REPORT

NORSEMAN GOLD PROJECT

COBBLER DEPOSIT

SURFACE WATER MANAGEMENT REPORT

Prepared for:

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EXECUTIVE SUMMARY

Pantoro South Pty Ltd (Pantoro) owns a 50% interest and has management control of the Norseman Gold Project (NGP), which is roughly centred on the town of Norseman in the Eastern Goldfields Region of Western Australia. Pantoro is currently focussed on developing existing and recently discovered resources, including commencing open pit mining activities at the Cobbler deposit located on Lake Cowan about 4.5 km northwest of Norseman townsite.

Pantoro has initiated the processes for obtaining key environmental and project approvals and commissioned Groundwater Resource Management Pty Ltd (GRM) to complete hydrogeological and hydrological assessments to assist with the planning for this development. GRM has adopted a two stage approach to the hydrological/surface water studies, with an initial hydro-metrological study (Stage 1 – completed April 2020), followed by surface water management studies (Stage 2) for each of the mining areas. This report presents the management study for the Cobbler deposit. The studies for the other mining areas will be reported separately.

This report presents the findings from the Stage 2 Surface Water Management study which has built on the results of the Stage 1 hydro-meteorological desktop study completed previously. It is based on the findings from a three-day site visit and desktop hydrological analyses and presents the preliminary engineering design of the proposed surface water management measures for the Cobbler deposit at the NGP.

The following key findings were made with respect to surface water management:

- The regional climate is one of extremes and droughts and major floods can occur in the same area within a few years of each other. The climate in this region is highly variable, both spatially and temporally, and this can make hydrologic analysis and the design of water management measures difficult.
- Regional climatic conditions are arid with mean annual rainfalls of about 250 mm. The rainfall that occurs during the early winter months of May, June and July tends to be more reliable than the less dependable, but more intense, summer rainfalls from January to March which are due to remnant tropical cyclones and other depression related events.
- The NGP is located within the DWER's Balladonia Catchment in the south-central part of the much larger, internally draining Salt Lake Basin No. 24 which extends across much of central WA. The most significant hydrological features in the vicinity of the NGP are Lake Cowan to the north and Lake Dundas to the south of Norseman. These endorheic salt lakes drain a combined catchment area of about of 15,225 km^2.
- The Cobbler mining area is located approximately 4.5 km northwest of Norseman and is situated on the lakebed of Lake Cowan to the south of both the Coolgardie-Esperance Highway and Kalgoorlie-Esperance Railway causeways. It is considered that these causeways offer a degree of flood protection or, at least, flood attenuation from large runoff events generated over the upper Lake Cowan catchment area (>11,500 km^2). Regardless, the most significant flood risk to the proposed Cobbler Pit is potential inflow from the surrounding lakebed and robust flood protection works will be required.

  Primary flood protection should therefore be provided to the proposed Cobbler pit using a combination 1,790 m long flood bund along the lake side and 1,590 m long pit safety bund adjacent to the pit crest with a raised backfilled area between both bunds to form a flood levee.

  The minimum height of the flood protection bund should be set at 2 m above the highest adjacent lakebed level, while the safety bund height should be equal or greater than half the

maximum tyre height of on-site equipment. The thickness and width of the backfilled levee material will vary, but should be in the order of 1 to 1.5 m thick and comprise fresh, non-acid generating waste rock from the pit. This levee area may be used as lay-down or to accommodate lighting towers etc.

The outer flood protection bund should be set back from the proposed pit so that it may also serve as part of the abandonment bund to be completed at the end of Operations.

- There are no noteworthy creeks or drainages in the vicinity of the on-shore Cobbler mine facilities and runoff that does occur mostly reports as sheet flow in a generally west to east direction towards Lake Cowan. There are three relatively small catchment areas upstream of the proposed facilities that will require management; namely, a 0.31 km^2 catchment upstream of the waste rock dump (WRD) and two catchments located north and south of the Mine Yard with areas of 0.48 km^2 and 0.20 km^2 respectively.

  A 1,635 m long "contact" drain should therefore be constructed along the upstream edge of the WRD to divert runoff from the upstream catchment area and direct it onto the lakebed via a rock armoured apron. Two 30 m long floodway type crossings with low-flow culverts will be required along the on-shore section of haul road, to the north and south of the Mine Yard. Twin 600 mm diameter "equalisation" culverts should be installed below both two section of haul road on the lakebed, between the pit and WRD and the pit and Mine Yard.

GLOSSARY OF TERMS

Annual Exceedance Probability (AEP)	The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.
Antecedent Soil Moisture	Water present in the soil prior to a rainfall event.
Average Recurrence Interval (ARI)	The average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration. It is implicit in this definition that the periods between exceedances are generally random.
Australian Rainfall and Runoff (ARR)	National guideline document, data and software suite that can be used for the estimation of design flood characteristics in Australia. Currently in its 4th edition it is commonly referred to as ARR2016.
Australian Hydrological Geospatial Fabric (AHGF)	The Australian Hydrological Geospatial Fabric (Geofabric) is a specialised Geographic Information System (GIS). It identifies and registers the spatial relationships between important hydrological features such as watercourses, water bodies, canals, aquifers, monitoring points and catchments
Backwater	Water backed-up or retarded in its course as compared with its normal or natural condition of flow
Baseflow	The component of streamflow supplied by groundwater discharge
Basin	A tract of country, generally larger catchment areas, drained by a river and its tributaries.
Catchment	The land area draining to a point of interest, such as a water storage or monitoring site on a watercourse.
Channel	An artificial or constructed waterway designed to convey water. Often described as open channels to distinguish them from pipes.
Control	Physical properties of a cross-section or a reach of an open channel, either natural or artificial, which govern the relation between stage and discharge at a location in the open channel.
Dead Storage	In a water storage, the volume of water stored below the level of the lowest outlet (the minimum supply level). This water cannot be accessed under normal operating conditions.
Discharge	Volume of liquid flowing through a cross-section in a unit time.
Drainage Division	Representation of the catchments of the 12-major surface water drainage systems across Australia, generally comprising a number of river basins.
Endorheic Basin	A closed surface water drainage basin that retains water and has no outflow to the sea.
Environmental Flow	The streamflow required to maintain appropriate environmental conditions in a waterway or water body.
Ephemeral	Something which only lasts for a short time. Typically used to describe rivers, lakes and wetlands that are intermittently dry.
Evapotranspiration (ET)	The sum of evaporation and plant transpiration from the earth's land surface to the atmosphere.
Evaporation	A process that occurs at a liquid surface, resulting in a change of state from liquid to vapour.
Floodplain	Flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding
Full Supply Level (FSL)	The normal maximum operating water level of a water storage when not affected by floods. This water level corresponds to 100% capacity.

Generalised Short-Duration Method (GSDM)	Appropriate for estimating probable maximum precipitation for durations up to six hours and for an area of less than 1000 square kilometres.
Generalised Tropical Storm Method – Revised (GTSMR)	Appropriate for estimating probable maximum precipitation in regions of Australia affected by tropical storms.
Intensity-Frequency-Duration (IFD)	Design rainfall intensities (mm/h) or design rainfall depths (mm) corresponding to selected standard probabilities, based on the statistical analysis of historical rainfall.
Minimum Supply Level (MSL)	The lowest water level to which a water storage can be drawn down (0% full) with existing outlet infrastructure; typically, equal to the level of the lowest outlet, the lower limit of accessible storage capacity.
Precipitation	All forms in which water falls on the land surface and open water bodies as rain, sleet, snow, hail, or drizzle.
Probable Maximum Flood (PMF)	The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation (PMP, and coupled with the worst flood producing catchment conditions.
Probable Maximum Precipitation (PMP)	The theoretically greatest depth of precipitation for a given duration under modern meteorological conditions for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends.
Rainfall	The total liquid product of precipitation or condensation from the atmosphere, as received and measured in a rain gauge
Riparian	An area or zone within or along the banks of a stream or adjacent to a watercourse or wetland; relating to a riverbank and its environment, particularly to the vegetation.
Stage	The water level, typically measured at a water monitoring site
Storage	A pond, lake or basin, whether natural or artificial, for the storage, regulation and control of water.
Surface Runoff	Water from precipitation or other sources that flows over the land surface. Surface runoff is the fraction of precipitation that does not infiltrate at the land surface and may be retained at the surface or result in overland flow toward depressions, streams and other surface water bodies
Sustainable Yield	The level of water extraction from a particular system that would compromise key environmental assets, or ecosystem functions and the productive base of the resource, if it were exceeded.
Total Suspended Solids (TSS)	The sum of all particulate material suspended (i.e. not dissolved) in water. Usually expressed in terms of milligrams per litre (mg/L). It can be measured by filtering and comparing the filter weight before and after filtration.
Transpiration	Evaporative loss of water from the leaves of plants through the stomata; the flow of water through plants from soil to atmosphere.
Watercourse	A river, creek or other natural watercourse (whether modified or not) in which water is contained or flows (whether permanently or from time to time).
Wind Run	The product of the average wind speed and the period over which that average speed was measured

Ref: Australian Water Information Dictionary, Bureau of Meteorology, Commonwealth of Australia 2017 (http://www.bom.gov.au/water/awid/all.shtml)

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1.0 INTRODUCTION

1.1 Background

Pantoro South Pty Ltd (Pantoro) owns a 50% interest and has management control of the Norseman Gold Project (NGP), which is roughly centred on the town of Norseman in the Eastern Goldfields Region of Western Australia. Pantoro is currently focussed on developing existing and recently discovered resources, including commencing open pit mining activities at the Cobbler deposit located on Lake Cowan about 4.5 km northwest of Norseman townsite.

Pantoro have initiated the processes for obtaining key environmental and project approvals and has commissioned Groundwater Resource Management Pty Ltd (GRM) to complete hydrogeological and hydrological assessments to assist with the planning for this development. GRM adopted a two stage approach to the hydrological/surface water studies, with a desktop review and analysis of hydro-meteorological data (Stage 1), followed by a surface water management study (Stage 2).

The Stage 1 – Hydro-meteorological Study was completed in April 2020[1] and found that:

- The regional climate is one of extremes and droughts and major floods can occur in the same area within a few years of each other. The climate in this region is highly variable, both spatially and temporally, and this can make hydrologic analysis and the design of water management measures difficult.
- Regional climatic conditions are arid with mean annual rainfalls of about 250 mm. The rainfall that occurs during the early winter months of May, June and July tends to be more reliable than the less dependable, but more intense, summer rainfalls from January to March.
- Although remnant tropical cyclones (TC) and associated depressions may bring heavy rains to the region, they are erratic in nature and occur relatively infrequently. An analysis of cyclone data for the last 48 years shows that, on average, one cyclone will pass within 200 km of the NGP approximately every eight years. Three cyclones have passed within 100 km of the NGP in the last 48 years or so.
- The Bureau of Meteorology (BoM) "Norseman Combined" rainfall station (i.e. Norseman No. 12065 Jan 1907-Dec 2003 and Norseman Aero No. 12209 Jan 2004-Present) is located in central Norseman and has over 112 years of relatively high quality daily data (99.4% complete). These data yield mean and median annual rainfalls of 289 and 270 mm respectively. These annual values are considered to be representative of conditions at the NGP and their use is recommended for design purposes.
- Locally, maximum and minimum annual rainfalls of 638.4 mm and 51.0 mm have been recorded at Grass Patch in 1992 and at Widgiemooltha in 1976 respectively. The 1992 maximum rainfall has an annual exceedance probability (AEP) in the order of 0.4% (1 in 250 years) and was largely due to the passage of TC Ian which crossed the Goldfields in early March that year. The 1976 minimum rainfall is representative of 1% AEP drought conditions.
- Typically there are in the order of 75 rain days each year, although as few as 6 days and as many as 142 days have been recorded locally. The longest period without rain was 223 days and was recorded at Widgiemooltha between 18 November and 27 June 1976 and was in part due to the absence of remnant cyclones or depression related events over the Goldfields that year.

[1] "*Baseline Hydro-Meteorological Report, Pantoro South Pty Ltd, Norseman Gold Project*", GRM Report No. J2016R01, 01 April 2020.

- Locally the wettest day on record occurred on 23 February 1948, when 163.6 mm was recorded at Norseman adjacent to the NGP. This rainfall was directly associated with the passage of TC Unnamed #4 1947/48 and had an AEP well in excess of 0.5% (1 in 200 years).
- A rainfall intensity-frequency-duration (IFD) relationship was developed for the NGP using the BoM's recently updated database (2016). In summary, the 1% AEP intensities for 1, 3, 12, 24 and 72 hr duration events are 38.2, 19.1, 8.5, 5.4 and 2.2 mm/hr respectively (yielding equivalent storm depths of approximately 38, 57, 102, 130 and 155 mm).
- In order to estimate the probable maximum rainfall (PMP) that might be experienced at the NGP the BoM GSDM and GTSMR Coastal/GSAM Inland methods were applied. These resulted in 12, 24 and 72 hour PMP rainfall depths of 650, 740 and 1,350 mm respectively.
- In the absence of a local evaporation record it is recommended that distance-averaged pan evaporation data for the Kalgoorlie-Boulder Airport and Salmon Gums Research Station be used for design purposes for the NGP. This gives a mean annual pan evaporation of approximately 1,962 mm, some 65-70% of which can be expected to evaporate from shallow freshwater ponds on site.

This Stage 2 - Surface Water Management report builds on the earlier hydro-meteorological study and combines the findings from a recent site visit with preliminary mine planning data to provide feasibility engineering level designs of the works required to protect the proposed Cobbler open pit and associated facilities. The Stage 2 scope of work comprised the following surface water tasks:

- Site Visit - findings from a three-day visit to site in late-July 2020.
- Floodwater management - hydrologic and hydraulic analyses.
- Surface water management - philosophy and design criteria.
- Feasibility level design of water management measures - described in the report and presented on preliminary engineering drawings.

A hydrological assessment of the local catchment areas is presented in the following section, while the design philosophy for floodwater and surface water management measures is presented in Section 3.0. Preliminary engineering designs for those measures are presented in Section 4.0

The hydrologic and hydraulic calculations required as part of this study have been presented in the Appendices. The accompanying drawings have been completed to a level suitable for inclusion in the project FS and will be used to inform the future detailed engineering design of the project.

2.0 HYDROLOGICAL ASSESSMENT

2.1 NGP Location & Physiographic Setting

The NGP is roughly centred on the town of Norseman in the Eastern Goldfields Region of Western Australia (refer to Figure 1). The operation is located within the Shire of Laverton Local Government Area of the Goldfields-Esperance Region. Main vehicular access to the NGP from the north and south is via the Coolgardie-Esperance Highway (No. 94) or from the east via the Eyre Highway (No. 1).

Physiographically the NGP is located within the Kambalda Zone (No. 265) of the Kalgoorlie Province[2] and is typified by flat to undulating plains with hills, ranges and some salt lakes and stony plains on greenstone and granitic rocks of the Yilgarn Craton. Soil types include calcareous loamy earths and red loamy earths with salt lakes soils and some red-brown hardpan. It is located within the Coolgardie Region of the Eremaean Province[3] and common vegetation species comprise red mallee/blackbutt/salmon gum/gimlet woodlands with mulga, halophytic shrublands and some spinifex grasslands.

2.2 NGP Regional Catchment Delineation

The NGP is located within the DWER's Balladonia Catchment (area = 34,810 km^2) in the south-central part of the much larger, internally draining Salt Lake Basin No. 24 (area = 441,000 km^2) which extends across much of central WA, as shown in Figure 1.

The Salt Lake Basin comprises several large and broad, sub-parallel, southeast trending salt-lake drainage systems that extend from a regional divide to the west of Wiluna/Sandstone and either drain into Ponton Creek (Raeside and Rebecca system) or terminate at the edge of sand plains (Carey/Minigwal system). These drainages have very low gradients and contain small to very large playa lakes. The lakes may fill following occasional intense rainfall as a result of tropical cyclones or depression related events and on rare occasions may overflow, link-up and discharge onto the Nullarbor Plain through Ponton Creek (this last occurred following the passage of TC Bobby in February 1995).

The most significant hydrological features in the vicinity of the NGP are Lake Cowan to the north of Norseman and Lake Dundas to the south as shown in Figure 2. These endorheic salt lakes drain a combined catchment area of about of 15,225 km^2, with Lake Cowan having a surface area of some 970 km^2 with few islands and Lake Dundas having a surface area of about 280 km^2 and comprising about 75 km^2 of islands of low relief (typically less than about 5 m).

The Lake Cowan lakebed nominal surface elevation is approximately 262 mAHD in the vicinity of the Cobbler deposit, while typical elevations on Lake Dundas are at about 245 mAHD. Surface gradients are very low over the lakes (typically less than 0.01%). Similarly, much of the land adjoining the lakes

[2] "*Soil-landscapes of Western Australia's Rangelands and Arid Interior*", Department of Agriculture and Food, Western Australia, 2006.
[3] '*Plant life of Western Australia',* Beard JS, 1990.

is also relatively flat with average slopes of between 1% and 2%. The local topographic high, Woolyeenyer Hill (elevation 485 mAHD) is located amongst a range of hills that forms part of the watershed between Lake Cowan and Lake Dundas and some 11 km south-southeast of the Cobbler deposit.

Inspection of public domain topographical data indicates that the overall natural surface water flow direction on both lakes is from north to south, which is contrary to the groundwater flow direction. However, this is significantly affected on Lake Dundas by the presence of islands.

Although local surface drainage is typically towards Lake Cowan and Lake Dundas, there are no major river systems in the vicinity of the NGP deposits and much of the runoff from local catchments reports to the lakes by a combination of shallow sheetflow and channelized flow via minor creeks and watercourses.

2.3 Cobbler Deposit Location & Hydrological Setting

The Cobbler deposit, one of several deposits that constitute the NGP, is located about 4.5 km northwest of Norseman townsite and is situated on the lakebed of Lake Cowan near its southern limit. The Coolgardie-Esperance Highway causeway is located approximately 1,200 m to the north of the proposed Cobbler pit and the Kalgoorlie-Esperance railway is located immediately to the north of the highway, as shown in Figure 3.

The Cobbler deposit has not been developed previously and, other than some minor remnant earthworks and raised drill pads associated with the drilling programme, there are no notable surface features at the proposed mining area, as shown in Figure 4. Photographs taken in the vicinity of the Cobbler deposit during the July 2020 site visit are presented in Appendix A.

The proposed mine development will comprise mining of a single open pit about 645 m long and up to 250 m wide and 75 m deep fully on the lakebed, along with the development of a waste rock dump (WRD) also on the lakebed, but abutted against the western shoreline. A run-of-mine (ROM) stockpile, mine services area and other miscellaneous facilities will be developed on the lake shore to the north of the pit, as shown in Figure 5.

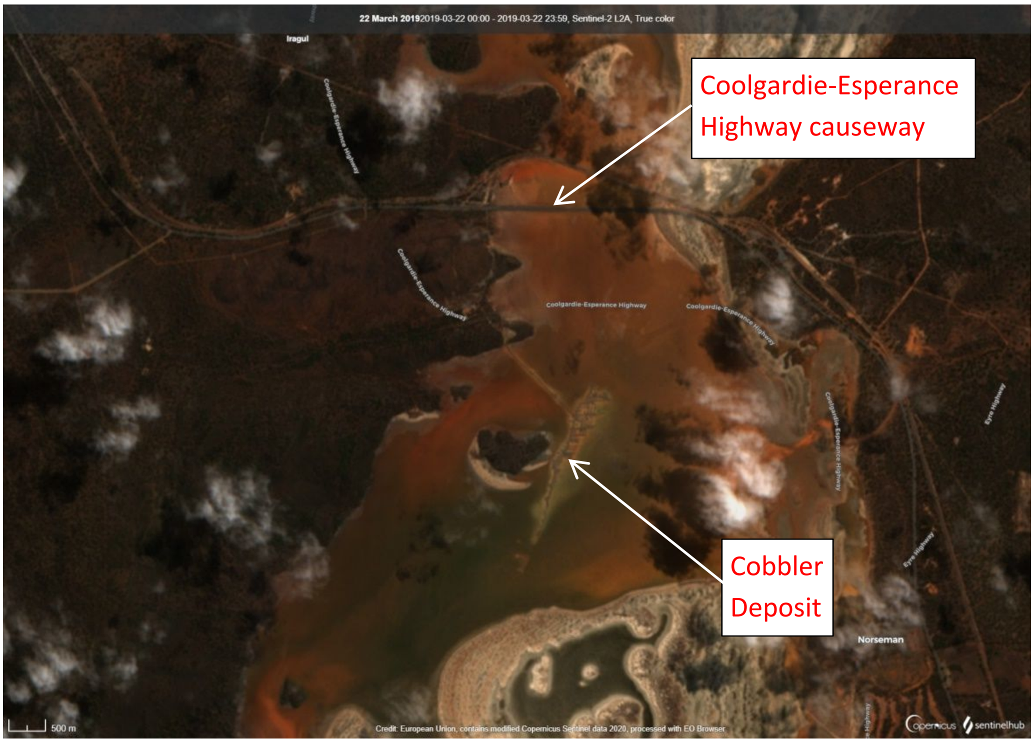
A catchment delineation was completed using GIS spatial analysis tools applied to the client-supplied detailed digital elevation model (DEM) data over the immediate mining area and regional public domain SRTM DEM data[4] and indicates the following (refer to Figure 5):

- Ground elevations over the proposed Cobbler open pit are at the lakebed elevation of approximately 262 mAHD and therefore runoff events on Lake Cowan pose the most significant potential flood risk to the proposed pit.
- The Coolgardie-Esperance Highway causeway is raised about 1.5 to 2.0 m above the lakebed. A field inspection found only two 600 mm diameter concrete culverts located at either end of the causeway (refer to Figure 4 and photographs in Appendix A). Given the very limited flow capacity of these culverts it is considered that they act solely as an "equalisation" culverts to prevent the uneven build-up of water on either side of the causeway. It is suggested therefore that the highway causeway (and perhaps also the railway causeway further to the north)

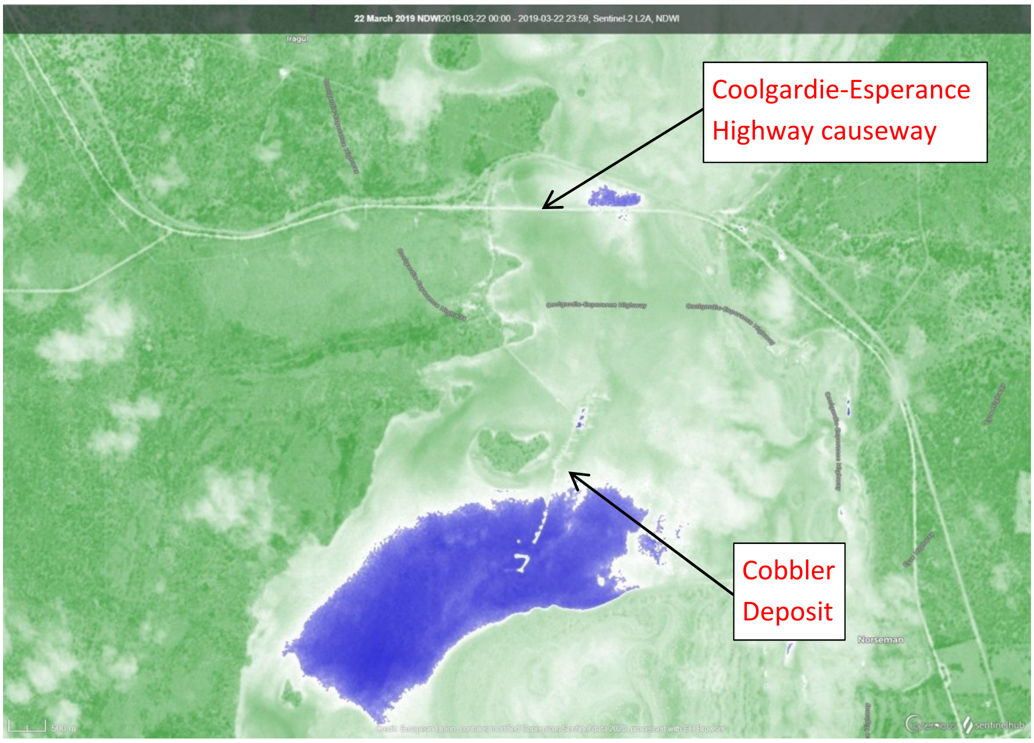
[4] *Hydro Enforced 1-Second SRTM DEM*, Geoscience Australia.

provides a level of flood protection or, at least, flood attenuation to the proposed mining area. A review of satellite imagery[5] between March 2013 and the present appears to support this suggestion, as shown by the True Colour and Near Difference Water Index images shown below.

Example "True" Colour Satellite Image 22 March 2019 (Sentinel-2)



Example "NDWI" Satellite Image 22 March 2019 (Sentinel-2)



[5] Sentinel-2 and Landsat 8 imagery from Sentinel Hub (https://www.sentinel-hub.com/).

The images above were captured on 22 March 2019 when 43 mm of rainfall was recorded at Norseman. It should be noted that the NDWI image indicates the presence of standing water, as opposed to just wet surfaces and shows standing water between the railway and highway causeways, as well as over the southern part of the Cobbler deposit (the outlines of the remnant raised drill pads are visible).

Regardless, flood protection will be required for the proposed Cobbler pit and could comprise a combination of a flood bund, raised flood levee and pit crest safety bund (refer to preliminary design information presented in Section 4.0 of this report).

- There are no noteworthy creeks or drainages in the vicinity of the on-shore Cobbler mine facilities and runoff that does occur mostly reports as sheet flow in a generally west to east direction towards Lake Cowan. However, there are three small catchment areas upstream of the proposed facilities that will require management; namely, a 0.31 km^2 catchment upstream of the WRD and two catchments located north and south of the Mine Yard with areas of 0.48 km^2 and 0.20 km^2 respectively, as shown in Figure 5.

  An estimate of peak flows and runoff volumes from these areas is provided below and preliminary design information is presented in Section 4.0 of this report).

2.4 Peak Flow & Volume Estimates

Generally flow statistics at any location of interest can be generated using three different approaches (in order of preference):

- *Site Measured Streamflow Analysis* - from long-term streamflow records collected at the location of interest;
- *Regional Hydrological Analysis* - from streamflow records collected at the nearby watersheds with similar hydrological characteristics (e.g., similar drainage area, soils, vegetation and slopes); or,
- *Hydrological Calculation/Modelling* – using published regional methods applied to site specific rainfall and catchment characteristics.

Due to the absence of local or regional streamflow data, it was necessary to carry out hydrological calculations using published methods in order to estimate peak flow and runoff volumes for the relatively modest catchment area upstream of the proposed Cobbler open pit.

The rainfall IFD data developed previously (refer to Appendix B) were applied to the "Arid Interior Rational Method" as presented in Australian Rainfall and Runoff[6] to develop peak flow estimates for the catchment areas upstream of the proposed WRD and north and south of the Mine Yard, delineated above. The results for a range of annual exceedance probabilities (AEP) are presented in Table 1 (calculation worksheets are presented in Appendix C).

[6] *"Australian Rainfall and Runoff – Book 4, Estimation of Design Peak Discharges",* Institution of Engineers Australia, 1987.

Table 1: Cobbler Upstream Catchments - Peak Flow Estimates

Catchment ID	Area (km^2)	Length (km)	Slope (m/km)	Peak Flow Estimate (m^3/sec)					
				50% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
WRD Upstream	0.313	0.595	114.3	0.3	0.8	1.3	2.1	3.2	4.3
Mine Yard North	0.476	0.476	20.7	0.2	0.7	1.2	1.9	2.9	3.8
Mine Yard South	0.198	0.785	42.0	0.1	0.4	0.7	1.0	1.6	2.2

The preliminary design of the required surface water management measures is presented in Section 4.0 of this report.

3.0 SURFACE WATER MANAGEMENT

3.1 Surface Water Management Objectives

The following three goals define the objectives for surface water management for the Cobbler mining area at the NGP:

Goal No 1 - Reduce Potential Risk of Loss of Life, Health Hazards or Property Damage

- provide protection for life, livelihood, and property;
- control the incidence of nuisance or damage related to flooding, poor drainage and sedimentation to an acceptable level; and,
- protect project infrastructure.

Goal No 2 - Preserve the Environment

- minimise the potential project impacts such as changes in the stream-flow regime, alteration of habitat, pollution or increased erosion and sedimentation;
- where feasible, maintain the shape and composition (geomorphology) of the natural watercourse geometry, natural biological indicator conditions and flow conditions;
- employ protection measures to prevent adverse hydrological and water quality impacts for all recognised watercourses within the site limits;
- promote sound development that respects the natural environment; and,
- rehabilitate any watercourses that are impacted as soon as practicable.

Goal No 3 - Conserve Social and Financial Resources

- treat water as a resource, ensuring that water management facilities are functional and integrate multi-use objectives where possible;
- provide a system of infrastructure that enhances site personnel convenience and safety, and allows development to proceed according to the mine plan;
- sustain future mine development, support orderly and managed development of resources and integration of land uses within the site limits;
- use best management water and sediment practices where feasible; and,
- encourage economic design of drainage systems.

These objectives are intended to ensure a consistent approach to:

- planning and analyses required for surface water management;
- constructing new operational phase surface water management works; and,
- installing future closure phase surface water management works.

3.2 Hydrological Risk

Lake Cowan and all the relatively minor watercourses and drainages that exist in the vicinity of the proposed Cobbler mining area are ephemeral. However, flows may occur periodically during the summer months from January to March, when the potential exposure to high intensity rainfall from remnant tropical cyclones or depression related events is greatest. Consequently runoff may report to the lakebed and watercourses in the vicinity of the project and, on occasion, may cause localised flooding if appropriate measures are not in place.

The hazard that such flooding poses to the proposed infrastructure depends, amongst other things, on the following:

- the magnitude of the flood event;
- the proximity of the facility to the watercourse in flood;
- the sensitivity of the facility to flooding; and,
- the level of protective flood measures provided to the facility.

While the latter three factors can be controlled or engineered to some degree, the magnitude of the naturally occurring rainfall-runoff events may lead to flooding that cannot be controlled.

Although significant rainfall-runoff events do not occur cyclically, especially in a climatic region as variable as this, their probability of occurrence within any given period can be estimated. The reciprocal of this probability is typically expressed as an AEP which is the probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.

Table 2 shows the percentage probability for a range of different AEP rainfall events that could occur during the approximately five year operational life of the Cobbler mining area.

Table 2: Probability of Rainfall Events Occurring During Cobbler Operational Life

Annual Exceedance Probability (AEP)	**20% AEP**	**10% AEP**	**5% AEP**	**2% AEP**	**1% AEP**
Probability of Occurrence	67.2%	41.0%	22.6%	9.6%	4.9%

Note: Probabilities above assume 4 year operational life/exposure period.

Typically it is recommended that a 1% AEP design criterion be applied to pit flood protection measures during Operations, while it is usually assumed that a 10% AEP criterion is suitable for the design of all other on-site drainage measures. A range of ARI events are often used for the design of various mine facilities, depending on their sensitivity to flooding and the period of exposure. Good practice suggests that when preparing earthworks pads for mine facilities that they be kept above the 5% AEP flood level as minimum[7].

It should be noted that the probabilities of occurrence of the 10% or 1% AEP events occurring during the envisaged five year operational life of the project are roughly 41% and 5% respectively.

3.3 Pit Flood Protection Design Philosophy

Field inspection and a desktop review of the available topographical mapping and aerial photography indicate that the most significant flood risk to the proposed Cobbler Pit relates to potential inflows from Lake Cowan. This risk will be ameliorated primarily by the construction of a

[7] Water and Rivers Commission, Western Australia, 2000, *Water Quality Protection Guidelines No. 6, Mining and Mineral Processing Minesite Stormwater*

dual purpose pit flood/abandonment bund, flood levee and safety bund. The preliminary design of these measures is presented in Section 4.0 of this report.

In addition to these measures, flood risks to the open pit should also be minimised by a combination of the following customary measures:

- grading (cut/fill earthworks) of laydown areas etc. and roadside drainage to direct runoff away from the pit; and,
- provision of in-pit storage sumps and in-pit pumps.

Ideally only direct precipitation that falls within the pit crest should report to sumps on the floor of the pit.

3.4 In-Pit Runoff Volume Estimate

Even with the provision of the surface water management measures identified above some amount of runoff will still report to the floor of the pit from direct precipitation. Such rainfall-runoff will typically collect at the lowest points on the pit floor and will need to be removed using in-pit sump pumps in order to minimise interruptions to operations (given that no underground workings are currently scheduled at Cobbler, it is not considered to pose a significant mine safety risk).

An estimate of the anticipated in-pit rainfall-runoff volume from a range of events is presented in Table 3 based upon the pit crest area plus a 10% allowance for small trapped areas adjacent to the pit crest, a 90% runoff coefficient and the rainfall depths of 45, 67, 85, 104, 132 and 155 mm for 50%, 20%, 10%, 5%, 2%, and 1% AEP-72 hour duration events (refer to rainfall IFD in Appendix B).

Table 3: In-Pit Runoff Volume Estimates

72 hour Duration Rainfall Event	Cobbler In-Pit Runoff Volume (m^3)[see note]
50% AEP	4,500
20% AEP	6,600
10% AEP	8,400
5% AEP	10,200
2% AEP	13,000
1% AEP	15,200

Note: Assumes that pit is empty at start of rainfall event. Cobbler ultimate pit crest = 99,000 m^2.

As mentioned above, the periodic collection of in-pit runoff within the open pits is likely to only lead to operational delays and it is therefore unlikely that special measures such as a minimum capacity sumps and dedicated, fixed pumps are warranted. When it is necessary to remove runoff that might periodically collect on the floor of these pits, it is envisaged that mobile pumps will be used temporarily, with pumpage delivered ex-pit.

3.5 Site Wide Surface Water Management

In addition to protecting the proposed Cobbler Pit against flooding from low frequency flood events such as those discussed above, it will also be necessary to manage runoff from more frequent, less significant rainfall events. Although such events give rise to much lower runoff rates and volumes they should be managed appropriately in order to protect project infrastructure, minimise erosion and reduce the potential loss of sediment laden or other contaminated runoff from the proposed mining area.

For the management of stormwater the various Cobbler mining area facilities have been generally classified as follows:

- Mine Services Area;
- Hazardous Material Storage Areas;
- Disturbed Mine Areas; and,
- Undisturbed Areas.

3.5.1 Mine Services Area

The Mine Services Area will include a surface water drainage system with rainfall runoff from roads, building roofs, laydown yards etc. captured in open drains. The drains will report to a water management pond where water will be stored temporarily prior to reuse.

To aid management of runoff from areas likely to be impacted by hydrocarbons, e.g. fuel storage and dispensing areas, truck wash, workshops etc., it is proposed to capture runoff from these areas using open drains that report to an oily water separator (OWS) provided upstream of a water management pond.

Mine Services Area drains will be sized for the peak of the 10% AEP event as a minimum. Flow velocities along such drains should be limited to minimise erosion and the generation of sediment.

3.5.2 Hazardous Materials Storage Areas

Any chemical, oil or other hazardous material storage areas within the Mine Services Area will be enclosed within a bund in accordance with the relevant codes and standards. Water collected within the bunds will be assessed and, if suitable, will be discharged to the water management pond.

Water collected within the bunds that is found to be impacted, will be disposed of appropriately.

3.5.3 Disturbed Areas

Outside the Mine Services Area the mine facilities will comprise pits, waste rock dumps, topsoil stockpiles, ROM and access and haul roads. Source controls will be used to improve the quality of runoff from these facilities. Runoff from these facilities will be directed to a sedimentation pond where possible.

For runoff within the proposed pit, source controls will comprise practices such as mining from upper benches or processing stockpiled material following significant rainfall events. In-pit sumps will be used to settle out sediment from collected runoff prior to pumping to surface for re-use or discharge off-site.

3.5.4 Undisturbed Areas

All practical steps will be taken to divert runoff from undisturbed catchment areas around all proposed mine facilities to minimise potential lowering of water quality.

3.6 Drainage and Sediment Control Design Criteria

The following design criteria will be applied to drainage measures for the project facilities:

3.6.1 Peak Flow Estimation

Peak discharges from catchment areas of less than 10 hectares will be estimated using the Rational Method (i.e. Q = CIA). The average run-off coefficient (C) will be based on the values presented in Table 4 below.

Table 4: Run-off Coefficients

Catchment Type	**Run-off Coefficient**
Undisturbed areas	0.20
Gravel roads and yard areas	0.50
Asphalt, concrete and roof areas	0.90

Rainfall intensity (I) for the event duration will be interpolated from the rainfall Intensity Duration Frequency (IDF) relationship developed for the IMGP provided in Appendix B. The time of concentration of each catchment area will be determined in accordance with the Kirpich Equation as follows:

$T_c = 0.00032 \times L^{0.77} \div S^{0.385}$

Where:

T_c = Time of concentration (hours).

L = Maximum length of water travel (m).

S = Average Slope (m/m).

The minimum time of concentration to be used for design purposes will be 5 minutes. Catchment areas (A) will either be measured directly in the field or calculated using CAD tools and the latest field survey data.

Peak discharge estimates from areas larger than 10 hectares will be obtained by using hydrologic modelling methods such as those presented in ARR16.

3.6.3 Channel Design

Channel design parameters will be determined using Manning's Equation as follows:

$Q = (A\ R^{2/3}\ S^{1/2})/n$

Where:

Q = flow rate (m^3/sec).

A = cross-sectional area of channel (m^2).

n = roughness coefficient, as per values presented below (dimensionless).

R = hydraulic radius, i.e. cross-sectional area, A, divided by wetted perimeter, P (m).

S = channel slope (m/m).

Roughness coefficients will be based on the values presented in Table 5 below:

Table 5: Roughness Coefficients

Channel Type	Roughness Coefficient
Unlined Earth, Clean, recently completed	0.016-0.018
Unlined Earth, With short grass, few weeds	0.022-0.027
Unlined Rock, Smooth and uniform	0.035-0.040
Unlined Rock, Jagged and irregular	0.040-0.045
Lined, Formed concrete	0.017-0.020
Lined, Random stone mortar	0.020-0.023
Lined, Dry rubble (rip-rap)	0.023-0.033

3.6.4 Drainage Design

Open Drain Construction

Open drain construction will be based upon the following criteria:

- Minimum self-cleansing velocity of 0.7 m/sec for a 50% AEP event.
- Maximum velocity of 1.0 m/s for a 10% AEP event for unlined earth channels with no specific erosion protection.
- Minimum 300 mm freeboard on open drains.
- Channel erosion control protection in the form of appropriate drop structures, rock check dams, rock-lined channels or concrete lined channels.

Culvert Installation

The minimum culvert diameter will be 450 mm. Culverts will be installed at slopes that will provide self-cleansing minimum velocities of 0.7 m/s for one-third depth of full-flow wherever possible.

Hardstand Area Drainage

Hardstand area drainage will be designed with a minimum surface grade of 0.5% in open yard areas and a minimum grade of 2% for a distance of 25 m away from structures.

Hardstand areas with finished elevations 1 m or greater above natural surface elevations will have a safety bund constructed along their outside edge. Suitably spaced breaks will be placed along the bund to allow runoff to escape. Rock or geomembrane lined slope drains will be constructed at these breaks to minimise erosion of fill material.

3.6.5 Water Management/Sedimentation Pond Design

For preliminary design purposes water management/sedimentation ponds will be designed to store runoff from the 10% AEP 24-hour rainfall event i.e. 69 mm rainfall, without discharge.

The detailed design of sedimentation ponds will be based on removing the settleable fraction down to a selected minimum design particle size based on an analysis of the sediment particle size distribution reporting to the pond. The adopted design particle size will correspond to 25% of the sample passing by weight or an absolute minimum particle size of 20 micron (unless chemical coagulant dosing is used). The required pond surface area will be estimated using the peak inflow rate and design particle settling velocity according to Stokes Law and applying published sedimentation efficiency factors[8].

Sedimentation ponds will have a minimum live settling depth of 1 m and an aspect ratio (length: width) of not less than 3:1 and preferably 5:1. Sufficient provision for dead (sediment) storage and freeboard will also be made.

3.6.6 Oily Water Separator Design

All potentially hydrocarbon impacted water from wash-down and re-fuelling facilities will be directed to a suitable gravity type OWS prior to collection and re-use.

[8] *The Constructed Wetlands Manual (Volumes 1 & 2)*, Department of Land and Water Conservation, New South Wales, 1998.

4.0 PRELIMINARY ENGINEERING DESIGN OF SURFACE WATER MANAGEMENT MEASURES

The accompanying Drawing Nos. J2018R04-D01 and –D02 shows the layout and preliminary engineering design of the proposed surface water management facilities for the Cobbler mining area, as described in the following sections. This layout has been based on the Pantoro's aerial photography, topographical data and October 2020 project infrastructure layout.

4.1 Pit Flood Protection Bunding

It was identified earlier that the most significant flood risk to the proposed Cobbler Pit is posed by its location on Lake Cowan and potential inflow from the surrounding lakebed. Primary flood protection will therefore be provided to the pit using a combination 1,790 m long flood bund along the lake side and 1,590 m long pit safety bund adjacent to the pit crest with a raised backfilled area between both bunds to form a flood levee.

The minimum height of the flood protection bund should be set at 2 m above the highest adjacent lakebed level, while the safety bund height should be equal or greater than half the maximum tyre height of on-site equipment. The thickness and width of the backfilled levee material will vary depending on the settlement of the fill material on the lake surface, but will likely be in the order of 1 to 1.5 m thick and comprise fresh, non-acid generating waste rock from the pit. This levee area may be used as lay-down or to accommodate lighting towers etc.

The outer flood protection bund should be set back from the proposed pit crest in accordance with current design guidelines[9] so that it may also serve as part of the abandonment bund to be completed at the end of Operations.

The proposed flood levee and bund should be built from select waste material placed and compacted in controlled layers. The upstream (outside) face of the flood bund should be armoured with suitable, graded broken rock. The key specifications for the flood bund are as follows:

- Upstream maximum side slope = 2:1 (H:V).
- Downstream maximum side slope = 1.5:1 (H:V).
- Minimum height above highest adjacent lakebed = 2 m.
- Minimum base width = 10 m.
- Maximum compacted layer thickness = 500 mm.
- Minimum compaction standard = 95 % standard maximum dry density.
- Moisture conditioning = ± 2% optimum moisture content.
- Bund fill material to be select graded clayey gravel material from pit excavation with maximum particle size of 150 mm.
- Riprap specification to be D_{max}= 450 mm, D_{50}= 300 mm and thickness = 700 mm.

4.2 WRD Drainage

[9] "*Safety Bund Walls Around Abandoned open Pit Mines – Guideline*", DoIR Western Australia, December 1997.

The proposed surface water management works for the Cobbler WRD will comprise the construction of a rock lined diversion drain along the dump/hillside "contact" interface. This drain will be used to convey runoff from the approximately 0.3 km^2 upstream catchment area while the WRD is being constructed, as well from the rehabilitated upper surface of the completed dump. Two lengths of diversion drain will be required; an approximately 750 m long section to the north and an 885 m long section to the south. Both drains will report to rock lined aprons at lakebed level at the northern and southern limits of the dump.

For preliminary design purposes each of the sections of contact drain should be designed to convey half of the 10% AEP peak flow estimated earlier for the upstream catchment area i.e. 0.65 m^3/s. Applying the Rational Method to each half of the 0.33 km^2 dump top with a conservative 15 minute time of concentration rainfall intensity (55 mm/hr) and a 15% runoff coefficient results in a 10% AEP peak design flow from the dump top to each section of drain of 0.35 m^3/s. The contact drains should therefore be designed for 1.0 m^3/s peak flow with a 0.3 m freeboard allowance. The resulting preliminary design parameters for both sections of contact drain are summarised in Table 6.

Table 6: Cobbler WRD – Contact Drain – Preliminary Design Parameters

Design Parameter	Units	Northern Drain	Southern Drain
10% AEP Peak Flow[1]	m^3/sec	1.0	1.0
Minimum Gradient	%	0.5	0.5
Length	m	750	885
Base Width	m	1.0	1.0
Side Slopes	H:V	2H:1V	2H:1V
10% AEP Peak Flow Velocity[2]	m/s	0.94	0.94
10% AEP Peak Flow Depth[2]	m	0.5	0.5
Freeboard Allowance	m	0.3	0.3
Channel Design Depth	m	0.8	0.8
Channel Top Width	m	4.2	4.2

Notes:
1. Assumes 50% of upstream catchment area and 50% of WRD top reports to each section of drain.
2. Hydraulic design assumes Manning Roughness "n" = 0.035.

It is also recommended that a standardised approach is adopted by Pantoro when constructing the various WRD's to facilitate surface water management. This standardised approach should generally comprise the following:

- Benches should be graded back at 5% from dump edge and longitudinally at 0.25-0.50% to the "contact" drain.
- Contact drains should be constructed where practicable in in-situ ground i.e. not on dump fill, along the "contact" between the natural hillside and dump material. Contact drains should be constructed in advance of dump construction and should be sized for the 10% AEP peak flow with freeboard allowance. A broken rock (riprap) lining, rock check dams and drop structures should be used to reduce flow velocity and minimise erosion.

- It is recommended that dump slopes are reshaped, topsoiled and revegetated progressively, commencing as soon as active dumping starts on the next lift.
- A windrow should be constructed along the bench crest in order to prevent runoff from going over the edge onto newly revegetated surfaces.

4.3 Haul Road Crossings

In order to permit the passage of runoff along the existing watercourse to the north and south of the Mine Yard, a floodway type haul road crossings with "low-flow" culverts should be constructed at the two locations shown on Dwg No. –D01.

For preliminary design purposes these crossings have been assumed to comprise multiple corrugated metal pipe (CMP) low-flow culverts and a depressed or lowered section of roadway to contain flows that, on occasion, may overtop the roadway. The low-flow culverts should be capable of passing events up to the 2 year ARI with acceptable head build-up at inlet before spilling across roadway.

The 0.48 and 0.20 km^2 catchment areas to the north and south of the Mine Yard respectively were delineated and peak flows developed earlier (refer to Section 2.4). The upstream catchment areas, and the resulting 50% and 10% AEP peak flow estimates and preliminary culvert selections are summarised in Table 12 (refer to Appendix C for calculations).

Table 7: Haul Road Crossings - Preliminary Culvert Selections

Catchment ID	Area (km^2)	50% AEP Peak Flow (m^3/s)	10% AEP Peak Flow (m^3/s)	Culvert Selection
Mine Yard North	0.48	0.2	1.2	1 No. 600 Dia
Mine Yard South	0.20	0.1	0.7	1 No. 600 Dia

Note: Peak Flow Estimates from Regional Flood Frequency Estimation Model (ARR 4th ed. 2016).

The preliminary culvert selections summarised above were based on the manufacturer's design charts, assuming inlet control with a maximum headwater:diameter ratio of 1.5:1 and a k_e of 0.9 i.e. square-ended culverts projecting from the road fill. Given that heavy traffic will traverse these roads it is recommended that an absolute minimum cover of 600 mm be adopted between the road surface and the top of the CMP. Based on the 10% AEP peak flows, a standard floodway length of 30 m should be adopted at both floodway crossings.

Where haul roads traverse the lakebed between the Cobbler Pit and the WRD or the Mine Yard, "equalisation" culverts should be installed to prevent the uneven build-up of water against the road embankment. It is recommended that twin 600 mm diameter hollow wall HDPE culverts be installed below each section of road. This is equivalent to that provided by MRWA below the Coolgardie-Esperance Highway causeway to the north.

5.0 CONCLUSION

This Stage 2 - Surface Water Management report builds on the earlier hydro-meteorological study and combines the findings from a recent site visit with mine planning data to provide feasibility engineering level designs of the works required to protect the proposed Cobbler Pit and associated facilities.

The following surface water tasks were completed as part of this study:

- Site Visit – findings from a three-day visit to site in July 2020.
- Hydrologic assessment.
- Floodwater and surface water management philosophy and design criteria.
- Feasibility level design of water management measures - described in the report and presented on a preliminary engineering drawing.

The hydrologic and hydraulic calculations required as part of this study have been presented in the Appendices. The accompanying drawings have been completed to a level suitable for inclusion in the project FS and may form part of the future detailed engineering design of the project.

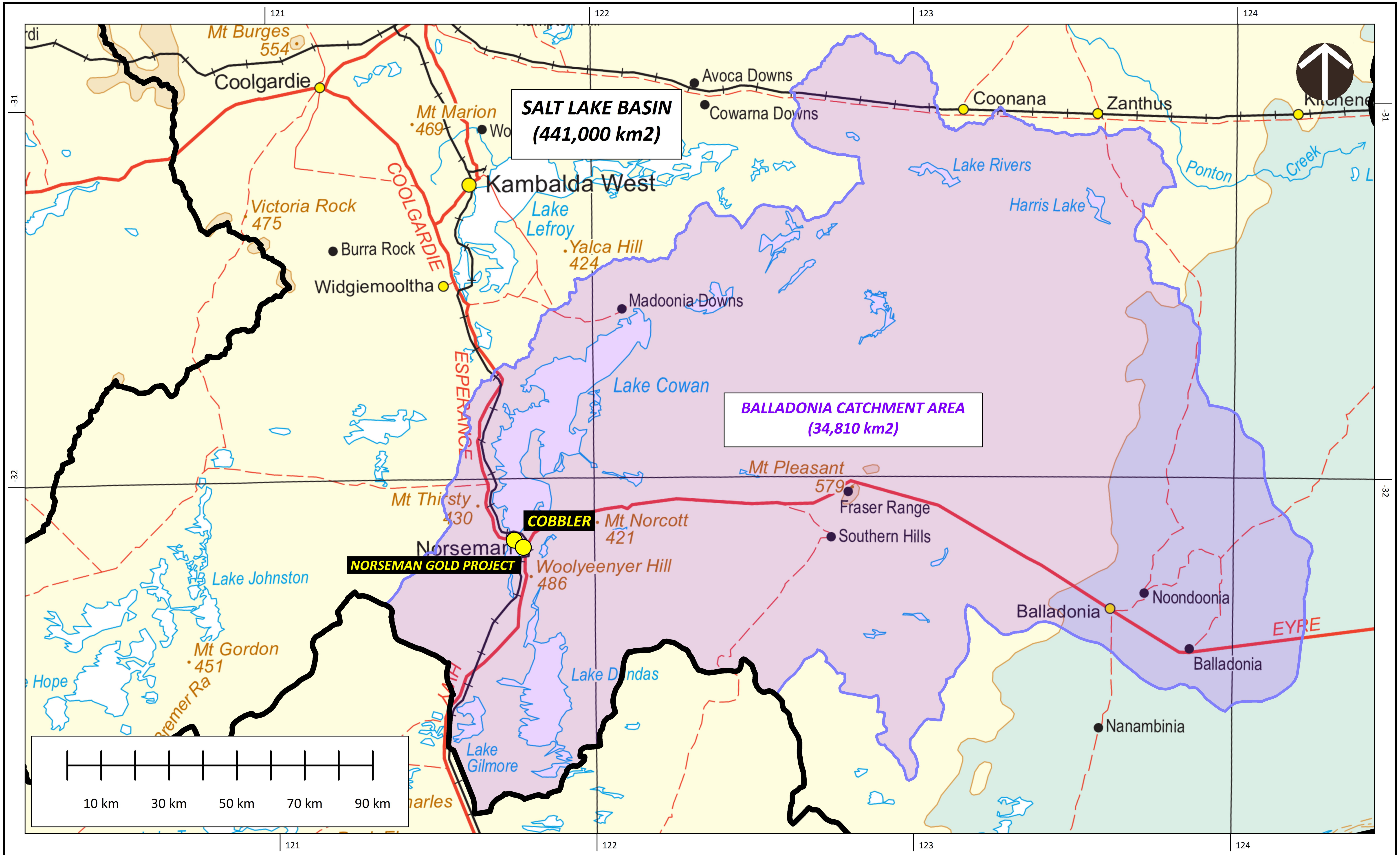
We trust that this report satisfies Pantoro's current requirements and we look forward to discussing the future development of the project with you.

Groundwater Resource Management Pty Ltd

Alistair Lowry
Civil Engineering Hydrologist

Rob Garnham
Principal Hydrogeologist

Doc Ref: J2018R04V04.docx



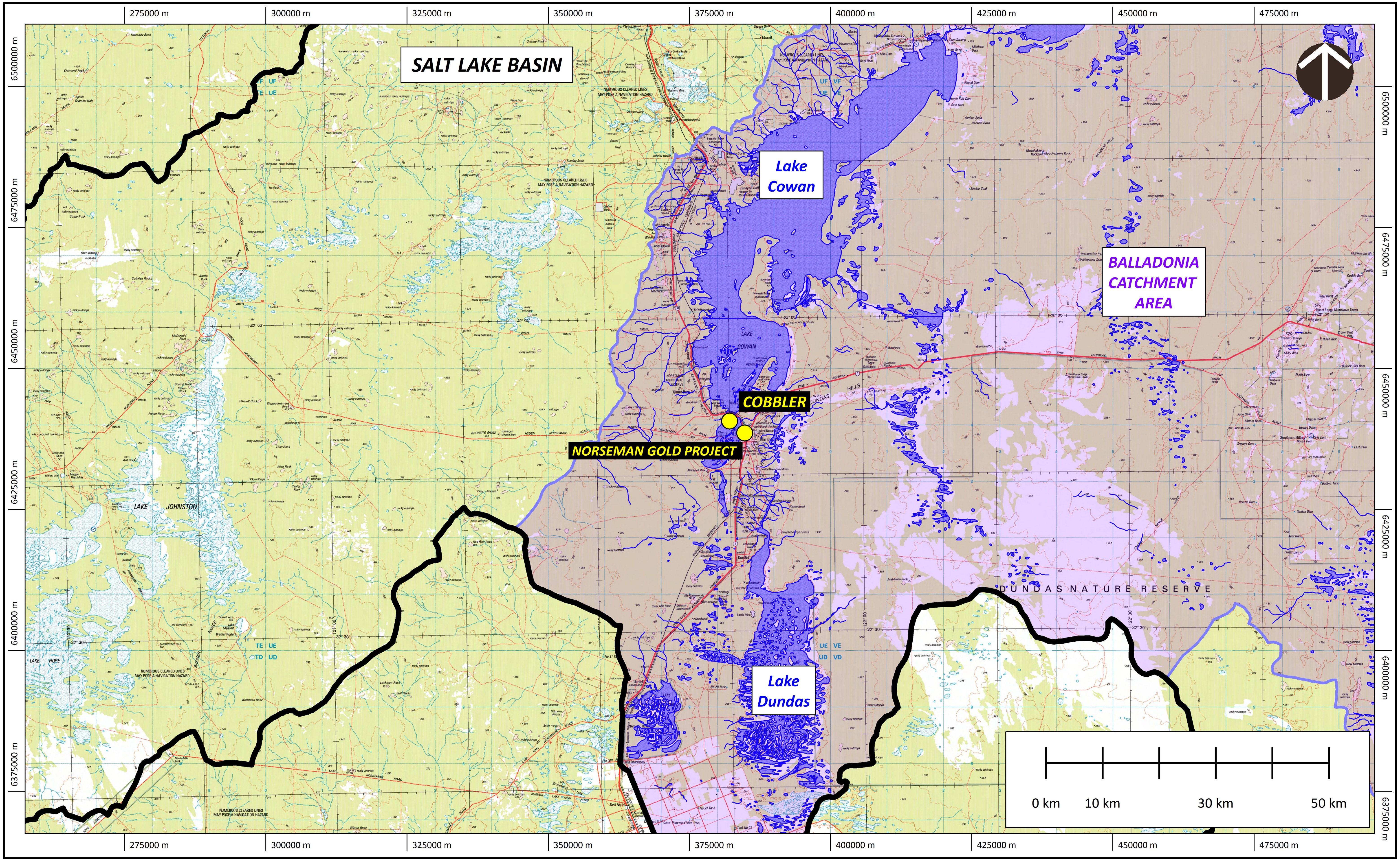
GROUNDWATER
RESOURCE MANAGEMENT

FIGURE 1
NORSEMAN GOLD PROJECT LOCATION PLAN WITH DWER REGIONAL CATCHMENT BOUNDARIES

Date Nov 20
Client Pantoro South Pty Ltd
Project Norseman Gold Project
Document J2018R04

Notes
1. Figure scale = 1:1,000,000 @ A3.
2. Coordinates to WGS84/Lat-Lon.

Sources
1. Catchment boundaries from DWER https://www.water.wa.gov.au/maps-and-data/monitoring/spatial-data-download.
2. Topo mapping Geoscience Australia https://ecat.ga.gov.au/geonetwork



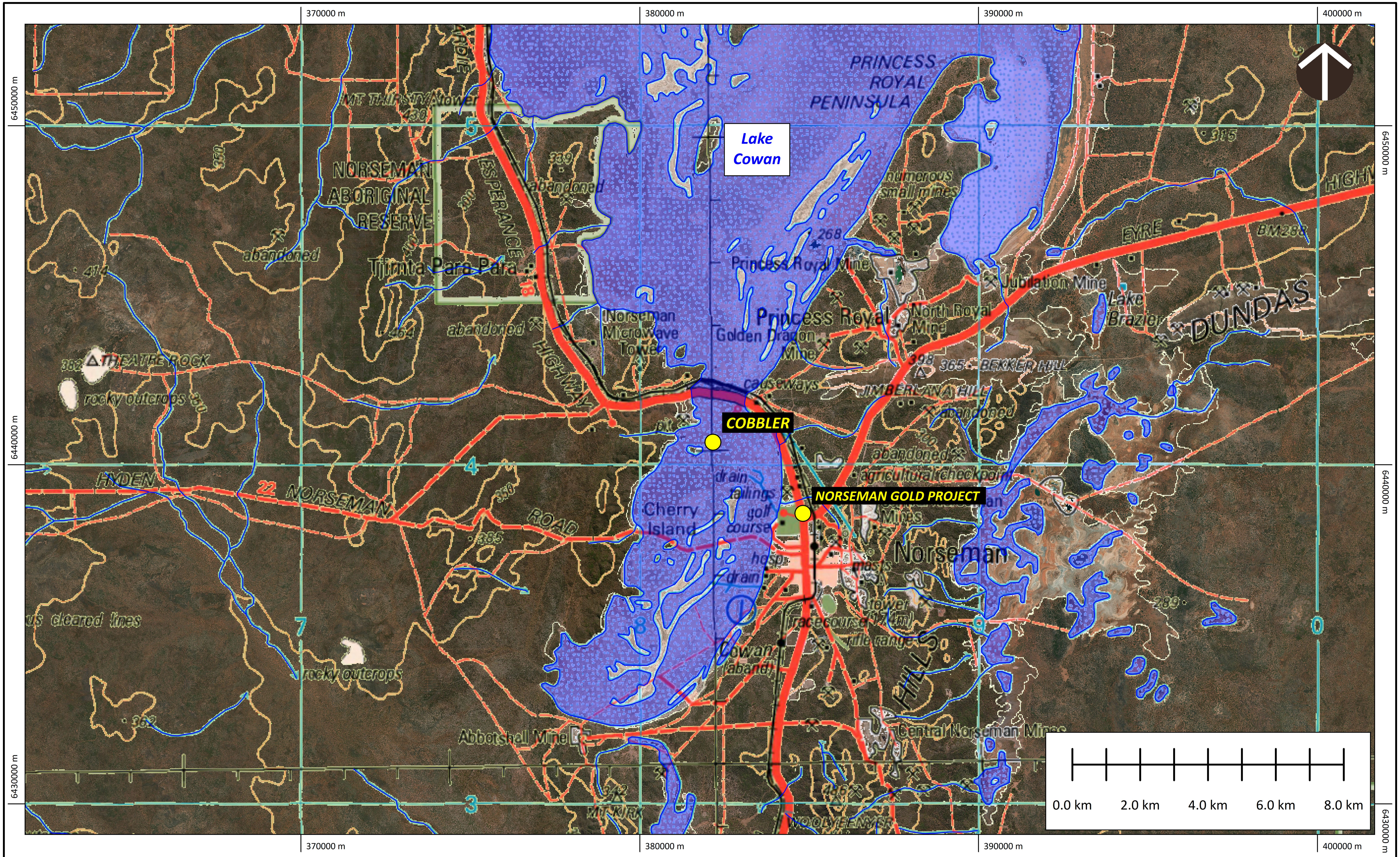
GROUNDWATER RESOURCE MANAGEMENT

FIGURE 2
NORSEMAN GOLD PROJECT
COBBLER DEPOSIT LOCATION PLAN
WITH REGIONAL HYDROLOGIC FEATURES

Date November 2020
Client Pantoro South Pty Ltd
Project Norseman Gold Project
Document J2018R04

Notes
1. Figure scale = 1:600,000 @ A3.
2. Coordinates to GDA94/MGA Zone 51.

Sources
1. Background topo mapping is 250k NATMAP from Geoscience Australia.
2. Catchment boundaries from DWER https://www.water.wa.gov.au/maps-and-d/monitoring/spatial-data-download



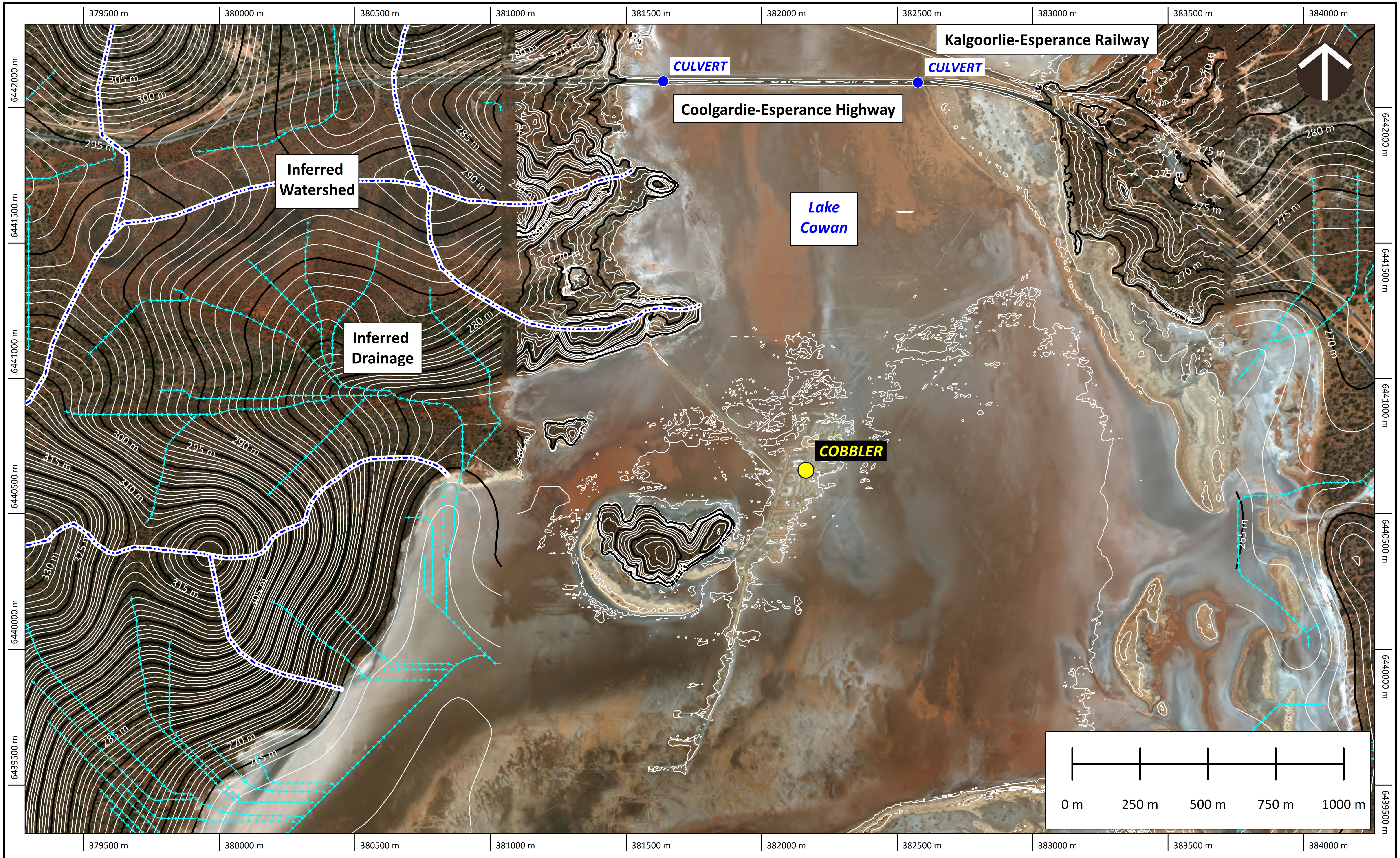
GROUNDWATER RESOURCE MANAGEMENT

FIGURE 3
NORSEMAN GOLD PROJECT
COBBLER DEPOSIT LOCATION PLAN
OVER REGIONAL AERIAL IMAGERY

Date November 2020
Client Pantoro South Pty Ltd
Project Norseman Gold Project
Document J2018R04

Notes
1. Figure scale = 1:100,000 @ A3.
2. Coordinates to GDA94/MGA Zone 51.

Sources
1. Background topo mapping is 250k NATMAP from Geoscience Australia.
2. Regional aerial imagery from ESRI World Imagery.



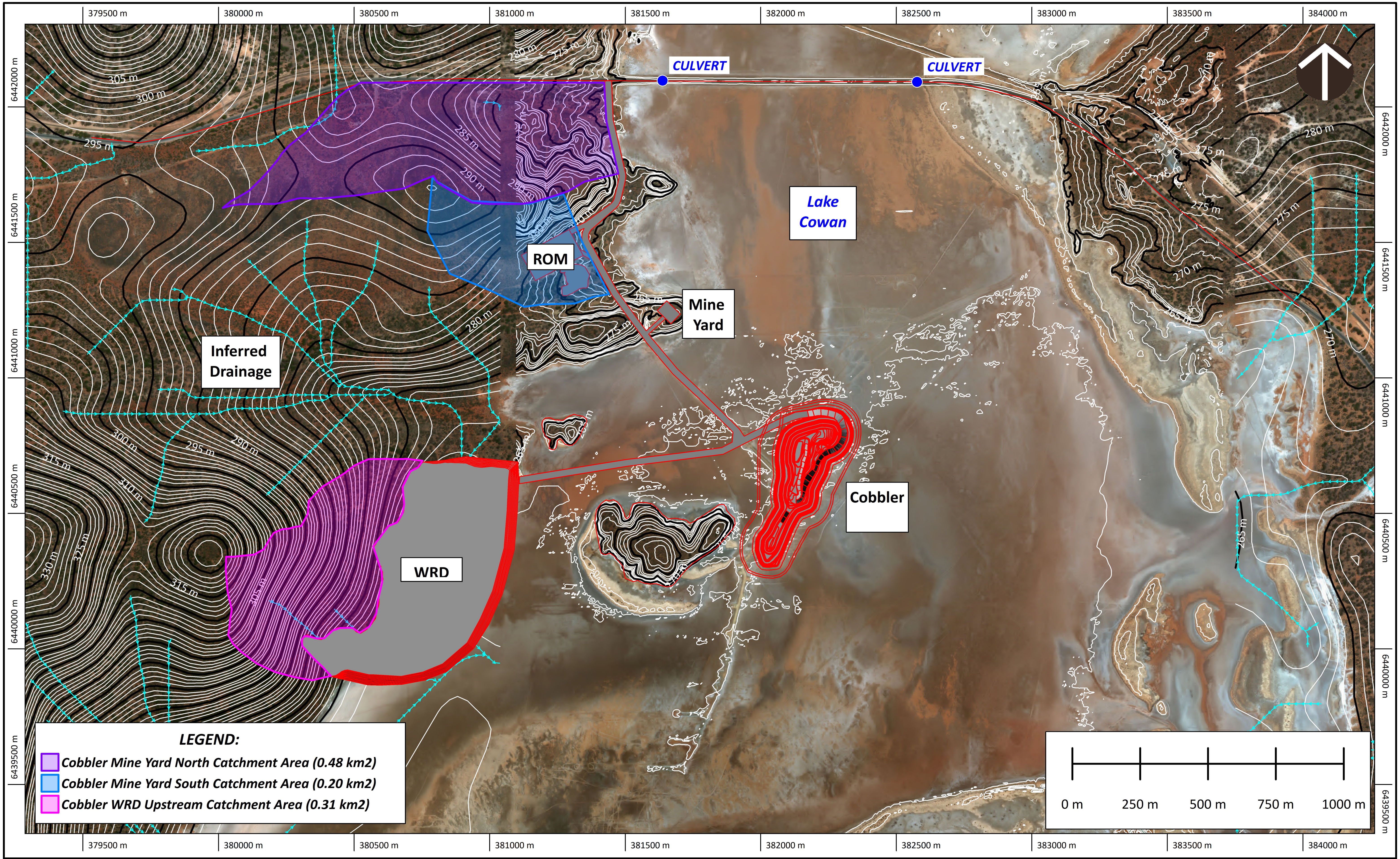
GROUNDWATER RESOURCE MANAGEMENT

FIGURE 4
NORSEMAN GOLD PROJECT
COBBLER MINING AREA
EXISTING FEATURES

Date November 2020
Client Pantoro South Pty Ltd
Project Norseman Gold Project
Document J2018R04

Notes
1. Figure scale = 1:12,500 @ A3.
2. Coordinates to GDA94/MGA Zone 51.

Sources
1. Background aerial imagery from ESRI World Imagery.
2. 1m contours developed from Pantoro supplied DTM over Cobbler deposit and from Geoscience Australia SRTM DTM to the east and west.



GROUNDWATER RESOURCE MANAGEMENT

FIGURE 5
NORSEMAN GOLD PROJECT
COBBLER MINING AREA
PROPOSED FEATURES

Date November 2020
Client Pantoro South Pty Ltd
Project Norseman Gold Project
Document J2018R04

Notes
1. Figure scale = 1:12,500 @ A3.
2. Coordinates to GDA94/MGA Zone 51.

Sources
1. Background aerial imagery from ESRI World Imagery.
2. 1m contours developed from Pantoro supplied DTM over Cobbler deposit and from Geoscience Australia SRTM DTM to the east and west.

Appendix A: Selection of Photographs from July 2020 Site Visit

Culvert below Coolgardie-Esperance Highway

Culvert below Coolgardie-Esperance Highway

Existing borrow pit near proposed ROM

Existing borrow pit near proposed ROM

Existing roadway between ROM and Mining Area

Existing roadway between ROM and Mining Area

Existing roadway between ROM and Mining Area

Existing roadway between ROM and Mining Area

View north from existing causeway

View east from existing causeway

View southeast from existing causeway

View south from existing causeway

View south from existing causeway

View south west from existing causeway

Appendix B: NGP Rainfall Intensity Frequency Duration Relationship

IFD Design Rainfall Intensity (mm/h)

Issued: 27 March 2020

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart

Unit: mm/h ▼

	Annual Exceedance Probability (AEP)						
Duration	**63.2%**	**50%#**	**20%***	**10%**	**5%**	**2%**	**1%**
1 min	72.6	83.4	120	147	176	217	251
2 min	64.6	73.8	104	126	148	179	204
3 min	57.3	65.6	93.1	113	134	163	186
4 min	51.7	59.2	84.5	103	122	150	172
5 min	47.1	54.1	77.5	94.9	113	139	160
10 min	33.7	38.8	56.0	68.9	82.6	102	119
15 min	27.0	31.0	44.7	55.1	66.0	81.8	94.9
20 min	22.8	26.2	37.7	46.3	55.5	68.6	79.5
25 min	19.9	22.9	32.9	40.3	48.2	59.5	68.8
30 min	17.8	20.4	29.3	35.9	42.8	52.8	61.0
45 min	13.8	15.8	22.6	27.6	32.8	40.3	46.4
1 hour	11.4	13.1	18.7	22.8	27.1	33.2	38.2
1.5 hour	8.77	10.0	14.3	17.5	20.8	25.4	29.3
2 hour	7.25	8.31	11.9	14.5	17.3	21.2	24.4
3 hour	5.53	6.36	9.13	11.2	13.4	16.5	19.1
4.5 hour	4.21	4.85	7.03	8.67	10.4	12.9	15.1
6 hour	3.46	3.99	5.83	7.23	8.73	10.9	12.8
9 hour	2.61	3.02	4.46	5.58	6.80	8.60	10.1
12 hour	2.13	2.47	3.68	4.62	5.67	7.21	8.54
18 hour	1.58	1.84	2.77	3.51	4.33	5.54	6.60
24 hour	1.27	1.49	2.25	2.85	3.53	4.53	5.40
30 hour	1.07	1.25	1.90	2.41	2.99	3.84	4.57
36 hour	0.931	1.09	1.65	2.10	2.60	3.33	3.96
48 hour	0.741	0.864	1.31	1.66	2.06	2.62	3.11
72 hour	0.532	0.620	0.932	1.18	1.45	1.83	2.15
96 hour	0.419	0.487	0.728	0.915	1.12	1.40	1.63
120 hour	0.347	0.404	0.600	0.751	0.914	1.14	1.32
144 hour	0.298	0.347	0.513	0.640	0.777	0.962	1.11
168 hour	0.263	0.305	0.450	0.561	0.680	0.840	0.971

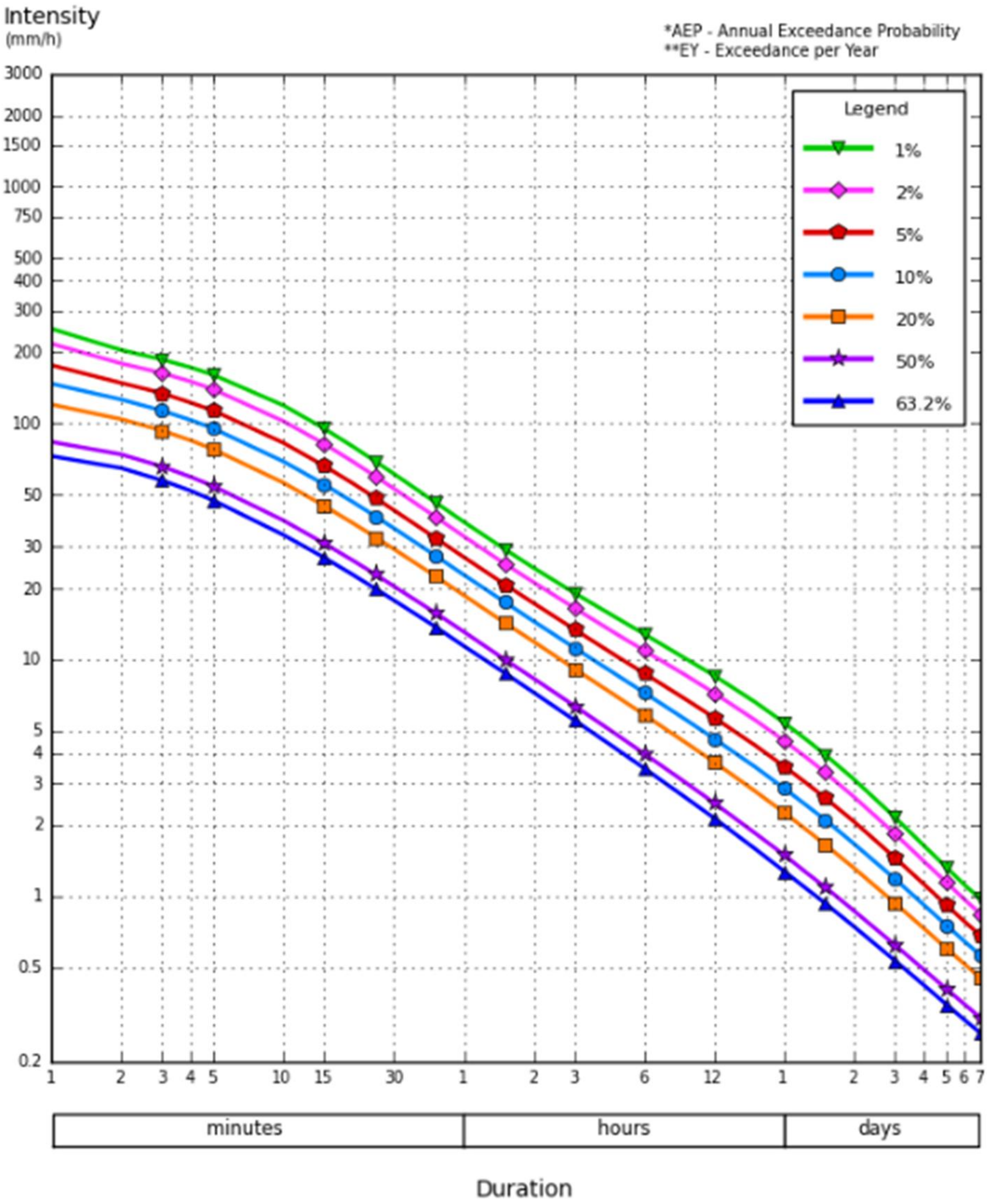
IFD Design Rainfall Intensity (mm/h)

Issued: 27 March 2020

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart

Unit: mm/h ▼



GROUNDWATER RESOURCE MANAGEMENT

APPENDIX B2
CENTRAL NORSEMAN GOLD PROJECT
POINT RAINFALL INTENSITY FREQUENCY DURATION CHART

Date Mar 20
Client Pantoro South Pty Ltd
Project CNGP
Document J2016R01

IFD Design Rainfall Intensity (mm/h)

Issued: 27 March 2020

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart

Unit: mm/h ▼

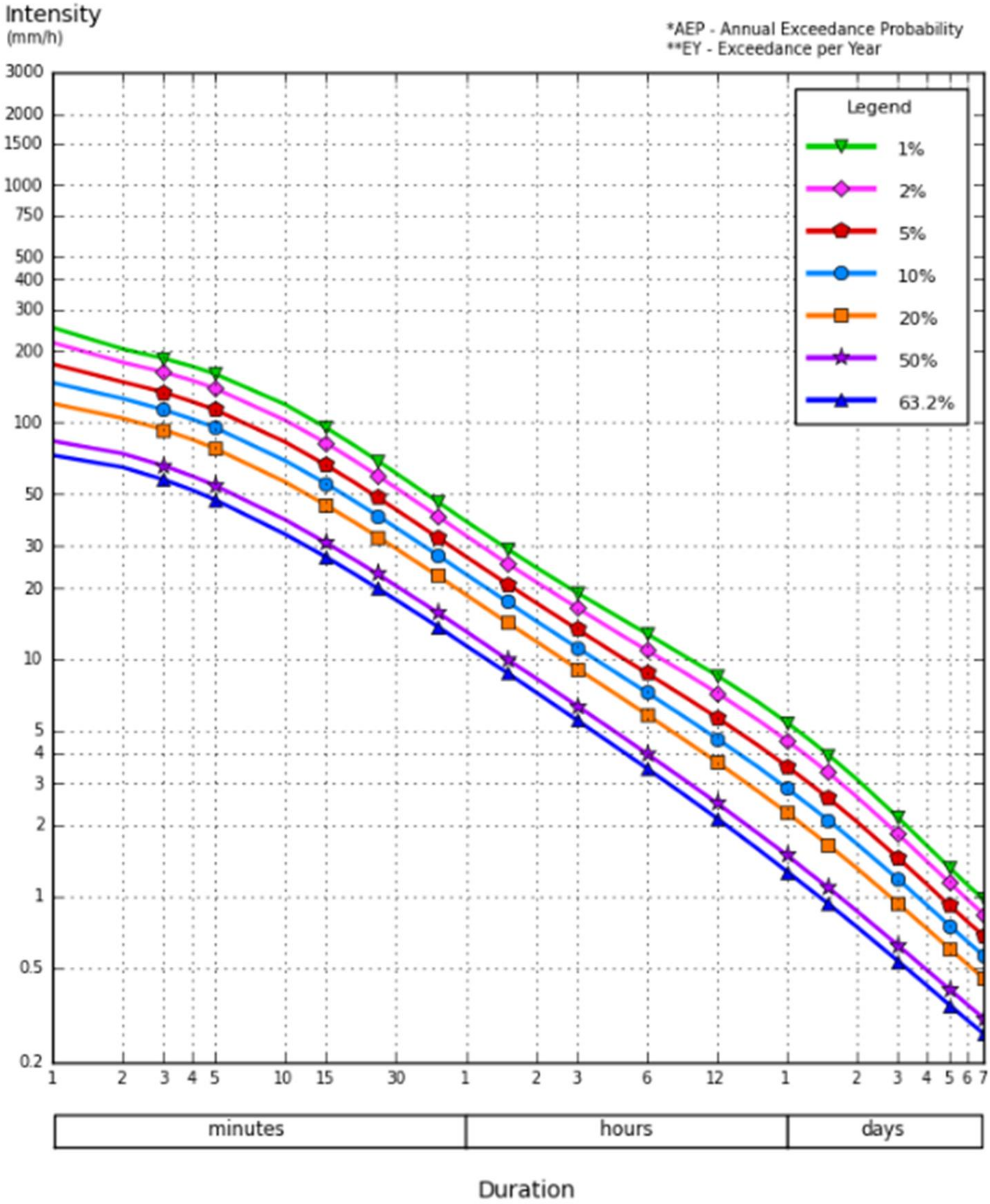
	Annual Exceedance Probability (AEP)						
Duration	63.2%	50%#	20%*	10%	5%	2%	1%
1 min	72.6	83.4	120	147	176	217	251
2 min	64.6	73.8	104	126	148	179	204
3 min	57.3	65.6	93.1	113	134	163	186
4 min	51.7	59.2	84.5	103	122	150	172
5 min	47.1	54.1	77.5	94.9	113	139	160
10 min	33.7	38.8	56.0	68.9	82.6	102	119
15 min	27.0	31.0	44.7	55.1	66.0	81.8	94.9
20 min	22.8	26.2	37.7	46.3	55.5	68.6	79.5
25 min	19.9	22.9	32.9	40.3	48.2	59.5	68.8
30 min	17.8	20.4	29.3	35.9	42.8	52.8	61.0
45 min	13.8	15.8	22.6	27.6	32.8	40.3	46.4
1 hour	11.4	13.1	18.7	22.8	27.1	33.2	38.2
1.5 hour	8.77	10.0	14.3	17.5	20.8	25.4	29.3
2 hour	7.25	8.31	11.9	14.5	17.3	21.2	24.4
3 hour	5.53	6.36	9.13	11.2	13.4	16.5	19.1
4.5 hour	4.21	4.85	7.03	8.67	10.4	12.9	15.1
6 hour	3.46	3.99	5.83	7.23	8.73	10.9	12.8
9 hour	2.61	3.02	4.46	5.58	6.80	8.60	10.1
12 hour	2.13	2.47	3.68	4.62	5.67	7.21	8.54
18 hour	1.58	1.84	2.77	3.51	4.33	5.54	6.60
24 hour	1.27	1.49	2.25	2.85	3.53	4.53	5.40
30 hour	1.07	1.25	1.90	2.41	2.99	3.84	4.57
36 hour	0.931	1.09	1.65	2.10	2.60	3.33	3.96
48 hour	0.741	0.864	1.31	1.66	2.06	2.62	3.11
72 hour	0.532	0.620	0.932	1.18	1.45	1.83	2.15
96 hour	0.419	0.487	0.728	0.915	1.12	1.40	1.63
120 hour	0.347	0.404	0.600	0.751	0.914	1.14	1.32
144 hour	0.298	0.347	0.513	0.640	0.777	0.962	1.11
168 hour	0.263	0.305	0.450	0.561	0.680	0.840	0.971

IFD Design Rainfall Intensity (mm/h)

Issued: 27 March 2020

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart   Unit: mm/h ▼



GROUNDWATER RESOURCE MANAGEMENT

APPENDIX B4
CENTRAL NORSEMAN GOLD PROJECT
POINT RAINFALL DEPTH
FREQUENCY DURATION CHART

Date Mar 20
Client Pantoro South Pty Ltd
Project CNGP
Document J2016R01

Rare Design Rainfall Intensity (mm/h)

Issued: 27 March 2020

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart

Unit: mm/h

	Annual Exceedance Probability (1 in x)				
Duration	1 in 100	1 in 200	1 in 500	1 in 1000	1 in 2000
1 min	251	297	368	430	501
2 min	204	241	295	342	395
3 min	186	220	270	314	363
4 min	172	204	251	292	339
5 min	160	190	234	273	317
10 min	119	141	174	204	238
15 min	94.9	112	139	163	190
20 min	79.5	94.0	116	136	159
25 min	68.8	81.3	101	118	137
30 min	61.0	72.1	89.1	104	121
45 min	46.4	54.8	67.7	79.0	91.8
1 hour	38.2	45.2	55.7	65.0	75.5
1.5 hour	29.3	34.6	42.7	49.8	57.9
2 hour	24.4	28.8	35.6	41.5	48.3
3 hour	19.1	22.6	27.9	32.6	38.0
4.5 hour	15.1	17.8	22.1	25.9	30.2
6 hour	12.8	15.1	18.8	22.1	25.8
9 hour	10.1	12.0	14.9	17.5	20.5
12 hour	8.54	10.1	12.6	14.8	17.3
18 hour	6.60	7.81	9.69	11.4	13.3
24 hour	5.40	6.39	7.90	9.23	10.8
30 hour	4.57	5.37	6.64	7.72	8.92
36 hour	3.96	4.63	5.70	6.60	7.60
48 hour	3.11	3.61	4.41	5.09	5.82
72 hour	2.15	2.49	3.01	3.45	3.94
96 hour	1.63	1.90	2.28	2.61	2.98
120 hour	1.32	1.53	1.83	2.10	2.41
144 hour	1.11	1.28	1.54	1.77	2.03
168 hour	0.971	1.10	1.33	1.54	1.77

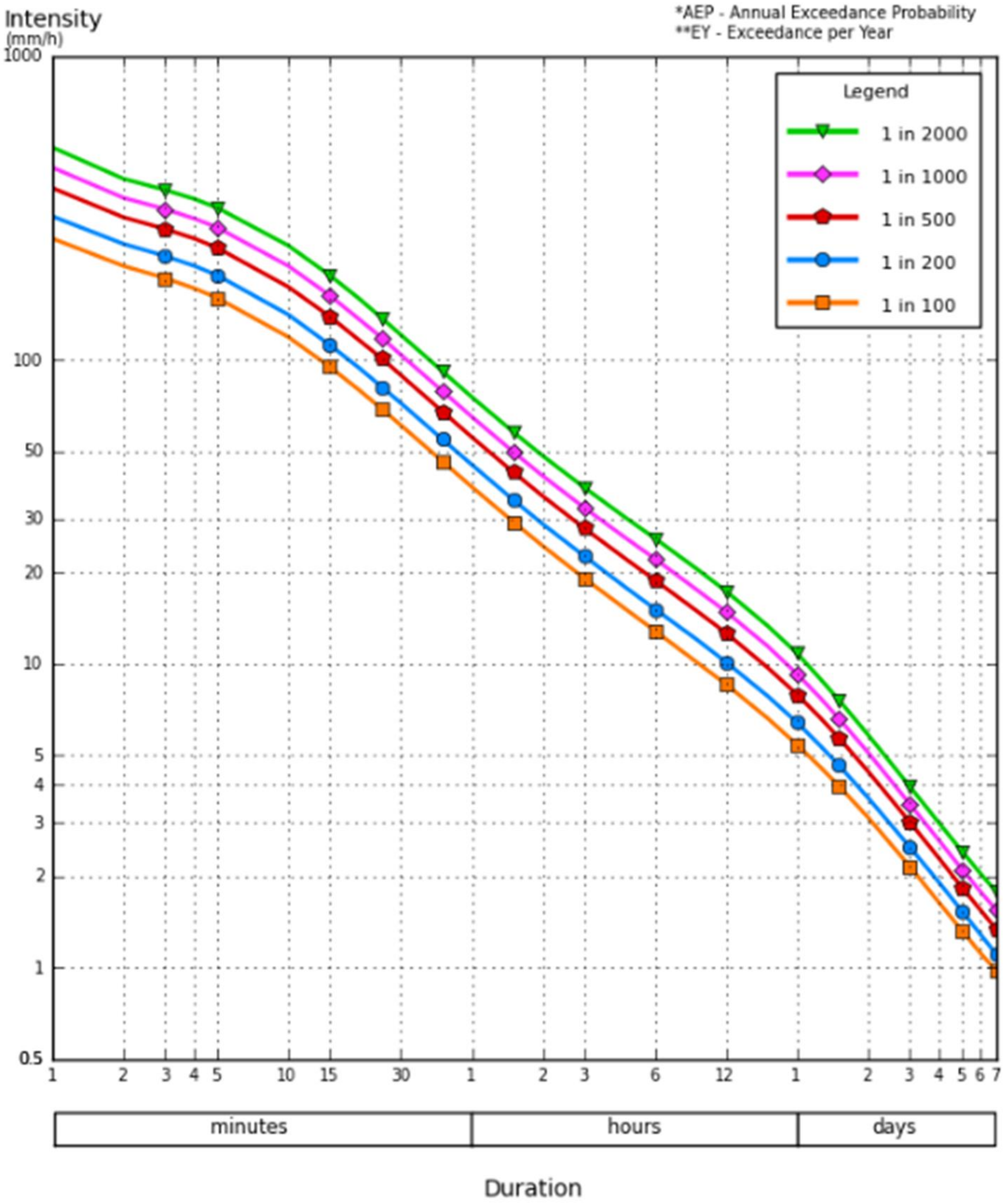
Rare Design Rainfall Intensity (mm/h)

Issued: 27 March 2020

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart

Unit: mm/h ▼



GROUNDWATER RESOURCE MANAGEMENT

APPENDIX B6
CENTRAL NORSEMAN GOLD PROJECT
RARE POINT RAINFALL INTENSITY FREQUENCY DURATION CHART

Date Mar 20
Client Pantoro South Pty Ltd
Project CNGP
Document J2016R01

Rare Design Rainfall Depth (mm)

Issued: 27 March 2020

Rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart

Unit: mm

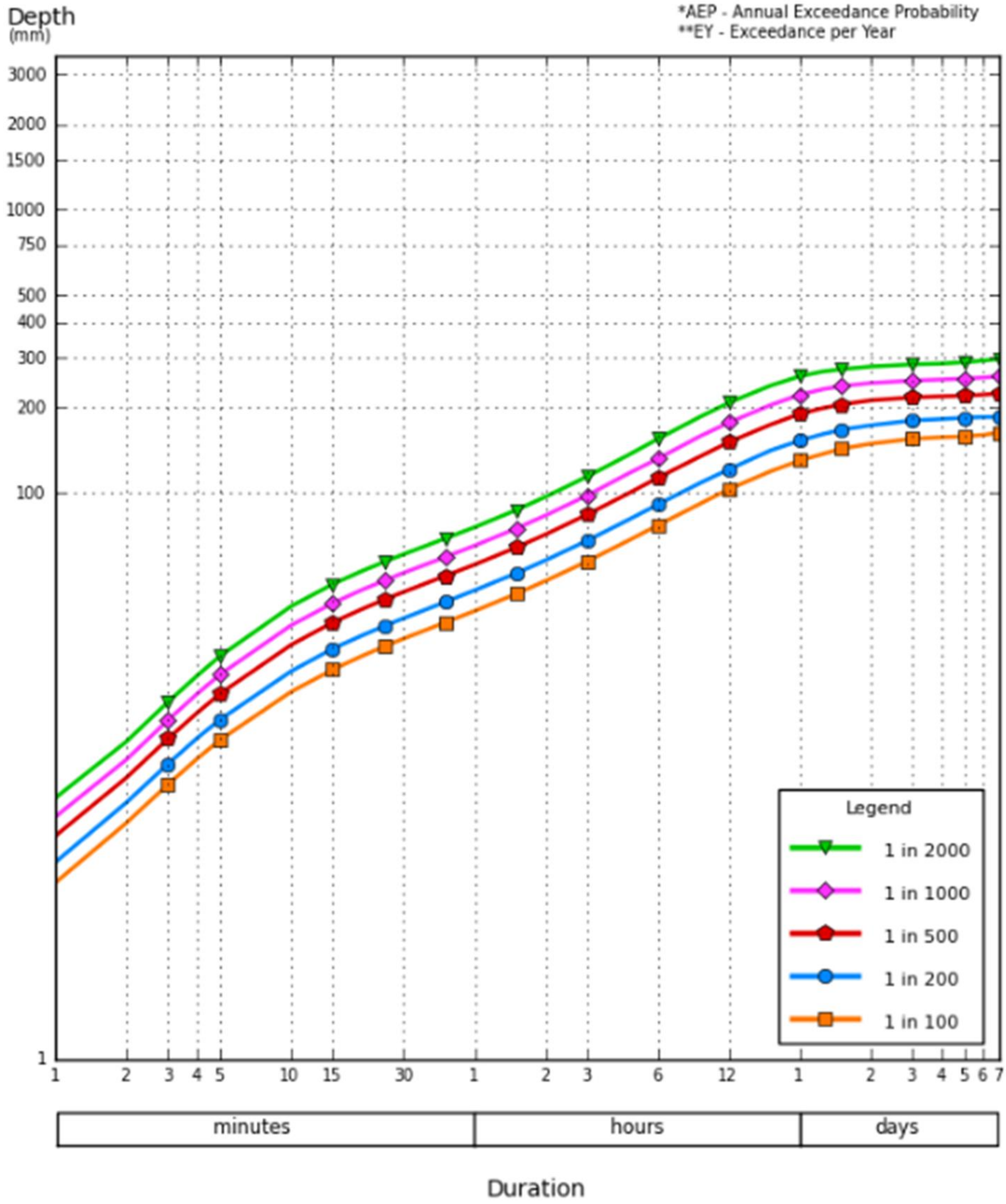
	Annual Exceedance Probability (1 in x)				
Duration	1 in 100	1 in 200	1 in 500	1 in 1000	1 in 2000
1 min	4.19	4.95	6.13	7.16	8.35
2 min	6.81	8.04	9.84	11.4	13.2
3 min	9.31	11.0	13.5	15.7	18.2
4 min	11.5	13.6	16.7	19.5	22.6
5 min	13.4	15.8	19.5	22.8	26.5
10 min	19.8	23.4	29.0	34.0	39.7
15 min	23.7	28.1	34.8	40.7	47.5
20 min	26.5	31.3	38.8	45.4	52.9
25 min	28.7	33.9	42.0	49.0	57.1
30 min	30.5	36.0	44.6	52.1	60.6
45 min	34.8	41.1	50.8	59.2	68.9
1 hour	38.2	45.2	55.7	65.0	75.5
1.5 hour	43.9	51.9	64.0	74.7	86.8
2 hour	48.8	57.7	71.2	83.1	96.7
3 hour	57.2	67.7	83.7	97.8	114
4.5 hour	67.8	80.3	99.5	117	136
6 hour	76.8	90.9	113	132	155
9 hour	91.2	108	134	158	185
12 hour	103	121	151	177	208
18 hour	119	141	174	204	239
24 hour	130	153	190	222	258
30 hour	137	161	199	232	268
36 hour	143	167	205	238	273
48 hour	149	173	212	244	279
72 hour	155	180	217	249	284
96 hour	157	182	219	251	286
120 hour	158	184	220	253	289
144 hour	160	185	222	255	293
168 hour	163	185	224	258	297

Rare Design Rainfall Depth (mm)

Issued: 27 March 2020

Rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart | Unit: mm



Appendix C: Hydrologic & Hydraulic Calculations

Pantoro - Norseman Gold Project
Cobbler WRD Upstream Catchment Area

Job No.: J2018		Sheet No.	1	of	3
Calc. By: Alistair Lowry		Chk'd By:			
Calc Date: 17 November 2020		Chk'd Date:			

Sub-Catchment Peak Flow Estimation
(ref: AR&R 1987, Vol. 1, Book 4)

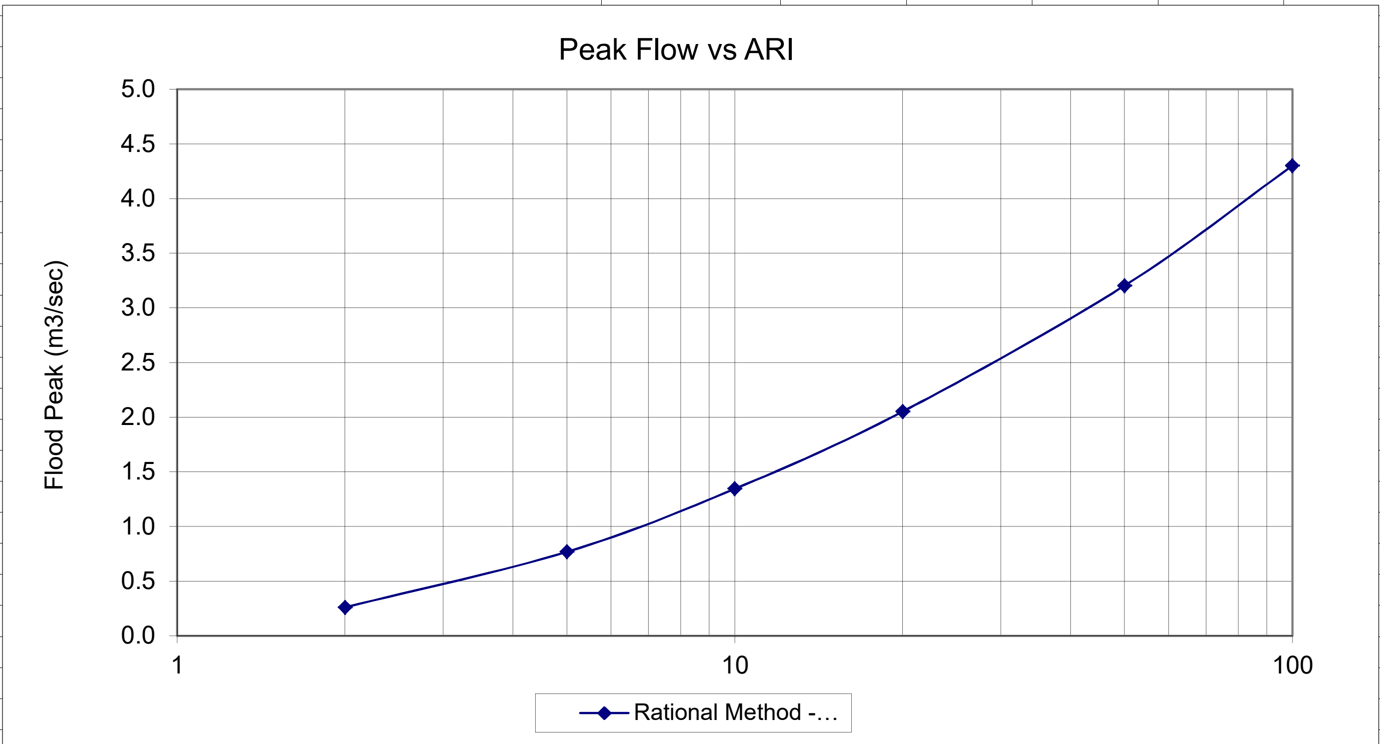
Assume Wheatbelt Loamy soil catchments 75-100% cleared
With Arid Interior Frequency Factors

Catchment Characteristics:

Catchment Area , A =	0.313	km2
Mainstream Length, L =	0.595	km
Equal Area Stream Slope, Se =	114.3	m/km
Cleared Area as percentage of catchment, CL =	75-100	%
Average Annual Rainfall, P =	289	mm

Rational Method - Peak Flow:	**2**	**5**	**10**	**20**	**50**	**100**
tc=0.76A^0.38=	0.5	hours	(30 mins)			
Rainfall Intensity for Time of Concentration => $I_{tc,Y}$=	20.4	29.3	35.9	42.8	52.8	61.0
C10=3.46*10^-1L^-0.42=	0.430	-				

	2	**5**	**10**	**20**	**50**	**100**
Frequency Factor (C_Y/C_{10})	0.34	0.7	1	1.28	1.62	1.93
Flood Peak Qy=0.278C_{10}(Cy/C10)IA (m3/sec)	0.3	0.8	1.3	2.1	3.2	4.3



Pantoro - Norseman Gold Project
Cobbler Mine Yard North Upstream Catchment Area

Job No.: J2018		Sheet No.	2	of	3
Calc. By: Alistair Lowry		Chk'd By:			
Calc Date: 17 November 2020		Chk'd Date:			

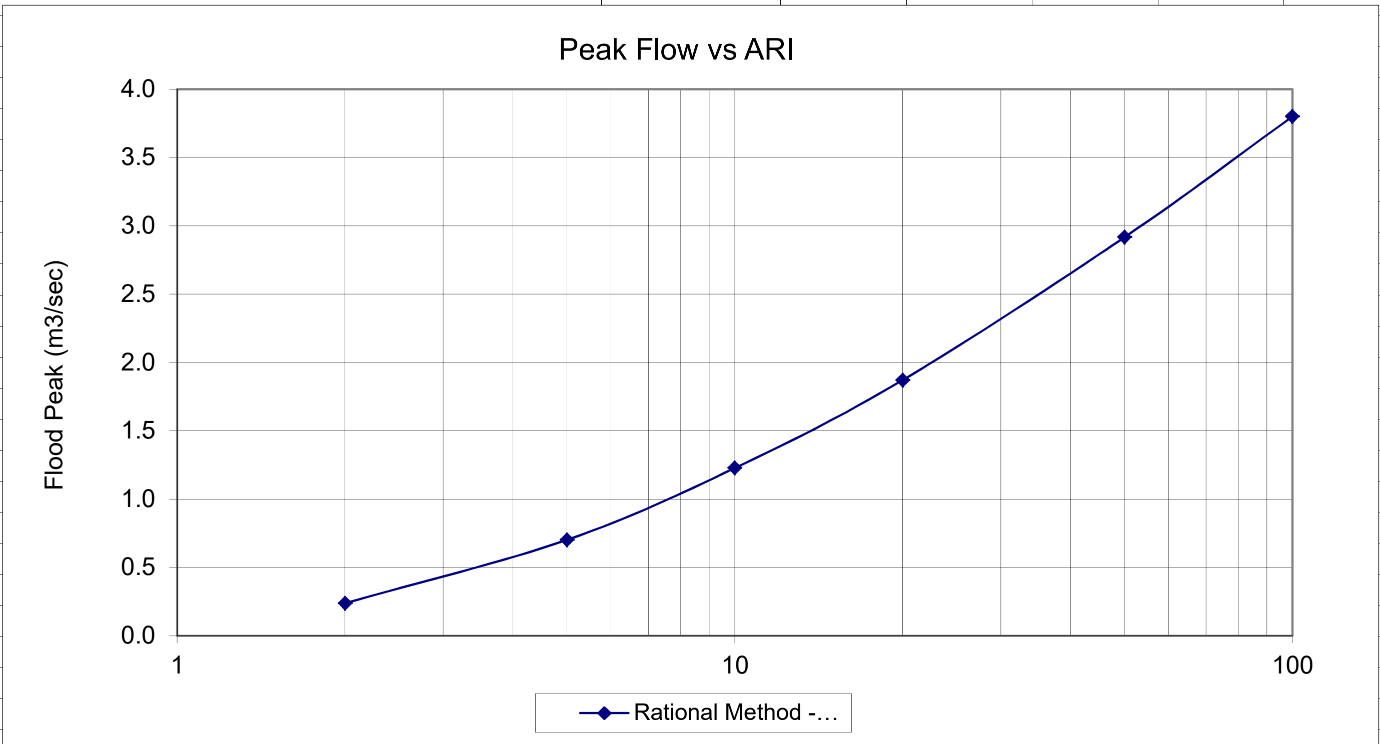
Sub-Catchment Peak Flow Estimation
(ref: AR&R 1987, Vol. 1, Book 4)

Assume Wheatbelt Loamy soil catchments 75-100% cleared
With Arid Interior Frequency Factors

Catchment Characteristics:

Catchment Area , A =	0.476	km2
Mainstream Length, L =	1.591	km
Equal Area Stream Slope, Se =	20.7	m/km
Cleared Area as percentage of catchment, CL =	75-100	%
Average Annual Rainfall, P =	289	mm

Rational Method - Peak Flow:	**2**	**5**	**10**	**20**	**50**	**100**
tc=0.76A^0.38=	0.6	hours	(36 mins)			
Rainfall Intensity for Time of Concentration => $I_{tc,Y}$=	18.6	26.6	32.6	38.8	47.8	55.2
C10=3.46*10^-1L^-0.42=	0.285	-				
	2	**5**	**10**	**20**	**50**	**100**
Frequency Factor (C_Y/C_{10})	0.34	0.7	1	1.28	1.62	1.93
Flood Peak Qy=0.278C_{10}(Cy/C10)IA (m3/sec)	0.2	0.7	1.2	1.9	2.9	3.8



Pantoro - Norseman Gold Project
Cobbler Mine Yard South Upstream Catchment Area

Job No.: J2018			Sheet No.	2	of	3
Calc. By: Alistair Lowry			Chk'd By:			
Calc Date: 17 November 2020			Chk'd Date:			

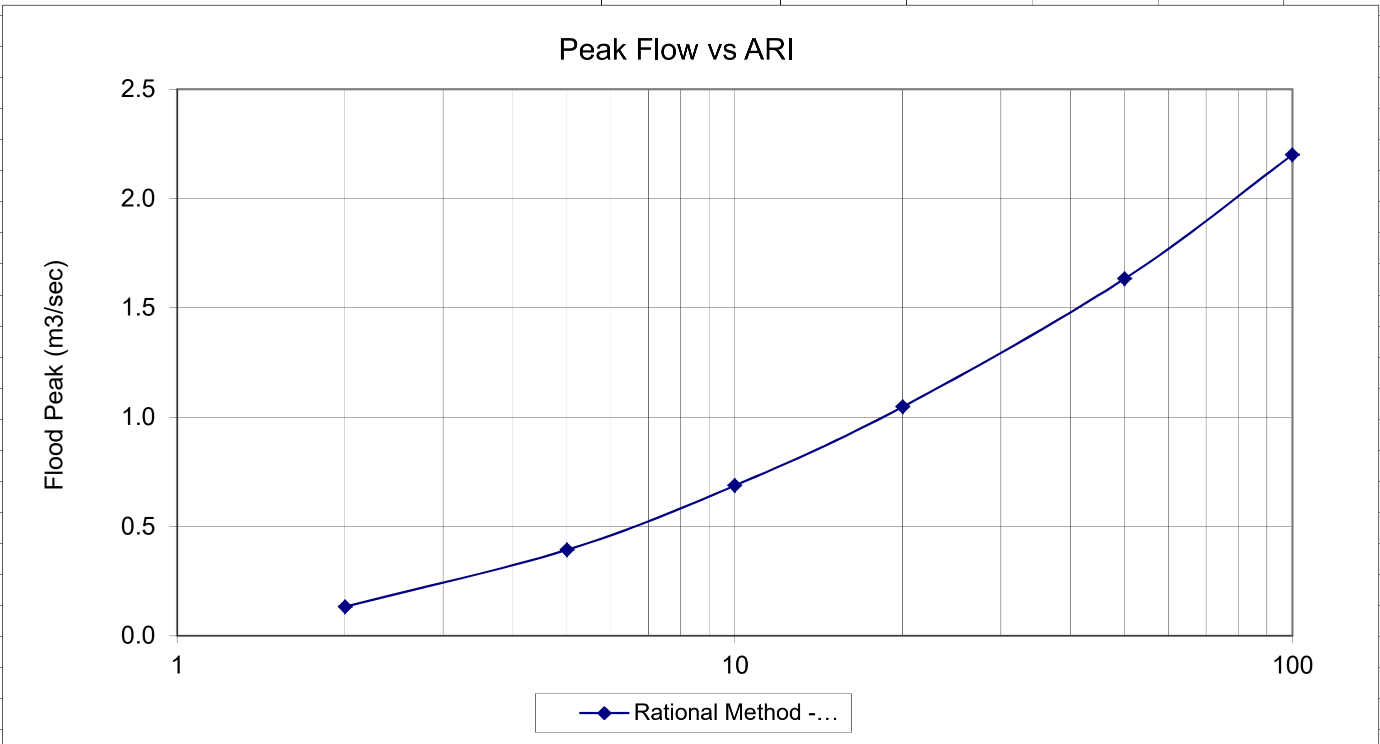
Sub-Catchment Peak Flow Estimation
(ref: AR&R 1987, Vol. 1, Book 4)

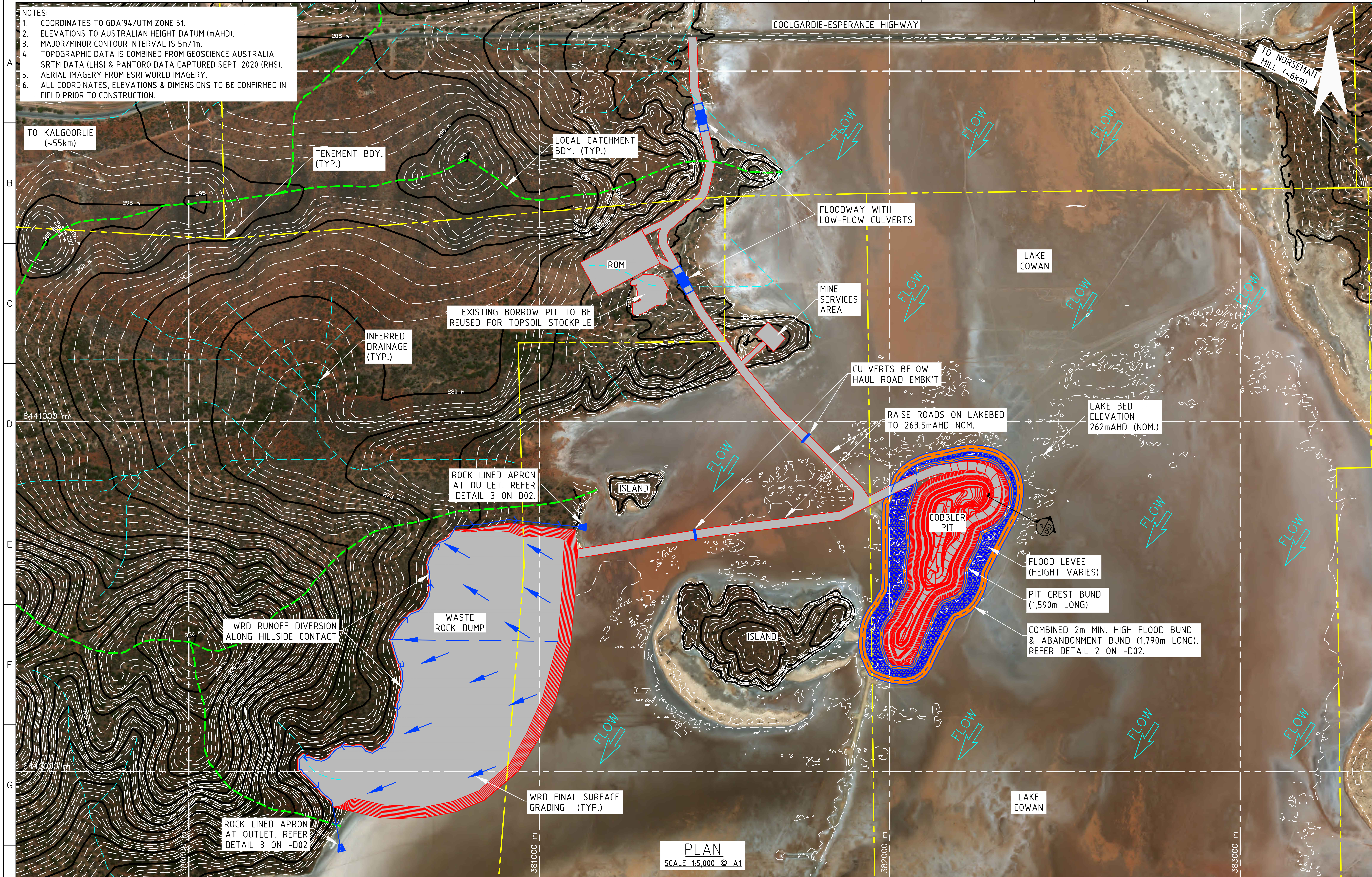
Assume Wheatbelt Loamy soil catchments 75-100% cleared
With Arid Interior Frequency Factors

Catchment Characteristics:

Catchment Area , A =	0.198	km2
Mainstream Length, L =	0.785	km
Equal Area Stream Slope, Se =	42.0	m/km
Cleared Area as percentage of catchment, CL =	75-100	%
Average Annual Rainfall, P =	289	mm

Rational Method - Peak Flow:	**2**	**5**	**10**	**20**	**50**	**100**
tc=0.76A^0.38=	0.4	hours	(24 mins)			
Rainfall Intensity for Time of Concentration => $I_{tc,Y}$=	18.6	26.6	32.6	38.8	47.8	55.2
C10=3.46*10^-1L^-0.42=	0.383	-				
	2	**5**	**10**	**20**	**50**	**100**
Frequency Factor (C_Y/C_{10})	0.34	0.7	1	1.28	1.62	1.93
Flood Peak Qy=0.278C_{10}(Cy/C10)IA (m3/sec)	0.1	0.4	0.7	1.0	1.6	2.2





PLAN
SCALE 1:5,000 @ A1

REVISION	DESCRIPTION	CHECKED INITS	CHECKED DATE	APPROVED INITS	APPROVED DATE
C	RE-ISSUED WITH CLIENT REVIEW COMMENTS	AL	19/10/20	_	_
B	RE-ISSUED WITH REVISED INFRASTRUCTURE LAYOUT	AL	16/10/20	_	_
A	ISSUED FOR CLIENT REVIEW	AL	14/10/19	_	_

PRELIMINARY NOT FOR CONSTRUCTION

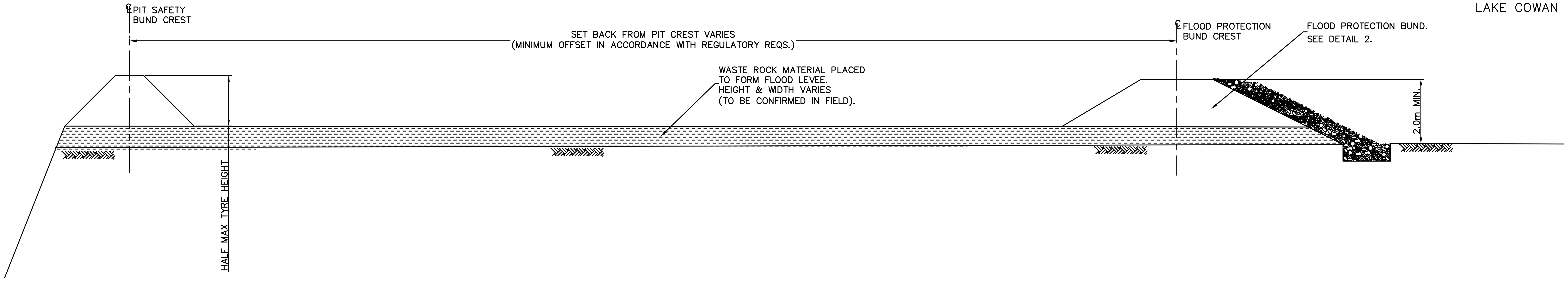
GROUNDWATER RESOURCE MANAGEMENT

CLIENT: PANTORO SOUTH PTY LTD
DRAWN: AL — DATE: 05-OCT-20
DRAWING CHECK: — DATE:
DESIGNED: AL — DATE: 05-OCT-20
DESIGN CHECK: — DATE:
AUTHORISED: — DATE:
SCALE: AS SHOWN

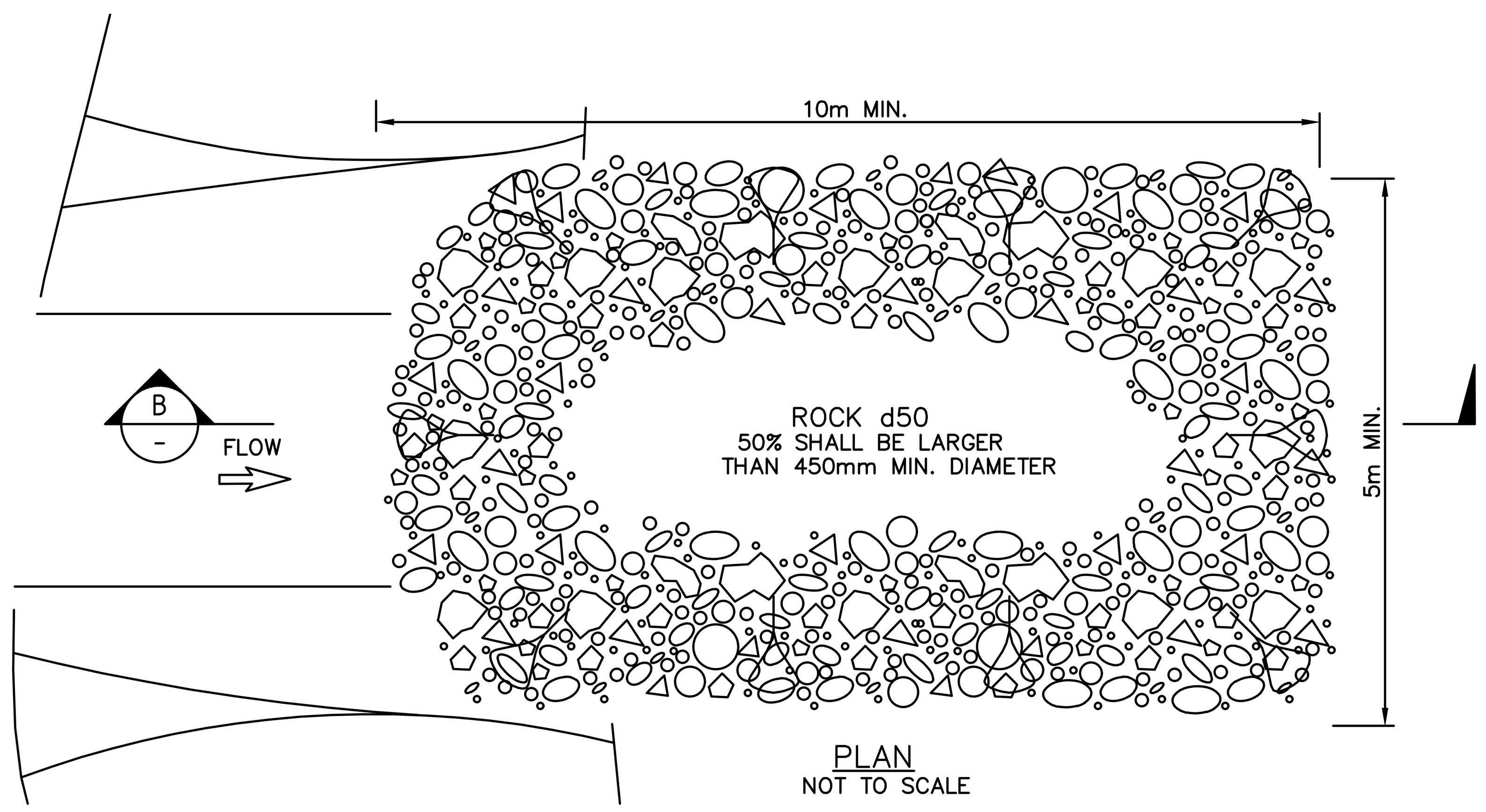
PROJECT: NORSEMAN GOLD PROJECT
DRAWING TITLE: COBBLER PRELIMINARY DESIGN OF SURFACE WATER MANAGEMENT MEASURES PLAN
DRAWING No. J2018R04-D01 — C

A1

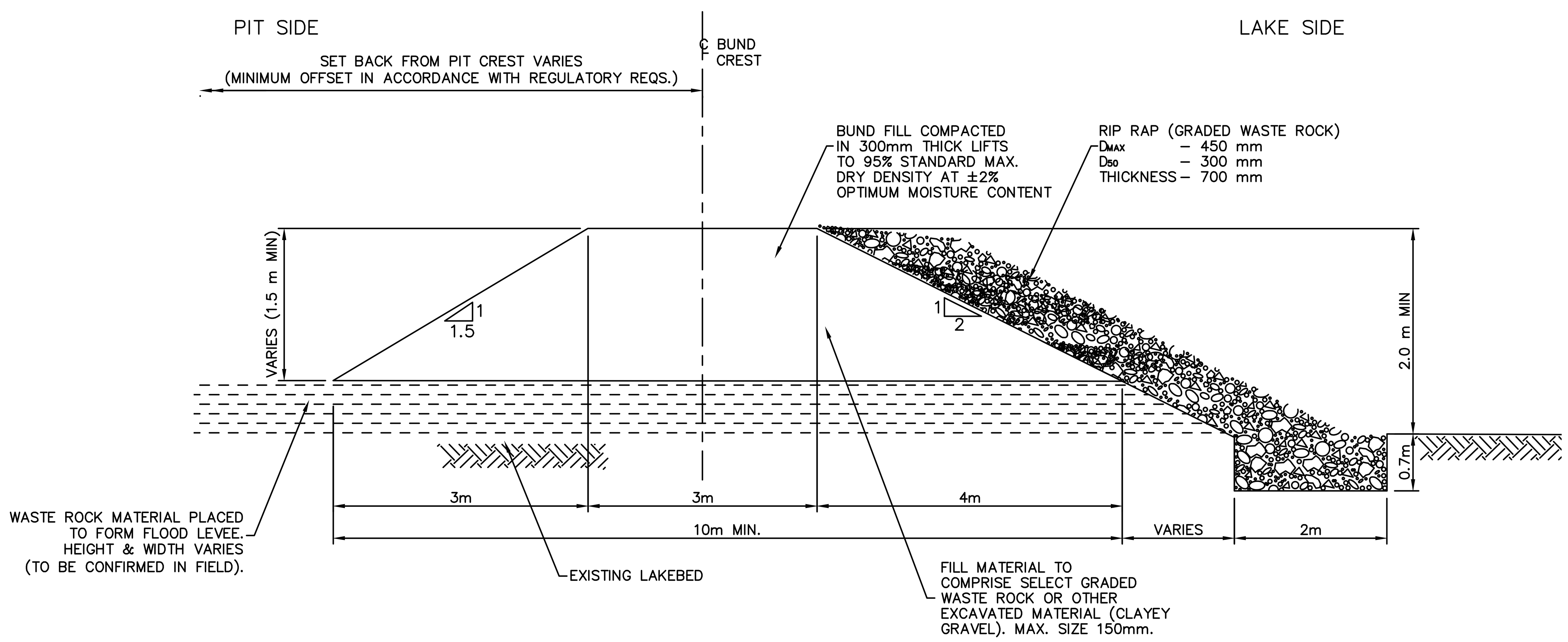
NOTES:
1. COORDINATES TO GDA'94/UTM ZONE 51.
2. ELEVATIONS TO AUSTRALIAN HEIGHT DATUM (mAHD).
3. ALL COORDINATES, ELEVATIONS & DIMENSIONS TO BE CONFIRMED IN FIELD PRIOR TO CONSTRUCTION.

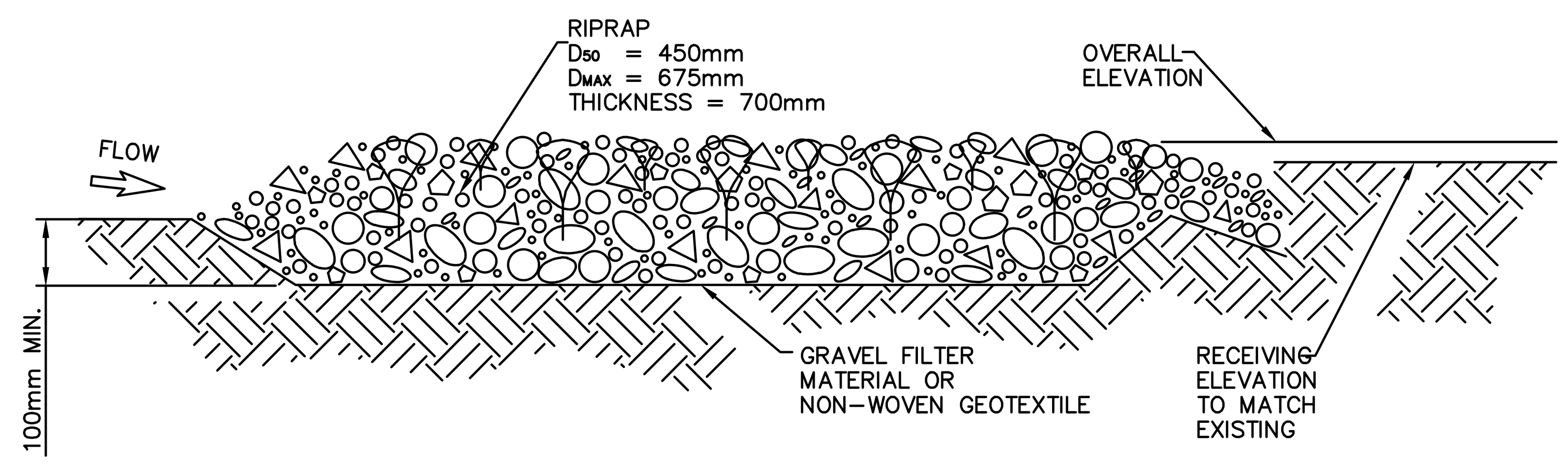


SECTION A–A THROUGH FLOOD PROTECTION WORKS
SCALE 1:100 @ A1



PLAN
NOT TO SCALE





SECTION (B/-)
NOT TO SCALE

FLOOD PROTECTION BUND TYPICAL SECTION (2/D01)
SCALE – 1 : 50 @ A1

ROCK LINED APRON DETAIL (3/D01)

REVISION	DESCRIPTION	INITS	DATE	INITS	DATE
B	REVISED & RE-ISSUED WITH DRAFT REPORT	AL	27/11/20	–	–
A	ISSUED FOR CLIENT REVIEW	AL	19/11/20	–	–
		CHECKED		APPROVED	

PRELIMINARY NOT FOR CONSTRUCTION

GROUNDWATER RESOURCE MANAGEMENT

CLIENT	PANTORO SOUTH PTY LTD
DRAWN	AL 05-OCT-20
DRAWING CHECK	
DESIGNED	AL 05-OCT-20
DESIGN CHECK	
AUTHORISED	
SCALE	AS SHOWN
PROJECT	NORSEMAN GOLD PROJECT
DRAWING TITLE	COBBLER PRELIMINARY DESIGN OF SURFACE WATER MANAGEMENT MEASURES SECTIONS & DETAILS
DRAWING No.	J2018R04-D02
REVISION	B

A1