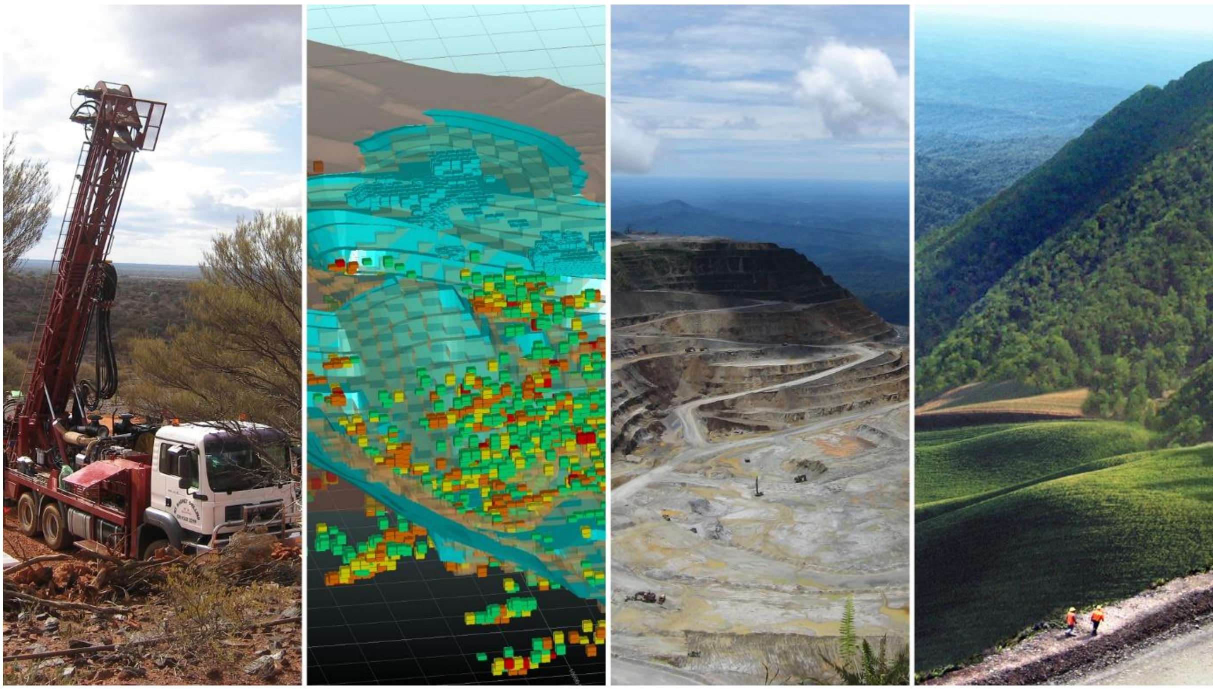
Yogi Stage 1 concept surface water management study

Yogi Magnetite Project, Yalgoo Western Australia

FI Joint Venture Pty Ltd



SRK Consulting (Australasia) Pty Ltd ▪ FIJ006 ▪ May 2022

Yogi Stage 1 concept surface water management study

Prepared for:
FI Joint Venture Pty Ltd
Level 14, ST George's Terrace
Perth, WA, 6000
Australia

+61 8 9485 0579
https://fijv.com.au/

FIJV

Prepared by:
SRK Consulting (Australasia) Pty Ltd
Level 3, 18–32 Parliament Place
West Perth, WA, 6005
Australia

+61 8 9288 2000
www.srk.com

ABN. 56 074 271 720

Certified System ™
Quality
ISO 9001

Lead Author Johan Hattingh, Consultant **Initials:** JH
Reviewer: Juanita Martin, Principal Consultant **Initials:** JM

File Name:
FIJ006_Yogi Stage 1 concept surface water management_Rev3.docx

Suggested Citation:
SRK Consulting (Australasia) Pty Ltd. 2022. Yogi Stage 1 concept surface water management study. Final. Prepared for FI Joint Venture Pty Ltd: Perth, WA. Project number: FIJ006. Issued May. 2022.

srk consulting

Contents

Tables

Figures

1 Introduction

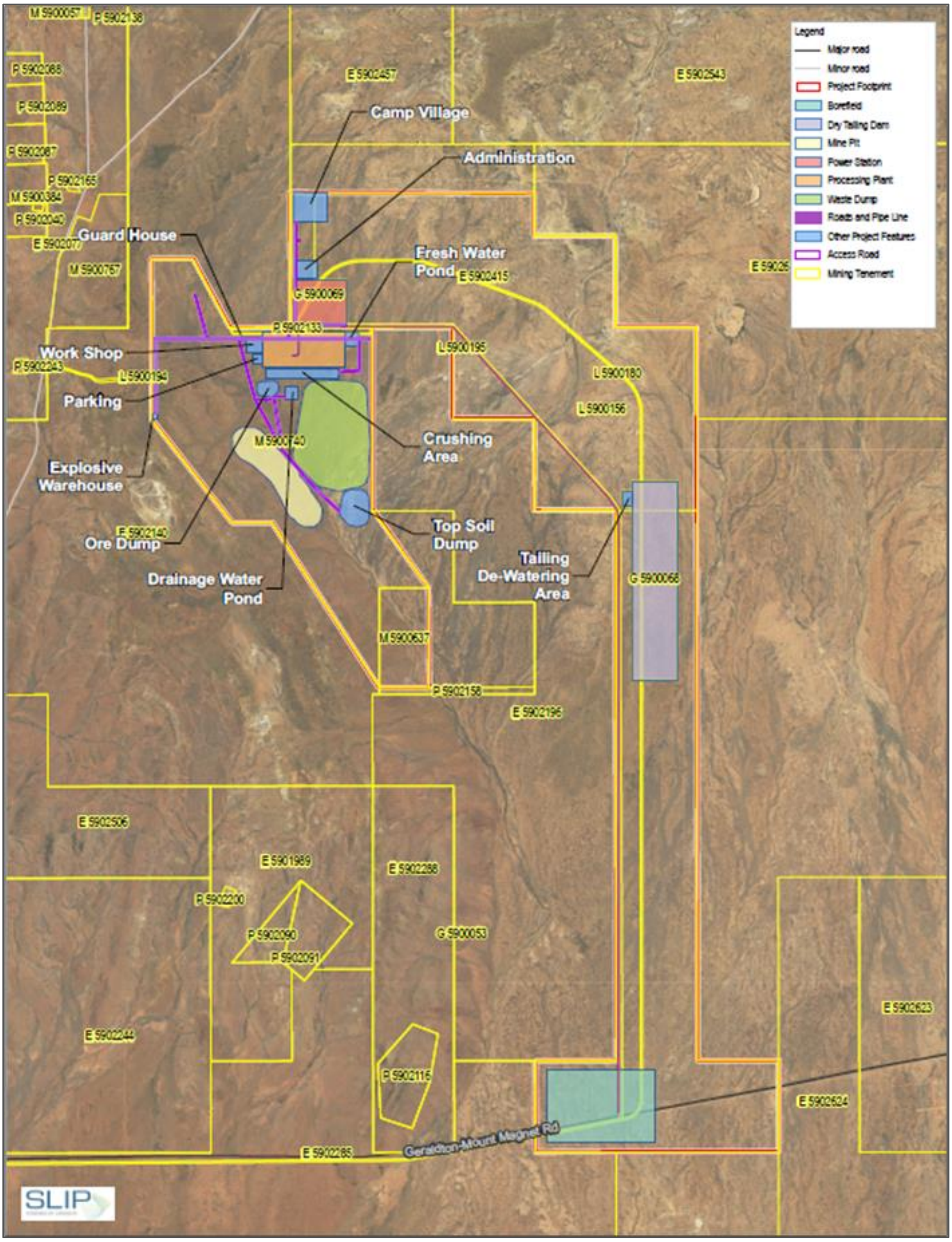
FI Joint Venture Pty Ltd (FIJV) engaged SRK Consulting (Australasia) Pty Ltd (SRK) to update the Yogi Magnetite Project (the Project) Stage 1 concept surface water management study issued in February 2022 by using the March 2022 LiDAR survey as the base topography and incorporating the latest haul road and access road layout.

The Yogi Magnetite Project is located approximately 17 km northeast of the Yalgoo townsite, in the Mid West region of Western Australia, 220 km east-northeast of Geraldton.

Stage 1 mining plans involve the development of an open pit and an associated waste rock dump (WRD), a power station, a processing plant and a dry stack tailings storage facility (TSF), as well as additional infrastructure including an explosives warehouse, guard house, drainage water pond, tailings de-watering area, crushing area, topsoil dump, ore dump, parking, administration, fresh water pond, workshop, camp village and bore field as depicted in Figure 1.1.

The surface water management design for the bore field and the internal drainage for all infrastructure have been excluded from this study. Only perimeter bunds have been considered.

Figure 1.1: Yogi conceptual Stage 1 site layout



Source: Email from Benjamin Sambell on 17 December 2021

2 Basis of design

2.1 Climatic information

The climate of the site is classified as warm and temperate with an average annual rainfall of 258 mm recorded at the nearest Bureau of Meteorology (BoM) Station 007091 in Yalgoo (BoM, 2022), which is located 15 km southwest of the site.

Evaporation is not recorded at Yalgoo station, nor at any other available weather stations within 100 km of the site. As such, SILO synthetic pan evaporation data for Yalgoo 7091 station (1970–2021) has been used for the purpose of this study. Total average annual pan evaporation is 2,700 mm, with average monthly evaporation far exceeding rainfall.

Monthly average precipitation and evaporation data are shown in Table 2.1.

Table 2.1: Average monthly pan evaporation and rainfall data for Yalgoo (BoM Station 007091)

Month	Rainfall (mm)[1]	Pan evaporation (mm)[2]
January	15.8	384.7
February	25.0	321.2
March	25.0	291.7
April	20.7	192.5
May	31.6	130.8
June	41.3	89.0
July	34.8	90.0
August	25.5	116.1
September	11.7	166.9
October	8.2	246.7
November	8.0	304.5
December	11.9	365.6
Annual	**258.0**	**2,700**

Sources:
[1] BOM weather station 007091 (available online, issued 5 April 2022)
[2] Evaporation data sourced from the SILO data downloaded from https://www.longpaddock.qld.gov.au/silo/point-data/ on 5 April 2022.

2.2 Rainfall intensity-frequency-duration relationship

Intensity-frequency-duration (IFD) relationships were sourced from BoM, as recommended by *Australian Rainfall and Runoff: A Guide to Flood Estimation* (ARR) (Ball et al., 2019). The IFD relationships for the Project, corresponding to the Project location (the nearest IFD grid cell coordinates are 28.21° S 116.81° E), are presented in Table 2.2.

Table 2.2: IFD relationship

IFD rainfall depth (mm)						
Duration	Annual exceedance probability (AEP) (%)					
	50%	20%	10%	5%	2%	1%
10 min	6.76	10.7	13.8	17.1	22.1	26.3
20 min	9.57	15.2	19.5	24.3	31.3	37.4
30 min	11.4	18.1	23.3	28.9	37.4	44.7
45 min	13.4	21.2	27.3	34	44	52.7
1 hour	14.9	23.6	30.4	37.8	49.1	58.9
2 hours	19.1	30.2	38.8	48.3	62.8	75.4
3 hours	22	34.7	44.6	55.5	72	86.4
6 hours	27.9	43.7	56.2	69.8	90.1	108
12 hours	34.4	53.9	69.3	86.2	110	131
24 hours	40.7	63.8	82.1	102	130	153
48 hours	45.4	71.5	92.1	115	145	169
72 hours	47.5	74.7	96.1	120	151	176

Sources: Bureau of Meteorology, 2016. Rainfall IFD Data System (coordinates 28.21° S 116.81° E), issued 25 March 2022.

2.3 Design parameters

The recommended relevant surface water design criteria are shown in Table 2.3, with the selected events that are considered appropriate for this level of study. These design criteria should be revised in the following stages of design once the Project risks are better defined.

Table 2.3: Surface water design criteria

Parameter	Design criteria	Comments
Flood assessment events	▪ 1% AEP ▪ 5% AEP	Assumed by SRK
Design storm for channels and bunds	1% AEP	Assumed by SRK
Design storm for sediment ponds	24 h, 10% AEP	Assumed by SRK
Minimum freeboard	0.3 m	Assumed by SRK
Channel and bunds side slopes	1V:2H[1]	To be verified at a later stage
Minimum channel slope	0.2%	To promote flow

[1] V:H = vertical to horizontal ratio

The side slopes of bunds and channels should be checked and designed for slope and erosion stability at a later stage (depending on final geometry and material used).

3 Catchment areas

The proposed Yogi mine site is located within the Yarra Yarra Basin, which forms part of what is referred to as the Moore-Monger or Yarra-Monger Drainage Basin System. The Yarra Yarra basin is characterised by flat to gradual slopes, ephemeral streams with intermittent flow and salt pans or salt playas along the flow lines (GHD, 2019).

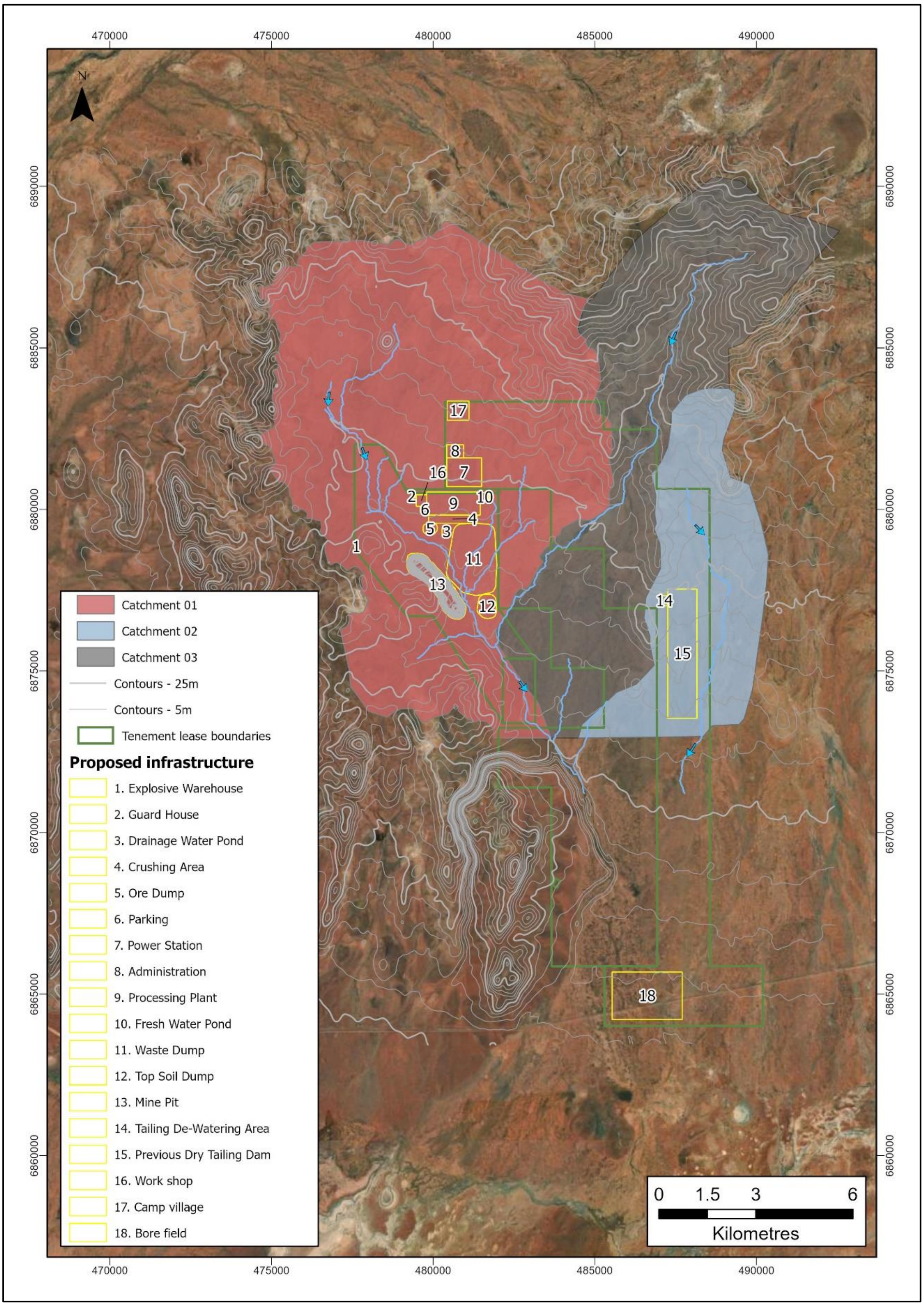
There are no permanent surface water bodies near the site due to limited rainfall and high evaporation rates (Section 2.1). There are two non-perennial streams that intersect the mining tenement, these being the Western primary watercourse and the Eastern primary watercourse. Both these watercourses discharge south into the Salt River. These watercourses divide the tenement into three distinct catchment areas.

The catchments and their infrastructure distribution for the Stage 1 Yogi mining areas are presented in Table 3.1 and Figure 3.1. The values provided in Table 3.1 are based on the topography provided and do not reflect proposed surface water infrastructure.

Table 3.1: Catchment areas

Catchment	Catchment area (ha)	Infrastructure
Catchment 1	11,697	Pit, WRD and general infrastructure
Catchment 2	3,516	TSF
Catchment 3	6,120	No infrastructure located in this sub-catchment
Total	**21,333**	

Figure 3.1: Yogi mining catchments



4 Flood assessment

4.1 Stream flood analysis

The flood extents were estimated using a two-dimensional (2D) unsteady flow model, with precipitation applied directly to the 2D flow area as a time-series of rainfall depths. The model was developed using the U.S Army Corps of Engineers' *Hydraulic Engineering Centre River Analysis System* (HEC-RAS) Version 6.1 software.

4.1.1 Model controls

The March 2022 Lidar topographic data for the entire catchment area covering the tenement lease boundary were provided by FIJV for the flood assessment. A diversion channel north of the pit and between the pit and WRD have been included in the models to intercept and divert excessive surface runoff. Bunding at the boundaries of the infrastructure of interest have also been included in the models to prevent flows from entering the infrastructure areas.

The pit design has been provided by FIJV and integrated with the topographical LIDAR survey.

Based on the review of the aerial imagery and site inspection photographs, a constant overland flow Manning's value of 0.05 was adopted across the entire Yogi development area. The Manning's value was denoted in Table 2.1 of the USACE HEC Manual (2020) as 'flood plains – scattered brush, heavy weeded flood plain'.

The 2D computational mesh for the flow area was built using a maximum grid size of 10 m × 10 m, which was found to adequately characterise the flat terrain and the water surface slope. The model was run for 24 hours to capture the maximum flood depth and velocity in the areas of interest. It should be noted that HEC-RAS Version 6.1 uses a different approach to other hydraulic models, in which each grid cell is not a simple plane but is assigned an elevation–volume/area relationship that represents the underlying surface topography. The grid was refined using breaklines along the natural drainage paths, and the perimeters of the pit, WRD and other general infrastructure. A time-step of 10 seconds was selected, which was appropriate for providing numerically stable and accurate solutions for the mesh size and the maximum velocities modelled.

4.1.2 Boundary conditions

The inflow boundary condition was represented as precipitation applied directly to the 2D flow areas as a time-series of rainfall. The model was run with each of the following rainfall events:

- 1% AEP
- 5% AEP.

The estimated time of concentration for each catchment is provided in Table 4.1. It should be noted that a time of concentration was not estimated for Catchment 3 as none of the mine infrastructure is located in Catchment 3.

Table 4.1: Time of concentration

Catchment	Estimated time of concentration (minutes)	Infrastructure
1	180	Diversion channel
	120	Pit, WRD, ore dump, topsoil dump and general infrastructure
2	90	TSF dewatering area
	120	TSF

The 10 temporal patterns ensemble provided in the Australian Rainfall and Runoff (ARR, 2019) Data Hub were modelled for each rainfall event. The temporal pattern one up of the average peak flows has been presented which is in line with the Australian Rainfall and Runoff (ARR, 2019) Data Hub recommended methodology.

The Yogi development area is located within the arid region of Australia, with annual rainfall less than 350 mm (Ball et al., 2019). ARR does not provide recommended loss values for this region as the equations developed to estimate initial and continuing losses were developed using data from wetter catchments (Ball et al., 2019). The loss values provided in Table 4.2 were adopted from the Australian Rainfall and Runoff (ARR, 2019) Data Hub for the area 230 km west of the site. Only half the losses have been applied to the design rainfall events, providing a conservative estimate of peak flows.

Table 4.2: Loss types and values

Loss type	Value
Initial loss (mm)	30
Continuing losses (mm/h)	2

The outflow boundaries were modelled using the normal depth method selected to represent the natural slopes for the topography at the outlet of each area.

The absence of stream gauging stations in the vicinity of the Project area do not make calibration of the model possible.

4.1.3 Flood extents

The estimated flood extents for the site are presented in Figure 4.1 to Figure 4.4. The flood extents represent the maximum estimated flood area under design storm conditions. The stream flood analyses are also provided including the maximum estimated depth, flow and velocities under design storm conditions.

Pertinent stream cross sections were selected for the presentation of results and their locations are included in the flood extent maps (Figure 4.1 to Figure 4.4). It is noted that the cross sections where flows are measured are placed to capture the entire width of the stream (more than 30 m in length) at the boundary of the infrastructures of interest. Flows should be managed by considering the bunds, bunds coupled with channels and sediment ponds. The modelled peak flows, velocities and water depths for the 1% AEP flood event are summarised in Table 4.3, and results for the 5% AEP event are included in Table 4.4.

Table 4.3: Flood analysis results for the 1% AEP event

Cross section	Location	Time to Maximum flow (hours)	Maximum flow (m^3/s)	Maximum velocity[1] (m/s)	Maximum water depth[1] (m)
ID1	Camp Village	2.4	8	0.9	0.6
ID2	Administration	1.7	<1	0.6	0.5
ID3	Power station	2.3	2	0.4	0.7
ID4	Fresh Water Pond	3.2	14	0.8	0.5
ID5	Processing plant	0.7	2	0.5	0.7
ID6	Workshop	3.0	6	0.7	0.6
ID7	Guard house	3.0	3	0.5	0.6
ID8	Cruising area	3.0	17	0.6	0.7
ID9	Ore dump	1.8	<1	0.2	0.2
ID10	Drainage water pond	2.3	4	0.6	0.3
ID11	WRD	3.4	39	1.0	0.8
ID12	Topsoil dump	3.6	30	0.9	0.7
ID13	Mine pit	1.6	12	1.3	0.8
ID14	Explosives Warehouse	1.2	<1	0.4	0.2
ID15	Tailings de-watering area	1.8	<1	0.3	0.3
ID16	Dry tailings dam	2.0	7	0.5	0.6
ID17	Parking	1.5	<1	0.3	0.2
ID18	Channel 01	5.0	233	1.9	3.8
ID 19	Channel 02	3.0	60	1.2	2.3
ID 20	Channel 02	3.0	52	1.2	2.5
ID 21	Channel 03	3.3	38	1.0	1.0

[1] Maximum velocity and depth are taken around the respective infrastructure, except for the WRD/mine pit location, where the values are taken at the cross section.

Table 4.4: Flood analysis results for the 5% AEP event

Cross section	Location	Time to Maximum flow (hours)	Maximum flow (m^3/s)	Maximum velocity[1] (m/s)	Maximum water depth[1] (m)
ID 1	Camp village	3.0	4	0.6	0.5
ID 2	Administration	2.0	<1	0.2	0.4
ID 3	Power station	3.5	<1	0.2	0.3
ID 4	Fresh water pond	4.0	6	0.6	0.4
ID 5	Processing plant	3.5	<1	0.2	0.5
ID 6	Workshop	5.0	2	0.2	0.4
ID 7	Guard house	2.5	<1	0.5	0.3
ID 8	Crushing area	4.5	6	0.4	0.4
ID 9	Ore dump	2.0	<1	0.2	0.1
ID 10	Drainage water pond	3.0	1	0.4	0.2
ID 11	WRD	5.0	18	0.6	0.7
ID 12	Topsoil dump	5.0	16	0.6	0.5
ID 13	Mine pit	2.5	6	0.6	0.5
ID 14	Explosive warehouse	2.0	<1	0.2	0.1
ID 15	Tailings de-watering area	1.8	<1	0.2	0.4
ID 16	Dry tailings dam	3.0	2	0.4	0.2
ID 17	Parking	1.5	<1	0.2	0.1
ID 18	Channel 01	5.0	150	0.8	1.8
ID 19	Channel 02	4.2	13	0.6	1.4
ID 20	Channel 02	4.2	12	0.6	1.5
ID 21	Channel 03	5.1	10	0.7	0.7

[1] Maximum velocity and depth are taken around the respective infrastructure, except for the WRD/mine pit location, where the values are taken at the cross section.

Figure 4.1: 1% AEP maximum depth

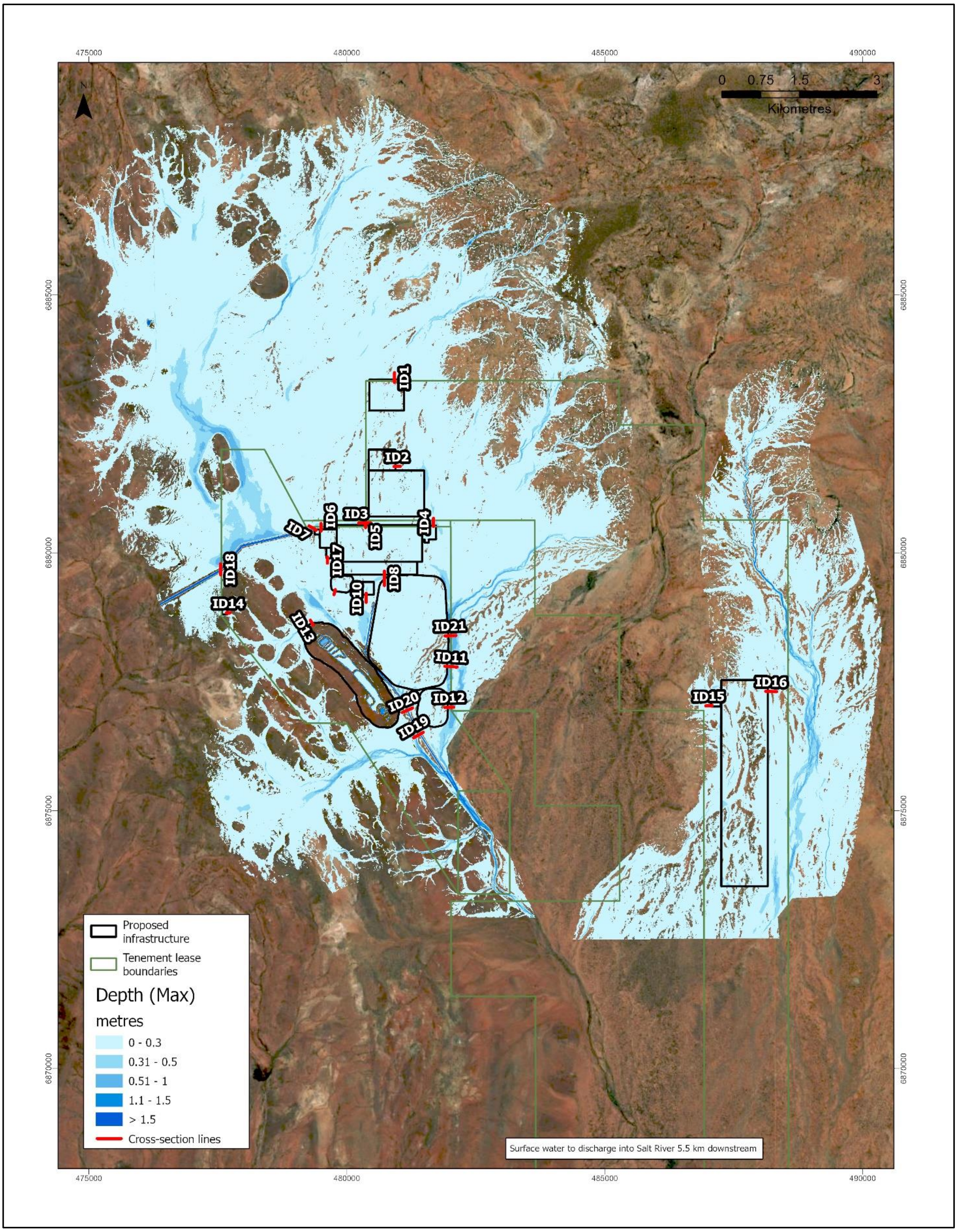


Figure 4.2: 1% AEP maximum velocity

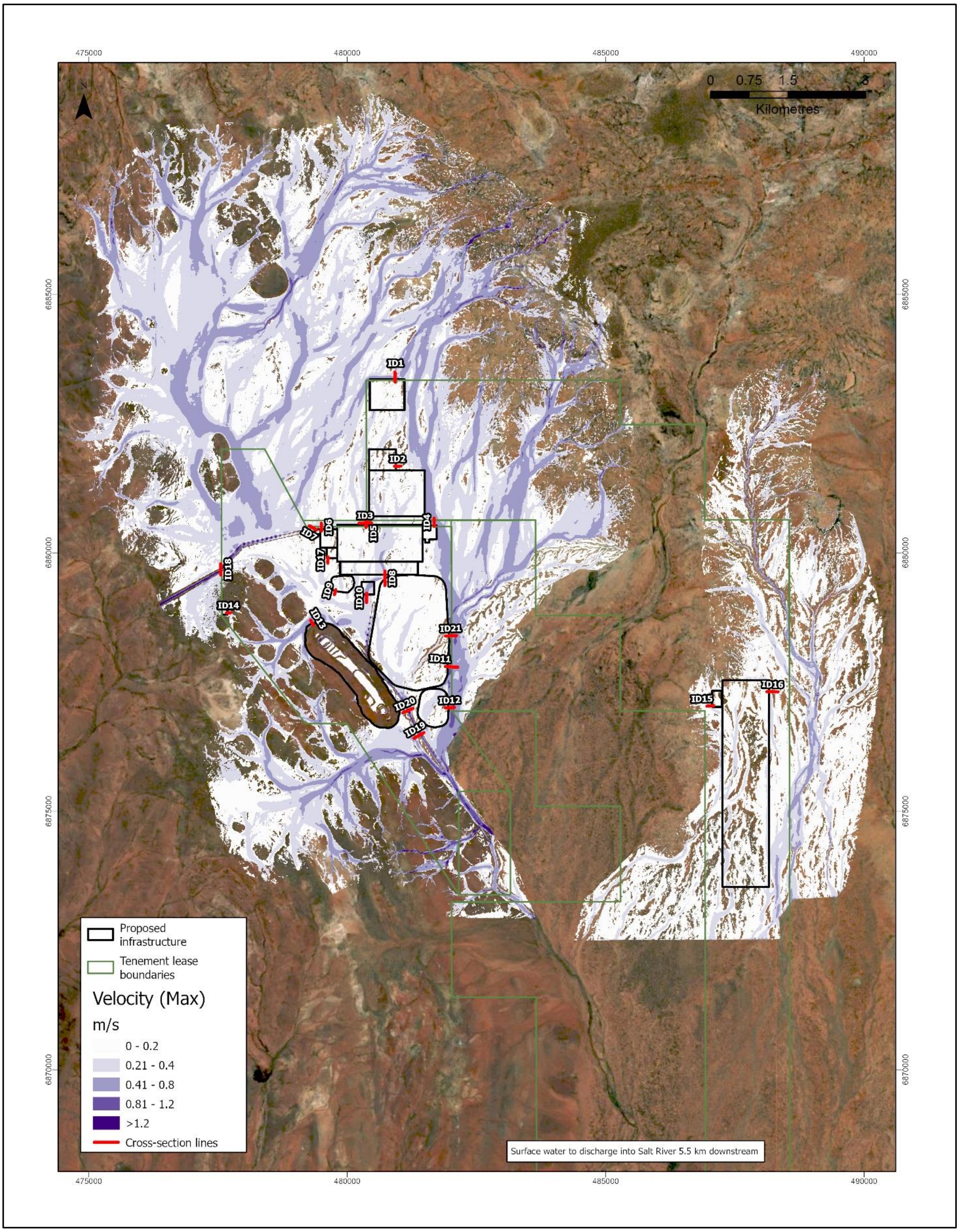


Figure 4.3: 5% AEP maximum depth

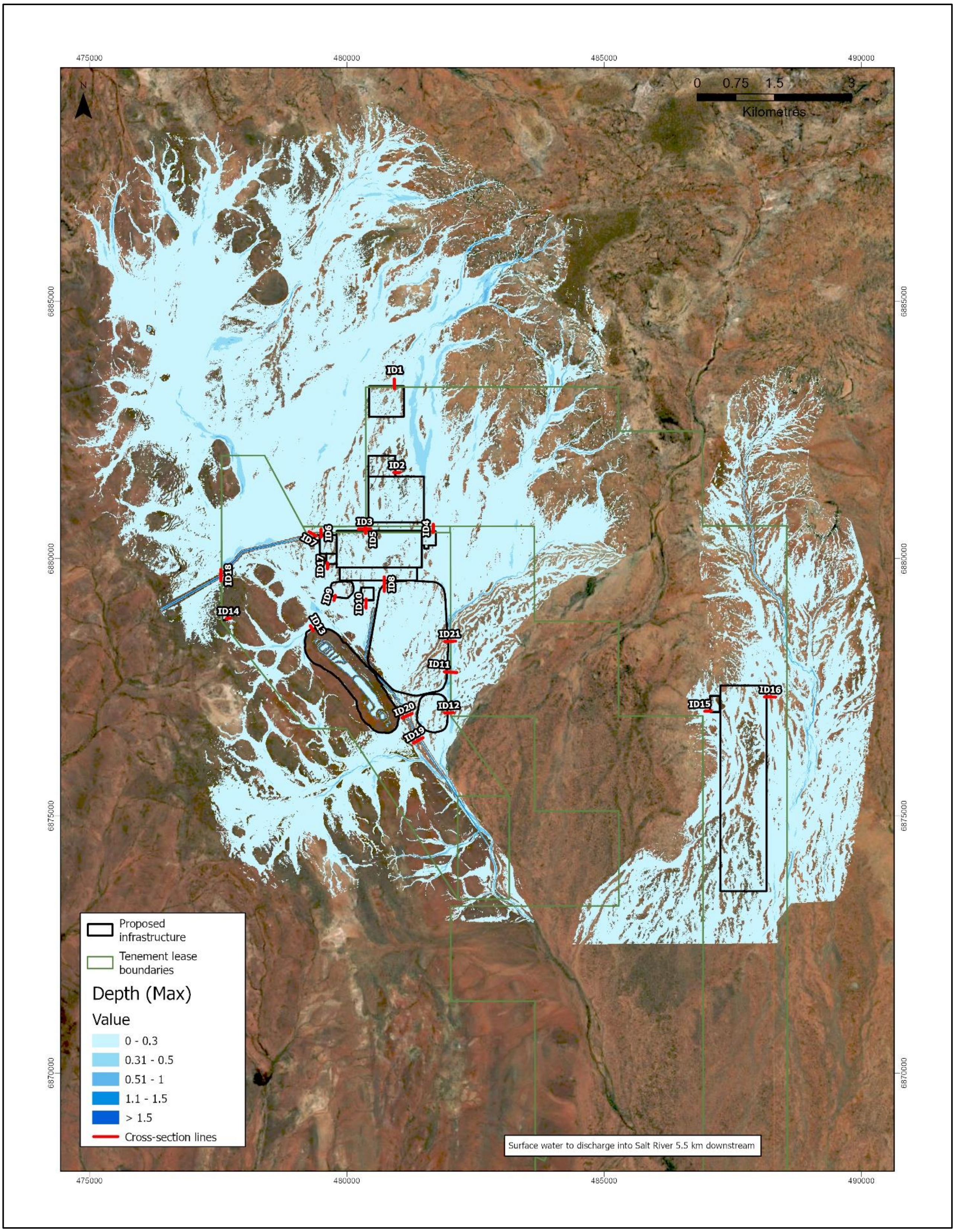


Figure 4.4: 5% AEP maximum velocity

5 Surface water infrastructure

The primary objective for surface water management at the Project is to keep clean water clean and direct contacted water to appropriate containment systems for later release. Several water management strategies have been proposed using diversion and collection structures.

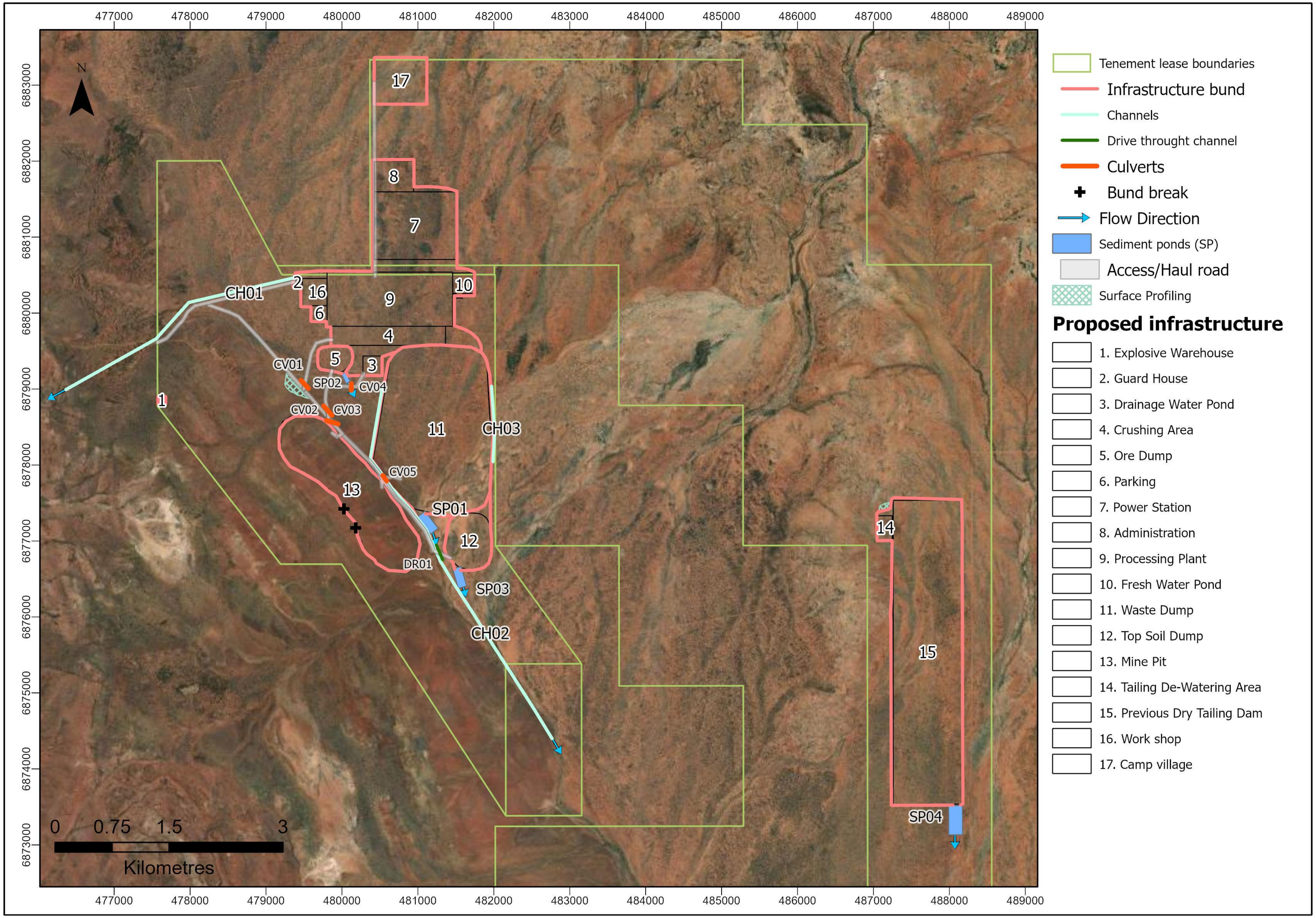
The proposed surface water management system for the site is as follows:

- channel 20 m north of the main access road to divert surface runoff west around the site
- two channels to convey water between the pit and WRD to the downstream area and along the WRD eastern bund
- bunds upstream of the pit to prevent surface runoff from flowing into the pit
- bund breaks at critical locations along the pit rim to prevent water ponding against the pit bund
- bunds around the WRD, ore dump, topsoil dump and TSF to collect runoff and direct it to the sediment ponds
- bunds surrounding all general surface infrastructure to divert surface runoff
- five culverts to direct runoff across the haul road at various locations
- one drive through channel to convey runoff across the haul road
- sediment ponds to store the potentially impacted water from the WRD, ore dump, topsoil dump and TSF internal catchment areas which allow for the settling of sediments, and eventually for any potential treatment or sampling, before release to the environment
- surface profiling to prevent long-term water ponding.

The configuration of the proposed surface water management system is shown in Figure 5.1. It is expected that surface water management infrastructure will be monitored during the mine life, and sampling for total suspended solids (TSS) will be undertaken to determine the post-closure infrastructure requirements.

It should also be noted that the diversion channel north of the main access road has to discharge outside of the mining tenement and a significant cut through the hill along the east is required.

Figure 5.1: Stage 1 Yogi conceptual surface water management system

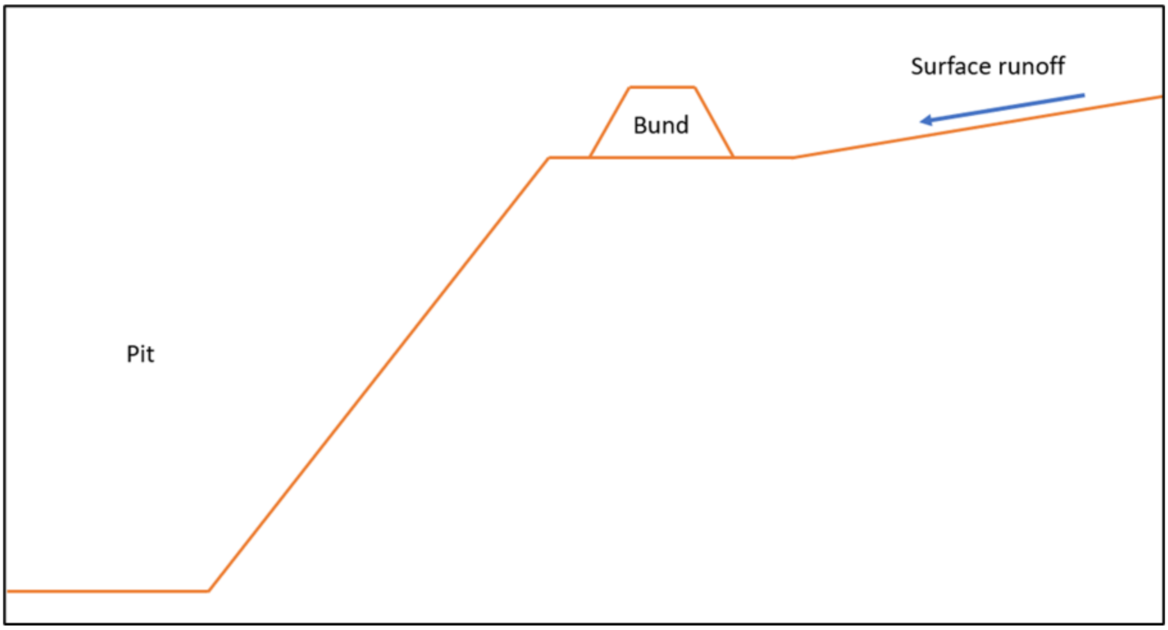


5.1 Pit bunds

Bunds as shown in Figure 5.1 should be constructed along the crest line of the pit to collect and divert runoff from the upper catchment area.

Conceptual designs for the pit bunds cater for the 1% AEP flood event. A schematic of a typical section is presented in Figure 5.2.

Figure 5.2: Schematic of a typical pit bund section



The concept design of the pit bunds has taken into consideration the surface water management system proposed and shown in Figure 5.1 to estimate the bund height required. Bunds were considered with crests 0.5 m wide and with side slopes of 1V:2H.

The minimum estimated pit bund height to accommodate the runoff from the 1% AEP event is 1.1 m which includes a freeboard of 0.3 m. It is noted that varying bund heights have not been considered in this study. It is possible that the minimum bund height required at some areas could be lower.

5.2 Bund breaks

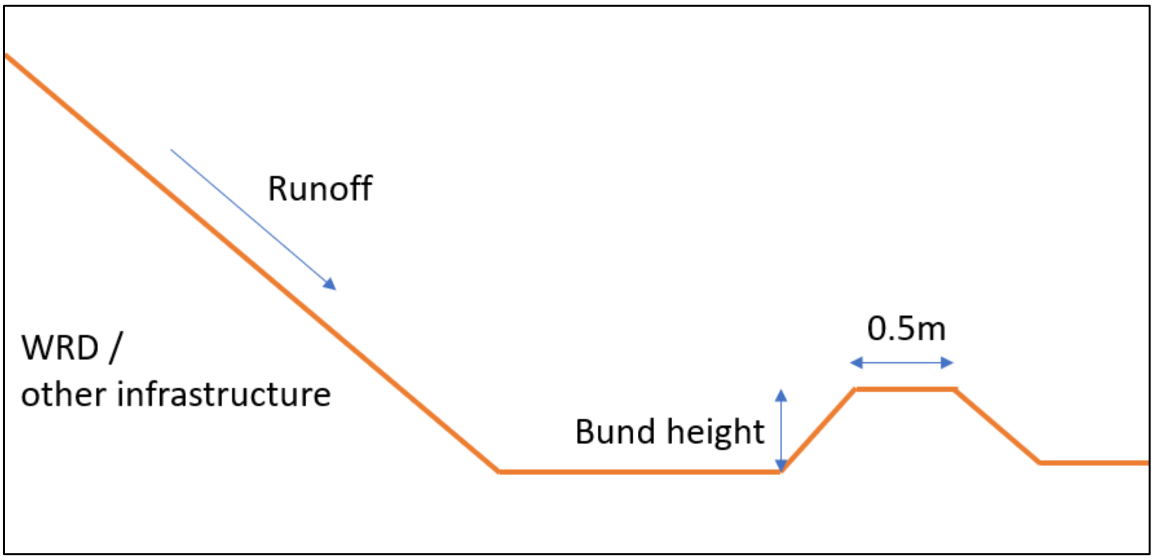
Two breaks in the bund along the western side of the pit are required to avoid ponding of water against the bund. The bund break locations are shown in Figure 5.1.

5.3 WRD, ore dump, topsoil dump, TSF and infrastructure bunds

Bunds should be constructed around all general surface infrastructure to divert clean surface runoff. Bunds are also required around the toe of the WRD, ore dump, topsoil dump and TSF to collect runoff and direct the contacted water to the sediment ponds.

Conceptual designs for the bunds cater for the 1% AEP flood event. Minimum distances between the toe of the infrastructure and the bunds should be confirmed during the next design stage. A schematic of a typical section is presented in Figure 5.3.

Figure 5.3: Schematic of a typical WRD, ore dump and topsoil dump bund section



The concept design of the WRD, ore dump, topsoil dump, TSF and general surface infrastructure bunds has taken into consideration the surface water management system proposed and shown in Figure 5.1 to estimate the bund height required. Bunds were considered with crests 0.5 m wide and with side slopes of 1V:2H.

The minimum estimated bund heights to accommodate the runoff from the 1% AEP event are listed in Table 5.1. It is noted that varying bund heights, within a location, have not been considered in this study. It is possible that the minimum bund height required at some areas could be lower.

Table 5.1: Infrastructure bund height

Location	Bund height[1] (m)
Camp village	0.9
Administration	0.8
Power station	1.0
Fresh water pond	0.8
Processing plant	1.0
Workshop	0.9
Guard house	0.9
Crushing area	1.0
Ore dump	0.5
Drainage water pond	0.6
WRD	1.1

Location	Bund height[1] (m)
Topsoil dump	1.0
Mine pit	1.1
Explosive warehouse	0.5
Tailings dewatering area	0.6
tailings dam	0.9
Parking	0.5

[1] Bund heights include 300 mm freeboard

5.4 Surface profiling

Surface profiling is required at two locations along the haul road and TSF to prevent the surface runoff from ponding along the haul road and TSF bunds. The preliminary locations requiring surface profiling are shown in Figure 5.1. Surface profiling may consist of a combination of cut (channels) and fill of a total volume of approximately 72,000 m^3.

Surface profiling will also be required along the inside toe line of the WRD, ore dump, topsoil dump and TSF to facilitate surface runoff towards the sedimentation ponds.

5.5 Channels

Three channels are required across the site to direct surface water in areas where increased runoff is expected. Figure 5.1 shows the locations of the channel. Channels are offset 20 m from bunds, access roads and haul roads where space allows.

Conceptual designs for the channels cater for the 1% AEP flood event. The flood estimates shown in Table 5.2 were taken from the model and used to inform the concept design of the diversion channels. The flood estimates are also presented in Table 4.1.

The typical channel layout was sized using the Manning equation. The inputs were channel gradients, peak flows and a freeboard allowance of 300 mm. Side slopes for the channels have been assumed as 1V:2H as per Section 2.3. Table 5.2 summarises the concept sizing for the surface water channels. Widening of the channels may be required at culvert crossings to accommodate the combined width of the pipe culverts.

A schematic of a typical channel section is presented in Figure 5.4.

Figure 5.4: Schematic of a typical channel section

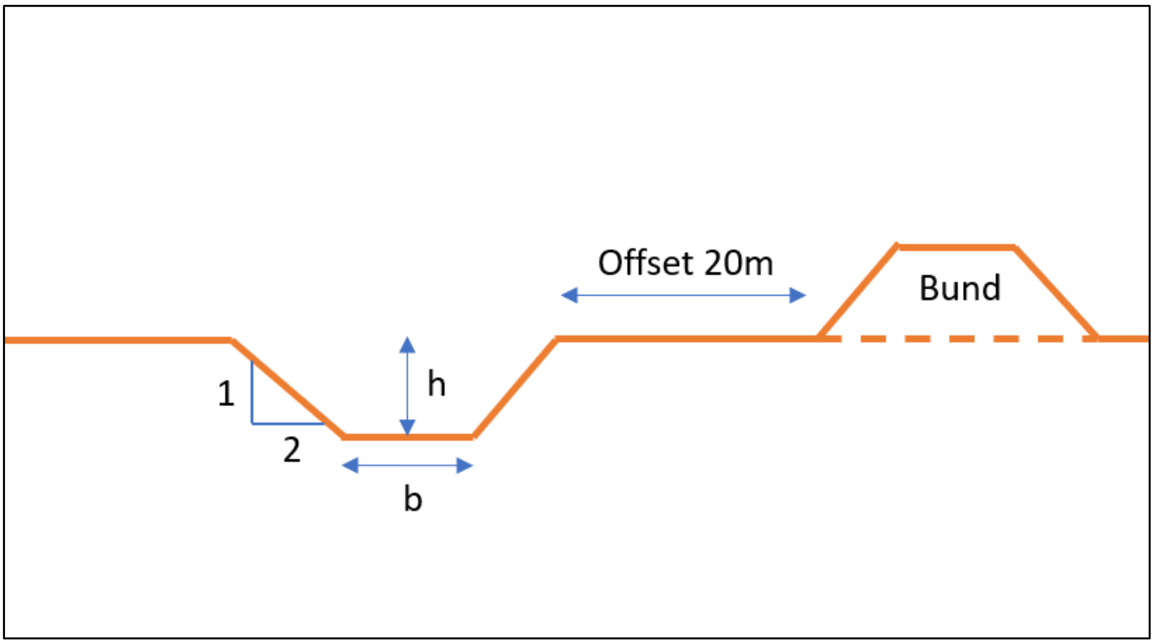


Table 5.2: Diversion channel sizing

Channel location	Channel ID	Chainage (m)	Flow Q (m^3/s)	Total Channel Depth[1], h (m)	Base width, b (m)	Approximate length (km)[2]
Main diversion channel	CH01	CH0–CH4600	233	3.5	15.5	4.6
WRD West	CH02	CH0–CH2500	52	2.8	4.5	2.5
		CH2500–CH3770	60	2.8	5.5	1.3
WRD East	CH03	CH0–CH840	38	1.8	9.0	0.8

Notes:

[1] Channel depth includes 300 mm freeboard

[2] An average channel slope of 0.2% has been assumed as per Section 2.3.

5.1 Drive through channels

A drive-through channel (designed to cater for the 1% AEP flood event) is required to convey runoff across the haul road. Figure 5.1 shows the proposed location of the drive through channel.

The channel was sized using the Manning's equation assuming a compacted in situ fill channel. Table 5.3 summarises the sizing of the drive through channel.

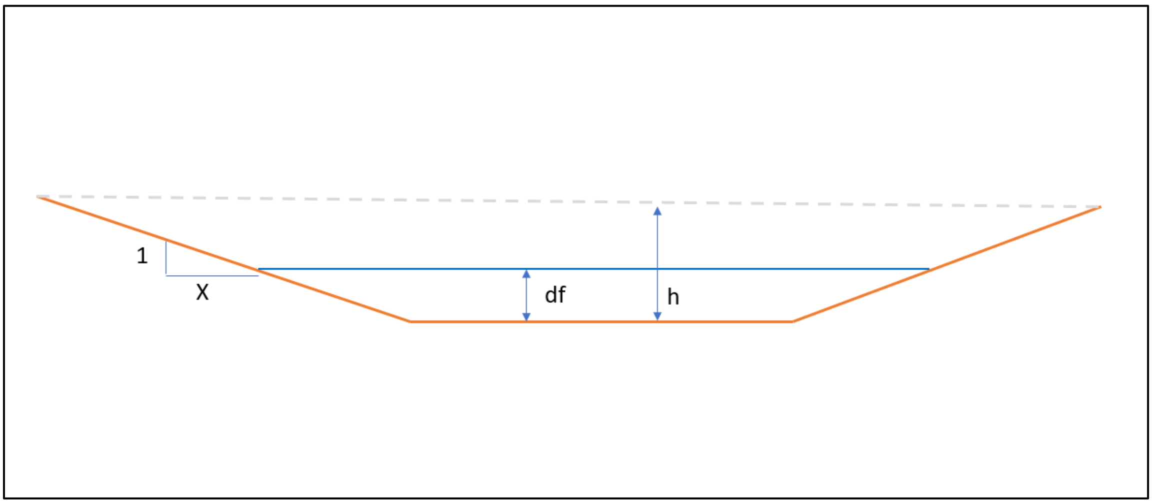
A schematic of a typical channel section is presented in Figure 5.5.

Table 5.3: 1% AEP peak flow channel sizing

Channel location	Channel ID	Flow Q (m^3/s)	Minimum channel depth, h (m)	Maximum flow depth, df (m)	Base width, b (m)	Side slopes 1V:XH	Minimum channel slope (%)
Haul road crossing	DR01	57	2.5	1.0	27.0	10	0.2

Note: Channel depth includes 300 mm freeboard.

Figure 5.5: Schematic of a typical drive through channel section



5.2 Culverts

Conceptually, four culverts are required to direct runoff across the access road and haul road at locations shown in Figure 5.1. The conceptual culvert sizes are summarised in Table 5.4.

Table 5.4: Culvert conceptual sizing

Culvert ID	Design Flow Q (m^3/s)	Minimum channel slope (%)	Culvert diameter (m)	# culverts	Approximate length (m)
CV01	6	0.2	1.5	4	45
CV02	20	0.3	2	5	50
CV03	5	0.3	1.5	3	45
CV04	45	0.2	2	13	45
CV05	6	0.2	1.5	4	45

Notes: Locations where culverts are required for the access road and haul road to cross a channel, the channel at these particular locations are required to be widened to accommodate the total width of the pipe culverts to convey the runoff.

5.3 Sediment ponds

Sediment ponds have been included in the concept design to provide storage for the estimated runoff from the WRD, ore dump, topsoil dump and the TSF resulting from the 24-hour 10% AEP event. It is assumed that surface runoff contained by the rest of the infrastructure bunds will be managed internally.

The required capacity for each sediment pond was estimated based on its respective catchment area. Estimated capacities for each sediment pond are shown in Table 5.5. The ponds will need to be maintained and sediments excavated periodically to maintain their settling and retention capacities. A schematic of a typical section is presented in Figure 5.6.

Figure 5.6: Schematic of a typical sediment pond

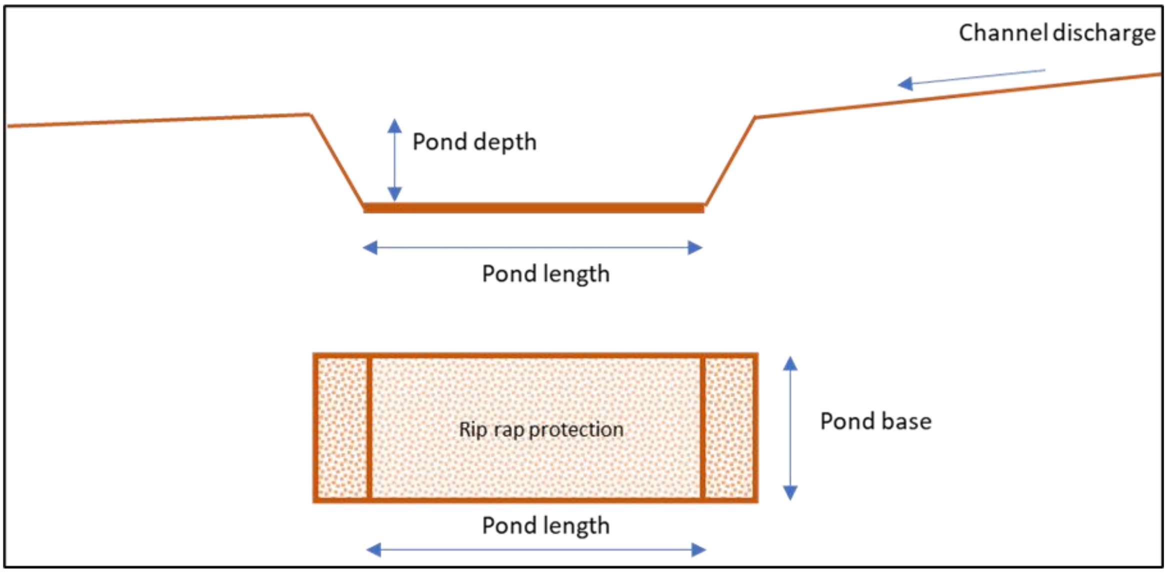


Figure 5.1 shows the locations of the sediment ponds. It is recommended that access roads should be created to all sediment ponds to conduct sampling and facilitate maintenance.

Table 5.5: Sediment pond sizing

Sediment ponds	Catchment area (ha)	Estimated runoff volume 24-hour, 10% AEP[1] (m^3)	Base (m)	Length (m)	Depth (m)	Design capacity (m^3)
SP01	240	197,040	130	390	4.0	202,800
SP02	12	9,852	50	150	1.5	11,250
SP03	36	29,146	70	210	2.0	29,400
SP04	40	32,617	67	200	2.5	33,333

[1] Conservatively assuming 100% runoff (no losses).

The constructability of the sediment ponds should be checked in the detailed design stage. Additional ponds may be considered to reduce the size of each single pond in future studies.

6 Conclusions and recommendations

The purpose of this study was to update the conceptual surface water management design for the Stage 1 mining infrastructures at the Yogi Magnetite Project by estimating the peak flows and depths through flood analysis. A 2D hydraulic model was developed using HEC-RAS, with precipitation applied directly to the flow area as a boundary condition.

Maps of maximum flood depth/extent and velocity over the study area were produced for each of the design flood events.

The main outcomes from the concept surface water design are as follow:

- Diversion of clean water is recommended upstream of the pit and WRD by constructing a channel 20 m north of the access road.
- Diversion of clean water is recommended for the pit by constructing bunds along the crestline.
- The runoff from the WRD, ore dump, topsoil dump and TSF must be contained by perimeter bunds.
- The maximum estimated flood depth in the Project area for the 1% AEP rainfall event is 3.8 m, while the maximum flow is 233 m^3/s. The results are presented in Table 4.3 (including surface water management).
- The maximum estimated flood depth in the Project area for the 5% AEP rainfall event is 1.8 m, while the maximum flow is 150 m^3/s. The results are presented in Table 4.4 (including surface water management).

The results of the flood analysis were used to inform the surface water infrastructure design.

Conceptual designs for bunds are presented to capture the outflow of potentially impacted runoff from the WRD ore dump, topsoil dump and TSF, and to direct it to sediment ponds to minimise the flow of potentially impacted water outside the mine footprint. The sediment ponds would allow for settling of any suspended solids (and the addition of chemicals and flocculants if needed) before the water would be discharged to the environment.

The main outcomes from the surface water infrastructure design are:

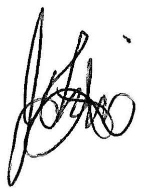
- A channel (4.6 km long) is required to direct runoff from the upper catchment west of the site.
- A channel (6.2km long) is required to direct runoff between the pit and WRD.
- The minimum height required of the bunds to direct runoff away from the pit is 1.1 m.
- The minimum height required of the bunds to direct runoff away from the WRD is 1.1 m.
- The minimum height required of the bunds to direct runoff away from the TSF is 0.9 m.
- The required capacities of the sediment ponds have been provided and range from 11,250 m^3 to 202,800 m^3.
- A drive through channel and various culverts have been included to convey runoff across the haul road and access road.

The surface water management strategy will need to be revised and updated in response to any changes in the infrastructure layout.

The side slopes of the bunds, channels, and embankments should be checked and designed for geotechnical and erosion stability at a later stage (depending on the final geometry and material used).

Closure

This report, Yogi Stage 1 concept surface water management study, was prepared by



Johan Hattingh, Consultant

and reviewed by

Juanita Martin, Principal Consultant

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

References

Australian Rainfall and Runoff Data Hub – Results. Version 2019_v1, accessed on 04 May 2021.

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

Bureau of Meteorology, 2022. Climate Statistics for Australian locations – 007091, http://www.bom.gov.au/climate/averages/tables/cw_007091.shtml.

Bureau of Meteorology, 2016. Rainfall Intensity Frequency Distribution (IFD), Bureau of Meteorology Rainfall IFD Data System, accessed on 24 February 2022.

GHD, 2019. Yogi – Magnetite Project Environmental Approvals Surface Water Assessment, March 2019.

U.S. Army Corps of Engineers Hydrologic Engineering Center (USACE HEC), 2020. HEC-RAS River Analysis System Hydraulic Reference Manual Version 6.0.