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16 August 2024

1571-39-D1

Mining & Energy Technical Services Pty Ltd (METServe)

310 Edward Street

Brisbane City, QLD 4000

Re: Supporting information for the PER and IESC responses for the Vulcan South Project

The Vulcan South Project (the Project) is a proposed new open pit mining operation located to the southeast of Moranbah, in Central Queensland. The Project will operate for approximately nine years, including primary rehabilitation works, following a 2 year construction period. The Project will extract approximately 13.5 million-tonnes (Mt) of ROM coal, consisting primarily of hard coking coal with an incidental thermal product at a rate of up to 1.95 Mt per annum.

The Project was referred under the Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act) to the Minister for the Environment on 5 February 2024 (Reference: EPBC 2023/09708). The delegate of the Minister determined, on 4 March 2024, that the proposed activity be assessed by a Public Environment Report (PER).

Further, the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) provided advice (document number IESC 2024-149) on 20 June 2024.

WRM Water and Environment Pty Ltd (WRM) was requested by METServe to prepare responses to information requests for the Vulcan South Project (the Project) relating to surface water. WRM's responses have been attached to this letter, which include:

- Appendix A: Vulcan South – Supporting information for the PER responses.
- Appendix B: Vulcan South – Supporting information for the IESC responses.

Please don't hesitate to contact us if you have any questions.

Regards,

Julian Orth

Director/Senior Principal Engineer

APPENDIX A SUPPORTING INFORMATION FOR THE PER RESPONSES

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WRM
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MEMORANDUM

Date	16 August 2024
Attention	Damien Plucknett
Company	METServe
WRM ref.	1571-34-B2
Subject	Vulcan South – Supporting information for the PER responses

1 OVERVIEW

This memorandum has been prepared in response to an information request (Reference: 2023/09708) for the Vulcan South Coal Mine (the Project). The proposed Project was referred under the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) to the Minister for the Environment on 5 February 2024. The delegate of the Minister determined, on 4 March 2024, that the proposed activity be assessed by a Public Environment Report (PER).

WRM Water & Environment (WRM) previously completed the Vulcan South Surface Water Assessment (SWA) (WRM, 2023a), which included an operational water balance assessment, a flood impact assessment, proposed surface water monitoring program and cumulative impact assessment. METServe (2023) has also prepared a Progressive Rehabilitation and Closure Plan (PRCP) for the Project which discusses the rehabilitation and conceptual design of the final landforms.

The following sections provides WRM's responses to the PER information request.

2 RESPONSES TO PER INFORMATION REQUESTS

2.1 PER SECTION 6.3.2 – THIRD PARTY USERS

2.1.1 Information request

A description of any potential third-party users of water in areas potentially affected by the proposed project, including municipal, agricultural, industrial, recreational and environmental uses of water including:

1. downstream water users accessing surface water via water access licences and basic landholder rights;
2. third-party landholder bores located upstream and downstream of the proposed action, typically installed in the alluvium; and
3. ecosystems that potentially rely on surface water and/or groundwater.

2.1.2 WRM response related to surface water

shows the water access licence holders in the vicinity of the Project which may be potentially affected. The active water access licences/licence to take water from waterways that drain through the Project area (Harrow Creek, East Creek, Boomerang Creek, and Hughes Creek) include:

- Moranbah Coal Measures WAL 608364/615421 (Purpose: Dewatering - Underground);
- Boomerang Creek WAL 617686 (Purpose: Site Water Management), Isaac Connors Water Management Area;
- Ripstone Creek WAL 614270 (Purpose: Site Water Management), Isaac Connors Water Management Area;
- Isaac River WAL 619183/619184 (Purpose: Any), Isaac Connors Water Management Area;
- Harrow Creek WAL 43158L (Purpose: Industrial), Isaac Connors Water Management Area;

Section 3 of WRM (2023a) describes the Environmental Values for the Project. The Queensland Water Quality Guidelines and EPP Water guidelines establish EVs and WQOs for natural waters in Queensland. The Project is located within the 'Isaac western upland tributaries' area of the Isaac River sub-basin. Site specific trigger values were derived in accordance with the methodology outlined in ANZG (2018). Where different EVs have different WQOs, the Project has adopted the lowest concentration value for mine water and receiving waters trigger levels (WRM, 2023b).

The Project does not propose to release mine affected water to the receiving waters, however, the water quality monitoring program will also include monitoring at all dams which contain mine affected water with the potential to discharge to the receiving waters to provide indication on mine affected water quality.

The Queensland Globe service (Queensland Government, 2019) was used to identify any wetlands in the vicinity of the Project. There were no matters of state environmental significance (MSES) wetlands, wetland values or wetland protection areas identified in or adjacent the Project area.

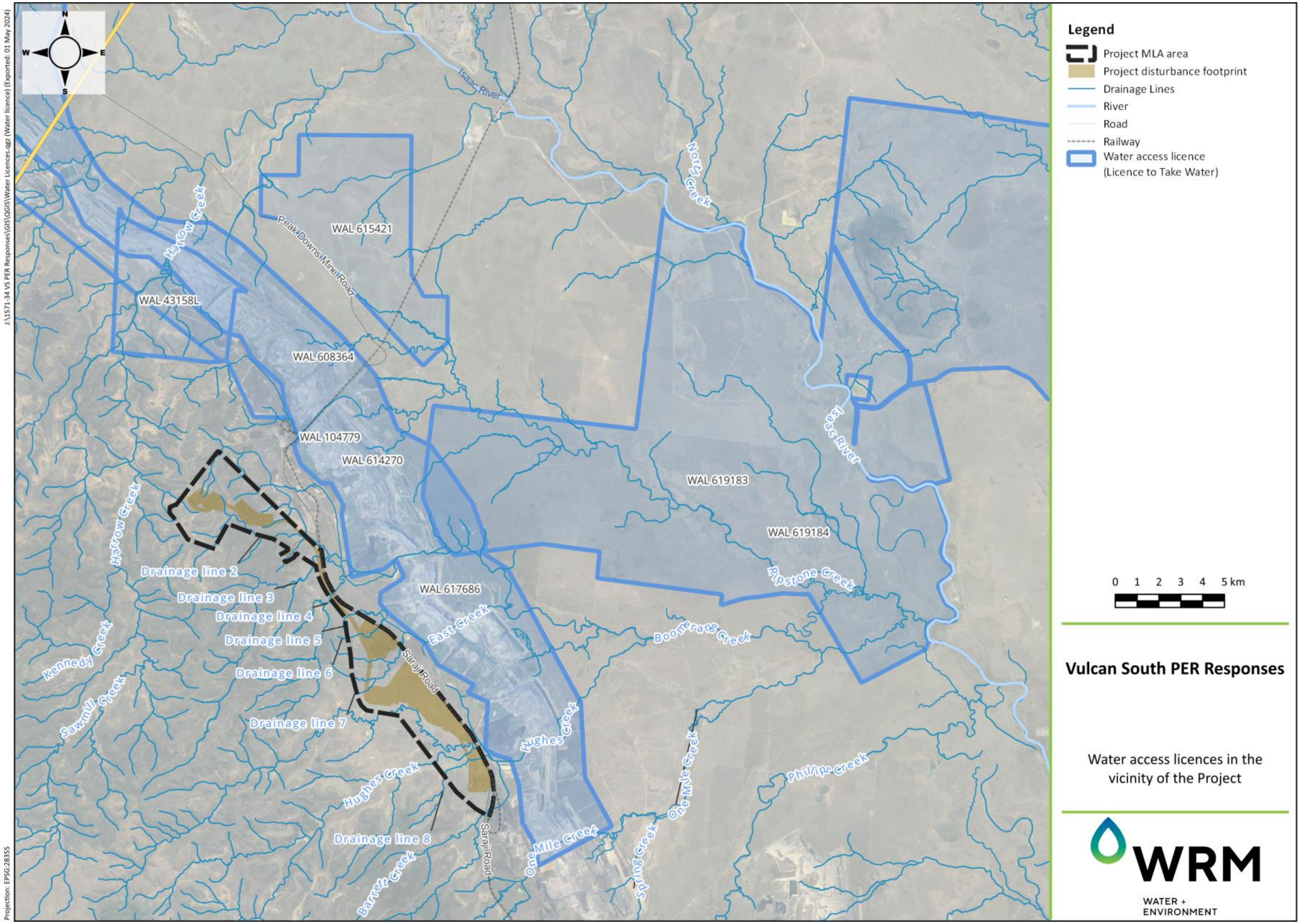

Figure 2.1 Active water access licences in the vicinity of the Project

2.2 SECTION 6.3.3 – HIGHWALL MINING

2.2.1 Information request

Include a description and assessment of likely and possible impacts to water resources resulting from highwall mining specifically.

2.2.2 WRM response

Section 5.7 of (WRM, 2023a) outlines the water management strategy for the proposed Project highwall mining. During active highwall mining stages, the maximum mine affected water catchment area would be 3.2 ha. The MAW catchment runoff for a 10% AEP 72 hour storm event containment (extreme storm storage [ESS]) = 6.1 ML (rainfall depth = 189 mm, catchment area of 3.2 ha, assumed all rainfall is converted to runoff). MAW runoff is proposed to be stored each completed plunge void capacity of (9.9 ML) assuming plunge dimensions of 1 m high, 3.5 m wide and 300 m deep at 3% gradient.

The proposed storage capacity is considered adequate to contain MAW generated from the highwall mining activities and the risk of releasing MAW runoff is low. Once plunges are no longer active, rehabilitation will commence to cover the voids at the surface. After covering the voids, surface runoff water would not be classified as MAW, and can be treated through the proposed sediment control structures.

Any potential releases from ESC structures will be in accordance with Schedule F and Condition F4 of the Vulcan South EA. Sediment dam trigger values will be monitored against the 'Surface water quality objectives' outlined in Table F3 of the EA.

The cumulative impact assessment undertaken in Section 10 of WRM (2023a) includes the likely and possible impacts of the highwall mining as part of the Project. Table 10.3 of the SWA is replicated in Table 2.1 with the highwall mining area added as a component of the cumulative impact assessment. The highwall mining component of the Project will have negligible contribution to the cumulative impacts for the Isaac River to Phillips Creek catchment.

Table 2.1 Catchment area of existing projects considered in the cumulative impact assessment from the SWA (Table 10.3 of WRM [2023a])

Catchment	Total catchment area (km^2)	Estimated mine affected catchment (km^2)
Vulcan South (the Project)	15.3	4.8
- Highwall mining area component	*2.7*	*0.03*
Other mines	551	182
Combined	566	187
Isaac River (to the Phillips Creek confluence)	7,731	-

2.3 SECTION 6.3.4 - SIGNFICANT IMPACT GUIDELINES

2.3.1 Information request

Include a description and assessment of the impacts to water resources giving consideration to relevant departmental policies and guidelines, including the *Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources (2022).* In addition, specific impact assessment requirements are outlined in the surface water, groundwater and GDE sections below.

2.3.2 WRM response

Per the *Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources* (2022) (the Impact guidelines), an action is likely to have a significant impact on a water resource if there is a real or not remote chance or possibility that it will directly or indirectly result in a change to:

- the hydrology of a water resource
- the water quality of a water resource

that is of sufficient scale or intensity as to reduce the current or future utility of the water resource for third party users, including environmental and other public benefit outcomes, or to create a material risk of such reduction in utility occurring. provides the relevant information requested by the Impact guidelines.

Table 2.2 Information provided as part of the SWA and supporting memorandums addressing the Impact guidelines

Information required	Section of WRM reports
The characteristics of the potentially impacted water resource(s)	Section 2 of WRM (2023b) characterises existing local and regional water courses.
Known baseline conditions of the water resource(s), including existing third party uses, including environmental and other public benefit outcomes	Section 3 of WRM (2023a) discusses baseline and environmental values for the Isaac River sub-basin.
Reasonably foreseeable future use of the water resource(s)	Section 7 of WRM (2023a) discusses the water balance model results which describes the planned use and any potential impacts to the water resource relative to the Project.
The likely impact of the action on the water resource(s), including consideration of impacts in the context of existing impacts	Section 10.4 of WRM (2023a) discusses the cumulative impacts of the Project in consideration of the existing and foreseeable projects nearby.
Proposed avoidance, monitoring and mitigation measures	Section 5.4 and Section 8.5.5 of WRM (2023a) describes the diverted water management measures proposed for the Project. WRM (2023b) describes the water monitoring program.
The alignment of the action with any relevant water resource and/or water quality plans;	WRM (2023b) describes the water monitoring program and water quality triggers in relation to the water resources. Receiving trigger values should be consistent with Table F3 of the Vulcan South EA.

2.4 SECTION 6.3.10 – FLOOD IMPACTS

2.4.1 Information request

An assessment of potential flood impacts upstream of the mine on the floodplain of Hughes Creek. Account for discharge from sediment dams when rainfall exceeds the design standards, including the release of contaminants if mine affected water storages overflow.

2.4.2 WRM response

Section 8.8 of WRM (2023a) describes the post-closure conditions flood impacts and Appendix D provides mapping of the post-closure conditions flood impacts as a result of the proposed disturbance from the Project. The flood impact assessment undertaken shows that there are no impacts upstream of the Project mine lease application area. Within the Project MLA area, there are negligible increases in flood levels and flood velocities within the Hughes Creek floodplain.

Any potential discharges from sediment dams will be in accordance with Schedule F and Condition F4 of the Vulcan South EA. Sediment dam trigger values will be monitored against the 'Surface water quality objectives' outlined in Table F3 of the EA.

Mine water dams will be managed and operated with a maximum 'operating volume' which defines the maximum volume the dams can operate up to before pumped inflows cease. The operating volumes of each dam are below their respective full storage volumes to maintain storage capacity below the spillway level of the dams which will reduce the risk of overflows to the receiving environment.

If mine water dams are at their operating volumes, mine water can be pumped back to the pits in emergency.

3 HYDRAULIC ASSESSMENT OF TEMPORARY DRAINAGE DIVERSIONS

3.1 INFORMATION REQUEST

Provide additional information about the design of the proposed diversions for the three headwater streams around the pits.

3.2 GENERAL ARRANGEMENT OF THE PROPOSED DIVERSIONS

Figure 3.1 shows the alignments of the temporary drainage diversions proposed during the mining stage of the Project. Table 3.1 summarises the proposed drainage diversions for the Project. Two temporary diversions are proposed:

- Drainage line 6 diversion will divert Drainage line 6 along the proposed haul road upstream of the Vulcan North pit before discharging south into Drainage line 7 at the proposed haul road crossing; and
- Drainage line 8 diversion will divert Drainage line 8 along the proposed haul road upstream of the Vulcan South pit before discharging north into Hughes Creek at the proposed haul road crossing.

Table 3.1 Proposed drainage diversion summary

Detail	Unit	Drainage line 6 diversion	Drainage line 8 diversion
Length	m	1,396	298
Channel base width	m	10	10
Maximum channel top width	m	30	30
Channel batter slopes	m:m	0.33	0.33
Longitudinal slope	%	0.5	0.8
Catchment area	km^2	1.1	5.7

3.2.1 Drainage line 6 diversion

Figure 3.2 shows the cross section of the Drainage line 6 diversion drain. The proposed diversion was designed to divert runoff from operational (mining stage) conditions catchments around the proposed Vulcan North pit to the proposed haul road crossing at Drainage line 7. The proposed Drainage line 6 diversion was designed for flood events up to the 0.1% AEP with the proposed haul road in place. The diversion drain and downstream Drainage line 7 will be suitably lined to manage channel erosion and prevent scour.

3.2.2 Drainage line 8 diversion

Figure 3.3 shows the cross section of the Drainage line 8 diversion drain. The proposed diversion was designed to divert runoff from operational (mining stage) conditions catchments around the proposed Vulcan South pit to the proposed haul road crossing at Hughes Creek. The proposed Drainage line 8 diversion was designed for local 10% AEP flows as the Hughes Creek floodplain is inundated during larger events. The diversion drain and downstream Hughes Creek drainage line channel will be suitably lined to manage channel erosion and prevent scour.

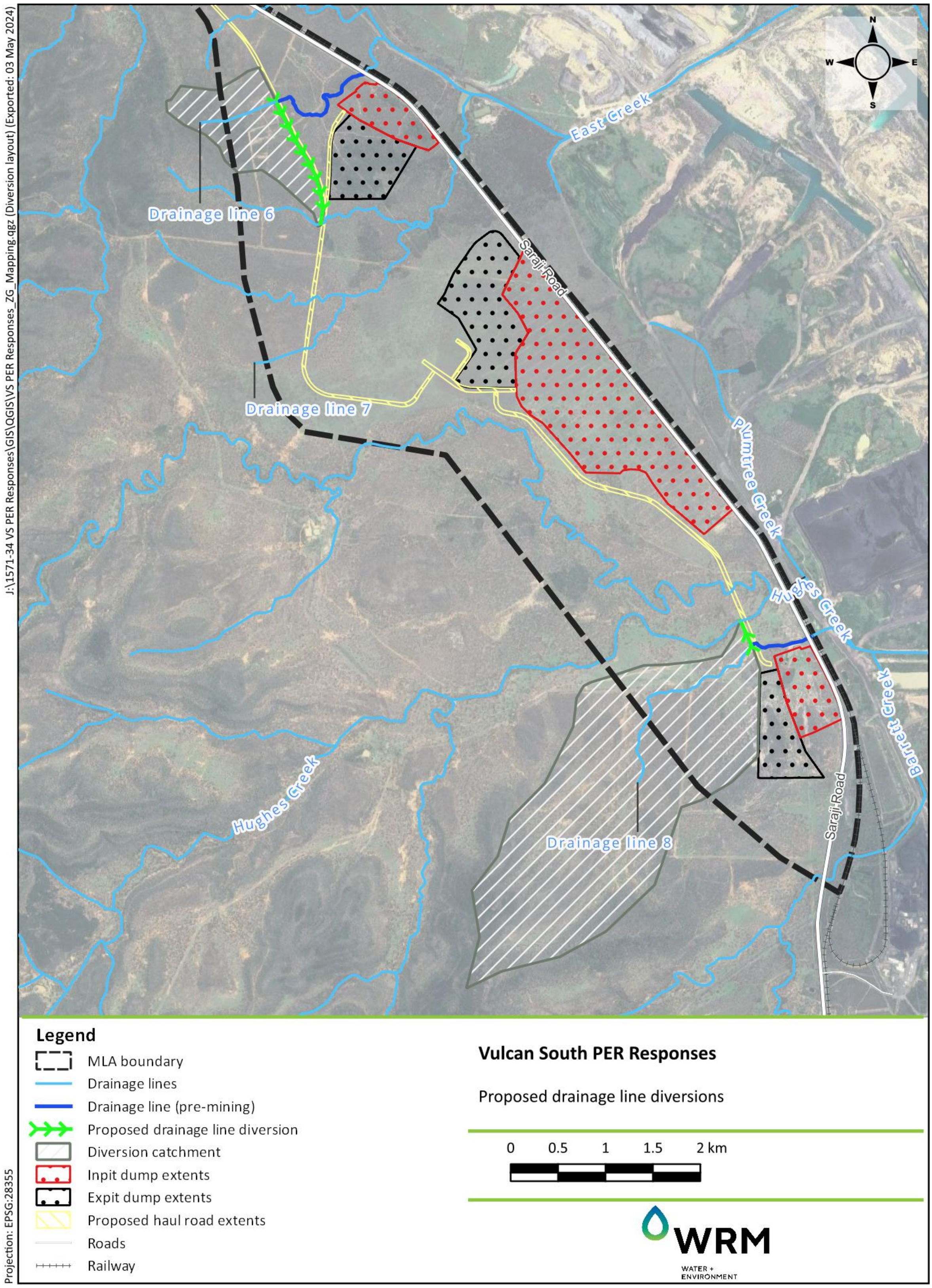

Figure 3.1 Proposed drainage line diversions

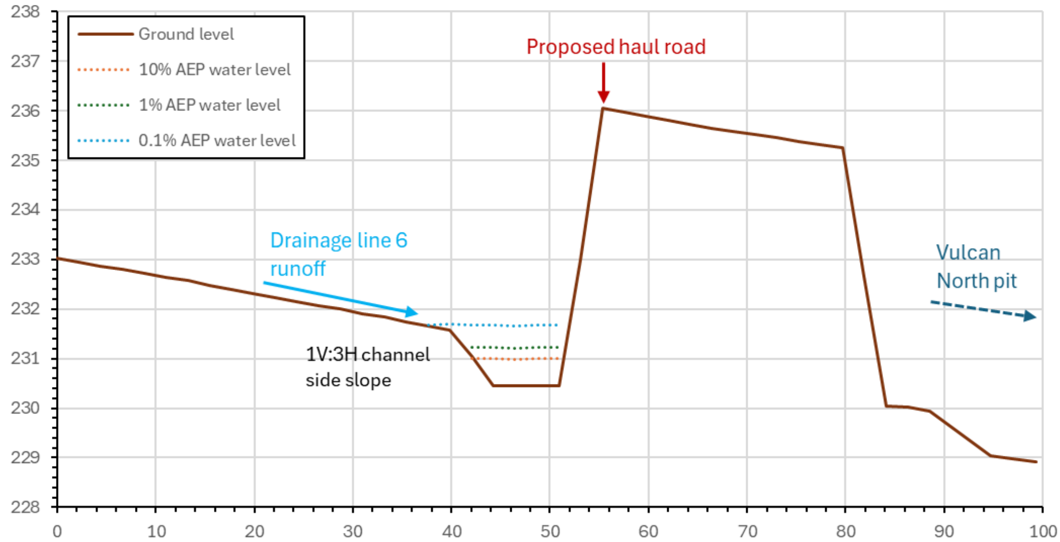

Figure 3.2 Typical Drainage line 6 diversion cross section

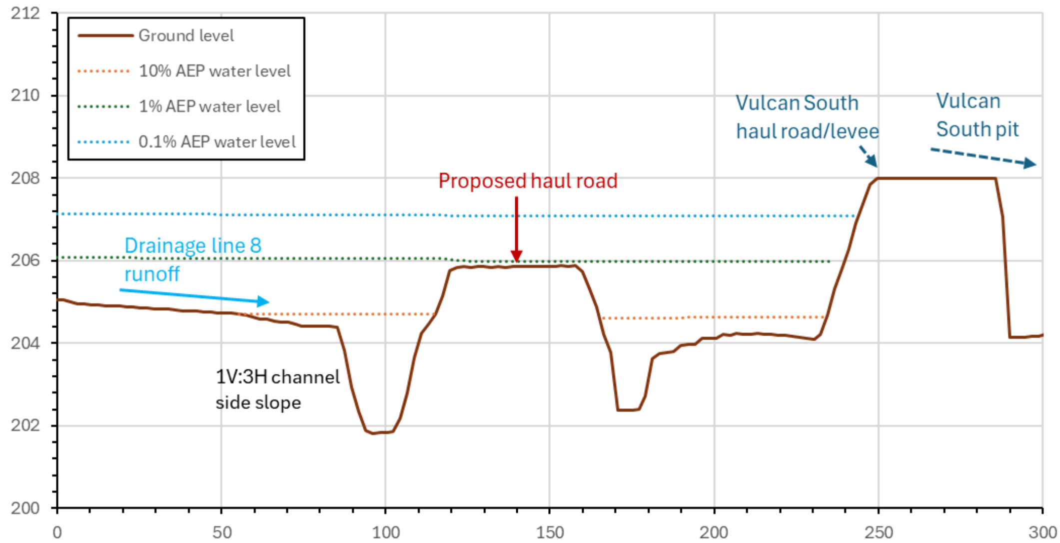

Figure 3.3 Typical Drainage line 8 diversion cross section

3.3 DIVERSION DESIGN PRINCIPLES

3.3.1 Guideline

The Queensland Government Department of Natural Resources, Mines and Energy (DNRME's) guideline: Works that interfere with water in a watercourse for a resource activity — watercourse diversions authorised under the Water Act 2000 (DNRME, 2019) guideline was adopted. Although the Drainage line 6 and Drainage line 8 diversions are not watercourses, the DNRME (2019) design principles have been adopted for the design.

3.3.2 DNRME (2019) design objectives

Under the DNRME (2019) guideline, the proposed watercourse diversion aims to achieve the following key objectives:

- be self-sustaining and include geomorphic and vegetation features of regional watercourses and the surrounding landscape;
- where possible, positively contribute to river health values for the system; and
- not impose liability on the Territory, the proponent or the community to maintain the watercourse diversion and its associated components.

3.3.3 Key Design Outcomes

The proposed diversions will need to satisfy the following outcomes:

OUTCOME 1 - The watercourse diversion incorporates natural features (including geomorphic and vegetation) present in the regional landscape and associated local watercourses.

OUTCOME 2 - The watercourse diversion maintains the existing hydrologic characteristics of surface water and groundwater systems.

OUTCOME 3 - The hydraulic characteristics of the watercourse diversion are comparable with other local watercourses and suitable for the region in which the diversion is located.

OUTCOME 4 - A sediment transport regime that allows the watercourse diversion to be self-sustaining and not result in material or serious environmental harm on upstream and downstream reaches.

OUTCOME 5 - The watercourse diversion and associated structures maintain stability and functionality and are appropriate for all substrate conditions they encounter.

3.3.4 Hydraulic design criteria

The DNRME (2019) guideline has been developed using the results of the Australian Coal Association Research Program (ACARP) stream diversion project (Fisher Stewart, 2002). The Fisher Stewart study investigated the hydraulic characteristics of a number of natural streams in the Bowen Basin. The performance and design faults of existing stream diversions within the Bowen Basin were also assessed as part of the Fisher Stewart study.

Table 3.2 shows the design criteria given in the DNRME (2019) guideline based on the ACARP study for the Bowen Basin streams. Stream power, stream velocity and shear stress are the main hydraulic characteristics of interest:

- Stream power is a function of discharge, hydraulic gradient and flow width. It represents the energy that is available to do work in and on the channel. High stream powers are indicative of elevated erosion potential.
- The velocity criteria have been selected to minimise the potential for damage to the channel through erosion associated with high flow velocities. Where calculated velocities exceed the adopted velocity criteria, additional bank protection (increased vegetation density or rock protection) will be required. Note there is no direct relationship between velocity and the force exerted on soil particles at the boundary and thus stream power and shear stress are used as more reliable indicators of erosion potential.
- The shear stress provides a measure of the tractive force acting on sediment particles at the boundary of the stream, and is used to determine the threshold of motion for bed material. It provides an indication of the potential for erosion of cohesive sediments or movement of non-cohesive sediments at the channel boundary.

Table 3.2 Design Criteria for the Bowen Basin (DNRME, 2019)

Scenario	Stream Power (W/m²)	Velocity (m/s)	Shear Stress (N/m²)
50% AEP event without vegetation	<35	<1.0	<40
50% AEP event with vegetation	<60	<1.5	<40
2% AEP event with vegetation	<150	<2.5	<50

The DNRME (2019) guideline design criteria are based on an incised channel with confinement of flows up to and including the 0.1% AEP design event. The DNRME (2019) guideline hydraulic parameters were derived in the Fisher Stewart (2002) study from depth averaged channel cross sections using the HEC-RAS one dimensional hydraulic model. The Fisher Stewart study also derived the small event values for the 2 year average recurrence interval (ARI) event and not the 10% AEP event, which is slightly larger. The difference is expected to be minor.

The guideline values given in Table 3.2 for the 50% AEP event are intended to reflect hydraulic behaviour during events which are confined within the channel, and the values for the 2% AEP event are for events which exceed the capacity of the channel.

Notwithstanding, for this assessment the 10% AEP was in lieu of the 50% AEP event because the diversion will be confined channel with no overbank floodplains. The 1% AEP was also used in lieu of the 2% AEP.

3.4 HYDRAULIC ASSESSMENT OF THE PROPOSED DIVERSIONS

3.4.1 Overview

A hydraulic analysis was undertaken to assess the performance of the proposed diversions using the hydrologic (XP-RAFTS) and hydraulic (TUFLOW) models developed for the Vulcan South SWA (WRM, 2023). The hydraulic characteristics of the proposed diversions were compared to the DNRME (2019) guidelines as well as the existing drainage lines that will be diverted.

Figure 3.4 to Figure 3.7 show the existing and diverted drainage lines reaches that have been assessed respectively. Table 3.3 and Table 3.4 presents the channel velocity (V), bed shear stress (BSS) and stream power (SP) along the existing and diverted drainage reaches for the 10% AEP and 1% AEP events. In summary, the proposed diversions should meet the DNRME (2019) hydraulic design objectives and key design outcomes for the diversions and receiving waters. The following is of note:

- Drainage line 6 diversion:
    - There are generally reductions in average and maximum V, BSS and SP values for both the reaches when compared with pre-mining conditions except for a small increase in average and maximum V when comparing Drainage line 6 diversion Reach 1 to the pre-mining Drainage line 6 Reach 2.
    - The average channel V, BSS and SPs and maximum channel V are below the DNRME (2019) guideline values for all reaches with vegetation. The maximum values are greatly reduced along the diversion length compared to pre-mining conditions, however at point locations along the reach, the maximum values exceed the guideline values similar to pre-mining conditions, which highlights the need to revegetate or rock line the channel to limit erosion risk. It is recommended that this reach is monitored and remediation works implemented where required. Where significant erosion is expected, reprofiling and rock lining may be required to stabilise the reach.
    - The diversion channel geomorphic indicators suggest that the channel will have similar to lower sediment transport characteristics when compared to the existing channel. This

suggests that the diversion will convey sediment through the reach similar to the existing natural conditions with some potential minor deposition over time.

  - Considering the drainage diversion is temporary, and the existing Drainage line 6 and floodplain will be reinstated during post-closure conditions, it is expected that any potential increase in deposition within the Drainage line 7 catchment will be negligible.

- Drainage line 8 diversion:
  - There is an increase in average and maximum channel V, BSS and SP, however, the average values are below the DNRME (2019) guideline values for all reaches with vegetation.
  - The maximum values exceed guideline values at point locations similar to pre-mining conditions, which highlights the need to revegetate or rock line the channel to limit erosion risk. It is recommended that this reach is monitored and remediation works implemented where required. Where significant erosion is expected, reprofiling and rock lining may be required to stabilise the reach.
  - The diversion channel geomorphic indicators suggest that the diversion will have similar to lower sediment transport characteristics when compared to the existing channel. This suggests that the diversion will convey sediment through the reach similar to the existing natural conditions with some potential minor deposition over time.
  - Considering the drainage diversion is temporary, and the existing Drainage line 8 and floodplain will be reinstated during post-closure conditions, it is expected that any potential increase in deposition within the Hughes Creek catchment will be negligible.

Table 3.3 Geomorphic characteristics – 10% AEP

Reach	Pre-mining		Diversion		Difference (%)	
	Mean	Max	Mean	Max	Mean	Max
Drainage line 6 diversion Reach 1	*Channel Velocity (m/s)*					
	0.9	1.4	0.8	1.3	-11.1	-7.1
	Bed Shear Stress (N/m²)					
	77.7	583.14	22.3	70.2	-71.3	-88.0
	Stream Power (W/m²)					
	74.1	696.7	19.8	91.2	-73.3	-86.9
Drainage line 6 diversion Reach 2	*Channel Velocity (m/s)*					
	0.6	1.0	-	-	33.3[a]	30.0[a]
	Bed Shear Stress (N/m²)					
	38.0	202.4	-	-	-41.3[a]	-65.3[a]
	Stream Power (W/m²)					
	24.0	165.3	-	-	-17.5[a]	-44.8[a]
Drainage line 8 diversion Reach 1	*Channel Velocity (m/s)*					
	0.4	0.9	1.1	1.6	175.0	77.8
	Bed Shear Stress (N/m²)					
	12.2	87.1	34.9	68.7	186.1	-21.1
	Stream Power (W/m²)					
	7.2	69.1	39.5	109.4	448.6	58.3

a – compared to Drainage line 6 diversion Reach 1

Table 3.4 Geomorphic characteristics - 1% AEP

Reach	Pre-mining		Diversion		Difference (%)	
	Mean	Max	Mean	Max	Mean	Max
Drainage line 6 diversion Reach 1	*Channel Velocity (m/s)*					
	1.1	1.8	0.9	1.5	-18.2	-16.7
	Bed Shear Stress (N/m²)					
	98.3	596.7	27.3	83.3	-72.2	-86.0
	Stream Power (W/m²)					
	114.1	714.5	28.0	121.2	-75.5	-83.0
Drainage line 6 diversion Reach 2	*Channel Velocity (m/s)*					
	0.7	1.1	-	-	28.6[a]	36.4[a]
	Bed Shear Stress (N/m²)					
	41.9	204.2	-	-	-34.8[a]	-59.2[a]
	Stream Power (W/m²)					
	29.2	166.8	-	-	-4.1[a]	-27.3[a]
Drainage line 8 diversion Reach 1	*Channel Velocity (m/s)*					
	0.5	1.5	1.2	1.7	140.0	13.3
	Bed Shear Stress (N/m²)					
	17.0	174.1	38.4	71.1	125.9	-59.2
	Stream Power (W/m²)					
	12.2	191.6	46.5	118.6	281.1	-38.1

a – compared to Drainage line 6 diversion Reach 1

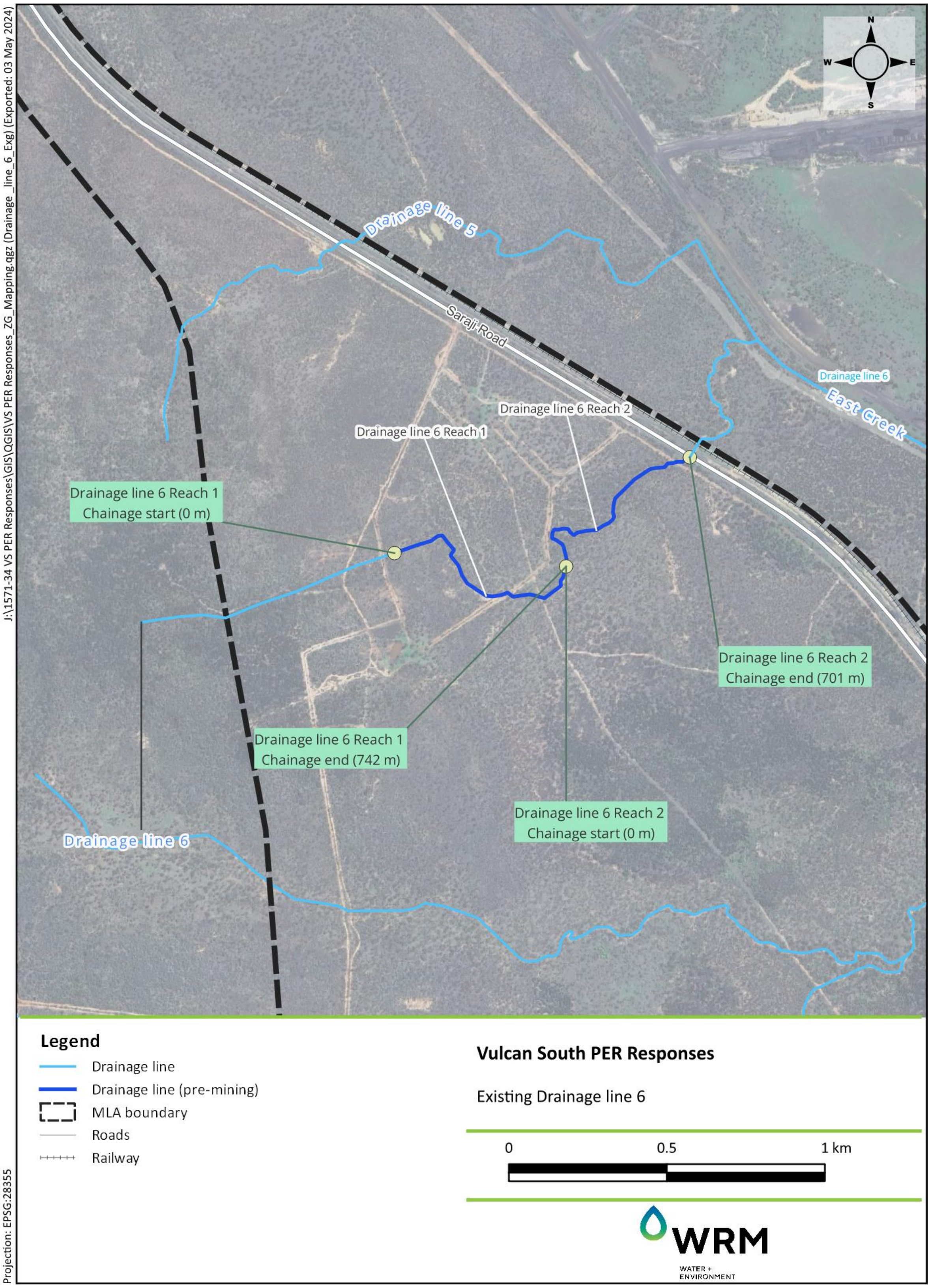

Figure 3.4 Existing Drainage line 6 features

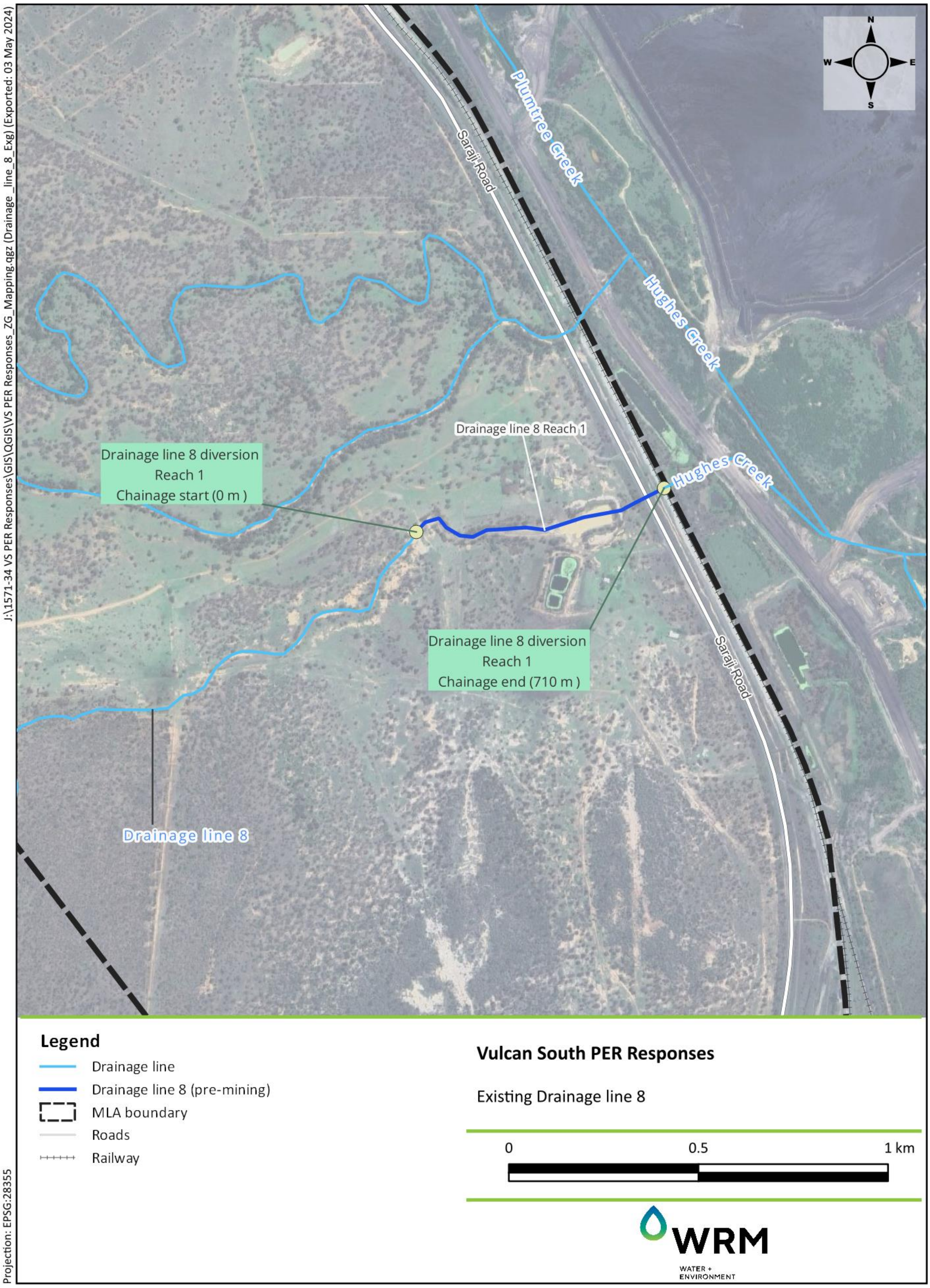

Figure 3.5 Existing Drainage line 8 features

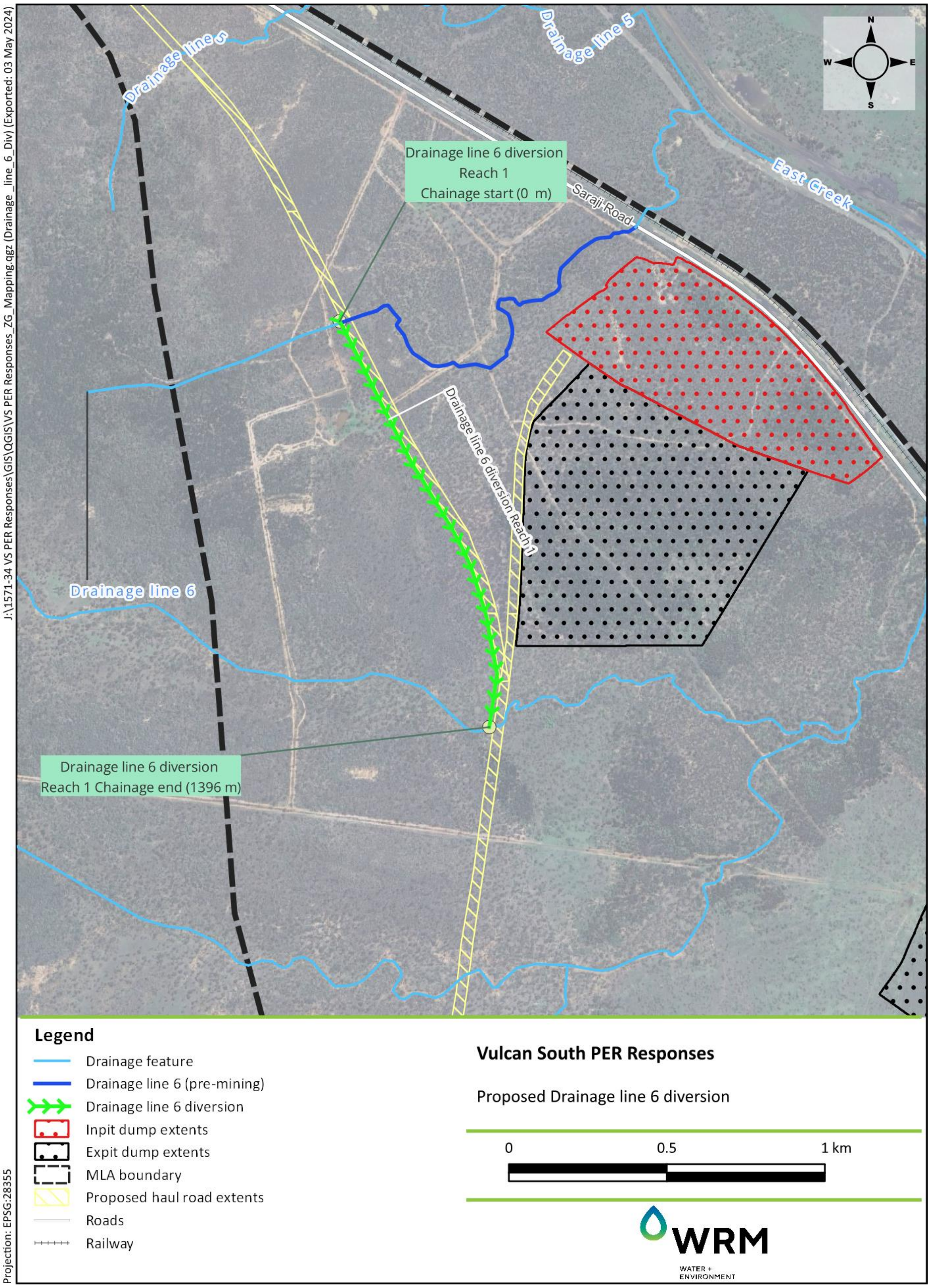

Figure 3.6 Proposed Drainage line 6 diversion – Operational conditions

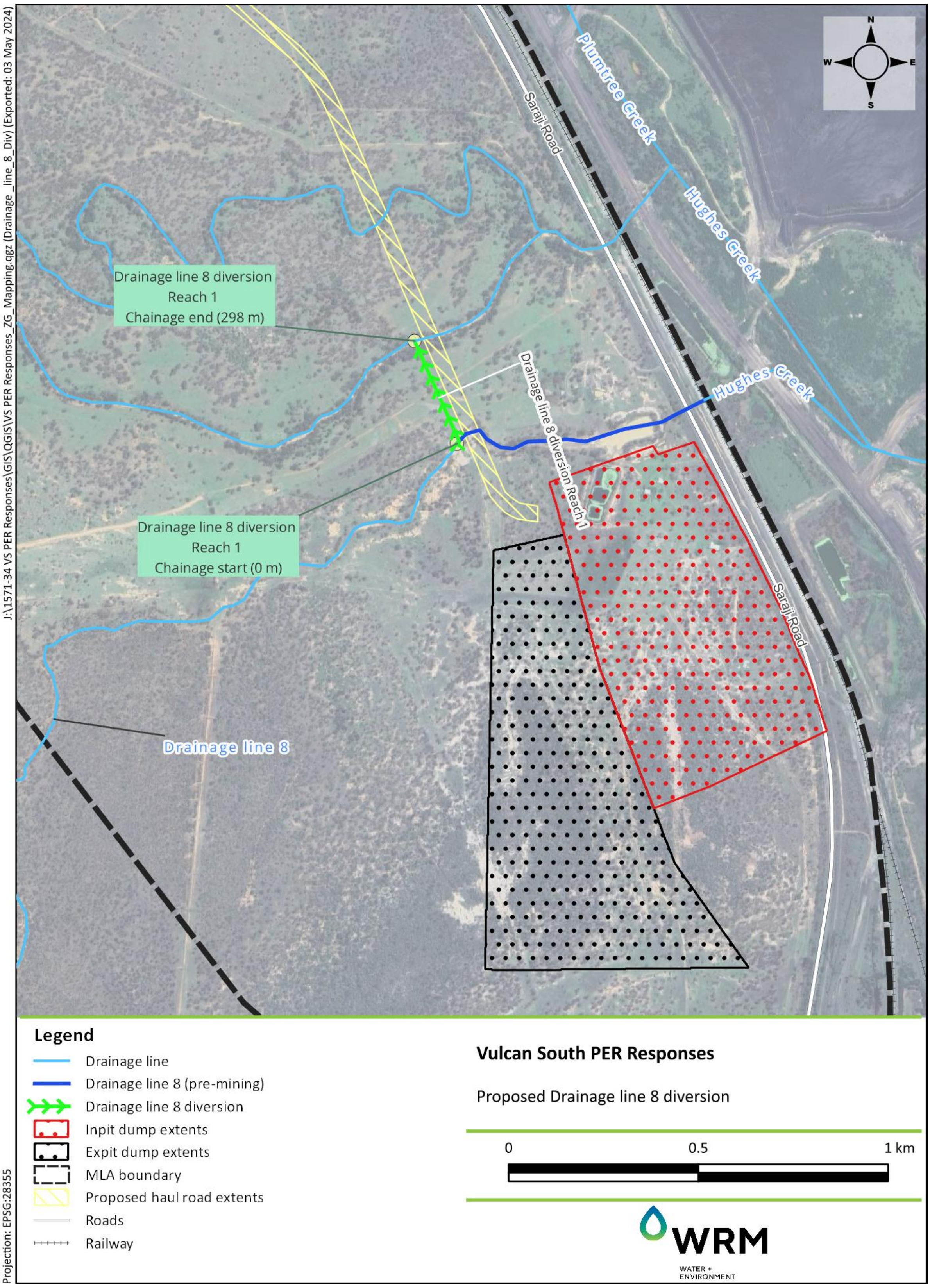

Figure 3.7 Proposed Drainage line 8 diversion – Operational conditions

4 REFERENCES

METServe, 2023	METServe, 2023 'Progressive Rehabilitation and Closure Plan – Vulcan South', Document ID 00285258-030, prepared by METServe Pty Ltd, March 2023.
WRM, 2023a	'Vulcan South Surface Water Assessment', Report number 1571-20-B6, prepared for Vitrinite Pty Ltd by WRM Water & Environment Pty Ltd, November 2023.
WRM, 2023b	'Vulcan South – Natural surface water monitoring plan'. Report number 1571-20-F2, prepared for Vitrinite Pty Ltd by WRM Water & Environment Pty Ltd, September 2023.

APPENDIX B SUPPORTING INFORMATION FOR THE IESC RESPONSES

WRM

VULCAN SOUTH

Supporting information and responses to the Independent Expert Scientific Committee Information Request relating to surface water

METServe

16 August 2024

1571-39-C3

DETAILS

Report Title	Vulcan South, Supporting information and responses to the Independent Expert Scientific Committee Information Request relating to surface water
Client	METServe

THIS REVISION

Report Number	1571-39-C3
Date	16 August 2024
Author	RN
Reviewer	JO

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FIGURES

TABLES

1 INTRODUCTION

1.1 OVERVIEW

This report has been prepared in response to an information request by the Independent Expert Scientific Committee (IESC) for the Vulcan South project (the Project). The information request (document number IESC 2024-149) dated 20 June 2024 was provided in response to the Vulcan South Coal Mine Project (EPBC 2023/09708) Expansion.

WRM Water & Environment has previously completed the following documents to support of the Vulcan South Environmental Authority (EA):

- *Vulcan South Surface Water Assessment*, report number 1571-20-B6 (WRM, 2023a);
- Vulcan South EA Application – Supporting information and responses to the Department of Environment and Science Information Request relating to surface water, report number 1571-20-D2 (WRM, 2023b), prepared in response to the Notice of Information Request dated 1 August 2022;
- *Vulcan South Environmental Authority Application – DES information request relating to surface water*, report number 1571-20-E1 (WRM, 2023c), prepared in response to DES information request dated 3 August 2023; and
- *Vulcan South – Supporting information for the PER responses*, report number 1571-34-B1 (WRM, 2024a), prepared in response to a referral under the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) which determined that the proposed activity be assessed by a Public Environment Report (PER) on 4 March 2024.

1.2 RESPONSE TO IESC ADVICE

Table 1.1 shows the surface water related comments in IESC 2024-149, and the relevant response sections in this report.

Table 1.1 WRM response sections to IESC advice relating to surface water

IESC item number	Description	WRM response
10	The proponent plans to divert two streams around the Vulcan North and Vulcan South pits (MetServe 2024a, Figure 5-11, p. 152). Due to the sodicity of the soil within the project area (RGS 2022, p. 22), there is an increased potential for impacts to the downstream environment from erosion and sedimentation during construction of the diversions and also during operation when the extent, depth and velocity of flood inundation will be considerably altered (see Figures C.1, C.3-C.6, D.1- D.4 and D.6, WRM 2023, pp. 184-196). The proponent should provide detailed information on the potential for erosion and sedimentation within the diverted channels and from the altered floodplain dynamics.	Section 2.1
11	Once operations cease and the pits are backfilled, the proponent plans to reinstate the drainage lines back to their original pre-mining state. However, the works will still have impacts on flood inundation behaviour post closure and there are areas that will require ongoing erosion control measures. It is unclear what measures will be put in place to monitor and control the legacy impacts post-closure. Although the proponent has considered bank stabilisation (MetServe 2024b p. 118) and rock lining to reduce erosion and sedimentation in stream (MetServe 2024a, p.325), the proponent has not assessed the potential impacts to stream hydrology, and aquatic and riparian habitats due to the initial diversions and then the reinstatement of the original channels across a different substrate (waste rock) that is likely to have very different streambed characteristics (e.g. greater infiltration capacity).	Section 2.3

12	The proponent has optimised the water management system to reduce the risk of uncontrolled releases during operations and it is stated (e.g. WRM 2023, p. 111) that no spills of MAW to the external environment will occur under any modelled climate sequence. While some sensitivity analyses were undertaken with respect to changing climate and haul-road dust suppression demands, little consideration appears to have been given to the uncertainties inherent in the dewatering rates associated with rainfall intensities and variable storm durations. Some assessment should be made of system performance under more extended and extreme storms, noting that this should now include allowance for the 1.3 °C of global warming that has occurred over the historical period used to derive design rainfall information (DCCEEW, 2023).	Section 4
13	As part of the water management system, the proponent will construct sediment dams where sediment will be allowed to settle (WRM 2023, p. 75) before water can overflow to Hughes and East creeks. There is limited discussion on the frequency of sediment removal from the sediment dams and whether this sediment might be contaminated (and therefore require suitable treatment or containment). The proponent should provide more information about sediment dam maintenance and the disposal of any sediment removed from the dams. There should also be a detailed monitoring program of sediment quality in the dams to ensure that any material released or removed does not pose a contamination risk.	Refer to ESCP (WRM, 2024b)
14	It is also noted that no sensitivity analysis was undertaken on the inflow estimates computed for mine water balance dynamics using the Australian Water Balance Model (AWBM) rainfall-runoff model. The parameters adopted for this model are solely based on regional information without site-specific calibration, and as such the likelihood of overflows from the 20 sediment dams is subject to high uncertainty. This uncertainty has not been considered in the performance assessment of forecast inventory and should be accounted for in further sensitivity analyses.	Section 5
15	The proponent discusses cumulative impacts on water quality from the project and surrounding mines (e.g. Saraji Mine Complex, Peak Downs, Caval Ridge) but does not provide details on potential cumulative impacts to surface water flows or cumulative impacts from the proposed project and other pits in the mining area (e.g. Matilda and Jupiter pits). a. The proponent has provided limited discussion about potential changes to surface water flows as a cumulative effect from different projects. Many of the surrounding streams have been diverted by other mines and these mines also collect rainfall runoff within water management systems. The proponent should assess the potential changes to surface water flows arising from the combined effects of stream diversions, changes in flooding and decreased stream flows due to rainfall runoff captured by the water management systems. b. The proponent should assess potential cumulative impacts to surface water for the entirety of the approved and planned operations at the Vulcan Complex to ensure an understanding of overall potential impacts to surface water.	Section 3
23	Rock-lining of diversions was mentioned as a mitigation measure to reduce the risk of erosion and sedimentation (see Paragraph 10); however, limited information was provided. A detailed description of this mitigation measure should be provided, along with a description of the program for monitoring the environments downstream from the diversions to assess the effectiveness of the mitigation.	Section 2.2
26	The Environmental Authority (EA) (DESI 2023) sets out the required monitoring of parameters for water quality. However, the EA does not mention monitoring of zinc or nickel (DESI 2023, Table E2, pp. 24-25) for groundwater quality, and copper (DESI 2023, Table F3, p. 34) in uncontrolled releases from sediment dams. Monitoring of these parameters would identify whether concentrations in groundwater or surface waters exceed water quality guidelines. Dissolved organic carbon (DOC) should also be monitored at the same time as the metals so that bioavailability of the metals released can be determined.	Refer to Vulcan South REMP (WRM, 2024c)

2 POTENTIAL EROSION AND SEDIMENT ISSUES

2.1 CONSTRUCTION AND OPERATIONS PHASE

The proposed temporary diversion drains were assessed during operational conditions by WRM (2024a), and the Erosion and Sediment Control (ESC) of the diversion drains is discussed further in Section 2.2. During the construction phase of the Project, a construction ESC will be developed and the recommended ESC mitigation measures will be implemented in accordance with the International Erosion Control Association (IECA) *Best Practice Erosion and Sediment Control Guideline* (IECA, 2008). Remediation works of the ESC measures will be undertaken if required to ensure potential erosion is captured and sediment laden runoff is managed within the site ESC prior to being released to the downstream environment.

The Project proposes to install cross drainage structures to convey the 20% AEP design discharge. Hence, it is unlikely that there will be significant impacts to the sediment transport to the downstream environment compared to existing conditions for smaller events. During large and infrequent events, the Project has potential to increase flood levels and velocities, however, the critical duration of these storm events are less than 6 hours as assessed in the Surface Water Assessment (SWA) (WRM, 2023a) and are unlikely given the expected duration of operations (less than 4 years).

2.2 EROSION AND SEDIMENT CONTROL OF PROPOSED DIVERSION DRAINS DURING OPERATIONS

The temporary diversion drains proposed have been designed in accordance with the Queensland Government Department of Natural Resources, Mines and Energy (DNRME's) *Guideline: Works that interfere with water in a watercourse for a resource activity — watercourse diversions authorised under the Water Act 2000* (DNRME, 2019). Although the Drainage line 6 and Drainage line 8 diversions are not watercourses, the DNRME (2019) design principles have been adopted for the design.

The diversions were assessed using the guideline by WRM (2024a), using the hydraulic design criteria based on the Australian Coal Industry's Research Program (ACARP) study for the Bowen Basin streams, which assess stream power, stream velocity and shear stress as the main hydraulic characteristics of interest.

The assessment shows that for the 10% and 1% annual exceedance probability (AEP) design flood events, the operational diversion channels will have similar sediment transport characteristics as the existing channels.

During detailed design of the temporary diversions, a detailed description of the ESC mitigation measures will be provided. The temporary diversions are proposed to be rock lined, which is a viable ESC measure in accordance with IECA (2008), however, this is one of many alternative ESC measures. The most appropriate ESC measures will be selected and implemented during detailed design.

Notwithstanding, the appropriate rock protection will be used in the diversion design, and will outline:

- Availability of rock types to be used for the diversion;
- Rock hardness; and
- Availability and design of rock sizing.

It is proposed that monitoring of the diversion drains will be undertaken post-flood event to inspect any sediment transport, erosion or scour issues, and remediation of the ESC measures will be undertaken if required.

2.3 REHABILITATION OF DIVERSION DRAINS

The Progressive Rehabilitation and Closure Plan (PRCP) (METServe, 2023) outlines the rehabilitation of the drainage lines in post-closure conditions and the landform design where drainage lines will be reinstated:

- Per Section 9.18 of the PRCP (METServe, 2023), it is proposed to monitor the landforms and reinstated drainage lines for erosion until the appropriate vegetative cover is established and rehabilitation milestones are achieved; and
- Per Section 6.2 of the PRCP (METServe, 2023), the pits will be backfilled progressively, utilising a combination of paddock dump and end-tipping techniques. Dump lifts are generally anticipated to be low, enhancing rapid material settlement. Placed waste shaping and profiling will be completed with bulldozers. Final landform geometry will be surveyed progressively to maintain adherence to the final landform and surface water management design. In-pit waste rock dumps will have a cover that facilitates plant establishment. Sub-soil, rock mulch and topsoil will be spread with bulldozers and will be the subject of depth and distribution survey and quality control monitoring. Minor shaping or reprofiling works will be undertaken once infrastructure has been removed and any contamination remediated, in order to smooth the ground surface and merge the landform into the surrounding natural contours.

The sub-soil, rock mulch and topsoil materials will generally be sourced within the vicinity of the Project and will be spread and compacted as part of the landform design, including where the drainage lines will be reinstated through backfilled spoil. The enhanced rapid material settlement of the backfilled spoil and the compaction of the sub-soil, rock mulch and topsoil layers over the backfilled spoil is likely to generate similar runoff characteristics to pre-mining conditions and it is unlikely that there will be a significant change to the reinstated drainage line streambed characteristics and infiltration capacity compared to pre-mining conditions.

Therefore, once the diversions are rehabilitated and pre-mining catchments are reinstated, it is expected there will be negligible post-closure impacts to stream hydrology or flood inundation as the catchments and drainage lines will be reinstated to pre-mining conditions. Restoration of the drainage lines post-closure will have negligible flood impacts compared to pre-mining conditions because the drainage lines being diverted are only temporary, and flows within the in the vicinity of the project are highly ephemeral.

Furthermore, as part of the *Vulcan South Groundwater Impact Assessment* (hydrogeologist.com.au, 2022), it was found that once mining, depressurisation and dewatering cease, groundwater will start to recover and eventually will reach steady state in the backfilled material within the former pit. Once groundwater table levels recover, groundwater recharge will also be similar to pre-mining conditions.

3 CUMULATIVE IMPACT ASSESSMENT

The cumulative impact assessment undertaken in Section 10 of WRM (2023a) includes the likely and possible impacts of the Project. Table 10.3 of the SWA (WRM, 2023a) is replicated in Table 3.1 and presents a comparison of the captured catchment areas of the existing mining projects considered in the cumulative impact assessment with the Isaac River catchment to the Phillips Creek confluence, including the Vulcan Coal Mine (VCM) project pits added as a component of the cumulative impact assessment.

The Project will result in a loss of catchment to the Isaac River during operations which will be reinstated post-mining. The potential cumulative impact to surface water flows (runoff volume) lost from the catchment considering water captured by water management systems will generally be in proportion to the loss of catchment area and is indicated by the following:

- The combined total catchment area of the existing mines (including the Project and VCM pits) represents around 7.4% of the total catchment area of the Isaac River to the Phillips Creek confluence. The Project area contributes approximately 0.2% of the Isaac River to Phillips Creek.
- The estimated mine affected catchment areas from existing mining projects represents less than 2.5% of the total Isaac River catchment area to the Phillips Creek confluence. The Project mine affected catchments contributes approximately 0.06% of the Isaac River to Phillips Creek.

The combined total catchment area of the existing mining projects suggests that the loss of Isaac River catchment during operations would reduce surface water flows when rainfall and runoff is collected within their respective water management systems. However, when considering the current approved release rules and their potential discharges and stream diversions generally only diverting catchments (not taking water) around the existing mining projects during operations, the overall loss of catchment area and associated decrease in stream flows is relatively small.

The Project does not contribute significantly to the cumulative impact on surface water flows as the Project itself proposes to only temporarily capture of mine water during operations. Post-closure, mining pits will be backfilled and the pre-mining catchment areas within the Project will be reinstated. During operations, approximately 50% of the Project disturbance area will be captured and the remainder will be released to the downstream environment following sediment removal by an ESC control. The neighbouring VCM applies similar principles in managing catchment runoff and diverting catchments around the operational areas and therefore when considering the entirety of the approved and planned operations at the VCM, the cumulative impact of the Project in post-closure within the Isaac River catchment to Phillips Creek confluence is negligible.

Table 3.1 Catchment area of existing projects considered in the cumulative impact assessment

Catchment	Total catchment area (km^2)	Estimated mine affected catchment area (km^2)
Vulcan South (the Project)	15.3	4.8
Vulcan Coal Mine	2.64	1.1
Other mines	551	182
Combined	569	188
Isaac River (to the Phillips Creek confluence)	7,731	-

4 SENSITIVITY ASSESSMENT - MINE AFFECTED WATER RELEASES

4.1 OVERVIEW

A sensitivity assessment of the mine water management system was undertaken using the RCP 8.5 climate change scenario which represents a 1.25°C global warming and increase in rainfall compared to the basecase scenario presented in the Surface Water Assessment (SWA) (WRM, 2023a). The dewatering rates of the proposed mine affected water (MAW) dams were also reduced by 50% to assess the risk of uncontrolled releases during operations.

4.2 RESULTS

4.2.1 Summary

Section 4.2.2 to Section 4.2.4 discusses the results of the sensitivity assessment. In summary, under the reduced dewatering scenario, the risk of uncontrolled releases is minimal and occurs only during the wettest climatic conditions assessed. However, there is sufficient MAW capacity overall (and within the pits if necessary) and redundancies to dewater the MAW dams prior to uncontrolled releases to the environment. Compared to the SWA, the risk of uncontrolled releases is not significantly increased when taking into account the potential impact of climate change and increase in rainfall and also a reduction in dewatering capacity of the MAW dams.

4.2.2 MWD8 inventory

Figure 4.1 shows the forecast inventory for MWD8 which is the key out-of-pit mine affected water storage, controlling the dewatering of the pit. The results show the 1%ile (wettest climatic conditions), 5%ile, 10%ile, 25%ile and 50%ile traces. The model results show the following:

- The MWD8 inventory is maintained below the FSV for all climatic conditions assessed and therefore is not predicted to spill under any modelled climate sequence.
- The MWD8 inventory is maintained below its MOV for 5%ile and drier conditions in Stage 1 and 25%ile & drier conditions in Stages 2 & 3. This means pit and mine dam dewatering is restricted under 1%ile in Stage 1 and 10%ile and wetter conditions in Stages 2 and 3.
- Under the 50%ile trace, the MWD8 inventory is maintained below 12 ML for the entire mine life.
- Under very wet (1%ile) conditions, MWD8 has an inventory of up to 156 ML during Stage 2.
- Under wet (10%ile conditions), MWD8 has a maximum inventory of approximately:
    - up to 62 ML during Stage 1; and
    - up to 132 ML during Stage 2 and 3.

4.2.3 MWD9 inventory

Figure 4.1 shows the forecast inventory for MWD9. The results show the 1%ile (wettest climatic conditions), 5%ile, 10%ile, 25%ile and 50%ile traces. The model results show the following:

- Under the 1%ile (wettest climatic conditions), the MWD9 inventory reaches the FSV under the reduced dewatering scenario. However, in the event that the proposed dewatering is constrained, there is sufficient storage within the MAW system for MWD9 to dewater to prevent uncontrolled releases.
- Under wet (10%ile conditions), MWD9 has a maximum inventory of approximately up to 18 ML during both Stage 1 & 2.

4.2.4 MWD6 and MWD7 inventories

Figure 4.3 shows the annual maximum forecast combined inventory for MWD6 and MWD7. The results show the 1%ile (wettest climatic conditions), 5%ile, 10%ile, 25%ile and 50%ile traces. The model results show the following:

- Under the 1%ile (wettest climatic conditions), the MWD6 and MWD7 inventory reaches the FSV under the reduced dewatering scenario and indicate that the mine dams spill into MWD8 very infrequently (i.e. less than 1% of the time).
- Under the 50%ile trace, the mine water inventory is maintained well below the MOV for all years.
- The maximum water inventory only rises above the MOV under conditions wetter than the 5%ile during all stages.

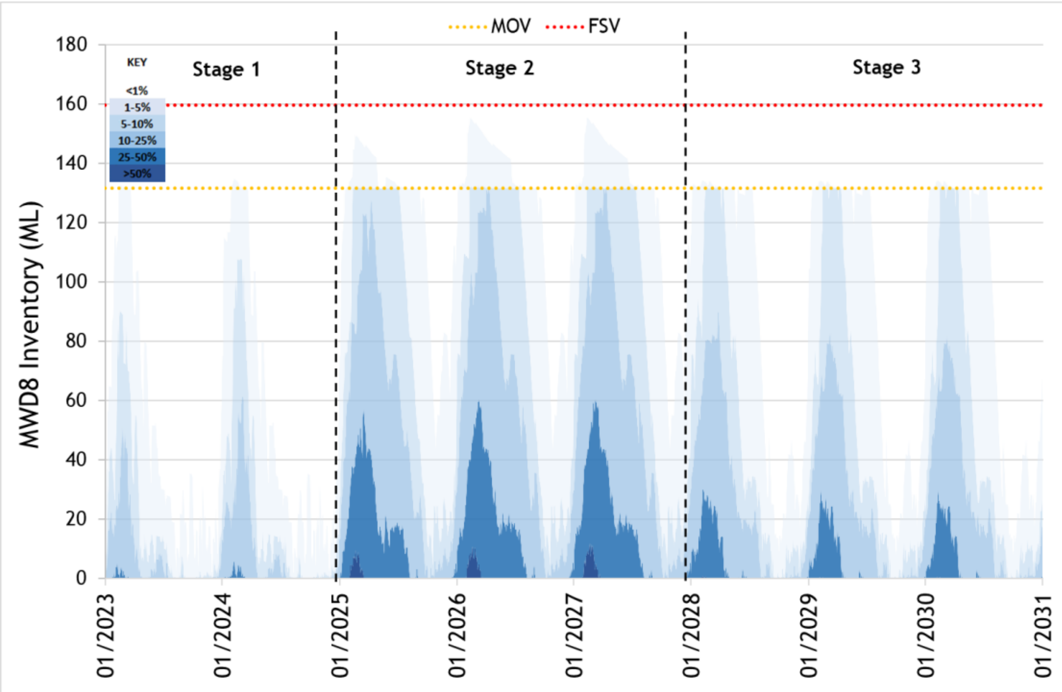

Figure 4.1 Forecast MWD8 inventory

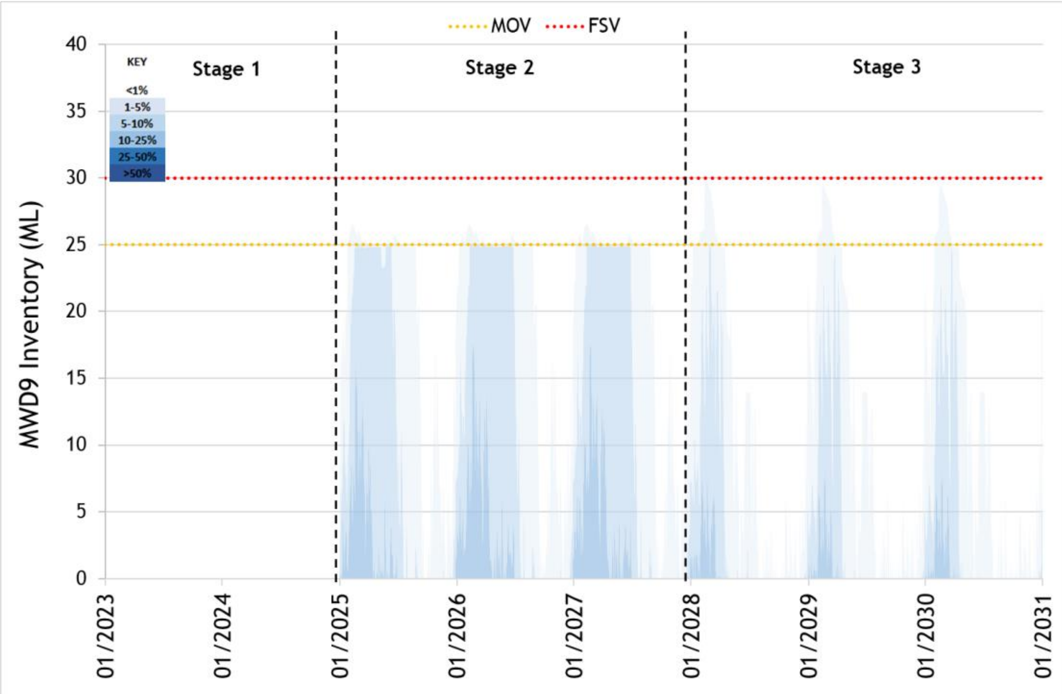

Figure 4.2 Forecast MWD9 inventory

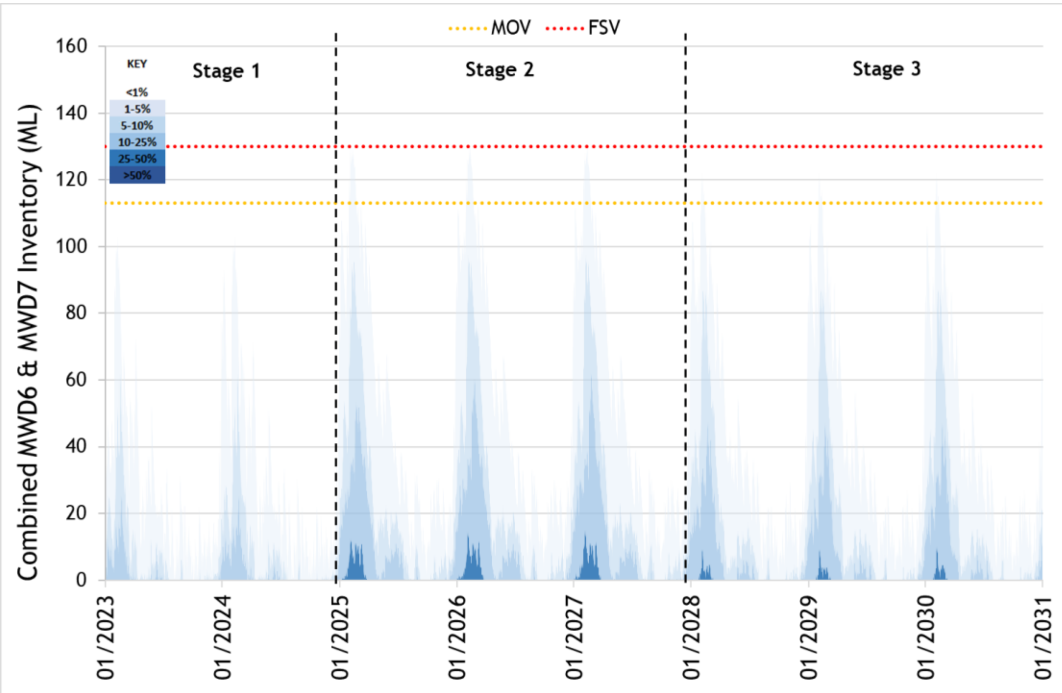

Figure 4.3 Forecast MWD6 and MWD7 inventory

5 SENSITIVITY ASSESSMENT – AWBM PARAMETERS

5.1 OVERVIEW

Although the AWBM parameters adopted in the SWA (WRM, 2023a) are typical for coal mines in the part of the Bowen Basin where the Project is located, a sensitivity assessment of the AWBM parameters was undertaken to assess the likelihood of overflows from the proposed sediment dams.

Table 5.1 shows the adjusted In pit spoil/Out of pit spoil landuse AWBM parameter adopted in the SWA (WRM, 2023a) compared to the sensitivity assessment. Consistent with the IECA guidelines (2008), sediment dams do not provide 100% containment for captured runoff. Hence overflows will occur from sediment dams when rainfall exceeds the design standard.

Table 5.1 Sensitivity assessment In pit spoil/Out of pit spoil AWBM parameter

Parameter	SWA adopted AWBM	Sensitivity AWBM
A1	0.07	0.07
A2	0.10	0.10
A3	0.83	0.83
C1	5	5
C2	10	10
C3	200	150
C_{avg}	167.4	125.8
BFI	0.5	0.5
k_{base}	0.9	0.9
k_{surf}	0.1	0.1
C_v*	12%	14%

*Long-term volumetric runoff coefficient

5.2 RESULTS

5.2.1 Overview

The results show that under 10%ile (wet conditions), releases to Hughes Creek increase by up to 57% (325 ML/year) and releases to East Creek are increased by up to 52% (82 ML/year) when compared with the SWA (2023a) results. However, there is negligible increase in EC in the receiving waters compared to the SWA (WRM, 2023a). Hence, whist there is a significant increase in modelled sediment dam releases, it is not expected to impact significantly on downstream water quality. Therefore, based on the model results the potential downstream impacts on EC are not expected to be sensitive to the adopted AWBM parameters.

5.2.2 Releases/overflows to the receiving waters

Figure 5.1 shows the forecast annual sediment dam releases to Hughes Creek. Figure 5.2 shows the forecast annual sediment dam releases to East Creek. The model results indicate that:

- The predicted sediment dam releases to Hughes Creek progressively increases over the mine life. This is due to sediment dams which release to Hughes Creek progressively being constructed over the mine life as the dump areas associated with the Vulcan Main and Vulcan South pits increases.

- The predicted sediment dam releases to East Creek increase in Stage 2 compared to Stage 1 before decreasing again in Stage 3. This is due to no new sediment dams draining to this creek being constructed at the commencement of Stage 3. The surface water catchment areas do not change between Stages 2 and 3, however mine demands for the sediment dam water increase in Stage 3.
- Under wet (10%ile) conditions, the annual volume of sediment dam releases to Hughes Creek is approximately:
  - up to 344 ML/yr during Stage 1;
  - up to 529 ML/yr during Stage 2; and
  - up to 899 ML/yr during Stage 3.
- Under wet (10%ile) conditions, the annual volume of sediment dam releases to East Creek is approximately:
  - up to 177 ML/yr during Stage 1;
  - up to 239 ML/yr during Stage 2; and
  - up to 236 ML/yr during Stage 3.
- Under 50%ile conditions, the annual volume of sediment dam releases to Hughes Creek is approximately:
  - up to 40 ML/yr during Stage 1;
  - up to 22 ML/yr during Stage 2; and
  - up to 48 ML/yr during Stage 3.
- Under 50%ile conditions, the annual volume of sediment dam releases to East Creek is approximately:
  - 0 ML/yr during Stage 1; and
  - up to 10 ML/yr during Stage 2 and Stage 3.
- Overall, the results indicate that under average or drier conditions low spill volumes are expected to the receiving waters, while wet conditions result in more significant spill volumes.

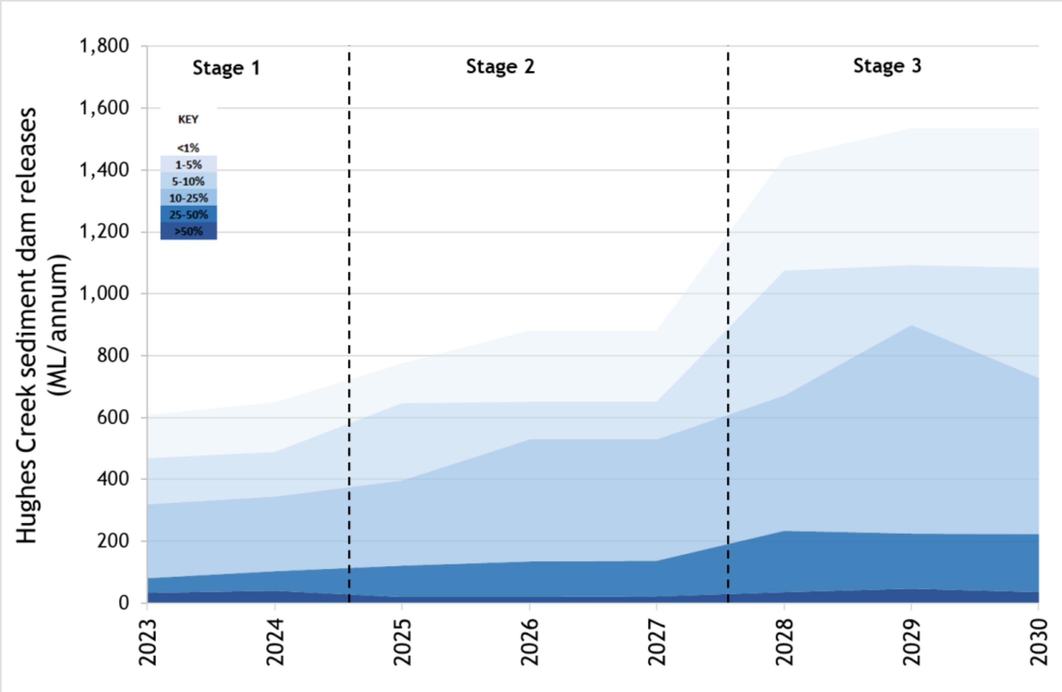

Figure 5.1 Forecast annual sediment dam releases to Hughes Creek

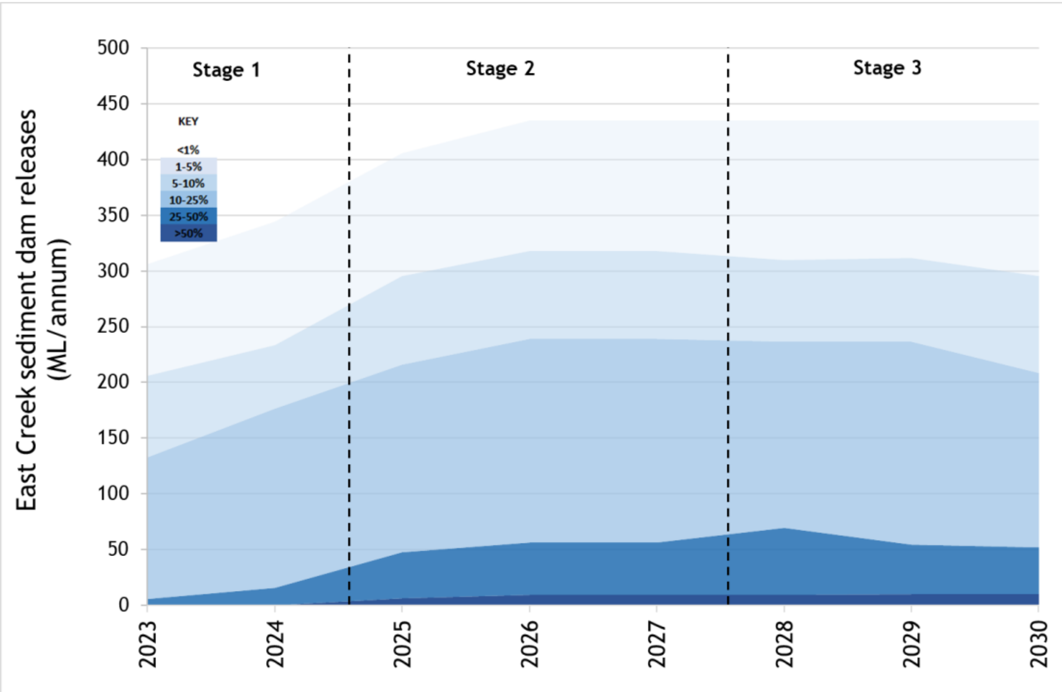

Figure 5.2 Forecast annual sediment dam releases to East Creek

5.2.3 Receiving waters quality

Figure 5.3 shows the predicted annual maximum EC in Hughes Creek over the mine life. Figure 5.4 shows the predicted annual maximum EC in East Creek over the mine life. The 1%ile, 5%ile, 10%ile, 25%ile and 50%ile (median climatic conditions) traces are shown. The results predict that:

- For Hughes Creek:
  - Under 1%ile conditions the maximum EC is approximately 430 µS/cm in Stage 1, 405 µS/cm in Stage 2 and 410 µS/cm in Stage 3; and
  - Under 50%ile conditions the maximum EC is approximately 320 µS/cm in Stage 1 and 350 µS/cm in Stage 2 and Stage 3.
- For East Creek:
  - Under 1%ile conditions the maximum EC is approximately 500 µS/cm in Stage 1, Stage 2 and Stage 3; and
  - Under 50%ile conditions the maximum EC is approximately 490 µS/cm in Stage 1, Stage 2 and Stage 3.

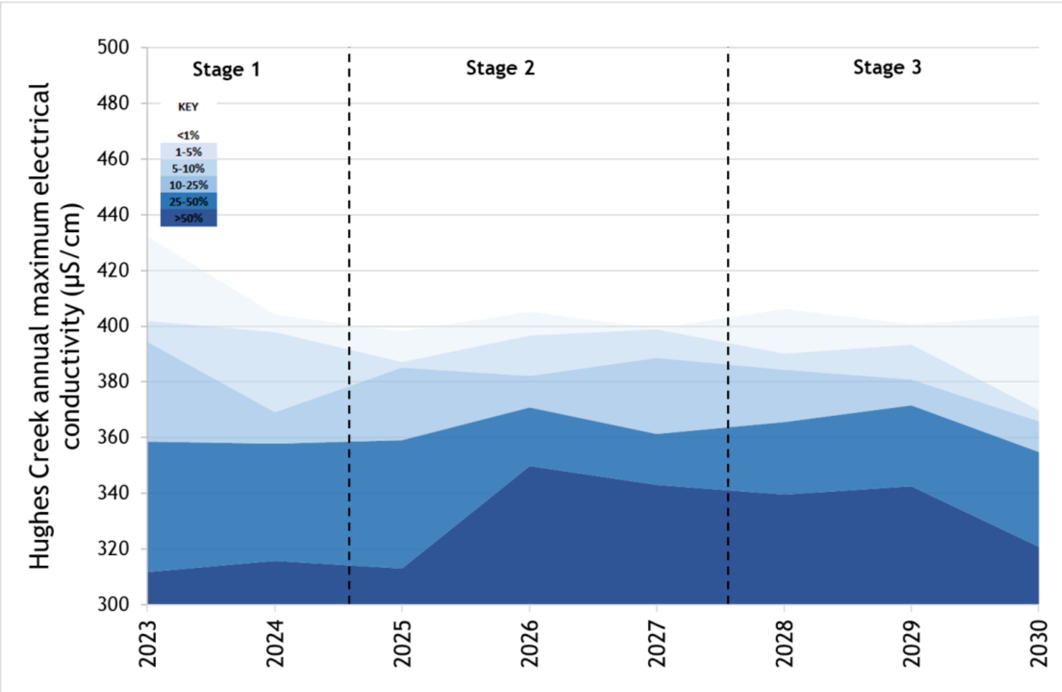

Figure 5.3 Predicted Hughes Creek annual maximum EC variation downstream of the Project

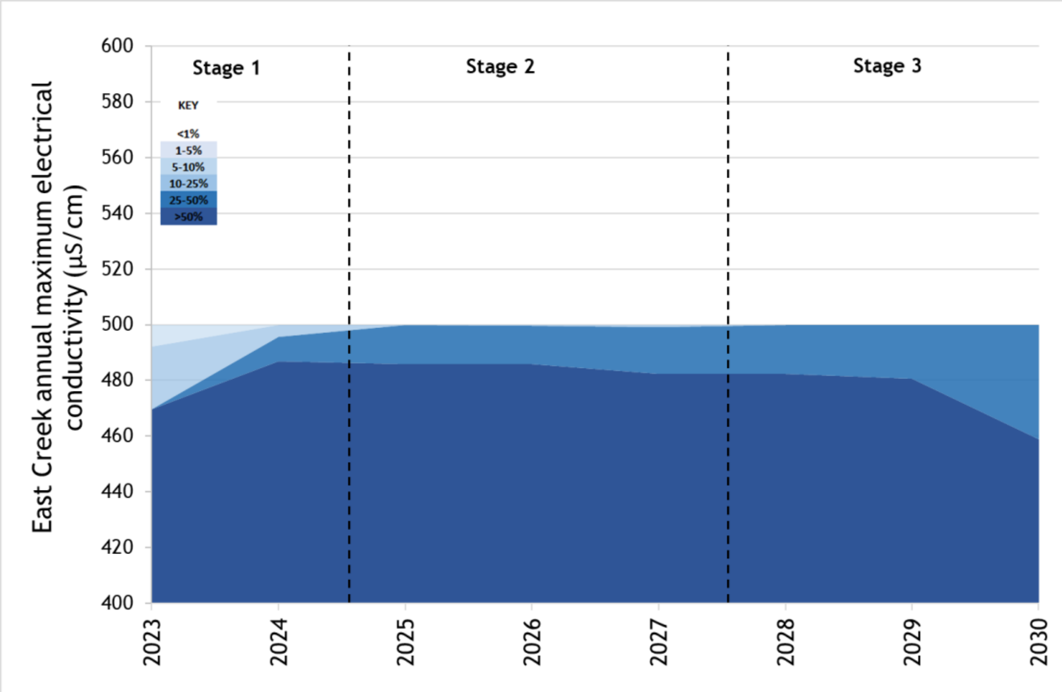

Figure 5.4 Predicted East Creek annual maximum EC variation downstream of the Project

6 REFERENCES

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