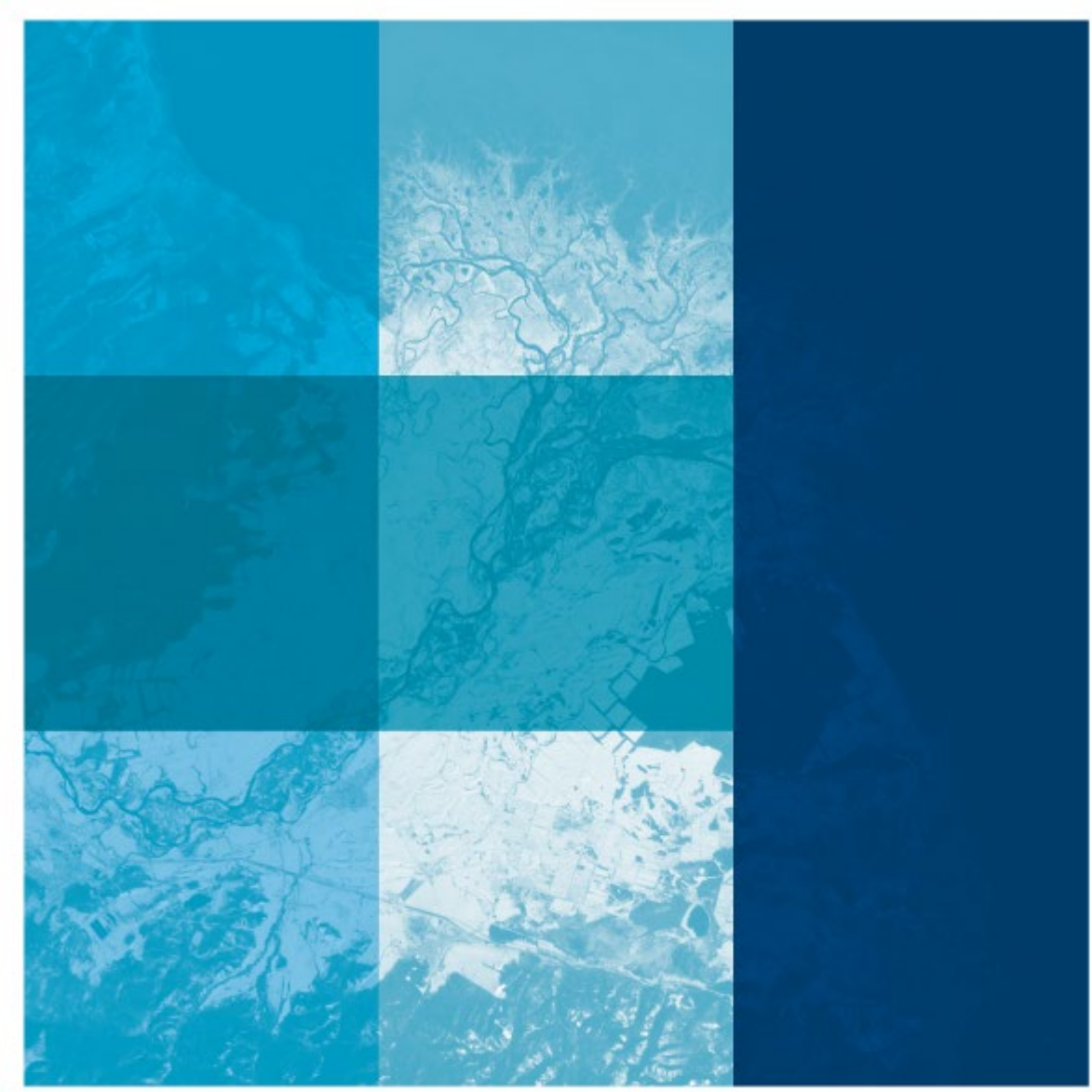


Hydrologia

Report: Golden Lode Surface Water Assessment

Client: Minstrel Resources Pty Ltd

Job number: J0100208

Date: 13 August 2025

Executive Summary

Introduction

Minstrel Resources is developing the Golden Lode project, located 120 km northwest of Kalgoorlie. Infrastructure that will be located at the site includes an open cut pit, waste dump, ROM, laydown area, workshop, offices, topsoil stockpiles and roads.

This report presents a baseline surface water assessment for the project area, to inform mine planning and environmental approvals.

Catchments

The site lies across a catchment divide for four catchments.

Catchments to the south of the site drain to the southeast, terminating in Wangine Lake.

Catchments to the north of the site drain northeast into Papertalk Creek. The creek dissipates onto a broad wash plain 15 km to the northeast. The wash plain terminates in a series of relatively small salt lakes 40 km northeast of the site. In very wet periods the lakes could overtop and flow toward Lake Goongarrie to the east.

As the project is located high in the catchments drainage lines are not well defined. There are no large, defined streams near proposed project infrastructure. The area is drained by broad shallow flow paths with limited development of incised drainage lines through the project area.

Surface hydrology

The site is located in the eastern goldfields. The area is arid with low, variable rainfall and high evaporation year-round, with very hot summers and cold winters.

Average annual rainfall at the site is 264 mm. Annual rainfall can vary by between -46% and +54% (between the 10 and 90 percentiles around the median).

Average annual evaporation is approximately 2,548 mm, much higher than average rainfall. Evaporation exceeds rainfall in every month of the year.

The landscape through the catchment and site area is mapped as broad flat to undulating valleys with isolated granitic rock outcrops, some low escarpments and seasonal lakes and clay pans. Chief soils are alkaline red earths.

The site is located in a gold mining and pastoral area. There are a number of active and residual mines in the region. Residual landforms from the old Golden Polt, Lights of Israel, Golden Eagle and Lady Eileen mines lie just to the east. Agricultural activity in the area is low intensity pastoral grazing. The Daveyhurst Mulline and Coolgardie North Roads pass the site.

Downstream areas potentially affected by project infrastructure are:

- The Daveyhurst Mulline and Coolgardie North Roads.
- Papertalk Brook to the north and the drainage line to the south draining toward Wangine Lake.
- Areas receiving shallow overland and concentrated flow to the east.

Local vegetation communities through the mine site are generally dependent on in situ rainfall or transient flow in shallow flow paths. Vegetation along larger channels from the

eastern side to the project area toward the east tends to be influenced by intermittent flows and short-lived flooding.

The site is located in the Salt Lake Basin surface water management area. It is not in a proclaimed surface water management area (under the *Rights in Water and Irrigation Act 1914*). A small part of the western end of the proposed waste dump lies in the Credo Conservation Park.

The project does not intersect or potentially impact any Primary Water Resource Management Areas, Threatened Ecological Communities nor RAMSAR wetlands.

There are no natural pools nor permanent water bodies through the area of the site or nearby. Several dams for stock watering are located to the east and south of the project area. The use of the dams will not be affected by project activities. There are no other beneficial uses in the project area.

The quality of stormwater flow through the area of the site will be fresh but may be turbid. Ponds and low-lying areas may retain fresh water for a short time after flooding.

Flooding

As the project area lies across the upper part of several catchments, stormwater moves as overland flow or in shallow concentrated flow paths. There are no large drainage lines that pose a flood risk to site infrastructure.

Flood modelling indicates that the waste dump and pit do not interact with drainage lines so have no impact on flooding.

On project closure, roads, ROM/laydown/workshop/office infrastructure and topsoil stockpiles will be removed, the ground surface reshaped similar to the pre-mining condition and rehabilitated. The pit and waste dump will remain but will be internally drained and not interact with the landscape nor influence flooding in the area. Even with a changing climate in the future the flood risk profile for site landforms remaining after closure (the pit and waste dump) does not change.

Potential Environmental Impacts

During operation

Potential impacts of the mine on the environment during mine operation include:

- Erosion of soil from disturbed areas, steep slopes and drainage infrastructure, leading to increased turbidity of stormwater discharged from the mine area.
- Contamination of stormwater from mining activities.
- Reduction in catchment area reducing flow to nearby downstream areas.

Erosion risk from topsoil stockpiles, haul road and ROM/laydown area can be managed using shallow drains, land grading and small drainage structures (road crossings).

Erosion from external slopes on the waste dump will be managed using a catch drain at the toe of the slope. The slopes will be progressively rehabilitated leading up to closure, which will help stabilise the slopes against erosion. The top of the waste dump will be internally drained. Stormwater ponding after heavy rainfall events will infiltrate and evaporate.

Stormwater falling within the pit safety bund will be directed into the pit or to sumps where it will be reused on site or allowed to infiltrate and evaporate.

The risk of hydrocarbon contamination can be managed using standard bunding design and rainfall exclusion for high risk areas, such as fuel tanks and workshops. Salt accumulation on roads can be managed in the road drainage network and with dilution.

Reduction in catchment area will occur during the life of the mine due to construction of temporary structures and areas with internal drainage and the phased construction of permanent structures (waste rock dump and pit). The risk of impact on the wider environment is low.

After closure

On closure most site infrastructure, including roads, ROM, laydown, workshop and office infrastructure will be removed and the site rehabilitated. Topsoil stockpiles will be respread as part of the rehabilitation.

The pit and waste dump will remain but will be internally drained and not interact with the external landscape. These structure are at low risk from flooding and there is a low risk of impact on water quality in surrounding drainage lines.

Across all of the catchments through the mine area, the total reduction in catchment area is 0.4%. This is a small component of stormwater flow. The effect will also rapidly diminish with distance downstream. The risk of impact on the wider environment is low.

The changing climate is unlikely to substantially change the environmental risk profile for the project area after closure.

Table of contents

Executive Summary 1
Table of contents 4
1. Introduction 6
1.1 Background 6
1.2 Scope of work 9
1.3 Summary of methods 9
1.4 Limitations 10
2. Baseline hydrology 12
2.1 Introduction 12
2.2 Catchments 12
2.3 Surface hydrology 14
2.4 Environmental values and beneficial uses 16
2.5 Surface water management areas 17
2.6 Water quality 17
2.7 Flooding characteristics 17
3. Potential environmental impacts 20
3.1 Introduction 20
3.2 Potential impacts during operation 20
3.3 Potential impacts after closure 21
4. References 23
Appendix A – Model parameter values 26
Appendix B – Risk Assessment Matrix 29

Figures

Figure 1 Project location 7
Figure 2 Proposed site layout 8
Figure 3 Existing site drainage 13
Figure 4 Rainfall and evaporation at the site 15
Figure 5 Predicted flooding 19

Tables

Table 1 Catchments 12

Table 2 Predicted design flows 12
Table 3 Catchment reduction 21

1. Introduction

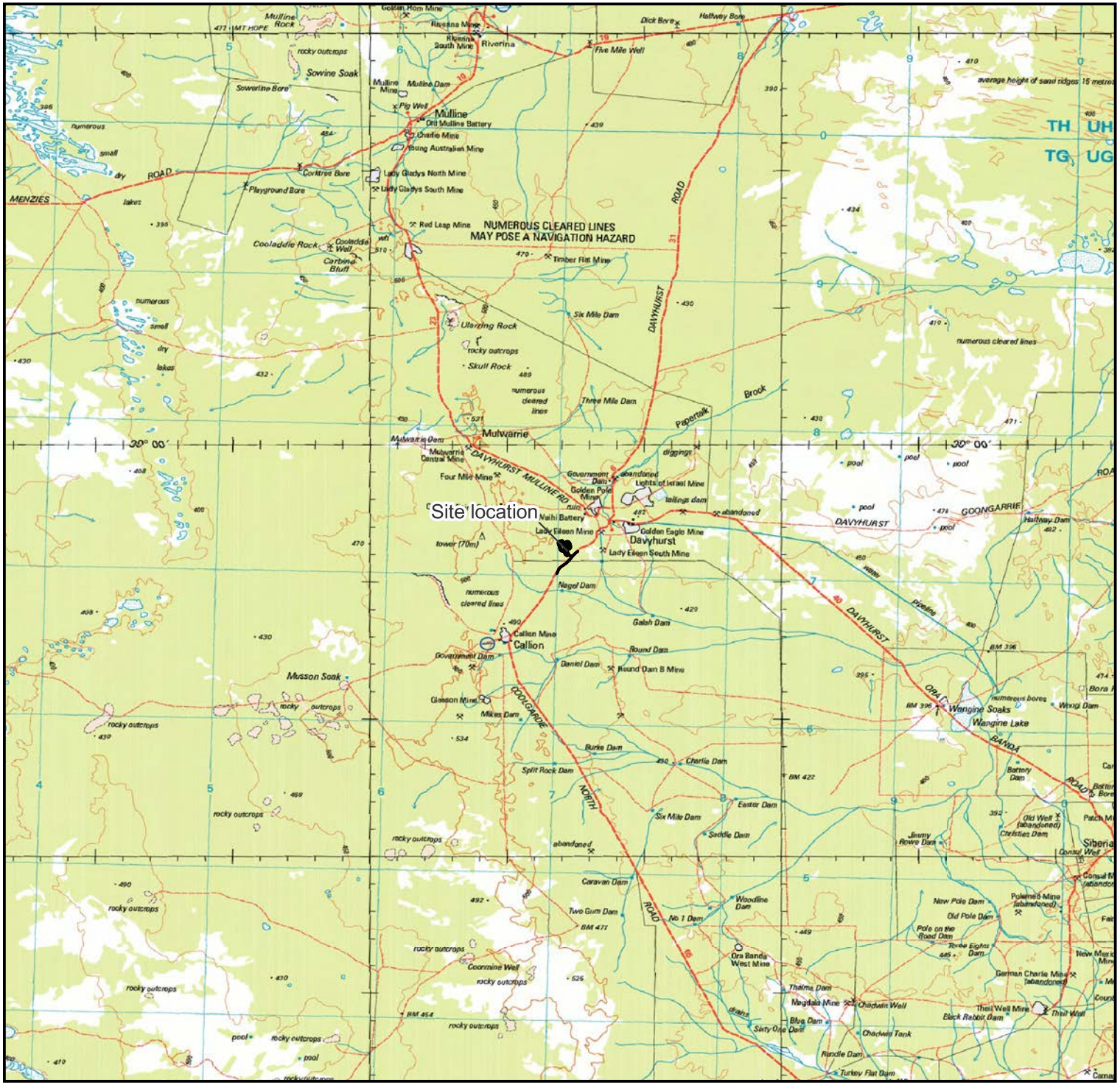
1.1 Background

Minstrel Resources is developing the Golden Lode project. The project is located 120 km northwest of Kalgoorlie. The site location is shown in Figure 1.

Minstrel Resources is developing planning for the project and has engaged Hydrologia to undertake a surface water study to inform environmental approvals.

Infrastructure that will be located at the site includes an open cut pit, waste dump, ROM, laydown area, workshop, offices, topsoil stockpiles and roads. Proposed site infrastructure is shown in Figure 2.

This report presents a baseline surface water assessment for the project area, formatted to address requirements of the WA EPA's Environmental Factor Guideline for Inland Water (EPA 2018).



Legend

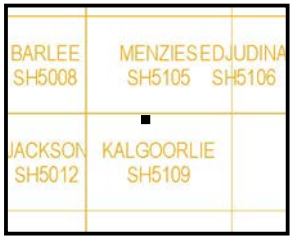
Proposed infrastructure

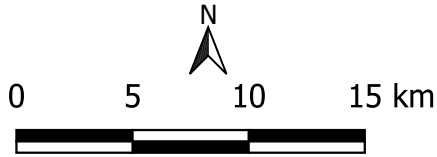
Data source:
Image - Geoscience Australia
Proposed infrastructure - Minstrel Resources

Location



250K map sheet location



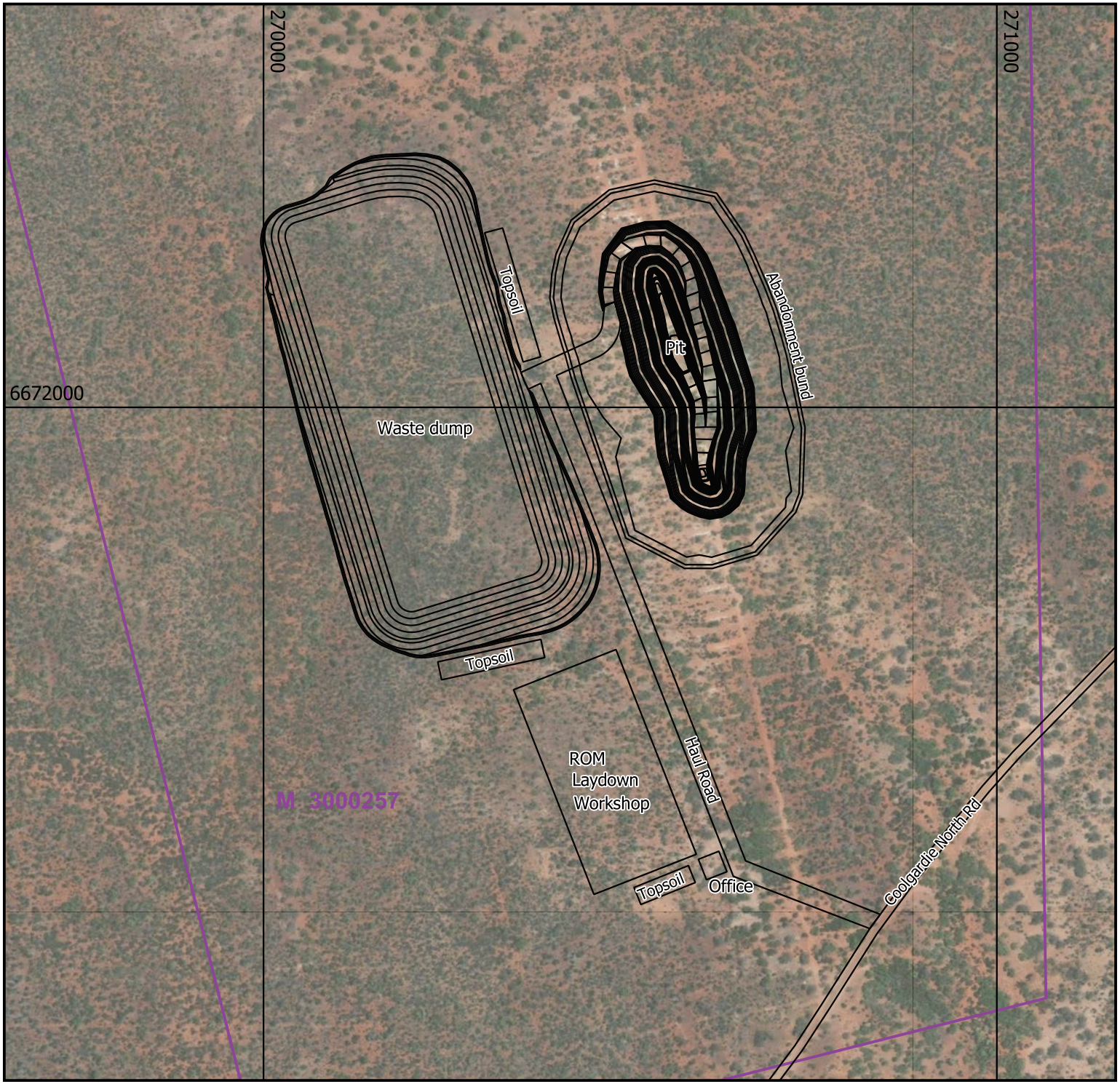


Hydrologia

Project: Golden Lode - Surface Water Assessment
Job No: J0100108

Figure 1
Project location

COMPILED: Hydrologia	DATE: 15/07/2025	LOCON: PERTH	A4	SCALE: 1:250 000
GDA 2020 MGA Zone 51	PLAN No: J0100108 Fig 01.pdf			
DOCUMENT NAME: J0100108 Map 01.qgz				



Legend

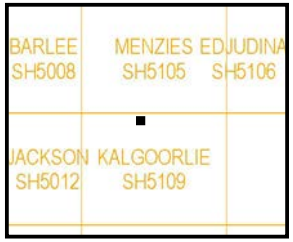
- Proposed infrastructure
- Tenement

Data source:
Imagery - ESRI
Infrastructure, tenements - Minstrel Resources

Location



250K map sheet location



N

0 0.1 0.2 0.3 0.4 km

Hydrologia

Project: Golden Lode - Surface Water Assessment
Job No: J0100108

Figure 2
Proposed site layout

COMPILED: Hydrologia	DATE: 24/07/2025	LOCON: PERTH	A4	SCALE: 1:7 500
GDA 2020 MGA Zone 51	PLAN No: J0100108_Fig 02.pdf			
DOCUMENT NAME: J0100108_Map 02.qgz				

1.2 Scope of work

The scope of work was to undertake a surface water assessment for the proposed Golden Lode project, northwest of Kalgoorlie.

The deliverable is this report containing the results of the investigation.

1.3 Summary of methods

The work was undertaken in the following stages:

- Source and review data.
- Baseline surface water assessment.
- Flood characterisation.
- Surface water management.
- Reporting.

Source data

The following data were used in the assessment:

- Details of the proposed site layout, from Minstrel Resources.
- Site survey, supplied by Minstrel Resources.
- Regional topographic data, supplied by Geoscience Australia.
- Weather data, supplied by the Bureau of Meteorology.
- Other data and reports, as referenced through this report.

The site survey data was a 1 m DTM covering the extent of the project area. No details of data accuracy were available.

The regional topographic dataset was a nation-wide DEM supplied by Geoscience Australia (GA 2011). The DEM was derived from Shuttle Radar Topography Mission data acquired by NASA in February 2000. The version of DEM used was a one second hydrologically enforced digital elevation model (SRTM-H). This dataset captures flow paths based on SRTM elevations and mapped stream lines and supports delineation of catchments and related hydrological attributes. The dataset has a spatial resolution of approximately 30 m and a vertical accuracy of up to 7.6 m. The DEM has an approximately 30 m wide rectangular cell.

The site survey data was merged with the Geoscience Australia data to produce a combined dataset that was used for catchment delineation and for the hydrologic modelling. The Geoscience Australia dataset was adjusted vertically to match, as closely as possible, the survey data. A single, merged DEM was produced using the site data in priority to the Geoscience Australia data.

The extent of the topographic data is given in Appendix A.

For characterisation of climate a daily record generated for the project using SILO Data Drill (Queensland Government 2025) and Bureau of Meteorology observed weather data for Station 012038 Kalgoorlie-Boulder Airport (BoM 2025a) were used.

Baseline design rainfall intensity data used was 2016 IFD and temporal data (ARR 2025, BoM 2025b) was adjusted for climate change scenarios Current and near term (2025) SSP2-4.5 and Long term (2081-2100) SSP2-4.5 (Ball *et al*. 2019).

Baseline assessment

The baseline assessment was developed to meet the WA EPA's Environmental Factor Guideline for Inland Water (EPA 2018) and Department of Energy, Mines, Industry Regulation and Safety guidelines for preparing mining development and closure proposals (DEMIRS 2025).

Assessment of potential impacts on the environment was included, based on assessment of the location of proposed infrastructure in the environment. It was assumed that footprints of waste rock dumps and pits are permanently internally drained on mine closure.

Flooding characteristics for the site were defined using hydraulic modelling of existing drainage lines that pass through the project area.

Potential environmental impacts

An impact assessment was undertaken by considering how existing surface water characteristics (flooding, overland flow patterns, flow volumes and water quality) could be impacted by project infrastructure (including structures and operational procedures).

General options for management of impacts, based on design principles applied to the site's specific characteristics was developed.

A risk assessment matrix formulated using guidelines given in DEMIRS (2025) was used to assess risk of impacts.

Modelling

A combined hydrologic and hydraulic model was setup for the project area and contributing catchment and used to model flooding throughout the project area.

Existing conditions, i.e. as defined by the topographic data and before mining, was modelled. The results of modelling for this existing conditions scenario was used to characterise baseline hydrology for the site.

The modelling was undertaken using the Mike SHE model (DHI 2025) guided by principles given in Ball *et al.* (2019). Mike SHE is a detailed catchment hydrology and hydraulic model. It was used here to characterise catchment hydrology and flooding characteristics of drainage lines through the project area. A rain-on-grid approach was used.

The 1% annual exceedance probability (AEP) design rainfall events was modelled. Climate change scenario Current and near term (2025) SSP2-4.5 was adopted as the baseline design rainfall for existing conditions.

The Mike SHE model was parameterised using the available data. Published sources and experience applying the model in similar environments were used to inform the model parameterisation.

Details of model parameters adopted are given in Appendix A. More detail on the Mike SHE software is given at DHI (2025).

1.4 Limitations

This report has been prepared by Hydrologia Pty Ltd for Minstrel Resources Pty Ltd and may only be used and relied on by Minstrel Resources Pty Ltd for the purpose agreed between Hydrologia Pty Ltd and Minstrel Resources Pty Ltd as set out in Section 1.2 of this report.

Hydrologia Pty Ltd otherwise disclaims responsibility to any person other than Minstrel Resources Pty Ltd arising in connection with this report. Hydrologia Pty Ltd also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by Hydrologia Pty Ltd in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. Hydrologia Pty Ltd has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by Hydrologia Pty Ltd described in this report (refer Section 1.3 of this report). Hydrologia Pty Ltd disclaims liability arising from any of the assumptions being incorrect.

Hydrologia Pty Ltd has prepared this report on the basis of information provided by Minstrel Resources Pty Ltd and others who provided information to Hydrologia Pty Ltd (including Government authorities), which Hydrologia Pty Ltd has not independently verified or checked beyond the agreed scope of work. Hydrologia Pty Ltd does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Model results and analysis

Flood magnitude predictions have a probability of occurrence. For example, a predicted 1% (or 1 in 100) AEP flood extent has a 1% probability of occurring or being exceeded in any given year. A flood of this magnitude could occur more than once in a year.

Floods greater than 1% AEP can occur. During such floods, impacts from flooding could be greater than indicated in this study. Conversely properties within the study area can be affected by floods of a lesser magnitude.

Predicted flood level, depth and velocity is predicted based on the available data and on assumptions and limitations described in our report. These results should be read in conjunction with this report.

The Mike SHE model was applied using a 20 m square grid derived from the merged site survey and Geoscience Australia SRTM topographic data. Topographic and drainage features, such as swales, gutters, levees, roads, changes in land use or hydraulic roughness are not necessarily accurately represented in the model. Buildings or elevated flood levels at or in buildings are not represented in the original topographic data nor in the model. Underground pipework, culverts or other structures are not represented in the model.

Local increases in flood levels, depths and/or velocities from those predicted in this study can occur as a result of local factors. Using more accurate topography will also affect the predicted flood extent.

The impact of climate change on the magnitude or frequency of occurrence of flood events has been considered following guidance given in Ball *et al.* (2019). It is widely accepted in the scientific community that changing climate could affect rainfall and runoff in Australia, including in the project area. Accordingly, the probability of occurrence for predictions given in this study could change in the future.

Catchments and drainage lines are indicative and based on the available data.

2. Baseline hydrology

2.1 Introduction

This section presents a description of baseline hydrology for the proposed Golden Lode project area.

The description is presented in a format recommended in the WA EPA's Environmental Factor Guideline for Inland Water (EPA 2018). Results of flood characterisation for the site is given in Section 3.

2.2 Catchments

The site lies across a catchment divide for four catchments.

Catchments and drainage lines are mapped on Figure 3. Catchment details are given in Table 1.

Catchments 1 and 2 drain to the southeast with stormwater flow merging downstream of the site. Flow drains toward the east, terminating in Wangine Lake.

Stormwater flow from Catchments 3 and 4 merges downstream of the site and drains northeast into Papertalk Creek. The creek dissipates onto a broad wash plain 15 km to the northeast. Flow from the wash plain generally terminates in a series of relatively small salt lakes 40 km northeast of the site. In very wet periods the lakes could overtop and flow toward Lake Goongarrie to the east.

Table 1 Catchments

Catchment*	Area (km^2)	Description
1	33.4	Southern drainage line.
2	11.7	Eastern drainage line.
3	7.2	Northeastern drainage line.
4	25.4	Northern drainage line.

* Catchments are shown on Figure 3.

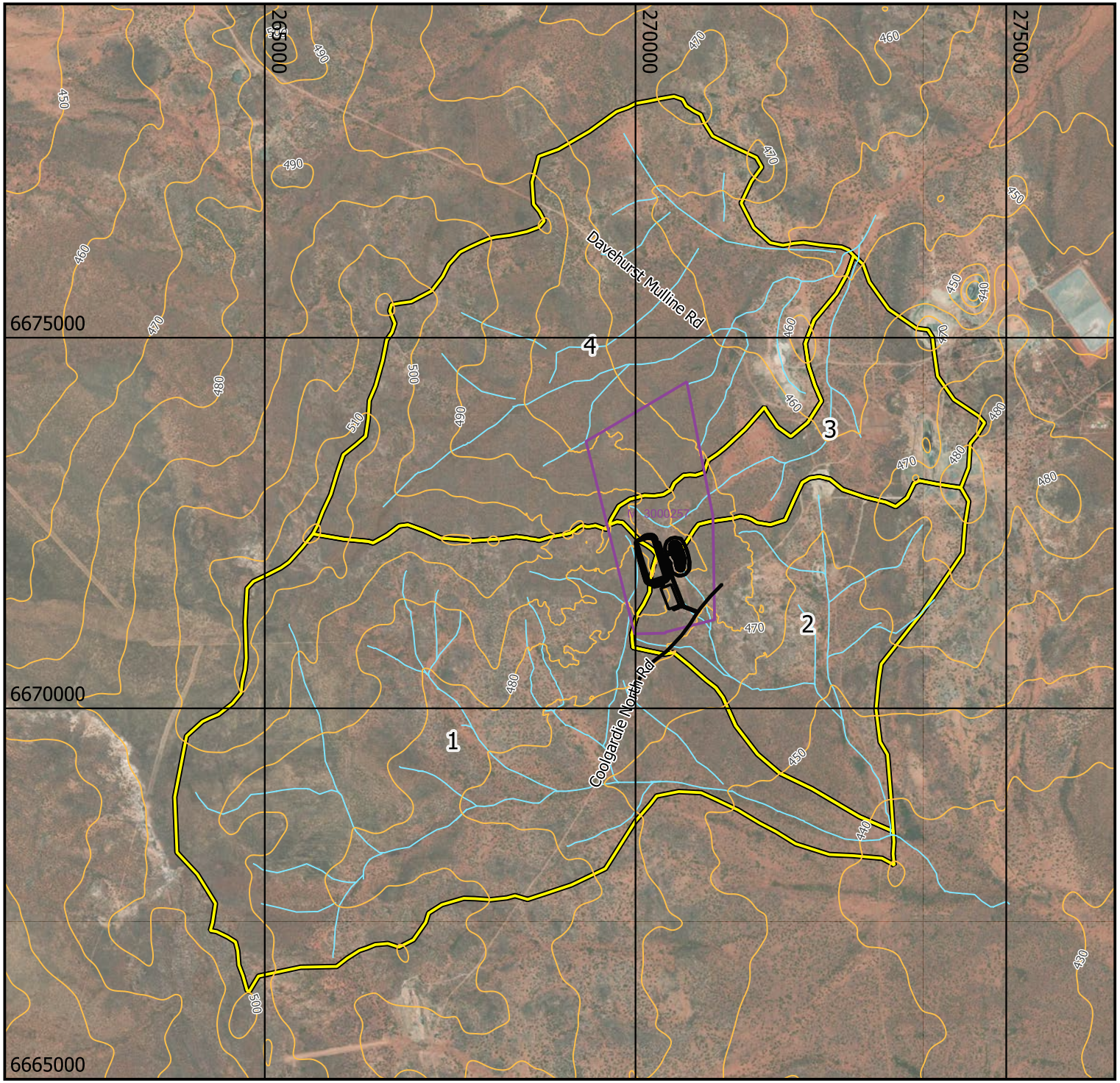
As the project is located high in the catchments drainage lines are not well defined. The area is drained by broad shallow flow paths with limited development of incised drainage lines through the project area. Downstream of the project area drainage lines become more defined in the southeast and extend to Wangine Lake. To the northeast the drainage lines dissipate onto the wash plain.

Predicted design flows for the four catchments that cover the site are given in Table 2.

Table 2 Predicted design flows

Catchment No.*	Area (km^2)	Peak flow (m^3/s) for AEP (%)*		
		10	1	PMF
1	33.4	11	39	295
2	11.7	20	69	701
3	7.2	8	29	294
4	25.4	12	50	565

* Flows are reported at the catchment outlet; catchment numbers refer to Figure 3.



Legend

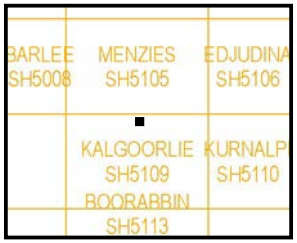
- Proposed infrastructure
- Tenement
- 10 m contours (m AHD)
- 1 Catchments
- Drainage lines

Data source:
Imagery - ESRI
Tenements - Minstrel Resources
Contours - Geoscience Australia/
Minstrel Resources
Catchments, drainage lines - Hydrologia

Location



250K map sheet location



N

0 1 2 3 4 km

Hydrologia

Project: Golden Lode - Surface Water Assessment
Job No: J0100108

Figure 3
Existing site drainage

COMPILED: Hydrologia	DATE: 24/07/2025	LOCON: PERTH	A4	SCALE: 1:75 000
GDA 2020 MGA Zone 51	PLAN No: J0100108 Fig 03.pdf			
DOCUMENT NAME: J0100108 Map 03.qgz				

2.3 Surface hydrology

Climate

The site is located in the eastern goldfields. The area has an arid climate with low, variable rainfall and high evaporation year-round, with very hot summers and cold winters. Climate of the area is classified by the modified Köppen system (BoM 2025c) as Grassland hot (persistently dry) but lies close to the border of the Desert hot (persistently dry) zone.

Average annual rainfall (as indicated by long term SILO data generated for the site) is 264 mm. Annual rainfall can vary by between -46% and +54% (between the 10 and 90 percentiles around the median).

Rainfall at the site often occurs as a result of decaying tropical cyclones in summer and cold fronts in winter. Thunderstorms also occur in the area. Spatial rainfall patterns tend to be highly variable, with individual rainfall event totals varying substantially across even short distances. Seasonal rainfall totals are variable.

Rainfall statistics for the site are plotted in Figure 4. Rain can fall all year round but the period between May and August can be wetter. Larger events tend to occur between January and March.

Average annual evaporation (as indicated by SILO data) is 2,548 mm, much higher than average rainfall. Evaporation exceeds rainfall in every month of the year.

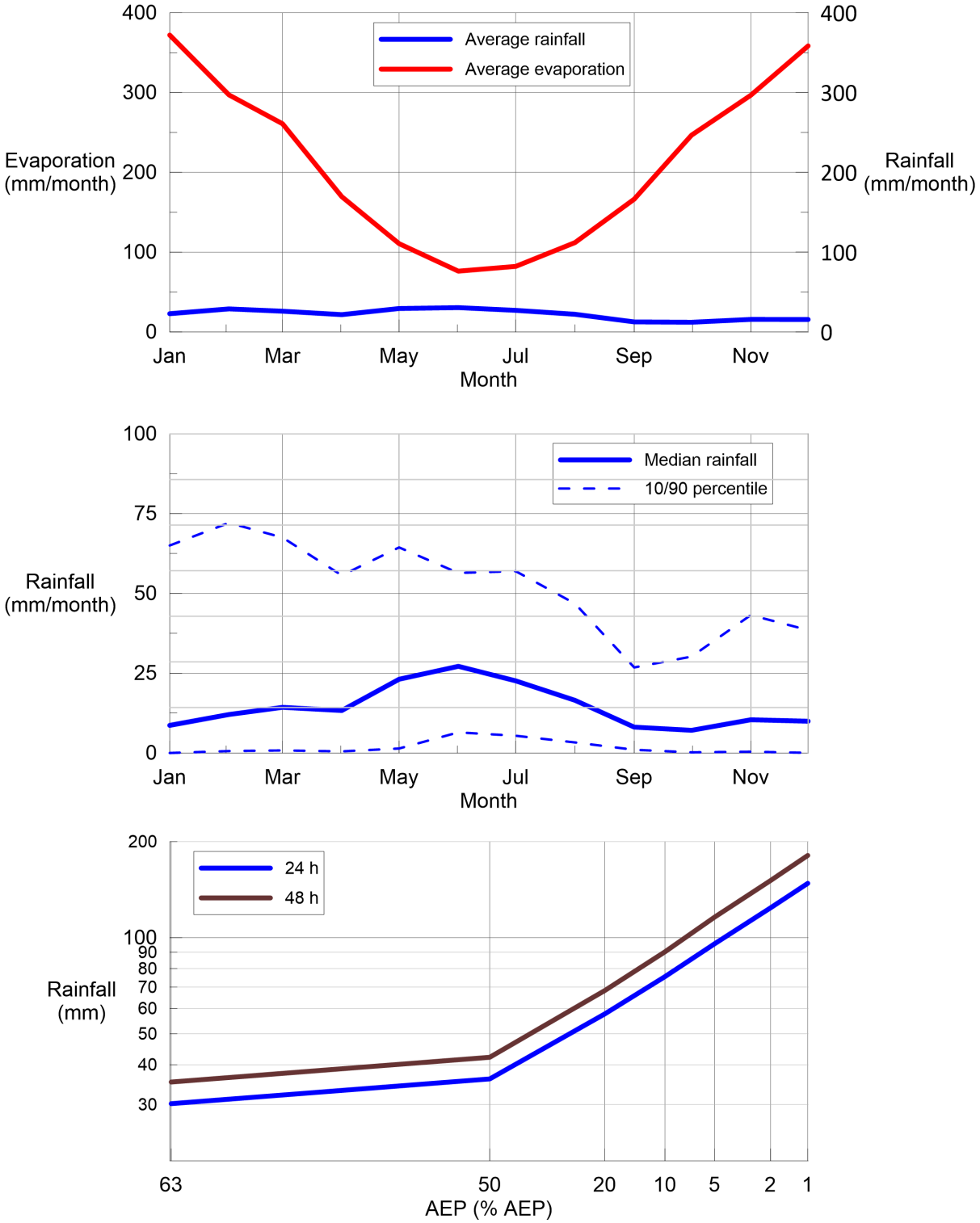


Figure 4 Rainfall and evaporation at the site

Data taken from long term SILO data (Queensland Government 2025).

Land systems and soils

Land system and soil mapping data at a large scale are available for the site (CSIRO 1991). Surface geology is mapped by Geoscience Australia (GA 2012). Mapping in these reports is at a much larger scale than that of the site so only indicative conditions can be inferred.

The landscape through the central and eastern part of the project area and western part of Catchment 1 is mapped in CSIRO (1991) as broad flat to undulating valleys with isolated granitic rock outcrops, some low escarpments and seasonal lakes and clay pans. Chief soils are alkaline red earths. A band of rocky ranges and hills of greenstones with shallow calcareous loamy soil extends through the middle of Catchment 1 and western part of Catchment 4.

Vegetation and land use

The site is located in a gold mining and pastoral area.

There are a number of active and residual mines in the region. Residual landforms from the old Golden Polt, Lights of Israel, Golden Eagle and Lady Eileen mines lie just to the east.

Agricultural activity in the area is low intensity pastoral grazing.

The Daveyhurst Mulline and Coolgardie North Roads pass the site.

Potentially affected downstream areas

Downstream areas potentially affected by project infrastructure are:

- The Daveyhurst Mulline and Coolgardie North Roads.
- Papertalk Brook to the north and the drainage line to the south draining toward Wangine Lake.
- Areas receiving shallow overland and concentrated flow to the east.

2.4 Environmental values and beneficial uses

The main values and beneficiaries of surface water through the project area relate to:

- Maintenance of native vegetation communities.

Local vegetation communities through the project area are generally dependent on in situ rainfall or transient flow in shallow flow paths. Vegetation along larger channels from the eastern side of the project area toward the east tends to be influenced by intermittent flows and short-lived flooding.

There are no permanent or semi-permanent pools nor large defined channels through the project area.

Several dams for stock watering are located to the east and south of the project area (as indicated by 1:250,000 scale topographic mapping). The closest is more than 2 km from the proposed mine infrastructure. All are located outside the project area. The use of the dams will not be affected by project activities.

There are no other beneficial uses in the project area.

2.5 Surface water management areas

The site is located in the Salt Lake Basin surface water management area (DWER 2025). It is not in a proclaimed surface water management area (under the *Rights in Water and Irrigation Act 1914*).

The project tenement lies partially within the Credo Conservation Park. Most of the proposed infrastructure lies outside the park. A small part of the western end of the waste dump lies in the park.

The project does not intersect or potentially impact any Primary Water Resource Management Areas, Threatened Ecological Communities nor RAMSAR wetlands (Western Australia Government 2025, Australian Government 2025).

2.6 Water quality

There are no natural pools nor permanent water bodies through the area of the site or nearby.

Flow in the main drainage line and shallow flow paths is intermittent and short lived. Residual ponding in small, shallow areas in drainage lines may occur after rain, which dry out after the event.

Accordingly, it is likely that the quality of stormwater flow through the area of the site will be fresh but may be turbid. Pools will retain fresh water for a short time after flooding.

2.7 Flooding characteristics

As the project area lies across the upper part of several catchments, there are no developed drainage lines that pose a flood risk to site infrastructure. Flow occurs as overland flow or in shallow concentrated flow paths.

Predicted flood extent for the 1% AEP event for existing (pre mining) conditions is shown in Figure 5. Proposed project infrastructure is superimposed for comparison. The modelling indicates the nature of concentrated flows in the area of project infrastructure through the existing, mining and closure stages of the project.

The waste dump lies just east of a small drainage line in Catchment 1 but does not affect it's flow. The remainder of the waste dump and the pit lie across the catchment divide and stormwater drainage is away from infrastructure, so have no impact on flooding.

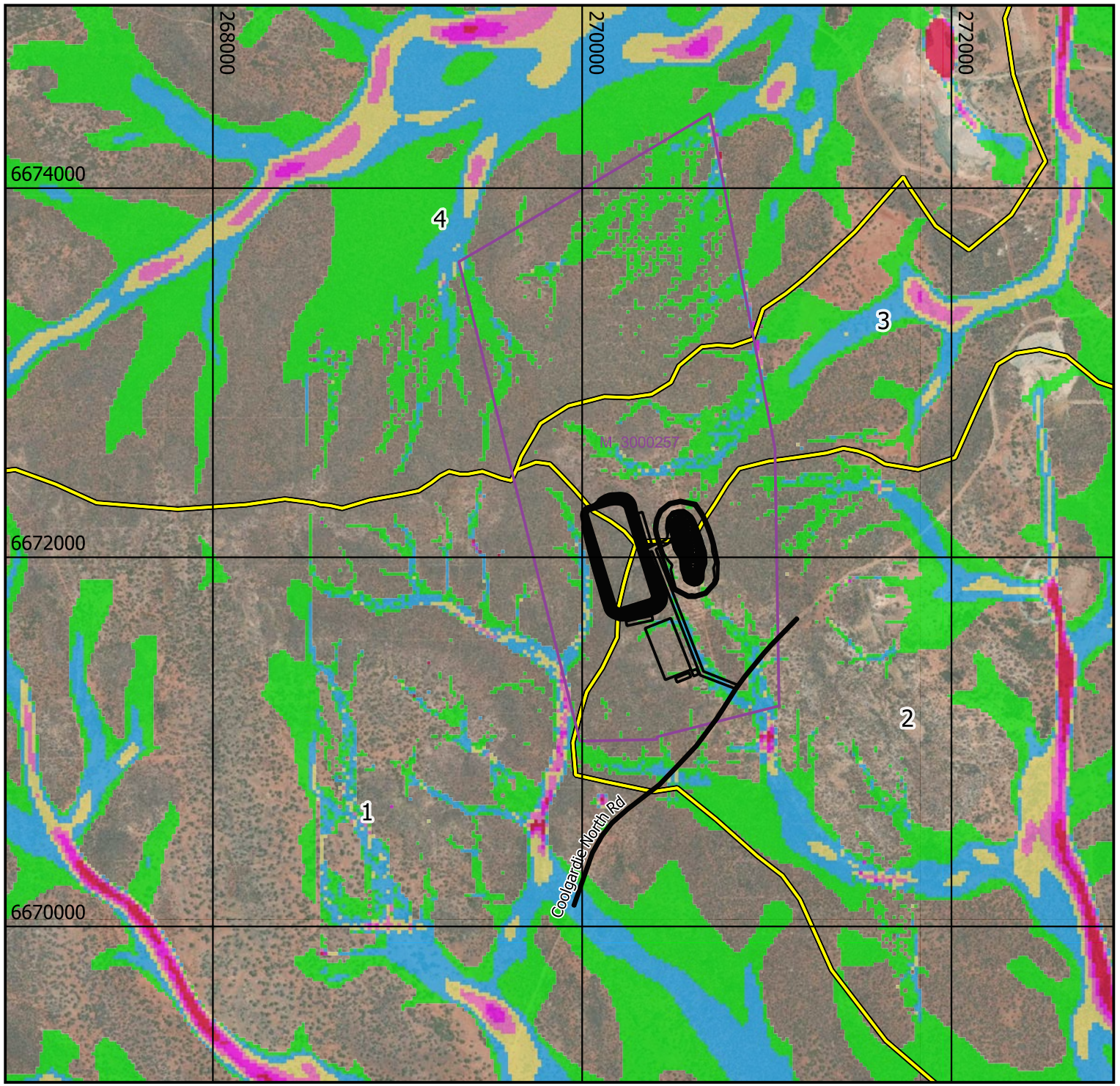
The ROM/Laydown/workshop area lies mid slope and away from concentrated flow. The access road past the pit to the Coolgardie North Road lies near and crosses a minor drainage line. Stormwater impinging on earthworks associated with this infrastructure can be managed using shallow drains, land grading and small drainage structures (road crossings).

Stockpiles are located downslope of site infrastructure and don't interact with concentrated flow.

On project closure, roads and the ROM/laydown/workshop/office infrastructure will be removed, the ground surface reshaped similar to the pre-mining condition and rehabilitated. The topsoil stockpiles will be respread as part of the rehabilitation. The pit and waste dump will remain but will be internally drained and not interact with the landscape nor influence flooding in the area.

The modelling includes the effect of climate change on design rainfall for current conditions (2025). Design rainfall totals are forecast to increase by an additional 14% (long term SSPR-

4.5 scenario) by the year 2100. Stormwater flows will also increase proportionally but the flood risk profile during mine operation and for site landforms remaining after closure (the pit and waste dump), does not change.



Legend

- Infrastructure
- Tenement
- 1 Catchments

Depth (m)

- <= 0.05
- 0.01 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- > 0.5

Data source:
Imagery - ESRI
Tenements - Minstrel Resources
Catchments, model results - Hydrologia

Location



250K map sheet location



N

0 0.5 1 1.5 km

Hydrologia

Project: Golden Lode - Surface Water Assessment
Job No: J0100108

Figure 5
Existing flooding, 1% AEP

COMPILED: Hydrologia	DATE: 24/07/2025	LOCON: PERTH	A4	SCALE: 1:30 000
GDA 2020 MGA Zone 51	PLAN No: J0100108 Fig 04.pdf			
DOCUMENT NAME: J0100108 Map 04.qgz				

3. Potential environmental impacts

3.1 Introduction

This section presents an evaluation of potential impacts of the mine on the environment with respect to surface water and options for mitigation of impacts.

Assessment of impacts is split into two phases:

- Operational.
- Closure.

The operational phase includes construction through to the end of mining operations and site rehabilitation. The closure phase covers the site after mine closure is completed, final landforms are stabilised and the site is closed.

A risk assessment matrix formulated using guidelines given in DEMIRS (2025) is given in Appendix B.

3.2 Potential impacts during operation

Potential impacts during the mine operation include:

- Erosion of soil from disturbed areas, steep slopes and drainage infrastructure, leading to increased turbidity of stormwater discharged from the mine area.
- Contamination of stormwater from mining activities.
- Reduction in catchment area reducing flow to nearby downstream areas.

The site lies across the upper part of several catchments. There are no developed drainage lines that require permanent diversion and flood risk for site infrastructure is low (see Section 2.7).

Flow is away from the pit and waste dump so no external stormwater nor flood management is required.

Increased turbidity of stormwater discharged from the mine area

Flow across the remainder of the site occurs as overland flow or in shallow concentrated flow paths. Some flow will interact with the main haul road and ROM/offices area. This can be readily managed using standard stormwater drainage structures (shallow drains, land grading and haul road crossings).

Erosion from topsoil stockpiles, haul road and ROM/laydown area could occur if stormwater flow accumulates and flow velocities become too high. Excessive erosion, particularly at or close to outfalls from the site, could lead to increased turbidity of stormwater in drainage lines near the site. This risk can be managed using landform shape and grading and with appropriate management of stormwater across the landform.

Erosion from external slopes on the waste dump will be managed using a catch drain at the toe of the slope. The slopes will be progressively rehabilitated leading up to closure, which will help stabilise the slopes against erosion. The top of the waste dump will be internally drained. Stormwater ponding after heavy rainfall events will infiltrate and evaporate.

Stormwater falling within the pit safety bund will be directed into the pit or to sumps where it will be reused on site or allowed infiltration and evaporate.

Discharge of stormwater containing contaminants

Stormwater generated in specific areas of the site could become contaminated. The most likely contaminants that could enter the wider environment in the stormwater pathway are hydrocarbons, from fuel tank areas and workshops, and salt, accumulated from dust suppression using saline water.

Discharge of contaminated stormwater could impact on downstream values, including affecting native vegetation and pasture accessed by livestock and native animals.

The risk of hydrocarbon contamination can be managed using standard bunding design and rainfall exclusion for high risk areas, such as fuel tanks and workshops. Salt accumulation on roads can be managed in the road drainage network and with dilution.

Reduction in catchment area

Reduction in catchment area will occur during the life of the mine due to construction of temporary structures and areas with internal drainage and the phased construction of permanent structures. Permanent structures on closure that will be internally drained are the waste rock dump and pit.

The pit and waste dump extend into Catchments 1, 2 and 3 (catchments are mapped on Figure 3). The area of reduction relative to catchments around the site are detailed in Table 3.

Table 3 Catchment reduction

Catchment*	Area existing (km^2)	Area on closure (km^2)	Reduction (km^2)	Reduction (%)	Comment
1	33.4	33.3	0.1	0.3%	Area reduced by part of a waste dump.
2	11.7	7.2	0.2	2.2%	Area reduced part of the waste dump and pit.
3	7.2	11.5	0.1	0.8%	Area reduced part of the waste dump and pit.
4	25.4	25.4	0.0	0.0%	No reduction.
Total local catchments:	77.8	77.5	0.3	0.4%	

* Catchments are delineated on Figure 3.

The biggest reduction in catchment area associated with these structures is likely to occur close to the end of the mine's life.

Across all of the catchments, the total reduction in catchment area is 0.4%. This is a small component of stormwater flow. The effect will also rapidly diminish with further distance downstream.

The risk of impact on the wider environment is low.

3.3 Potential impacts after closure

On closure most site infrastructure, including roads, ROM, laydown, workshop and office infrastructure will be removed and the site rehabilitated. Topsoil stockpiles will be respread as part of the rehabilitation.

The pit and waste dump will remain but will be internally drained and not interact with the external landscape. These structure are at low risk from flooding and there is a low risk of impact on water quality in surrounding drainage lines.

The main potential residual impacts on the environment will be reduction in catchment area due to internal drainage of the waste dump and pit. This is described in Section 3.2. Impact on the wider environment is considered to be low.

The changing climate is unlikely to substantially change the environmental risk profile for the project area after closure. The intensity of rainfall events is forecast to increase and the weather could become hotter and variably wetter (Western Australia Government 2025b). However, this is unlikely to change the interaction between site landforms and the environment.

4. References

ARR (2025). ARR Data Hub. https://data.arr-software.org/. Accessed 27 May 2025.

Australian Government (2025). Australian Ramsar Wetlands. https://www.dcceew.gov.au/water/wetlands/australian-wetlands-database/australian-ramsar-wetlands. Accessed 23 July 2025.

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors). (2019). Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia.

BOM (2025a). Western Australia Observations. http://www.bom.gov.au/wa/observations/. Australian Government, Bureau of Meteorology. Accessed 27 May 2025.

BOM (2025b). 2016 Rainfall IFD Data System. http://www.bom.gov.au/water/designRainfalls/revised-ifd/. Australian Government, Bureau of Meteorology. Accessed 27 May 2025.

BOM (2025c). Köppen system. http://www.bom.gov.au/jsp/ncc/climate_averages/climate-classifications/index.jsp. Australian Government, Bureau of Meteorology. Accessed 27 May 2025.

CSIRO (1991). Digital Atlas of Australian Soils. http://www.asris.csiro.au/themes/Atlas.html#Atlas_Digital. Australian government, CSIRO.

DEMIRS (2025). Guideline for preparing Mining Development and Closure Proposals. Government of Western Australia, Department of Energy, Mines, Industry Regulation and Safety. Version 2.0, May 2025.

DHI (2025). Mike software. https://www.mikepoweredbydhi.com/products. Mike powered by DHI.

DWER (2025). Surface Water Management Areas. https://catalogue.data.wa.gov.au/dataset/surface-water-management-areas. Government of Western Australia, Department of Water and Environmental Regulation. Accessed 27 May 2025.

EPA (2018). Environmental Factor Guideline. Inland Waters. https://www.epa.wa.gov.au/policies-guidance/environmental-factor-guideline-inland-waters. Government of Westerns Australia, Environmental Protection Agency.

GA (2011). 1 second SRTM. https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search?node=srv#/metadata/72759. Australian Government: Geoscience Australia. Accessed 22 May 2025.

GA (2012). Surface Geology of Australia 1:1 million scale dataset 2012 edition. Australian Government, Geoscience Australia. https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search?node=srv#/metadata/c8856c41-0d5b-2b1d-e044-00144fdd4fa6.

Queensland Government (2025). SILO Data Drill. https://silo.longpaddock.qld.gov.au/. Accessed 29 May 2025.

Western Australia Government (2025). Environment Online. https://environmentonline.dwer.wa.gov.au/. Accessed 23 July 2025.

Western Australia Government (2025b). Western Australia Climate Projections. https://www.wa.gov.au/service/science/earth-sciences/wa-climate-projections. Accessed 24 July 2025.

Appendices

Appendix A – Model parameter values

Mike SHE hydrology model

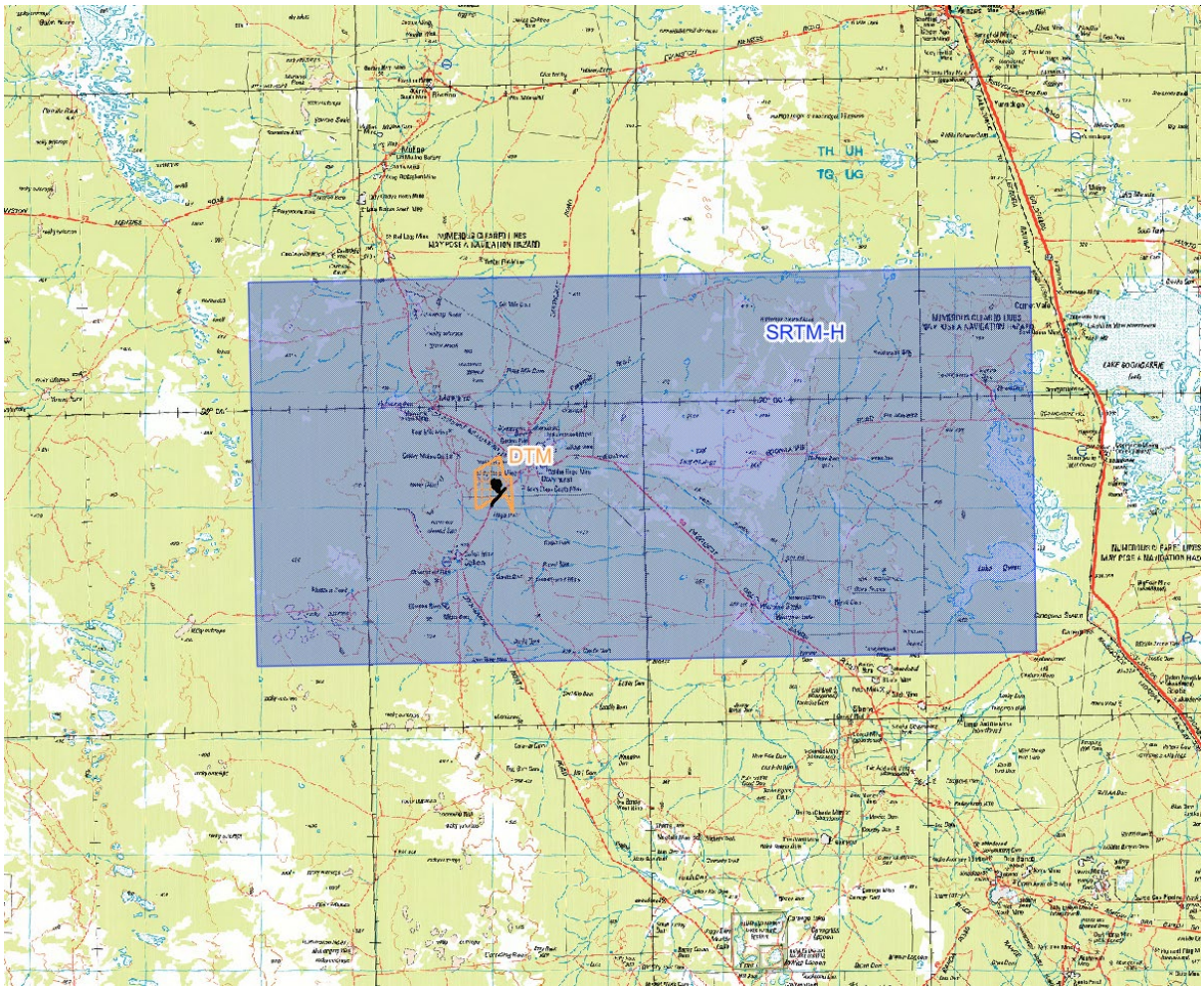
Software:

Mike SHE release 2025.

Simulation specification:

- Domain covered the area of catchments across the site and upstream.
- Overland flow represented using Mike SHE and rain-on-grid, 20 m square grid, topography derived from Landgate DEM.
- Mike SHE overland flow resistance: Manning's M of 20 (Manning's n = 0.05).
- Design rainfall:
    - Rainfall areally reduced for a 10 km^2 catchment, applied on-grid;
    - Design rainfall from 2016 IFD data (BoM 2025b) modified for climate change scenario Current and near term (2025) SSP2-4.5;
    - Critical temporal pattern: Site - 1% AEP: 3 h Pat01.
- Loss model:
    - 2 Layer UZ and evapotranspiration.
    - Evaporation 10.9 mm/day.
    - Detention storage: 1% AEP: 20.0 mm.
    - UZ hydraulic conductivity varyied with soil type: 1.0 mm/h (rocky), 2.5 mm/h (ferruginous duricrust), 3.0 mm/h (alluvium), 10.0 mm/h (sand).

Topographic data extents



Appendix B – Risk Assessment Matrix

Potential impacts	Potential risk*			Proposed management measure and control	Residual risk	Action
	L	C	R			
During mining operation:						
Deterioration of quality of stormwater in drainage lines.	P	Mi	M	Landform design and stormwater management, bunding of fuel and oil areas.	L	Incorporate into site landform and drainage design.
Reduction in flow to downstream drainage lines associated with internal drainage of the pit and waste dump.	P	I	L	Minimise internally drained footprint.	L	Incorporate in waste dump and pit design.
Flood risk for operational mine assets.	R	I	L	Pit safety bunding.	L	Pit design.
After mine closure:						
Deterioration of quality of stormwater in drainage lines.	R	Mi	L	Landform design.	L	Site rehabilitation. Waste dump design.
Reduction in flow to downstream drainage lines associated with internal drainage of the pit and waste dump.	P	I	L	Minimise internally drained footprint.	L	Incorporate in waste dump and pit design.
Flood risk for operational mine assets.	R	I	L	Pit safety bunding.	L	Pit design.

* L denotes likelihood, C consequence, R risk rating.
Likelihood: R - Rare, U - unlikely, P - possible, L - likely and A - almost certain.
Consequence: I - Insignificant, Mi - Minor, Mo - Moderate, Ma - Major and C - catastrophic. Likelihood: R - Rare, U - Unlikely, P - Probable, L - Likely and A - Almost Certain.
Risk Categories: L - Low: acceptable, M - Medium: tolerable/acceptable - requires management, H - High: intolerable/unacceptable - requires high level of management; E - Extreme: unacceptable - discard activity.