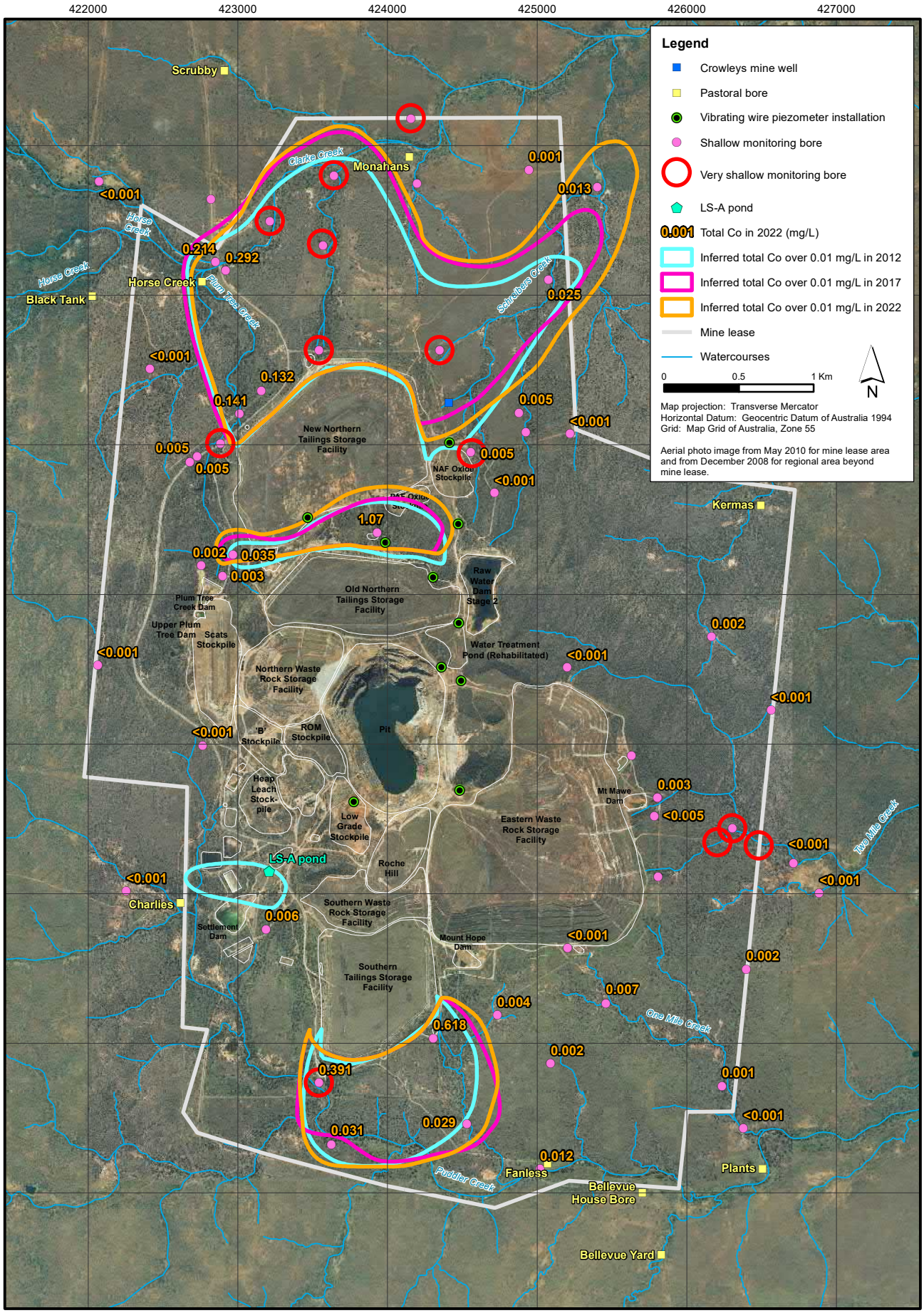

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BIG DOG HYDROGEOLOGY

Extent of total Co in groundwater

Figure 3

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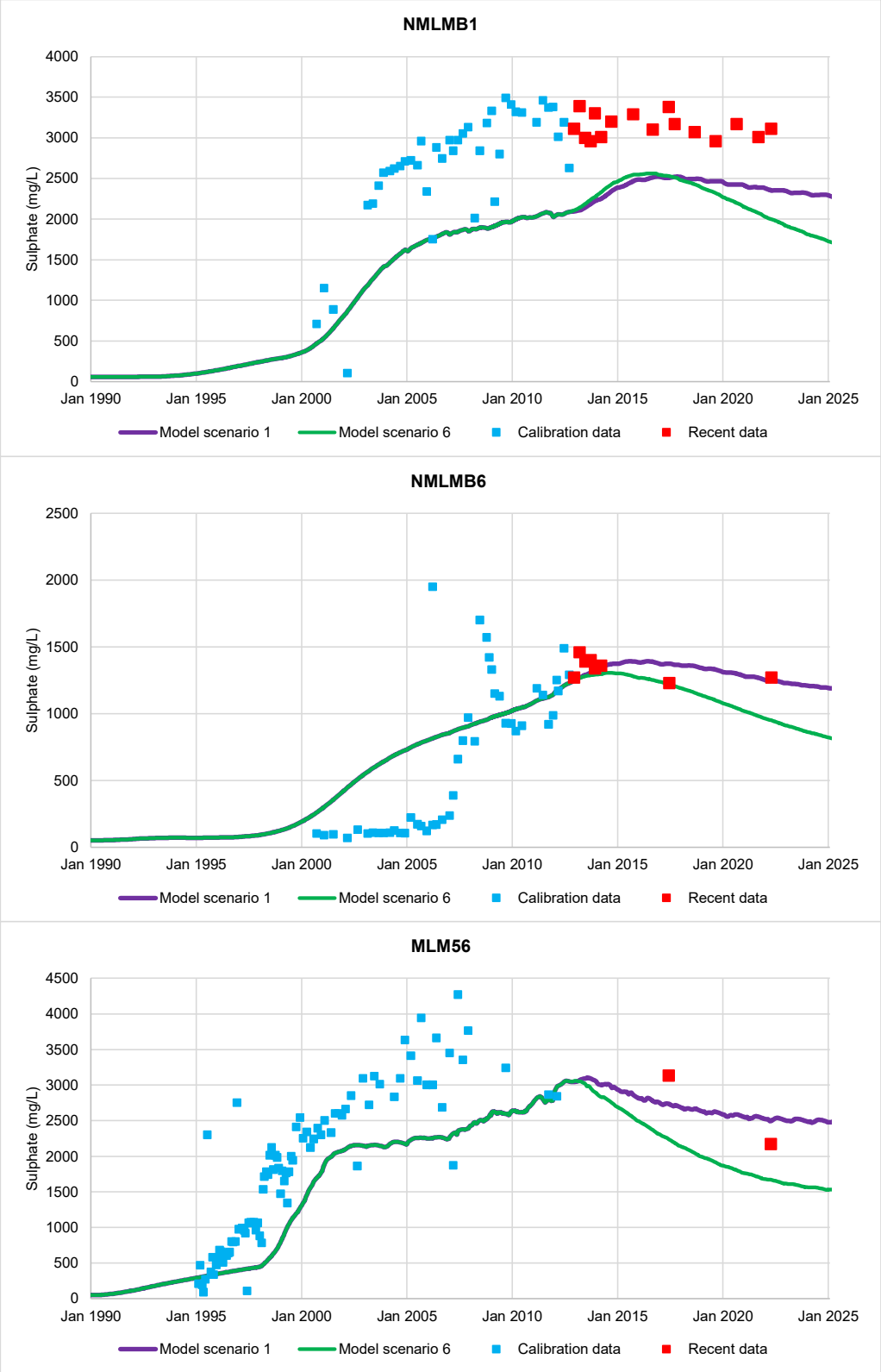

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BIG DOG HYDROGEOLOGY

Stabilisation sulphate responses

Figure 4

Date: June 2022

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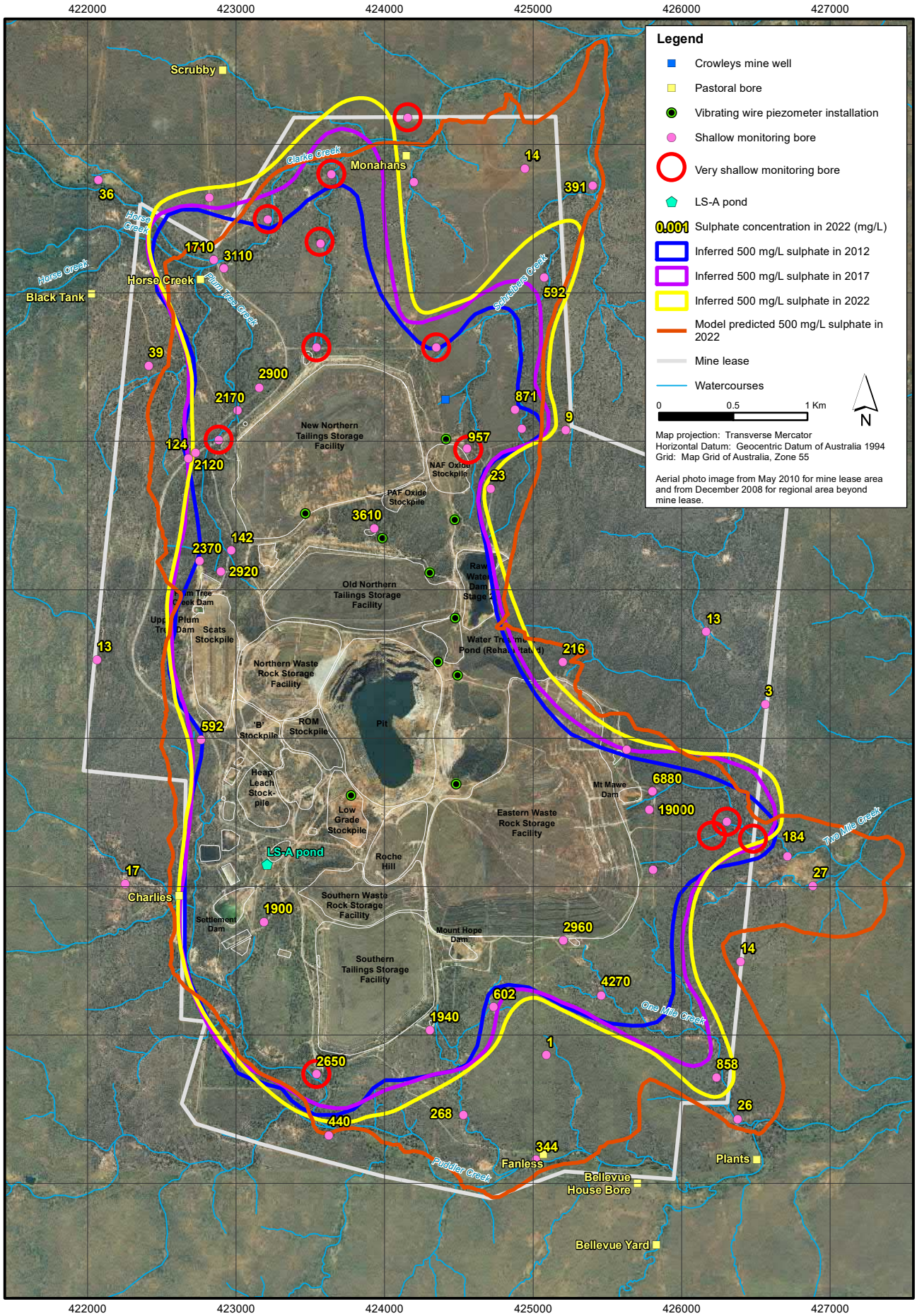

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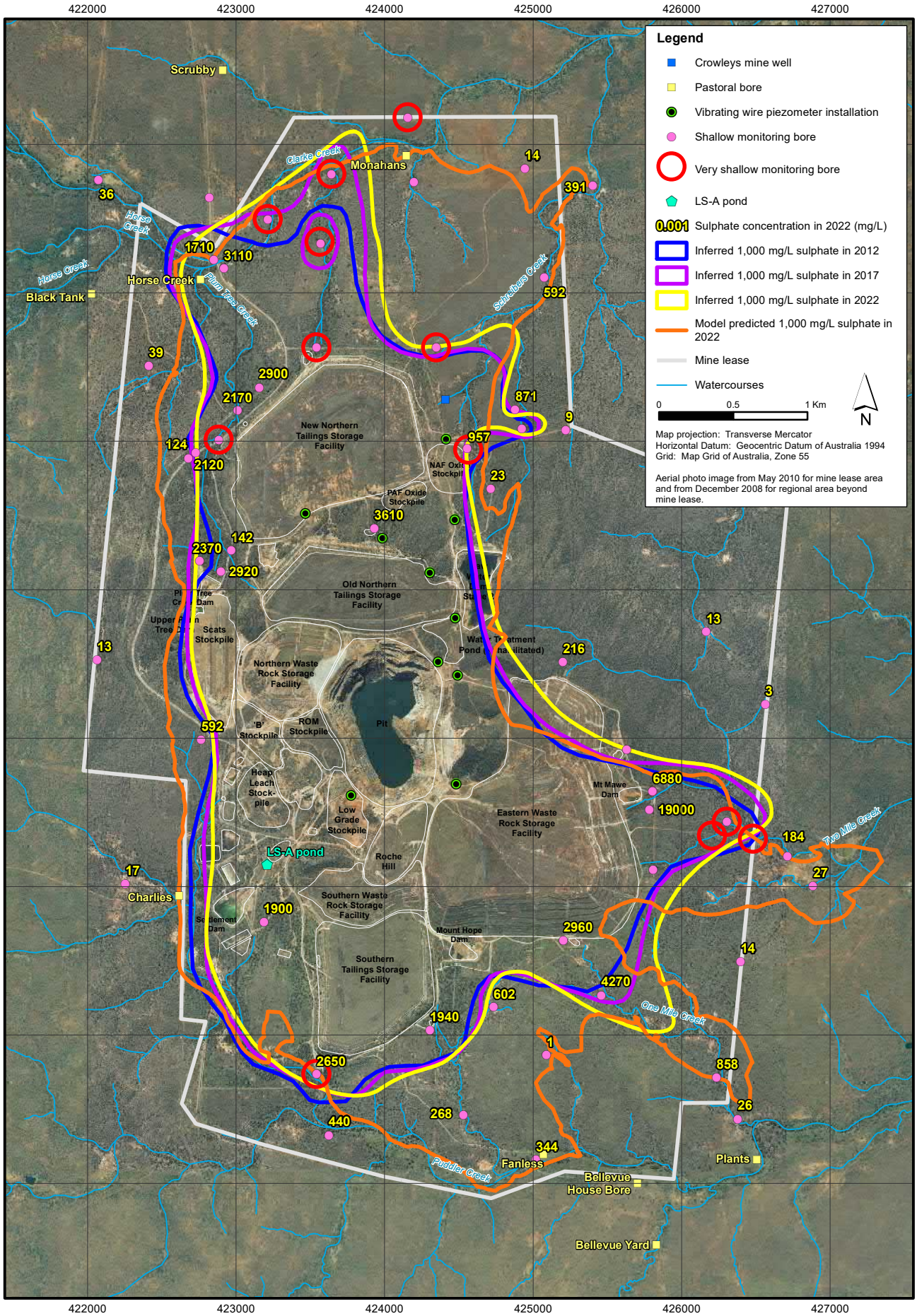
BIG DOG HYDROGEOLOGY

Extent of sulphate above 500 mg/L in groundwater

Figure 5

Date: June 2022

Report: Mt Leyshon Cover Performance Rev 1



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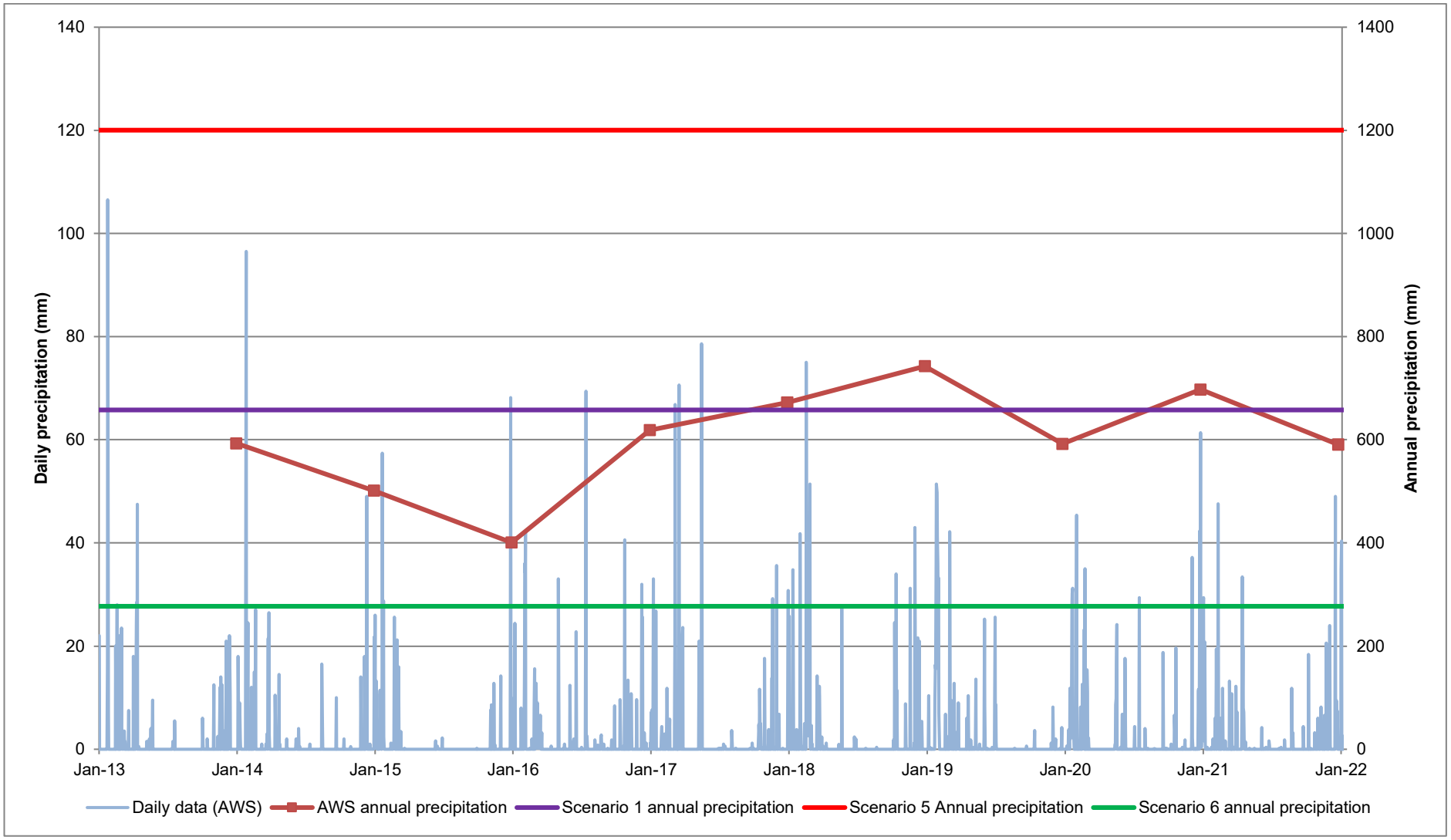
BIG DOG HYDROGEOLOGY

Extent of sulphate above 1,000 mg/L in groundwater

Figure 6

Date: June 2022

Report: Mt Leyshon Cover Performance Rev 1



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BIG DOG HYDROGEOLOGY Pty Ltd

Precipitation conditions

Figure 7

Date: June 2022

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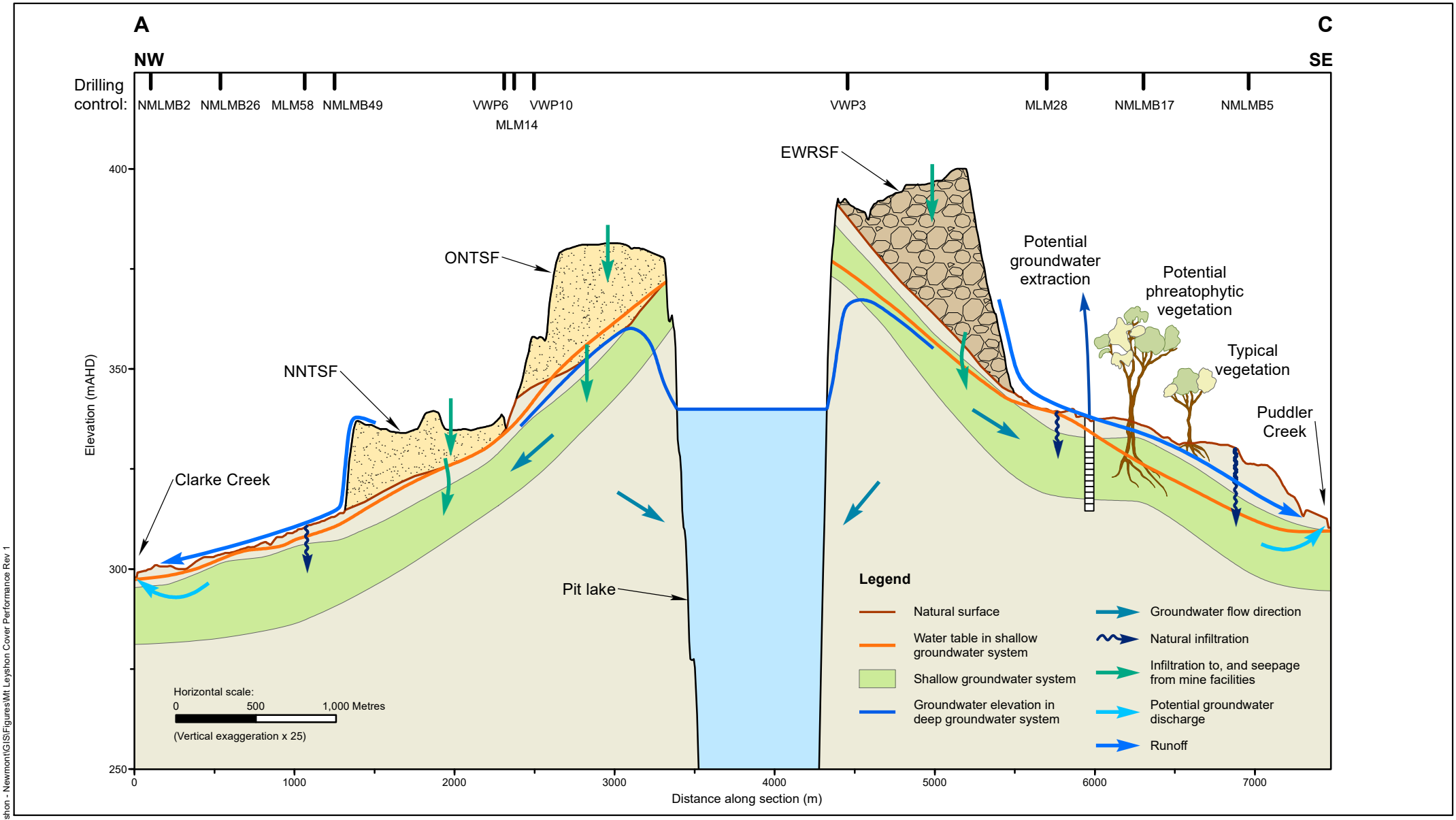

BIG DOG HYDROGEOLOGY

Schematic pathways for potential impacts

Figure 8

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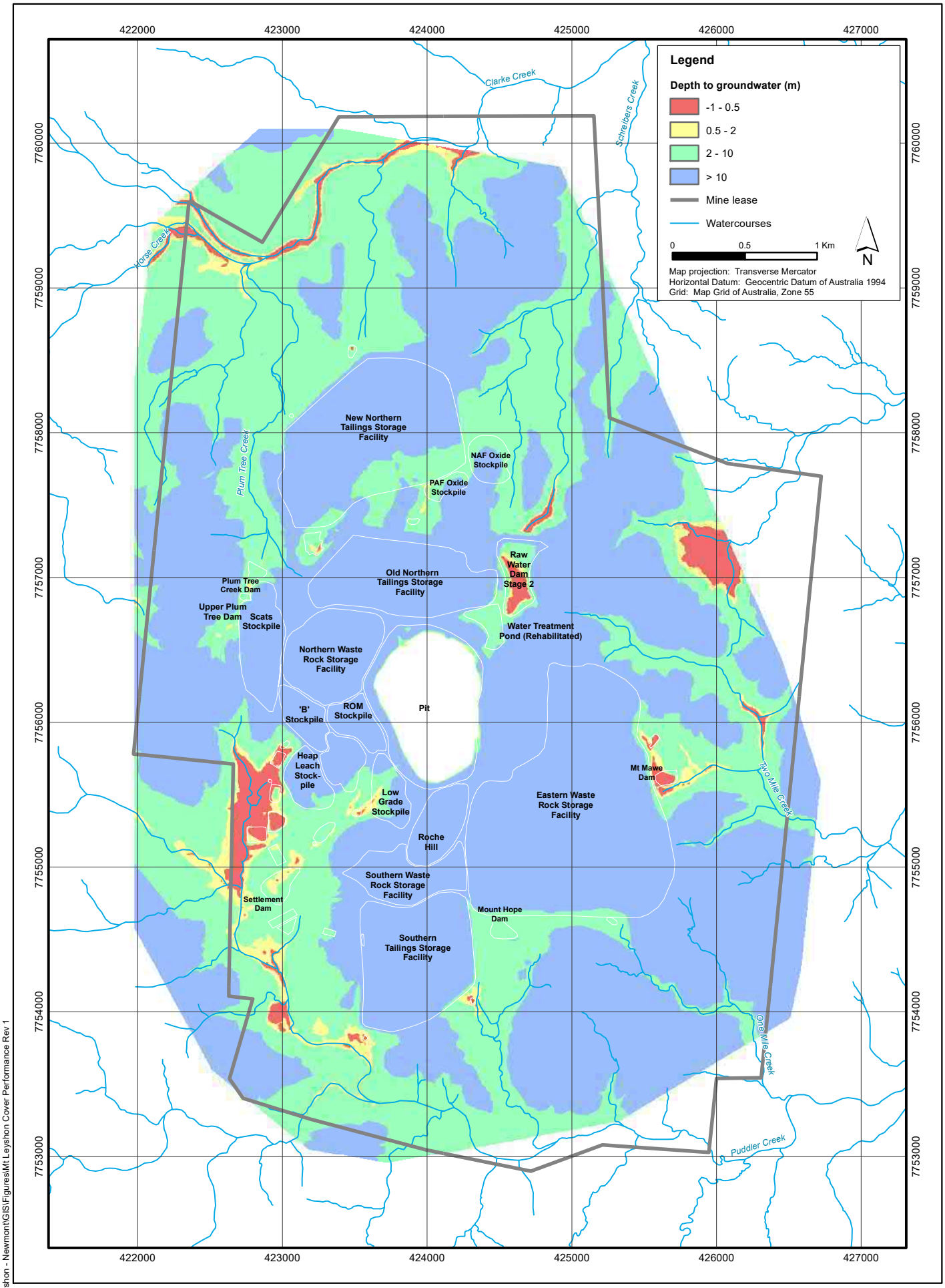

BIG DOG HYDROGEOLOGY

Interpolated groundwater depths in March 2021

Figure 9

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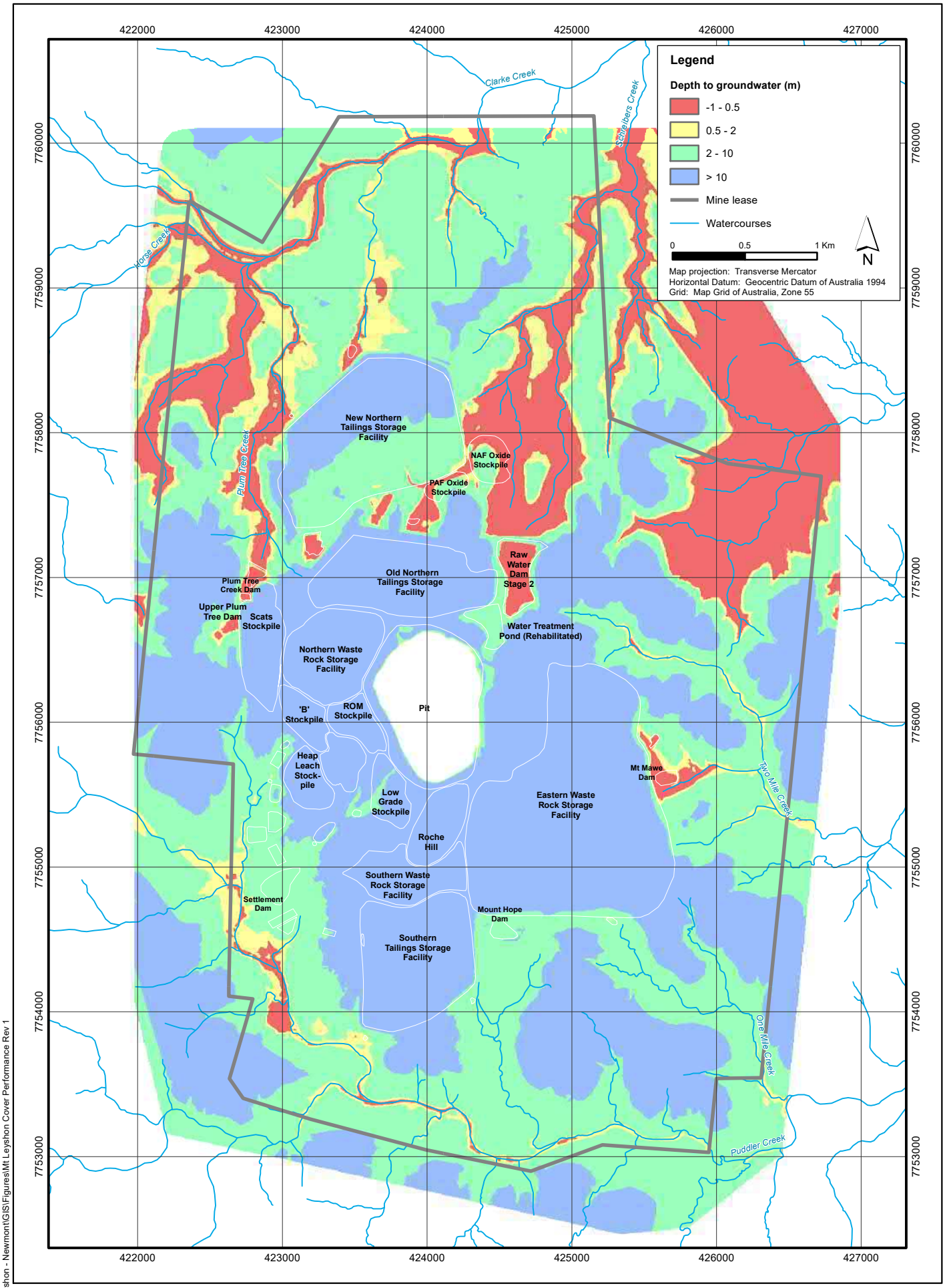

BIG DOG HYDROGEOLOGY

Interpolated groundwater depths in March 2013

Figure 10

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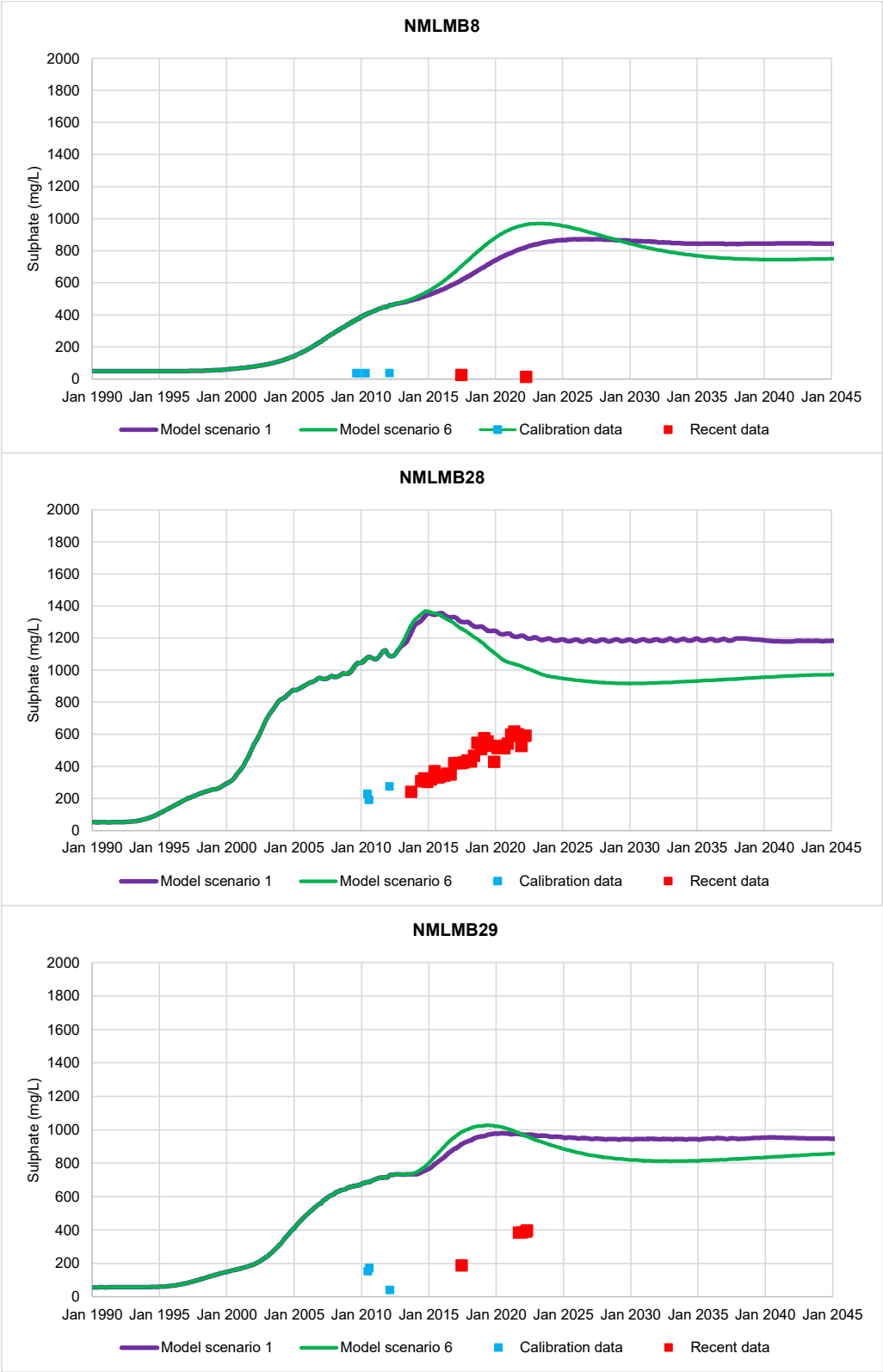

BIG DOG HYDROGEOLOGY

Predicted sulphate concentrations at Scheibers Creek

Figure 11

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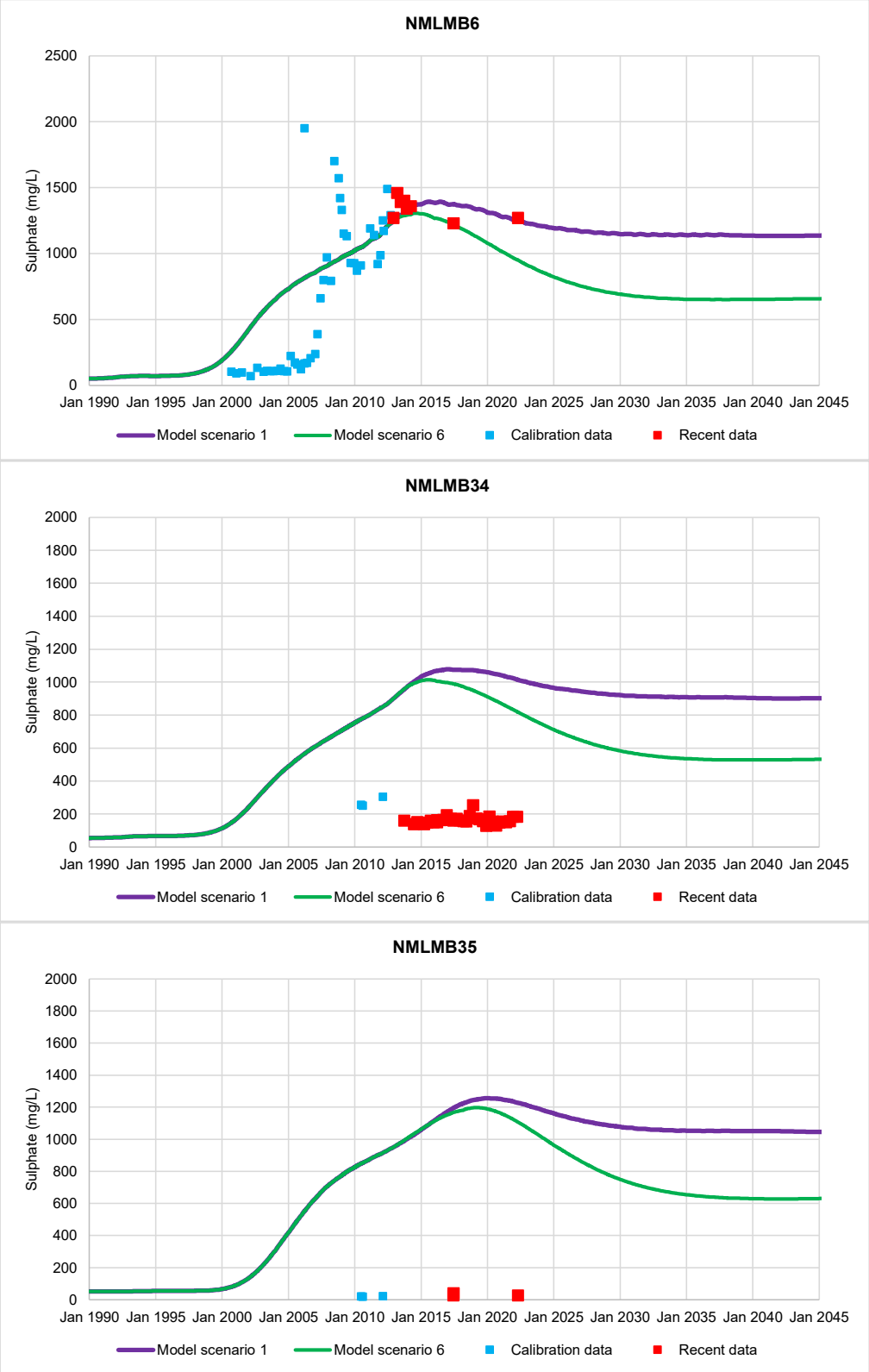

BIG DOG HYDROGEOLOGY

Predicted sulphate concentrations at Two Mile Creek

Figure 12

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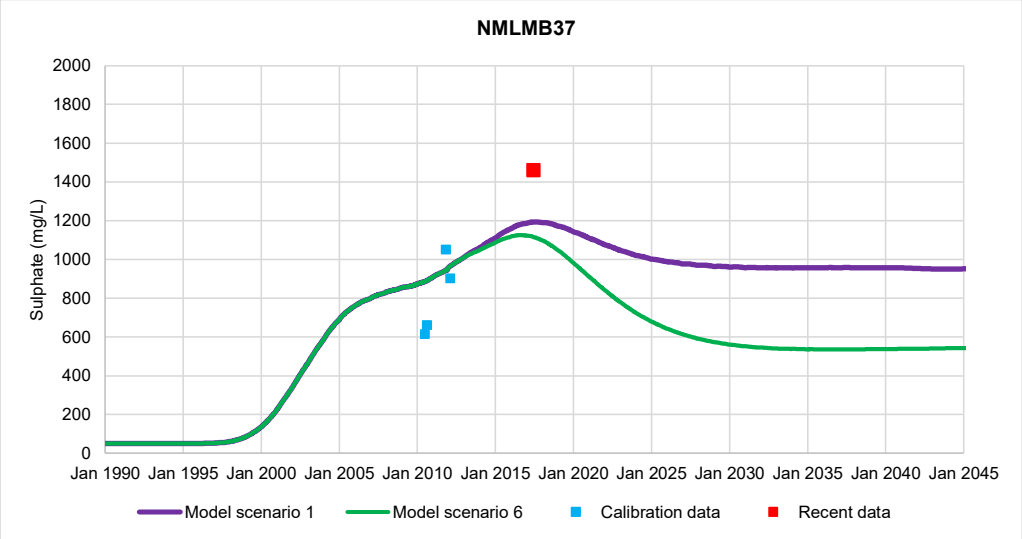

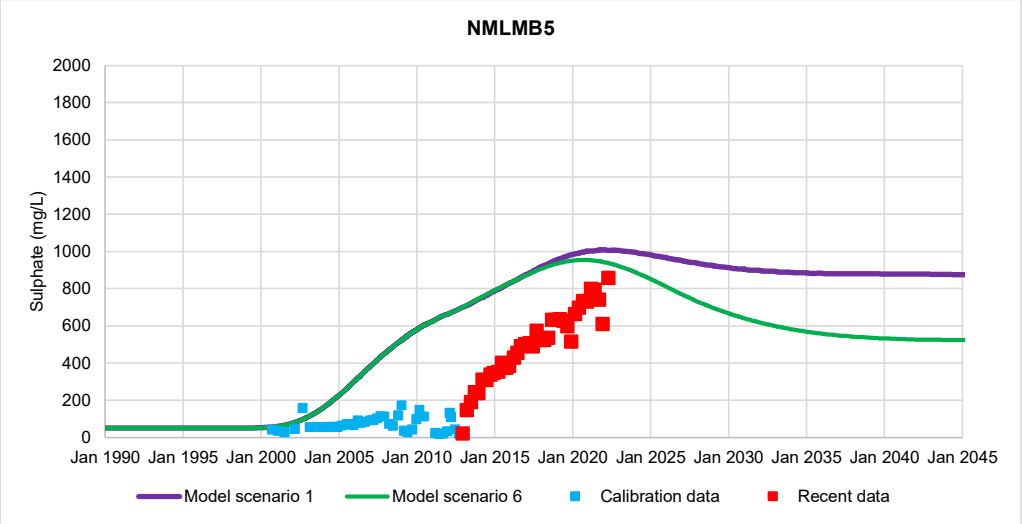

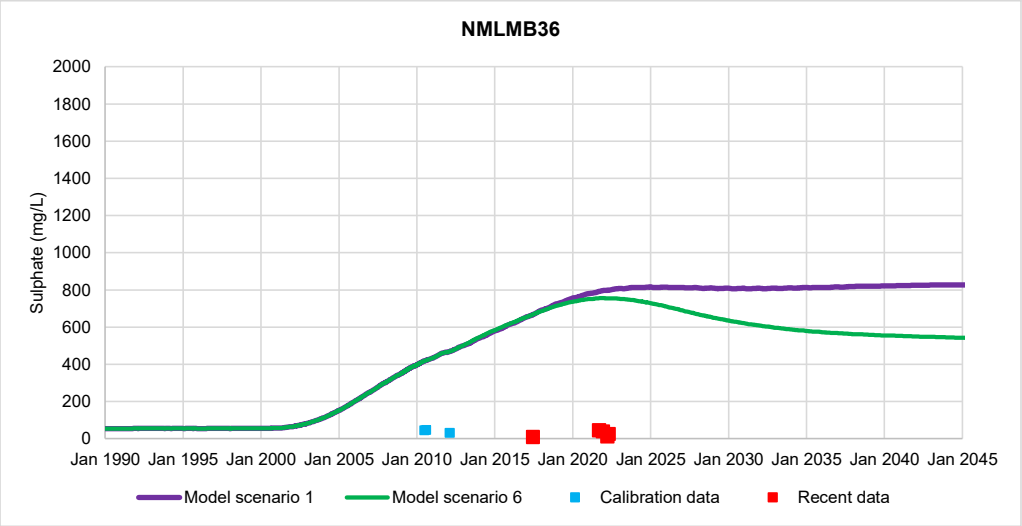

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BIG DOG HYDROGEOLOGY

Predicted sulphate concentrations at One Mile Creek

Figure 13

Date: June 2022

Report: Mt Leyshon Cover Performance Rev 1

Appendix Q:
TropWATER Report on Influence of Sulphate in Surface Water on Aquatic Ecology

TropWATER TECHNICAL MEMO

ASSESSMENT OF THE INFLUENCE OF SULPHATE IN SURFACE WATER ON AQUATIC ECOLOGY: MT LEYSHON MINE SUPPORTING INFORMATION

JUNE 2022

Author: Shelley Templeman

1. Background

The Mt Leyshon mine is a closed, open-pit gold mine located approximately 25 km south of Charters Towers in North Queensland, in the catchment of the Broughton River in the Upper Burdekin Basin. Under the current Environmental Authority (EA) EPML00863713, regular surface water sampling is undertaken in waterways around and downstream of the mine. The primary purpose of the REMP is to assess the receiving environment and establish whether the site left by closure of the Mt Leyshon operations is having any adverse impact on identified environmental values.

Further to this, the Queensland Department of Environment and Science (DES) is engaging with Newmont Australia to undertake an assessment of the estimated rehabilitation costs for the closed site under the Environmental Protection Act 1994. This document sets out to provide supporting information on the current sulphate conditions in the surface water receiving environment of MT Leyshon mine. It also provides as assessment of the potential for risk to the aquatic ecology in the receiving environment.

2. Description of the Receiving Environment

Mt Leyshon is located near the headwaters of the Broughton River, an ephemeral tributary of the Burdekin River (Figure 1). Prior to mining the local landscape was dominated by rocky outcrop hills including Mt Leyshon, Mt Mawe and Mt Hope. These hills formed a topographic high that defined several catchment boundaries, with natural surface water drainage away from the mine site to the north, south and east. The main drainage systems receiving runoff from the mine lease area comprise Clarke Creek to the north of the site and Puddler Creek to the south. Both systems have relatively large catchments upgradient of mine lease inputs. Two Mile Creek draining the eastern side of the mine lease area is a smaller system, wholly fed from within the lease.

Watercourses in and around the Mt Leyshon mine site are highly ephemeral with the normal ambient condition being a dry streambed. Permanent surface water is first encountered at the Burdekin River, although bed sands in the lower reaches of the major tributary streams and along the Broughton River can remain saturated for extended periods, in the wetter parts of the climate cycle. Elsewhere in the drainage system, streambed surfaces are normally dry throughout most of the year, and widespread surface flows are only sustained once pores in the bed sands have refilled.

Most of the stream flow passes through the system as short-term 'pulse' events immediately following heavy rainfall. These pulse events typically occur on just a few days each year. Surface flows recede rapidly after cessation of rainfall although sub-surface hyporheic flows can continue through the bed sands of larger watercourses for a longer period. Isolated surface expressions of this hyporheic reservoir can occur in scour hollows for several weeks to months after stream flows have ceased. These pools are typically small in area and can appear and disappear with movement of bed sediments.

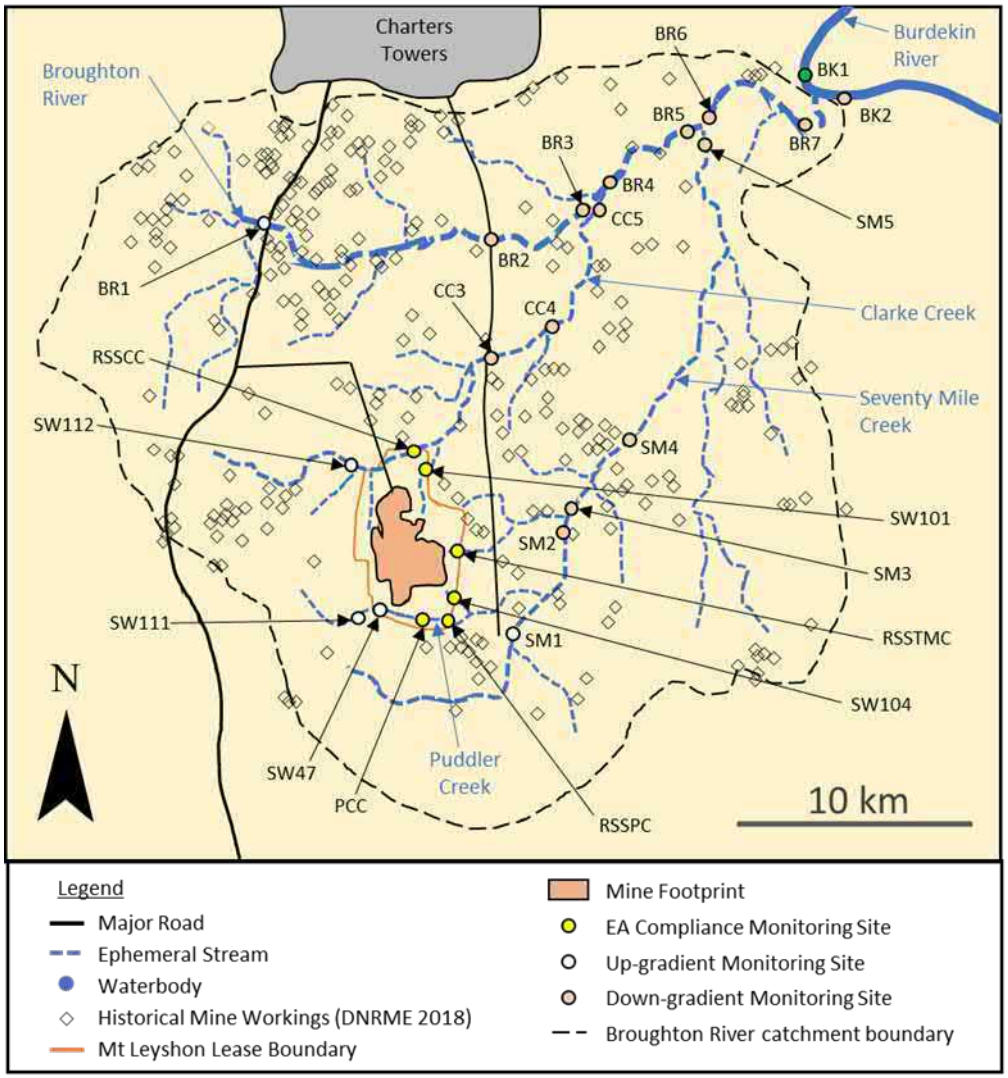


Figure 1: Surface water drainages and REMP surface water monitoring locations.

Year-on-year surface water conditions are heavily dependent on rainfall history and groundwater levels. In extended dry periods, low soil moisture and empty hyporheic reservoirs increase the rainfall threshold required to generate stream flows. Localised rainfall runoff and flows in one part of the system can be absorbed into the bed sands further downstream. In extended wet periods, trickle flows can be sustained for longer durations in the larger streams.

The main drivers of surface water quality are:

- direct surface runoff through the peak of the flow hydrograph;
- hyporheic seepage / groundwater efflux through the tail of the hydrograph; and
- residual water expressions.

Water quality during flow events tends to reflect rainfall characteristics, with the norm of sub-neutral pH and low conductivity. High sediment load and turbidity are also characteristic of high flows in many Burdekin River catchments due to past land clearing and land management practices. Ambient and no-flow water quality generally tallies with groundwater inputs and the associated drivers of geology, soil regolith characteristics and seasonal water balance. Background conditions reflect the mineralised nature of the catchment, wider land-use practices, and weed encroachment into the riparian zone along many watercourses. Cattle grazing is the dominant modern land-use around Mt Leyshon although the local region is heavily mineralised and widespread mining activity has occurred since the late 1800's (DNRME, 2018).

Cumulative differentials to long-term average rainfall describe a cyclical pattern of rainfall deficit (drought) and rainfall excess with a historical cycle period of roughly 10 years (McDonald et al, 2022). These shifts in cumulative rainfall and infiltration can drive variations in groundwater levels of up to 2.5 m (infiltration deficit) and 3.5 m (rainfall deficit) over time (McDonald et al, 2022).

The last peak of rainfall excess occurred in late 2012, and rainfall patterns since then have represented a drying phase of the climate cycle with progressively increasing rainfall deficit. To maintain water balance in the landscape, these cycles are also likely to present as medium-to-long term fluctuations in the underlying groundwater table (McDonald et al, 2022).

From a water quality perspective, these variable climatic patterns overlying a groundwater-coupled ephemeral drainage system add additional complexity to system interpretation. Phases of the climate cycle have implications for the extent and duration of groundwater expression, and historical surface water sampling results need to be standardised against these climatic influences for meaningful interpretation of underlying background conditions. Extrapolation of past water quality conditions to future outcomes also needs to account for the climate cycle.

3. Sulphate Concentrations in Mt Leyshon Receiving Waters

The contribution of groundwater to surface water across the Mt Leyshon site varies spatially and temporally. This is strongly driven by the stage/phase of the prevailing climate cycle. During the wetter phases of the climate cycle, such as that experienced between 2008 and 2012, groundwater levels were elevated with greater potential for sustained expression of groundwater to surface along key creek lines. In the current phase of the climate cycle, with much lower infiltrations rates and increased evaporation potential, there is limited expression of groundwater to surface and consequently reduced groundwater contributions to surface water conditions.

The variable sulphate concentrations measured in surface waters of the Mt Leyshon receiving environment is attributed to spatial and temporal variation in the mixing ratios between groundwater and hyporheic inputs. Higher than average ambient concentrations reflect a more dominant groundwater driver and reduced background hyporheic inputs from upstream rainfall and runoff. Lower than average ambient concentrations reflect a lower groundwater table and reduced groundwater inputs, with surface water expression dominated by hyporheic drivers. Accordingly, sites closer to catchment boundaries are unlikely to have sustained hyporheic inputs from upstream rainfall and run-off, with any sustained flows likely to reflect local groundwater contributions. This condition applies to both upgradient and compliance sites.

There is no groundwater quality monitoring data available prior to mining. Background groundwater character in the shallow groundwater system has been inferred from several bores that lie upstream of the mineralised zone and also potential mine influence. This data suggests that natural groundwater above the primary zone of mineralisation has a total dissolved solids (TDS) concentration between 650 mg/L and 2,000 mg/L, with an average around 1,000 mg/L. Electrical conductivity (EC) typically lies in the range 800 to 2,500 µS/cm, with an average pH of 7.2. Total alkalinity averages 600 mg/L as $CaCO_3$, with major ions dominated by sodium, chloride and bicarbonate. Sulphate concentrations are in the range 6 mg/L to 194 mg/L, with a median around 20 mg/L (McDonald et al, 2022).

4. Criteria for Defining Ambient Conditions in Mt Leyshon Receiving Waters

The Mt Leyshon surface water database contains data collected under pulse/event flow, ambient, first flush and intermediate conditions. To separate ambient water quality from other conditions, boundaries for EC and TSS were used to partition the data (Figure 2). If either the TSS or EC values for a given data point were missing, data was excluded from further assessment. Duplicate and blank samples collected for QA/QC purposes were also excluded (Tables 1 & 2).

The criteria for partitioning ambient conditions were TSS < 75 mg/L and EC > 500 µS/cm ('A' in Figure 2). Pulse flow conditions are typically represented by high TSS (>75 mg/L) and lower EC (< 500 µS/cm) values and identified as 'B' in Figure 2. Possible first flush conditions were characterised as being high TSS and corresponding high EC ('C' in Figure 2), while indeterminate conditions had low TSS and low EC ('D' in Figure 2). The 500 µS/cm EC threshold was used as a proxy for potential natural groundwater influence which typically lies in the range of 800 – 2500 µS/cm (see Section 3 above). The TSS threshold was set to reflect lower TSS conditions typical of ambient conditions. The threshold value for TSS is higher than ambient thresholds for ecological settings (e.g. Newham et al, 2017), but provides a slightly more conservative threshold for incorporating data that reflects first potential for groundwater expression into the surface water environment.

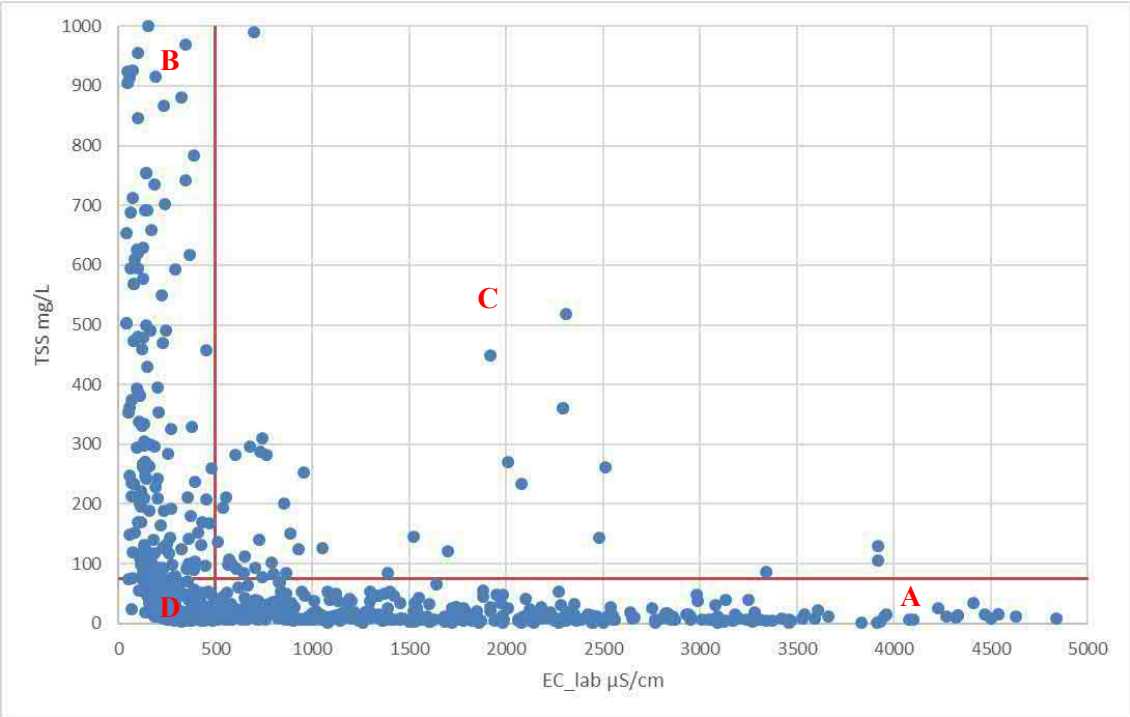


Figure 2: Boundary partitioning for discrimination of ambient water quality conditions for the historical sampling record at Mt Leyshon. The red lines represent an ambient boundary of 500 µS/cm (vertical) and 75 mg/L TSS (horizontal). Letter in red represent the different water quality conditions descried in Section 4 above.

Summary of ambient sulphate concentrations at the identified compliance sites are set out in Table 1 and upgradient sites in Table 2. None of the upgradient sites (SW47, SW111 and SW112) have been formally recognised as upgradient surface water sites by DES at his time. However, SW47 is categorised as an upgradient sediment site under the EA. The period of record (2010 – 2021) used for the partitioning reflects conditions of both high potential groundwater contribution (i.e.low infiltration deficit) for the period 2010-2012, as well as increasing infiltration deficit through the drying phase of the climate cycle that has been developing since 2014 (McDonald et al, 2022).

Sulphate concentrations at compliance sites ranges from a minimum of 1 mg/L at sites PCC to 2750 mg/L at RSSTMC. Of all sites, RSSCC has the largest data set with 96 separate ambient records for the recording period (Table 1). Sites SW101 and SW104 have the smallest datasets at n= 7 and 8 respectively. This reflects their location near the top of their respective catchments.

Table 1: Summary information for ambient sulphate concentrations at Mt Leyshon compliance sites for all database records defined as ambient under the criteria set out in Section 4.

Site	Count 'n'	Min	Max	Mean	Median	20th%ile	80th%ile
PCC	87	1	958	386	334	174	609
RSSPC	22	5	728	271	217	47	474
SW101	7	231	1030	527	340	244	880
SW104	8	167	2450	885	533	318	1518
RSSCC	96	89	1900	599	462	242	906
RSSTMC	40	80	2750	767	646	308	1009
All Compliance	260	1	2750	533	422	206	759

The upgradient record is more limited than the compliance record in both number of sites and total number of samples. SW47 is located at the point Puddler Creek crosses the southern boundary of the Mt Leyshon lease, and SW111 is located further upstream on the same system (Figure 1). SW112 is located upstream of the lease boundary on Clarke Creek (northern side of the lease area). None of the other compliance sites have corresponding upgradient sites as they arise from within the Mt Leyshon lease area (Figure 1). All the upgradient sites are located above the main zone of mineralisation associated with the lease area (McDonald et al, 2022). Accordingly, the recorded sulphate concentrations are lower than values recorded for compliance sites.

Table 2: Summary information for ambient sulphate concentrations at sites upgradient of the Mt Leyshon minesite for all database records defined as ambient under the criteria set out in Section 4.

Site	Count 'n'	Min	Max	Mean	Median	20th%ile	80th%ile
SW111	21	<1	18	5	<1	<1	13
SW47	36	<1	64	9	8	<1	15
SW112	29	<1	131	25	17	<1	40
All Upgradient	86	<1	131	13	6	<1	18

5. Sulphate Influences on the Aquatic Community

Sulphate in the freshwater system can act as both a salt stressor and a biotic toxicant. Sulphate toxicity for aquatic ecological communities is highly dependent on hardness and other ionic composition factors (Dunlop et al., 2016). A guideline value of 545 mg/L was established by Dunlop et al. (2016) for 95% species protection in very hard water (550 mg/L) with a relatively high Ca:Mg ratio (4.0) and high chloride concentration (>200 mg/L). Other literature on the synergistic and antagonistic effects of different ionic compositions on sulphate toxicity (Davies & Hall, 2007; Soucek and Kennedy, 2005) suggest that the context of the Dunlop et al. (2016) guideline is broadly compatible with potential very hard, high sulphate waters in the Mt Leyshon environment.

Drinking water guidelines for sulphate vary depending on species. ANZECC & ARMCANZ (2000) gives a guideline value of 1000 mg/L for sulphate in drinking water for young and lactating cattle although mature animals may tolerate concentrations up to 2000 mg/L. Human drinking water guidelines (NHMRC, NRMMC, 2016) identify taste / aesthetic limits of 250 mg/L for chloride and sulphate with possible purgative effects above >500 mg/L SO_4 (NHMRC, NRMMC, 2016). The draft water quality guidelines for the Burdekin Basin (Newham et al., 2017) identifies underlying sulphate values for baseflow conditions in the 'Burdekin above Dam' sub-catchment of 1-2-3 mg/L (20th percentile -median - 80th percentile).

The receiving environment monitoring program has derived a number of relationships between aquatic macroinvertebrate metrics and key parameters, including sulphate for the historical sampling record at Mt Leyshon.

The derived relationship between SIGNAL Score and sulphate is shown in Figure 3. In this assessment, the orange dots identify a thresholded subset of the data record excluding records with water quality parameter values in the lowest 5% of the parameter range. 'Regression n' = the number of records included in this thresholded data set. Grey dots identify the measures excluded by the thresholding – i.e. the balance of the historical record. The linear regression shown by the orange dotted line and orange text box reflects the thresholded dataset. The orange dashed line identifies the lower 80th percentile, one-tailed confidence limit for the regression. 'Signif. Slope' identifies whether the slope of the regression relationship is significantly different from zero (Figure 3).

Blue triangles identify measures at upgradient sites in Clarke, Puddler and Seventy Mile Creeks and the Broughton River. 'Upgradient n' = the number of upgradient records in the historical macroinvertebrate dataset. '40%ile BWQ' = the 40th percentile water quality value at upgradient sites across the full water quality dataset (including water quality records for which there was no corresponding macroinvertebrate sampling) (Figure 3).

'n <40%ile BWQ' = the number of upgradient records in the historical macroinvertebrate dataset where the corresponding water quality result was less than the '40%ile BWQ' (i.e. upgradient macroinvertebrate records associated with relatively 'natural' background water quality. '20%ile SIGNAL' = the 20th percentile SIGNAL score for the sub-set of upgradient records with relatively 'natural' background water quality. The horizontal blue line on the plot also shows this '20% SIGNAL' value (Figure 3).

'CL Intercept' = the water quality parameter value at the intercept between the lower 80th percentile, one-tailed confidence limit for the regression and the horizontal line defined by '20%ile SIGNAL'. 'Data 80%ile' = the 80th percentile water quality parameter value for all macroinvertebrate records with SIGNAL score greater than the '20% SIGNAL' value. 'Threshold' = the identified threshold for potential change in the macroinvertebrate community compared with relatively 'natural' background conditions. Where the slope of the regression is significantly different from zero ($p<0.05$) this was taken as the intercept of the regression confidence limit and the background 20th percentile condition (i.e. 'CL Intercept'). Where the slope of the regression is not significantly different from zero this was taken as the 80th percentile water quality value for the set of records with community outcomes better than the background 20th percentile condition (i.e. 'Data 80%ile'). The vertical black line on the plot also identifies the 'Threshold' value – n this case 944 mg/L SO_4.

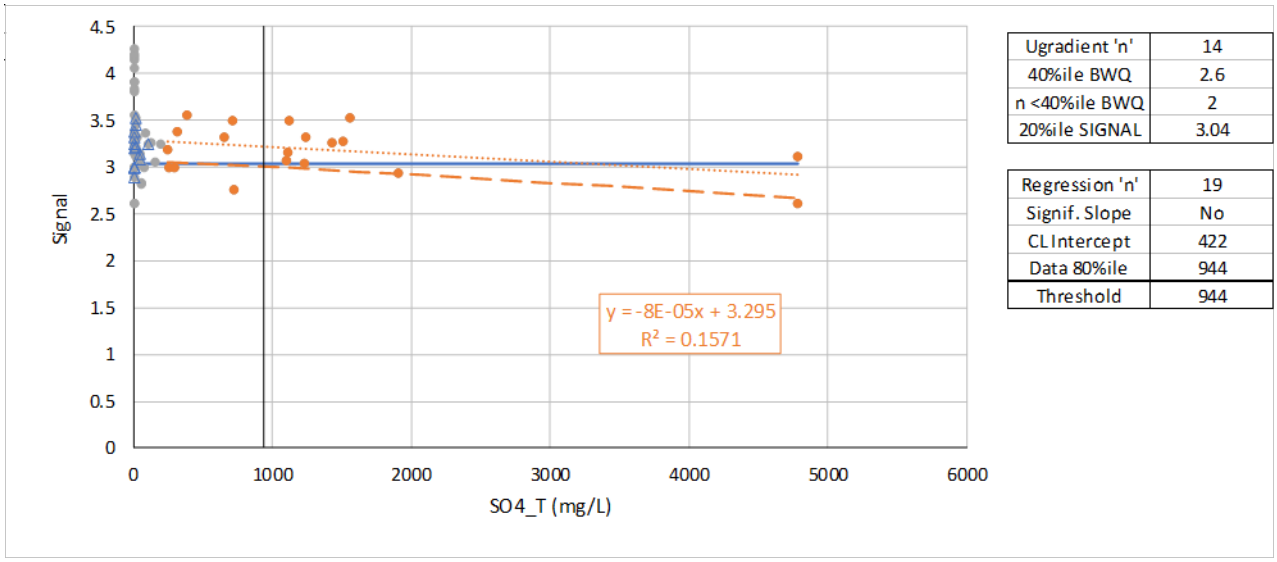


Figure 3: Historical relationship between aquatic macroinvertebrate SIGNAL score and sulphate for the historical sampling record at Mt Leyshon.

Similar relationships have been derived between sulphate and Taxonomic Richness and Diversity (Table 3). This relationship has also be derived for other parameters including EC, Mg, Cl and hardness and provided here for information purposes only (Table 3). The sulphate concentration relationship with both SIGNAL Score and Taxa Richness are similar (944 cv. 884) with the threshold for Diversity calculated at 1186 mg/L SO_4 (Table 3). In all cases, the slope of the regression is not significantly different from zero and therefore represents the 80th percentile water quality value for the set of records with community outcomes better than the background 20th percentile condition.

Table 3: Identified thresholds for change in macroinvertebrate community metrics compared with background conditions. '40th %ile Background Condition' = the 40th percentile water quality measure at upgradient monitoring sites across all historical water quality records. 'Invert Sample n' = the number of invert samples with an associated water quality result less than or equal to the 40th percentile background condition. 'Identified Threshold: SIGNAL' = the identified threshold based on historical macroinvertebrate community SIGNAL scores. 'Identified Threshold: Taxa Richness' and 'Identified Threshold: Diversity are the corresponding thresholds derived from macroinvertebrate community richness and diversity metrics.

Parameter	Units	40th %ile Background Condition	Invert Sample n	Identified Threshold: SIGNAL	Identified Threshold: Taxa Richness	Identified Threshold: Diversity
EC	µS/cm	820	9	2978	3038	2962
Sulphate	mg/L	2.6	2	944	884	1186
Magnesium	mg/L	22.8	9	186	626	140
Chloride	mg/L	118.8	9	286	293	284
Hardness	mg/L	178	4	767	1231	1076

This approach provides direct line of evidence into the influence of major ions, including sulphate on macroinvertebrate community structure and their tolerance/sensitivity in a highly dynamic ephemeral system.

Review of the AUSRIVAS band scores for period under assessment also demonstrates a level of tolerance of the local ecology to elevated sulphate conditions (Table 4). The AUSRIVAS band scores are based off a prediction of the expected community structure at a given site in comparison to expected reference

conditions (Davies 2000; Simpson & Norris 2000). A score of **A** under this model indicates that most of the expected taxa under these conditions have been found in the sample. This indicates that the water quality and/or habitat condition is roughly equivalent to reference conditions. Any deviation in water quality or habitat condition is not causing a loss of macroinvertebrate diversity. A score of **B** under this model indicates that fewer than expected taxa have been found in the sample. This indicates that there is some level of impairment to water quality and/or habitat condition compared to reference conditions (Table 4).

Table 4: SO_4 concentrations and respective AUSRIVAS band scores for pool bottom habitats across Mt Leyshon at surface water upgradient, interpretation and compliance sites. Values in cells represent measured SO_4 concentrations at time of sampling. Colour represents AUSRIVAS band score – Green = band score A (similar to reference conditions); Yellow = band score B (impaired compared to reference conditions). * indicates unable to be sampled for macroinvertebrates. Note: there was no on-lease AUSRIVAS data available for 2019-20.

Site	Site Type	System	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2020-21
SW103	Interpretation	Puddler	*	*	7	*	*	*	*
SW106	Interpretation	Clarke	1510	*	*	*	*	*	*
SW107	Interpretation	Puddler	*	*	*	256	121	378	*
SW108	Interpretation	Puddler	731	*	1120	295	1560	1510	324
PCC	EA Compliance	Puddler	661	*	*	*	*	71	*
SW112	Up-gradient	Clarke	46	*	*	*	*	*	*
RSSCC	EA Compliance	Clarke	298	1900	1230	*	1110	1100	*

Multiple REMP sampling events across both interpretation and compliance sites have shown no indication of impairment on the macroinvertebrate community at sulphate concentrations ranging from as low as 7 mg/L to as high as 1900 mg/L (Table 4). The two events indicating a level of impairment to the community diversity sit above 1000 mg/L SO_4 but the key contributor to impairment cannot be readily linked to the measured sulphate concentration alone.

Due to the physical nature of the upgradient sites and their respective limited water holding capacity, the macroinvertebrate record at these sites is very depauperate. Over the period 2014-2021 only one macroinvertebrate sampling opportunity has been possible at SW112 with none at SW47 or SW111 (Table 4).

Collectively, these assessments provide evidence of an aquatic macroinvertebrate community that is tolerant of high ionic composition. Repeated A band scores at sulphate concentrations above 600 mg/L SO4 along with derived threshold scores for other metrics including SIGNAL score, taxa richness and diversity demonstrate the tolerances of the local community in highly dynamic ephemeral sytems.

6. Summary Outcomes

The summarised dataset captures ambient surface water from 2010 – 2021. The surface water quality reflects both a period of sustained groundwater expression (i.e. 2010-2012) as well as the drying phase of the climate cycle that reflects limited groundwater expression to surface waters (2014-2021).

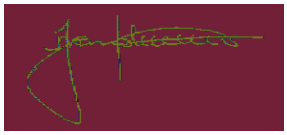
The use of the historical macroinvertebrate record provides bounds for effect thresholds for sulphate exposure with macroinvertebrate metric thresholds ranging from 884 to 1186 mg/L (Table 3). This work, taken in combination with sulphate guideline development work by Dunlop et al, 2016 which reported a 95% species protection sulphate guideline of 545mg/L. AUSRIVAS assessments showed limited impairment at concentrations as high as 1900 mg/L SO_4. Collectively, these lines of evidence suggest a level of tolerance of the local ecology to sulphate. These values also reflect long-term chronic

exposure levels and will be more conservative than short-term pulse exposures, more typical of these systems.

Sulphate concentrations in surface water in the Mt Leyshon receiving environment reflect the extent of groundwater expression to surface and are highly dependent on climatic factors. Prediction of absolute sulphate concentrations from groundwater to surface water is not possible based off this information. However, provided long-term surface water concentrations remain below the discussed thresholds, the potential for impact on the aquatic ecology is considered to be limited.

If you have any questions or queries regarding this assessment, please do not hesitate to contact me by email or telephone: Shelley.Templeman@jcu.edu.au or 0409636800

Regards



Shelley Templeman

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Appendix R:
PRCP Schedule

Post-mining land uses (PMLU)									
Rehabilitation area	RA1								
Relevant activities	Eastern Waste Rock Storage Facility								
Total rehabilitation area size (ha)	197.67								
Commencement of first milestone: <RM4>	10-Dec-22								
PMLU	Grazing								
Date area is available	10/12/2022								
Cumulative area available (ha)	197.67								
Milestone completed by	10/12/2024	10/12/2042	10/12/2044	10/12/2122					
Milestone Reference	**Cumulative area achieved (ha)**								
RM4	6.95								
RM5	197.67								
RM6		63.19	79.81	197.67					

1) Insert new columns to the <u>yellow table</u> to include further rehabilitation milestone dates.
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3) Insert new rows to the <u>blue table</u> to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area				RA2						
Relevant activities				Northern Waste Rock Storage Facility						
Total rehabilitation area size (ha)				38.48						
Commencement of first milestone: <RM4>				10-Dec-23						
PMLU				Grazing						
Date area is available	10/12/2023									
Cumulative area available (ha)	38.48									
Milestone completed by	10/12/2025	10/12/2042	10/12/2045	10/12/2122						
Milestone Reference	**Cumulative area achieved (ha)**									
RM4	14.98									
RM5	38.48									
RM6		21.51	29.63	38.48						

1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
2) Insert new columns to the blue table to match rehabilitation milestone dates.
3) Insert new rows to the blue table to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)									
Rehabilitation area	RA3								
Relevant activities	Southern Waste Rock Storage Facility								
Total rehabilitation area size (ha)	41.42								
Commencement of first milestone: <RM4>	10-Dec-24								
PMLU	Grazing								
Date area is available	10/12/2024								
Cumulative area available (ha)	41.41								
Milestone completed by	10/12/2026	10/12/2042	10/12/2046	10/12/2126					
Milestone Reference	**Cumulative area achieved (ha)**								
RM4	12.54								
RM5	41.42								
RM6		6.58	7.49	41.42					

1) Insert new columns to the <u>yellow table</u> to include further rehabilitation milestone dates.
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Post-mining land uses (PMLU)									
Rehabilitation area	RA4								
Relevant activities	New Northern Tailings Storage Facility								
Total rehabilitation area size (ha)	116.68								
Commencement of first milestone: <RM4>	10-Dec-25								
PMLU	Grazing								
Date area is available	10/12/2025								
Cumulative area available (ha)	116.68								
Milestone completed by	10/12/2027	10/12/2042	10/12/2047	10/12/2122					
Milestone Reference	**Cumulative area achieved (ha)**								
RM4	13.33								
RM5	116.68								
RM6		101.87	115.19	116.68					

1) Insert new columns to the <u>yellow table</u> to include further rehabilitation milestone dates.
2) Insert new columns to the <u>blue table</u> to match rehabilitation milestone dates.
3) Insert new rows to the <u>blue table</u> to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)									
Rehabilitation area	RA5								
Relevant activities	Old Northern Tailings Storage Facility								
Total rehabilitation area size (ha)	65.30								
Commencement of first milestone: <RM4>	10-Dec-26								
PMLU	Grazing								
Date area is available	10/12/2026								
Cumulative area available (ha)	65.30								
Milestone completed by	10/12/2027	10/12/2042	10/12/2047	10/12/2122					
Milestone Reference	**Cumulative area achieved (ha)**								
RM4	5.20								
RM5	65.30								
RM6		27.70	28.65	65.30					

1) Insert new columns to the <u>yellow table</u> to include further rehabilitation milestone dates.
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Post-mining land uses (PMLU)									
Rehabilitation area	RA6								
Relevant activities	Southern Tailings Storage Facility								
Total rehabilitation area size (ha)	68.19								
Commencement of first milestone: <RM4>	10-Dec-26								
PMLU	Grazing								
Date area is available	10/12/2026								
Cumulative area available (ha)	68.20								
Milestone completed by	10/12/2027	10/12/2042	10/12/2047	10/12/2122					
Milestone Reference	**Cumulative area achieved (ha)**								
RM4	0.69								
RM5	68.19								
RM6		34.92	35.49	68.19					

1) Insert new columns to the <u>yellow table</u> to include further rehabilitation milestone dates.
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3) Insert new rows to the <u>blue table</u> to include additional rehabilitation milestone references.
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Post-mining land uses (PMLU)									
Rehabilitation area	RA7								
Relevant activities	Stockpiles								
Total rehabilitation area size (ha)	60.94								
Commencement of first milestone: <RM4>	10-Dec-27								
PMLU	Grazing								
Date area is available	10/12/2027								
Cumulative area available (ha)	60.94								
Milestone completed by	10/12/2030	10/12/2042	10/12/2050	10/12/2122					
Milestone Reference	**Cumulative area achieved (ha)**								
RM4	11.36								
RM5	60.94								
RM6		14.13	16.12	60.94					

1) Insert new columns to the <u>yellow table</u> to include further rehabilitation milestone dates.
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Post-mining land uses (PMLU)									
Rehabilitation area	RA8								
Relevant activities	Dams and Sumps								
Total rehabilitation area size (ha)	50.19								
Commencement of first milestone: <RM6>	10/12/2121								
PMLU	Grazing								
Date area is available	10/12/2122								
Cumulative area available (ha)	50.19								
Milestone completed by	10/12/2124	10/12/2144							
Milestone Reference	**Cumulative area achieved (ha)**								
RM6		50.19							

1) Insert new columns to the <u>yellow table</u> to include further rehabilitation milestone dates.
2) Insert new columns to the <u>blue table</u> to match rehabilitation milestone dates.
3) Insert new rows to the <u>blue table</u> to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)									
Rehabilitation area	RA9								
Relevant activities	Roads and Mine Infrastructure								
Total rehabilitation area size (ha)	15.77								
Commencement of first milestone: <RM1>	10/12/2121								
PMLU	Grazing								
Date area is available	10/12/2122								
Cumulative area available (ha)	15.72								
Milestone completed by	10/12/2124	10/12/2144							
Milestone Reference	**Cumulative area achieved (ha)**								
RM1	4.08								
RM2	4.08								
RM4	4.08								
RM5	15.77								
RM6		15.77							

1) Insert new columns to the <u>yellow table</u> to include further rehabilitation milestone dates.
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Post-mining land uses (PMLU)									
Rehabilitation area	RA10								
Relevant activities	Northern Borrow Pits								
Total rehabilitation area size (ha)	40.10								
Commencement of first milestone: <RM2>	10/12/2030								
PMLU	Grazing								
Date area is available	10/12/2030								
Cumulative area available (ha)	40.01								
Milestone completed by	10/12/2032	10/12/2052							
Milestone Reference	**Cumulative area achieved (ha)**								
RM2	40.10								
RM4	40.10								
RM5	40.10								
RM6		40.10							

1) Insert new columns to the <u>yellow table</u> to include further rehabilitation milestone dates.
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3) Insert new rows to the <u>blue table</u> to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)									
Rehabilitation area	RA11								
Relevant activities	Quarry								
Total rehabilitation area size (ha)	3.30								
Commencement of first milestone: <RM2>	10/12/2030								
PMLU	Grazing								
Date area is available	10/12/2030								
Cumulative area available (ha)	3.30								
Milestone completed by	10/12/2032	10/12/2052							
Milestone Reference	**Cumulative area achieved (ha)**								
RM2	3.30								
RM4	3.30								
RM5	3.30								
RM6		3.30							

1) Insert new columns to the <u>yellow table</u> to include further rehabilitation milestone dates.
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3) Insert new rows to the <u>blue table</u> to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)									
Rehabilitation area	RA12								
Relevant activities	Scats Stockpile								
Total rehabilitation area size (ha)	30.02								
Commencement of first milestone: <RM2>	10-Dec-27								
PMLU	Grazing								
Date area is available	10/12/2027								
Cumulative area available (ha)	30.02								
Milestone completed by	10/12/2030	10/12/2040							
Milestone Reference	**Cumulative area achieved (ha)**								
RM2	28.71								
RM3	28.71								
RM4	28.71								
RM5	28.71								
RM6		30.02							

1) Insert new columns to the <u>yellow table</u> to include further rehabilitation milestone dates.
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3) Insert new rows to the <u>blue table</u> to include additional rehabilitation milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Non-use management area (NUMA)										
Improvement area	IA1									
Relevant activities	NUMA									
Total size (ha)	70.38									
Commencement of first milestone:	10/12/2021									
NUMA	Void									
Date area is available	10/12/2022									
Cumulative area available (ha)	70.38									
Milestone completed by	10/12/2122									
Milestone Reference	**Cumulative area achieved (ha)**									
MM1	70.38									
MM2	70.38									
MM3	70.38									

1) Insert new columns to the <u>yellow table</u> to include further management milestone dates.
2) Insert new columns to the <u>blue table</u> to match management milestone dates.
3) Insert new rows to the blue table to include additional management milestone references.
4) Insert the relevant number in the "Milestone reference" column (i.e. MM1).

Milestone reference	Rehabilitation milestone	Milestone criteria
RM1	INFRASTRUCTURE DECOMMISSION AND REMOVAL	All infrastructure (i.e., mining and ancillary) removed unless relied upon for rehabilitation and water management purposes or otherwise agreed and asset transfer agreement in place for infrastructure retained.
RM2	LANDFORM SHAPING	• Bulk earthworks have been completed to achieve final landform design batter slope requirements:
		Facility and (Batter slope (degrees))
		Scats stockpile (15)
		Northern Waste Rock Storage Facility (12)
		Southern Waste Rock Storage Facility (11)
		Eastern Waste Rock Storage Facility (13)
		Old Northern Tailings Storage Facility (15)
		Southern Tailings Storage Facility (14)
		New Northern Tailings Storage Facility (16)
		• Install future ESC Structures as per design and certified by an appropriately qualified person.
		• Report provided by suitably qualified person to verify "as constructed" complies with the final landform design for any future re-shaping works.
RM3	COVER SYSTEM INSTALL	• Bituminous Geo-Membrane transported, handled, stored, and installed to Original Equipment Manufacturers OEM specifications on Scats Stockpile.
		• Conformance checks verify "as constructed" complies with the design for:
		– slope angle (maximum 15 degrees)
		– sub grade preparation (i.e. uniform grades, acceptable deformities)
		– ultimate footprint extents
		anchoring and overlap/joining of materials
RM4	FINAL SURFACE PREPARATION	• Remediation of existing erosion/ponding and conformance checks by suitably qualified person demonstrate acceptable surface preparation to design.
		• Application of ameliorants to growth media harvested from Northern Borrow Pit sample locations prior to placement:
		– Samples 1-4; Gypsum at 5t/ha
		– Samples 1-11 Nitrogen, Phosphorous, Sulphur fertilizer at 150kg/ha
		– Samples 1-4, 6-9: Zinc Sulfate at 10kg/ha and samples 5, 10 and 11 at 5kg/ha
		– Samples 1, 4, 5: Organic matter at 20t/ha, samples 2,3 and 6-11 at 40t/ha
		• Apply nominated depth of growth media, 0.3m otherwise:
		– Stockpiles (0.45m)
		– Scats Stockpile (0.5m)
		– Mine Infrastructure (0.1m)
		– Northern Borrow Pit and Quarry (0.15m)
		Conformance checks by suitably qualified person verify "as constructed" complies with the design.
RM5	REVEGETATION (PASTURE GRAZING)	• Apply pasture grass seed mix (*Buffel, Seca, Couch, Wynn-Cassia, Rhodes*) at 5 to 8 kg/ha (equal portions).
		• Apply ameliorants at rates determined by an appropriately qualified person (see RM4).
		• Rip/plough/tyne growth media (preserving cover system) as per design.
RM6	ACHIEVEMENT OF PMLU TO STABLE CONDITION	• Infrastructure decommissioning and removal activities have been undertaken in accordance with a decommissioning strategy.
		• Infrastructure (i.e., mining and ancillary) removed unless otherwise agreed and asset transfer agreement in place for infrastructure retained.
		• Site contamination investigation report for mine has been prepared by an approved auditor under the *Environmental Protection Act 1994* and any requirements for a site management plan incorporated into the Land Use Management Plan (LUMP).
		• Groundwater quality meets EA conditions C15-1, C15-2, C15-3 for at least 18 samples collected over a two-year period
		• Surface water quality with the potential to directly discharge to the environment meets EA conditions C1-4, C2-2 to 4, C3-1 to 2, C4-1 to 3, C4-5 to 7 for 10 samples collected over a two-year period
		• Soil stability greater than or equal to the lower limit of the average regional range for three years of monitoring using full LFA/EFA methods
		• Erosion features less than or equal to the upper limit of the average regional range for three monitoring years using full LFA/EFA methods
		• >70% of analogue median using full LFA/EFA assessments for 3 years of monitoring for native grass cover and diversity, woody species cover and diversity, and perennial grass species cover and diversity

		• Full LFA assessment method for infiltration index and nutrient cycling index are at least 70% of median for target ecosystem (determined at analogue sites) for three years of monitoring.
		• No restricted invasive Category 3 plants not already present at analogue rehabilitation sites observed at rehabilitated sites measured by using the rapid assessment method.
		• 10-yearly report trending water interception volumes and quality against REMP trigger limits requirements submitted to DES for RA's reliant upon water interception system.

1) Insert new rows below the table to record more Rehabilitation Area Milestones for the project
2) Ensure all Rehabiitation Milestones recorded in this table align with those included in the RA sheets in this form.
3) See the PRCP guideline before developing site-specific Rehabilitation Area Milestones

Milestone reference	Management milestone	Milestone criteria
MM1	ACHIEVEMENT OF SURFACE WATER REQUIREMENTS	After decommissioning of water interception system (pumping ceases due to water quality meeting EA release requirements) Water balance model verification that RL340 will not be reached through inputs into void (catchment water flows, localised seepage, rainfall)
MM2	ACHIEVEMENT OF SURFACE REQUIREMENTS	Construction of hard control barrier (around perimeter of NUMA at minimum of 1m high Warning signage posted every 100 m of the perimeter
MM3	ACHIEVEMENT OF SUFFICIENT IMPROVEMENT	Certification from an appropriately qualified person that the water level and quality in the void will not cause environmental harm to the surrounding environment Certification from an appropriately qualified person that the void is safe to humans and livestock

1) Insert new rows below the table to record more Improvement Area Milestones for the project
2) Ensure all Management Milestones recorded in this table align with those included in the IA sheets in this form.
3) See the PRCP guideline before developing site-specific Improvement Area Milestones

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