BHP

South Walker Creek Mulgrave Resource Access: Stage 2C (MRA2C)

EPBC 2017-7957

Appendix C:
Surface Water Assessment

REPORT:

South Walker Creek Mine Mulgrave Resource Access 2C Project Surface Water Impact Assessment

June 2018

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Author/s	Jason Carter Tony Weber Rohan Lucas
Checked	Rohan Lucas
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Executive Summary

The purpose of this report is to provide a surface water impact assessment for the BHP Mitsui Coal (BMC) proposed South Walker Creek Mine Mulgrave Resource Access, Stage 2C (MRA2C) Project (the Project). The Project is a controlled action under the *Environment Protection and Biodiversity Conservation* Act 1999 (EPBC Act) (EPBC 2017/7957).

Under the EPBC Act, an action which involves a coal seam gas (CSG) development or a large coal mining development requires approval from the Minister for the Environment and Energy (the Minister) if the action has, will have, or is likely to have a significant impact on a water resource. The "Significant impact guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources" (Australian Government Department of Environment, 2013) were developed to assist proponents to decide whether the action has or is likely to have a significant impact on a water resource. This report provides an assessment of the significance of impact to users, including environmental function and features (identified in the environmental values) of the surface water resources in accordance with the EPBC Act and its guidelines. A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the water resource which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.

E 1.1 Significance of the MRA2C Project on hydrology of Walker Creek and Bee Creek

Hydrology of Walker and Bee Creeks

The maximum impact on flows in Walker Creek as a direct result of the increasing catchment areas of F, G & H and H & I Pits is a decrease of 0.47% and 0.08% of the Bee Creek catchment as measured downstream at Dipperu National Park by 2049. This estimate does not consider any compliant flows released from storage (in F Pit and/or two new proposed Northern and Southern Dams) under Environmental Authority (EA) conditions and can therefore be considered as the maximum catchment areas that could contribute to a decrease in flows. It is reasonable to consider this as a conservative (maximum upper limit) scenario as at pit closure the catchments and voids of F, G & H and H & I Pits will have no pumping and will not contribute any runoff to Walker Creek. Whilst final mine closure pit void and landform is not yet fully designed it is considered to be a reasonable scenario at this time to assess the expected magnitude of impacts. This percentage reduction in catchment area and flows is well within any margin of error in calculations and is not considered to represent any significant impact on the hydrology of Walker and Bee Creeks and is therefore considered to have no significant impacts to users.

Highwall drain catchments

The catchments on the western side of the pit progression that will continue to drain towards the highwall (highwall drain catchments) require consideration. Runoff will initially drain to the remnant Walker Creek channel from where it must be pumped out. This catchment will remain unaffected by mining activity and so runoff can be pumped directly to Walker Creek under existing EA conditions. As the mine develops between 2019 and 2065 the highwall drain catchments reduce as the pits progress. The remnant Walker Creek channel will be mined through and a number of subcatchments will be created, which can be joined by constructed drainage or managed separately. By 2065 the highwall drain catchment area will be minimal and the remaining catchments topography can be graded and/or built up to prevent ponding behind levees.

This water will be clean runoff, released to Walker Creek under EA conditions and with no identified significant impacts to users.

Flood flows and extents

Changes to flood flows and extents are localised to the diversion and the immediate reaches of Walker and Carborough Creeks upstream and downstream from the diversion. Changes will remain on lease or on BMC owned land and as such there are no significant impacts to users.

E1.2 Significance of the MRA2C Project on water quality

The catchment areas of the pits within the MRA2C Project have been determined and how they are predicted to change over the mine life. From commencement of the Project in 2019 until 2034 there is predicted to be very little change in the catchment areas and land use (spoil and pit void) compared to the current base case. Rehabilitated areas change over time as the pits progress but those areas drain away from the pit voids and runoff is treated prior to discharge. The sites' water management system including release of mine affected water operates effectively under current EA conditions – given that the catchment areas of the pits changes little over the period 2019 to 2034 it can be expected that the mine can continue to operate effectively without the need for changed EA conditions. From 2034 to 2049 the catchment area increases by 163.4 Ha (40% greater than the current base case); however, whilst the catchment areas of the pits increase, resulting in a greater volume of water being required to be removed from the pits to alternative storage (two new proposed Northern and Southern Dams) prior to discharge, water quality can be expected to be the same as the base case whilst annual volume increases. Never-the-less it is expected that with appropriate modified storage and discharge infrastructure (Northern Dam and Southern Dam) that discharges can continue to be undertaken in line with current EA conditions with no change in water quality to the downstream environment.

E1.3 Summary of significance of impacts

Under the definitions detailed in "Significant impact guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources" and described in Section 10.2 of this report, the development of the Project will not result in any identifiable significant impacts to users.

Contents

Figures

Tables

Abbreviations

Alluvium	Alluvium Consulting Australia Pty Ltd
AEP	Annual Exceedance Probability. The probability that a given rainfall total accumulated or peak flow rate for a given duration will be exceeded in any one year.
AHD	Australian Height Datum
ARI	Average Recurrence Interval. The average, or expected, value of the periods between exceedances of a given rainfall total accumulated or peak flow rate for a given duration.
EA	Environmental Authority
MRA	Mulgrave Resource Access
PMF	Probably maximum flood
REMP	Receiving Environment Monitoring Program
Stage 2A	MRA Walker Creek Diversion Stage 2A
Stage 2C	MRA Walker Creek Diversion Stage 2C
SWCM	South Walker Creek Mine

Glossary

TUFLOW	1D/2D Hydrodynamic modelling software package
XPSWMM	1D/2D Hydrodynamic modelling software package

1 Background and context

South Walker Creek Mine (SWC) is a BHP Billiton Mitsui Coal (BMC) owned and operated coal mining operation in Central Queensland, approximately 125 kilometres from Mackay. The mine operates under Queensland Environmental Authority (EA) – South Walker Creek Mine (Permit No. EPML00712313) (DEHP September 2016) and several project specific Federal *Environment Protection and Biodiversity Conservation Act* (EPBC) approvals. A copy of the EA is provided in Appendix A.

The SWC operation interacts with the Walker and Carborough Creek systems which overlie low strip ratio coal measures. Previous creek diversions have been constructed at SWC to provide access to these coal measures. The Mulgrave Pit now has three strips of coal left before being constrained from further mining by these creek systems. The mine planning process has identified the need for progression of the Mulgrave Pit, which will add significant value to the SWC operation.

BHP have conducted a study on creek diversion options for the Mulgrave Resource Access Project, which has resulted in preferred options known as Stage 2A and Stage 2C and shown in Figure 1.

Stage 2A of the project became operational in 2016. Stage 2C (referred to as the MRA2C Project, the Project), the focus of this report, has been subject to functional and detailed design and impact assessment and is scheduled to commence construction in 2019, subject to receipt of all approvals. The impact assessment is based on the Project disturbance footprint identified in Figure 2.

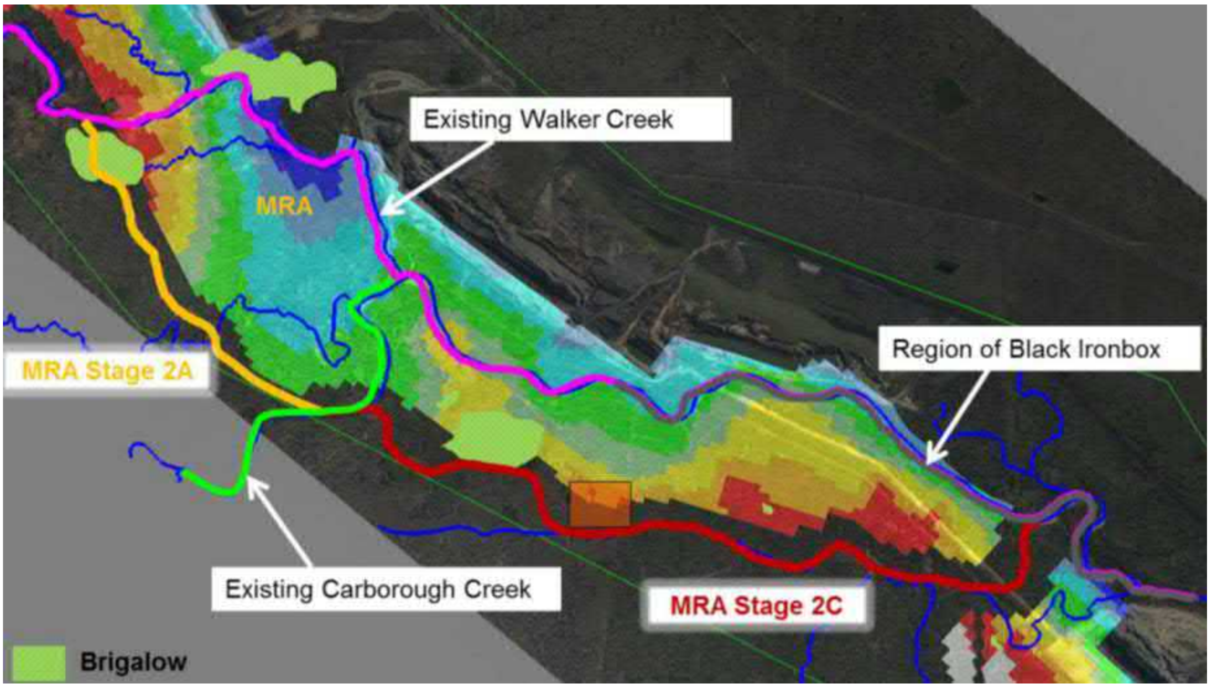


Figure 1. Stages 2A and 2C of the Walker Creek Diversion

This report details the findings of an assessment, which identifies and qualifies impacts from the Project to surface water resource users, including third parties and the environment. The primary assessment is of potential impacts to the quality and quantity of water for receiving users; including environmental function and features.

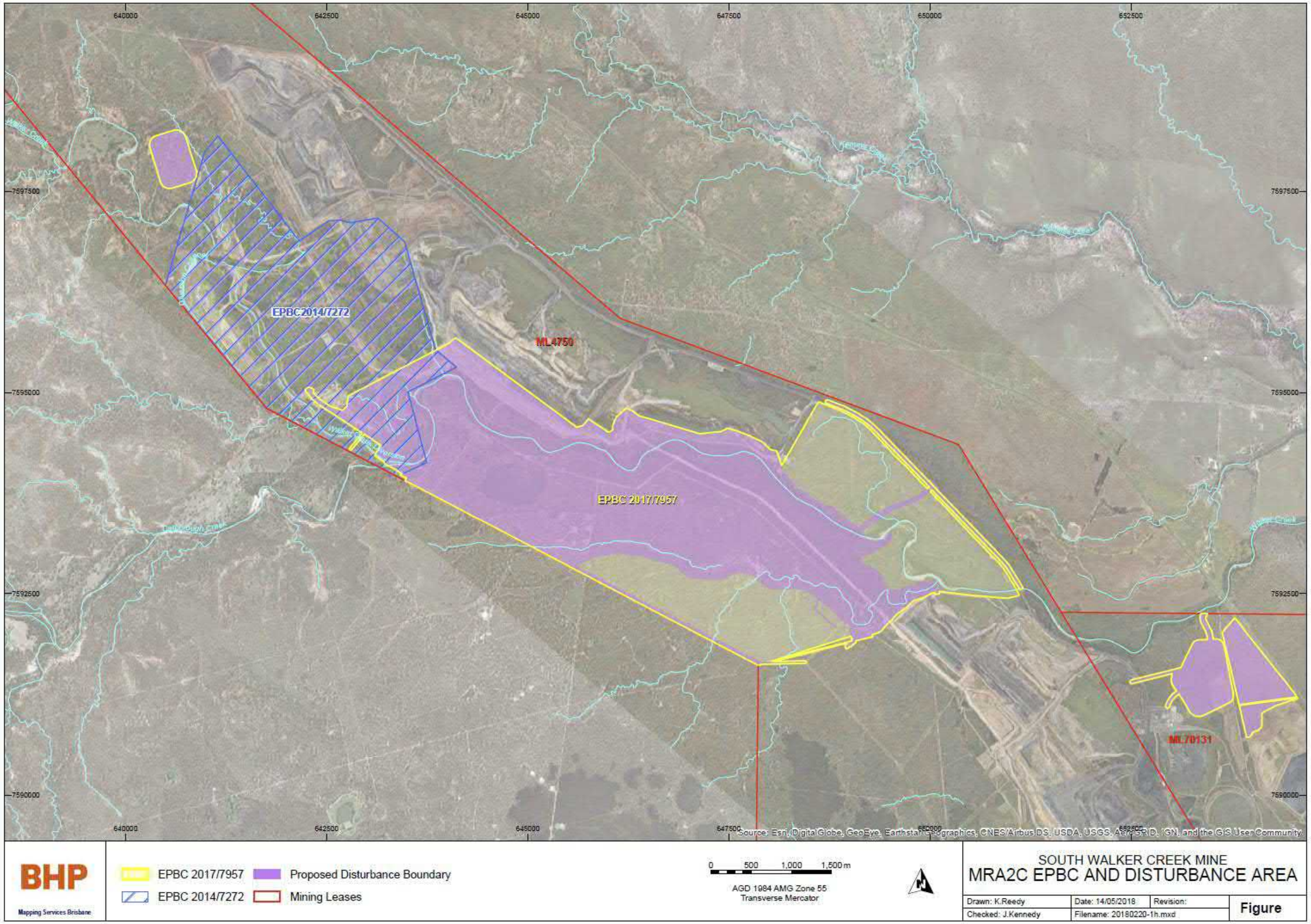


Figure 2. MRA2C EPCB area and disturbance area

2 Scope and purpose of the assessment

The purpose of this report is to provide a surface water impact assessment for the Project. The Project is a controlled action under the EPBC Act (EPBC 2017/7957). It provides surface water impact information that supports the Preliminary Documentation required for assessment under the EPBC Act.

A number of surface water surveys, monitoring and reports have previously been undertaken across SWC, including the following reports, which collectively provide much of the background information detailed in this report:

- Kemmis II – Impacts on water quality and hydrology (Texel Solutions, 2013)
- Mulgrave Pit – Surface Water Aspects (Texel Solutions,2013)
- MRA2A EPBC referral
- South Walker Creek and Poitrel Mines – salt assimilation studies – environmental values and water quality objectives (BMT WBM, 2011)
- Functional Design Report: Mulgrave Resource Access Walker Creek Diversion – Stage 2C (Alluvium, 2016)
- Summary Design Report: Mulgrave Resource Access Walker Creek Diversion – Stage 2C Detailed Design (Alluvium, 2016)

This report provides:

- Section 1 - Background and context of the Project
- Section 2 - Scope and purpose of the assessment
- Section 3 - Progression of mining - a description of the progress of the Project
- Section 4 - Hydrological setting - a description of the hydrological setting (catchments) within which the Project is located
- Section 5 - Condition of surface waters - a determination of the condition and value of surface water resources present
- Section 6 - Users and environmental values – relevant to the water resource
- Section 7 - Changes to hydrology as a result of the Project - an assessment of changes to the hydrology as described in Section 4.
- Section 8 - Changes to water quality as a result of the Project - an assessment of any changes, if any
- Section 9 - Significance of impact to the surface water resources - this is an assessment in accordance with the EPBC Act and its guidelines.

Under the EPBC Act, an action which involves a CSG development or a large coal mining development now requires approval from the Australian Government Environment Minister (the Minister) if the action has, will have, or is likely to have a significant impact on a water resource. The "Significant impact guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources" (Australian Government Department of Environment, 2013) were developed to assist proponents to decide whether the action has or is likely to have a significant impact on a water resource. Section 9 of this report provides an assessment of the significance of impact to the surface water resources in accordance with the EPBC Act and these guidelines.

3 Progression of mining

3.1 Current mine plan

The current mine plan progression of mining strips for the Project from 2016 to 2065 is shown in Figure 3 together with current subcatchments and water management system storages relevant to the Project. Over that period, four areas of interest to the study are identified as follows:

- Active pit – the area between the top of the high wall and the toe of the low wall – the area where direct rainfall and potential groundwater seepage will drain to. The active pit includes pre-strip areas.
- Spoil areas – the area of spoil from the crest of the low wall to the toe of the low wall – the unrehabilitated, active spoil area, where water runoff drains to the pit.
- Rehabilitated area – the area draining away from the crest of the low wall and pit where the spoil is rehabilitated to final landform or is in the process of rehabilitation. Runoff from this area is considered to be clean water runoff as it is sourced from either fully rehabilitated areas or has been treated by sediment control structures prior to discharge.
- Unmined areas – where clean water runoff drains directly or via drainage to Walker Creek. This includes all areas between the high wall and the western lease boundary, which may include capture and drainage (or pumping) of runoff between the highwall and diversion levees (referred to hereafter as the highwall drain catchments). All runoff from this area is assumed to be non-mine affected and will be directed to Walker Creek and not to the pit.

3.2 Base case

A base case for the Project study area has been established as at early 2016 as shown in Figure 2 with the following assumptions:

- The Project study area is 1,412 Ha, plus minor overlap with the previously approved MRA2A area
- Apart from minor overlap with the developed MRA2A Project area, all land surfaces are in a pre-disturbance condition. There are no current pit interceptions of the Project study area and all runoff flows to surface waterways and discharges from the study area via Walker Creek.
- The approximate average width of the base of the working pit is 150m and the approximate average width of the spoil area is 300m. These widths have been used as the basis for modelling the advancing pit over the 7 modelled blocks of time.
- There are three main subcatchments that define the area draining to the pits: F Pit; G & H Pit; and H & I Pit.
- There is a fourth group of subcatchments in the Project area that are of interest to the study; the area between the highwall and the Project diversion. This group of subcatchments are referred to as the highwall drain catchments. It is comprised of areas that are clean water runoff from undisturbed ground (and may include rehabilitated spoil areas from construction of the Project diversion and so will still be considered clean water runoff), drain to terminal catchments due to levee and plug construction (i.e. they do not discharge directly from site via Walker Creek). The terminal catchments will require active pumping or a one way valve to remove ponded water, or in some cases, grading along contours to divert water to Walker Creek. This catchment area will decrease over the lifespan of the Project as the pits advance. These catchments will require their own management system to ensure clean water continues into Walker Creek.
- There is a fifth area, to the west of the diversion, which is within the study area but is not considered as part of this assessment as it currently drains to Walker Creek and will continue to do so and will be undisturbed by the project.

3.3 Pit advancement

From the base case, advancement of the pits has been considered in logical blocks of years rather than annually due to scale of the project and minor variations at the annual scale. The following blocks provide the basis of a fit for purpose analysis of potential impacts and are based on mine planning as it is currently known.

- 2016-19 - The base case with existing pit, spoil and rehabilitation areas. This also includes the first pre-strips prior to interception with the Project study area.
- 2019-24 - This 5 year period is the first time that mining will intercept the Project study area.
- 2025-29 - This 5 year block is the first major advancement into the Project study area.
- 2030-34 - The 2nd 5 year block.
- 2035-39 - The 3rd 5 year block.
- 2040-49 - A ten year block.
- 2050-65 - The final block, 15 years. This will be the final configuration at pit closure.

For each of these blocks of time, areas have been calculated for each of the four areas of interest: active pit; spoil; rehabilitated areas; and unmined areas and for each of the catchments of F Pit; G & H Pit; and H & I Pit. From 2025 the rehabilitated areas are included with the natural (unmined) areas as all runoff from those areas is directed away from the pits, treated as clean water, and discharged as per EA conditions.

Figures 4 to 11 show these changing areas for each of the seven blocks of time. By the end of the 2050-65 block, the final pit void and spoil areas reduce as the area of rehabilitation, which drains external to the pit, is finalised. At that point the highwall catchments are minimal and remaining highwall drain catchments topography can be graded and/or built up to prevent ponding behind levees. As is shown in Table 1, the total area of internally draining catchment increases from the base case of 412 Ha in 2019 to a maximum of 579 Ha in 2049 before declining at closure to 395 Ha in 2065, a decrease of 20 Ha over the base case.

Table 1. Land use and catchment areas for F Pit; G & H Pit; and H & I Pit 2016 to 2065

Years	Pit (Ha)	Rehab/natural (Ha)	Spoil (Ha)	TOTAL (Ha)	% of Base Case
2016	100.6	73.1	241.0	414.7	
2016-19	91.8	50.8	269.5	412.0	99.3
2020-24	105.8	27.4	188.5	321.7	77.6
2025-29	130.6		256.4	387.0	93.3
2030-34	156.3		263.9	420.2	101.3
2035-39	199.9		360.5	560.5	135.1
2040-49	174.9		404.5	579.4	139.7
2050-65	101.6		293.	394.6	95.1

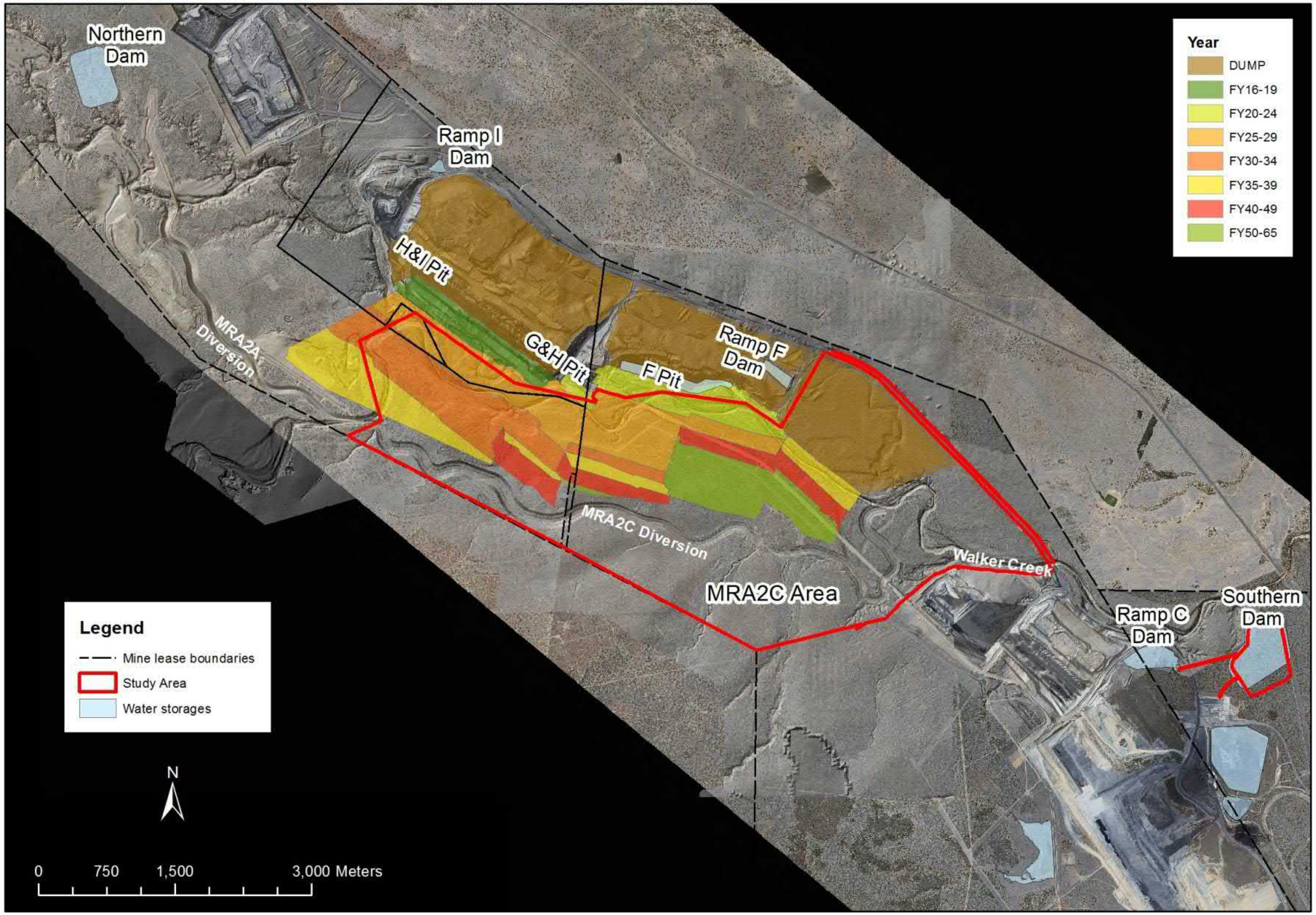


Figure 3. MRA2C Project Mine Plan 2016-65

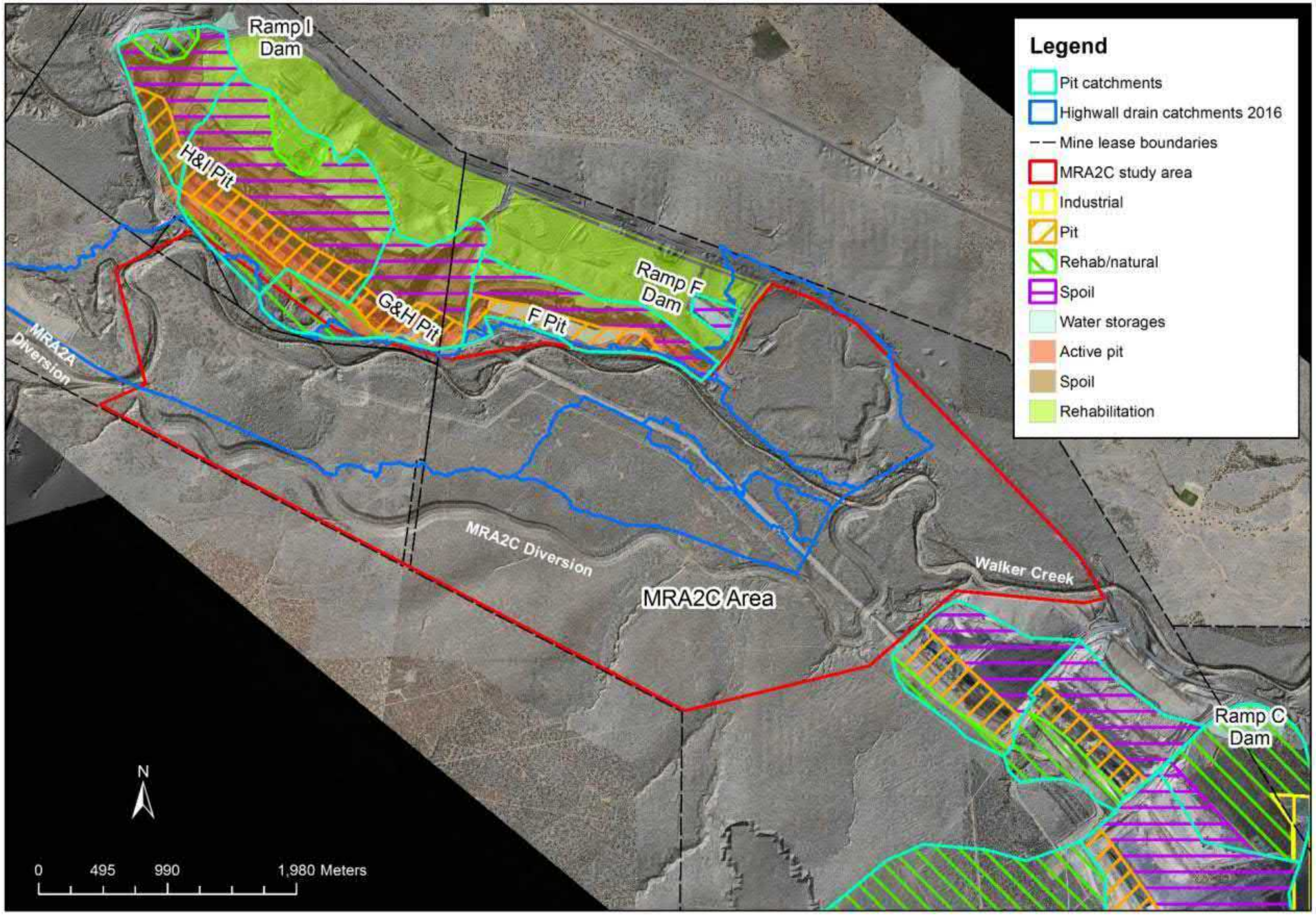


Figure 4. MRA2C Project Pit Catchments and land use as at 2016

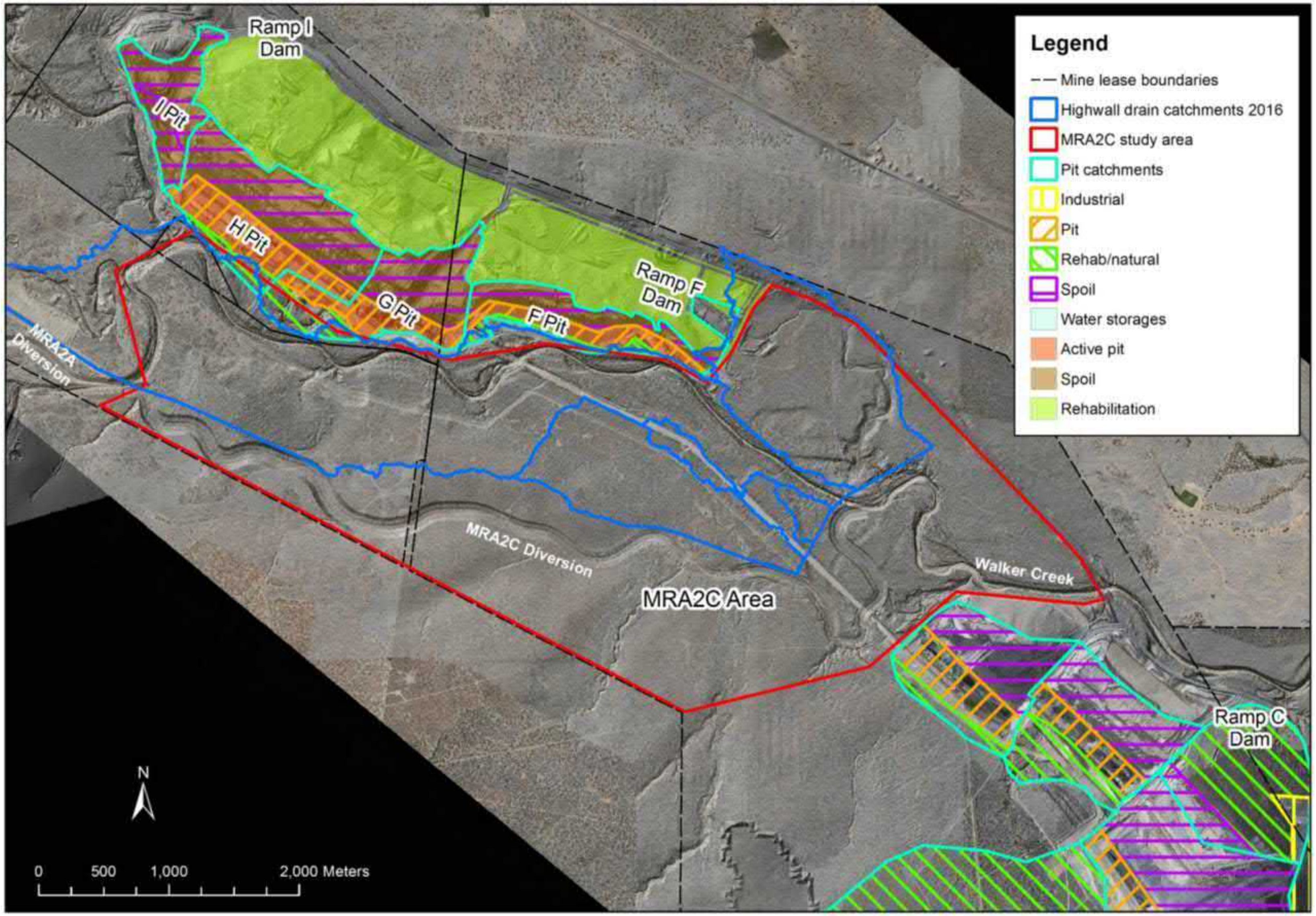


Figure 5. MRA2C Project Pit Catchments and land use as at 2019

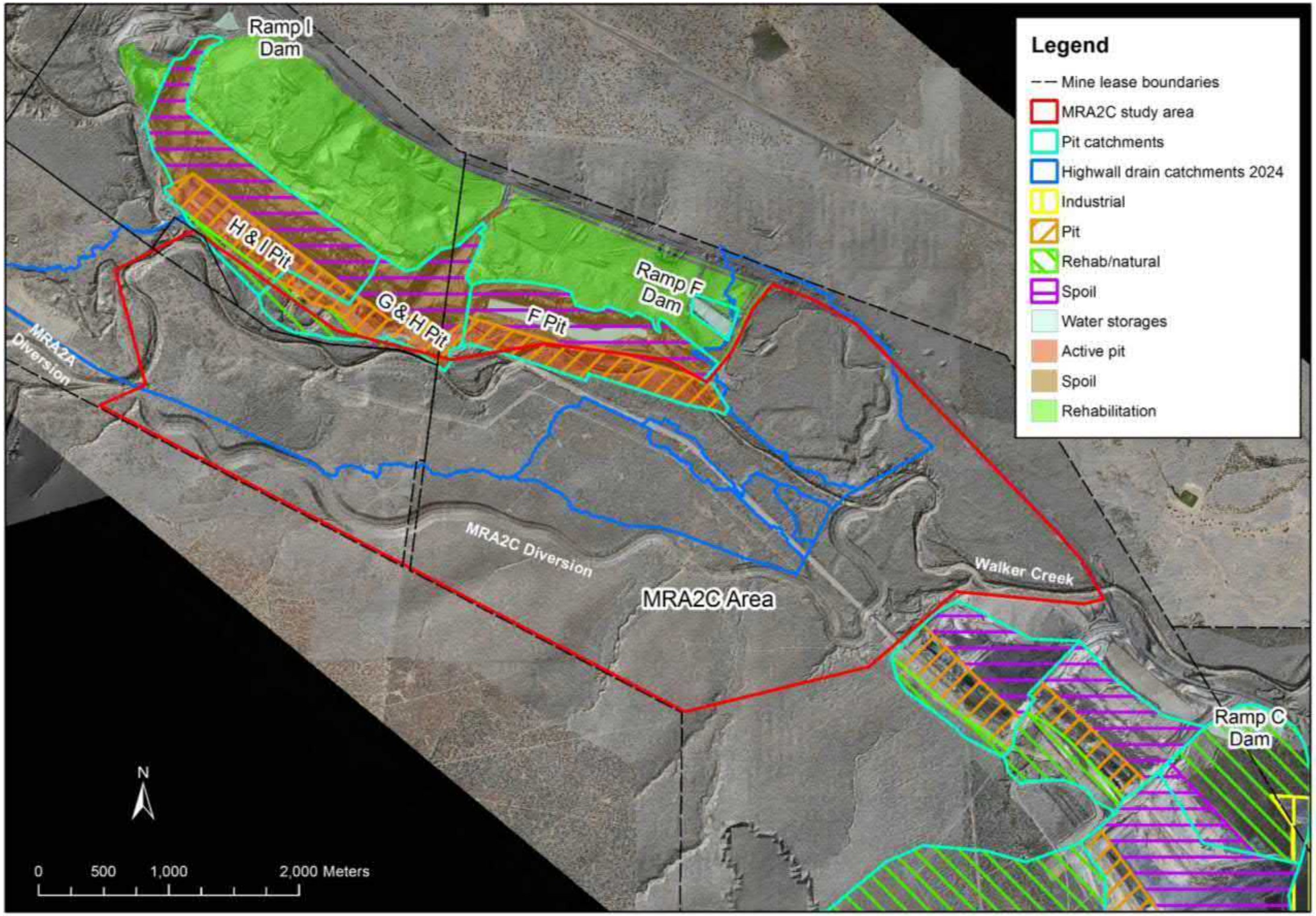


Figure 6. MRA2C Project Pit Catchments and land use as at 2024

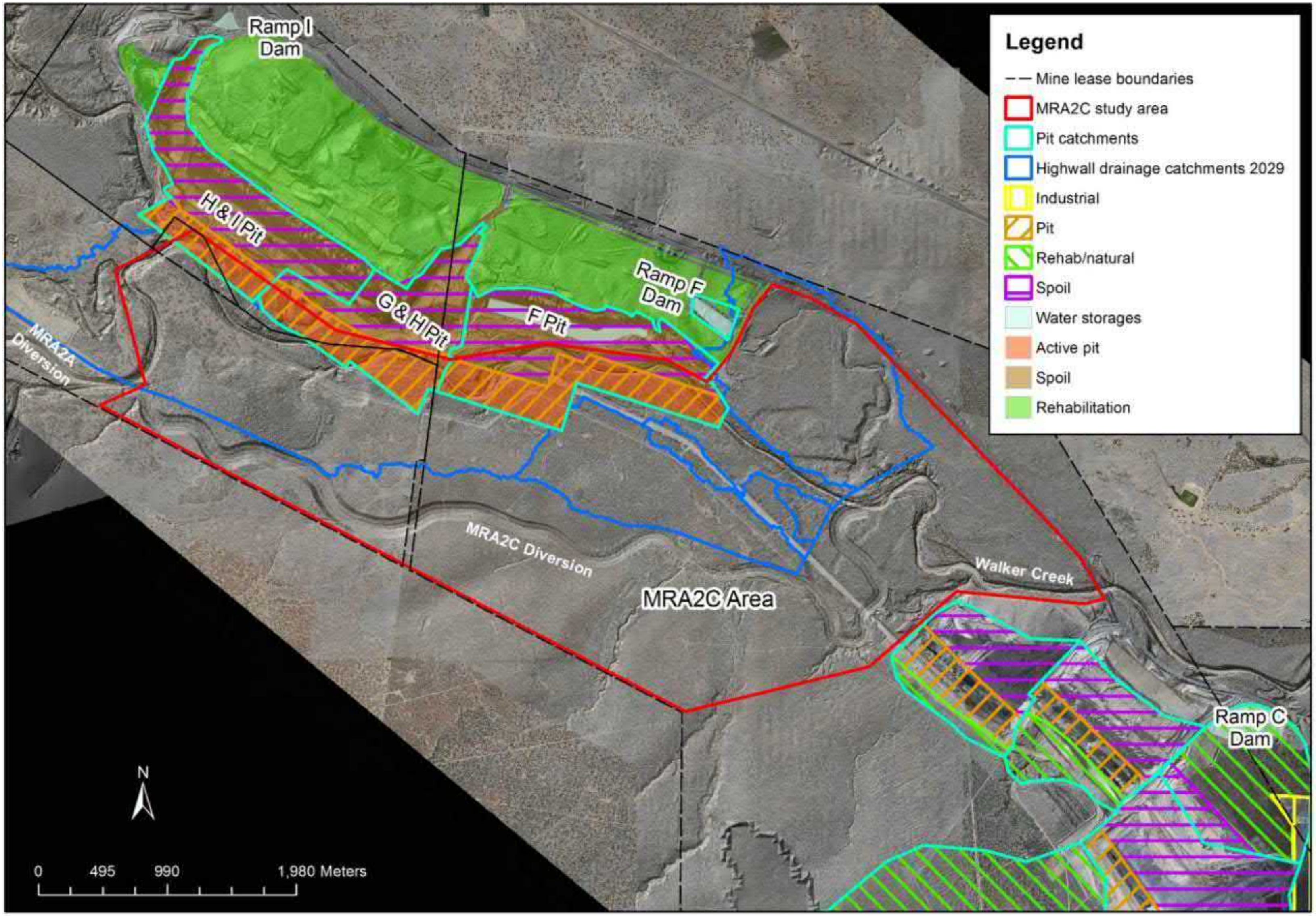


Figure 7. MRA2C Project Pit Catchments and land use as at 2029

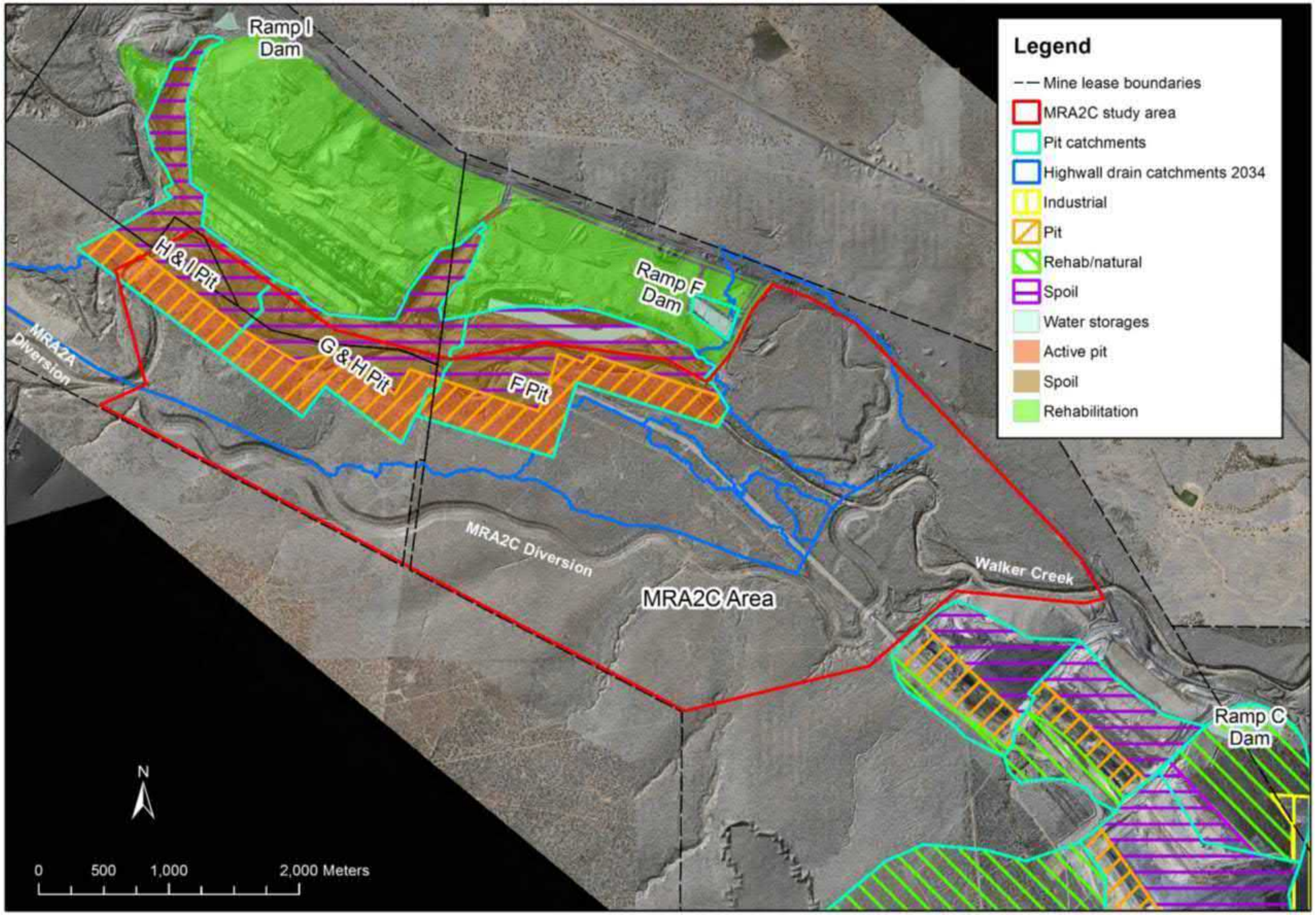


Figure 8. MRA2C Project Pit Catchments and land use as at 2034

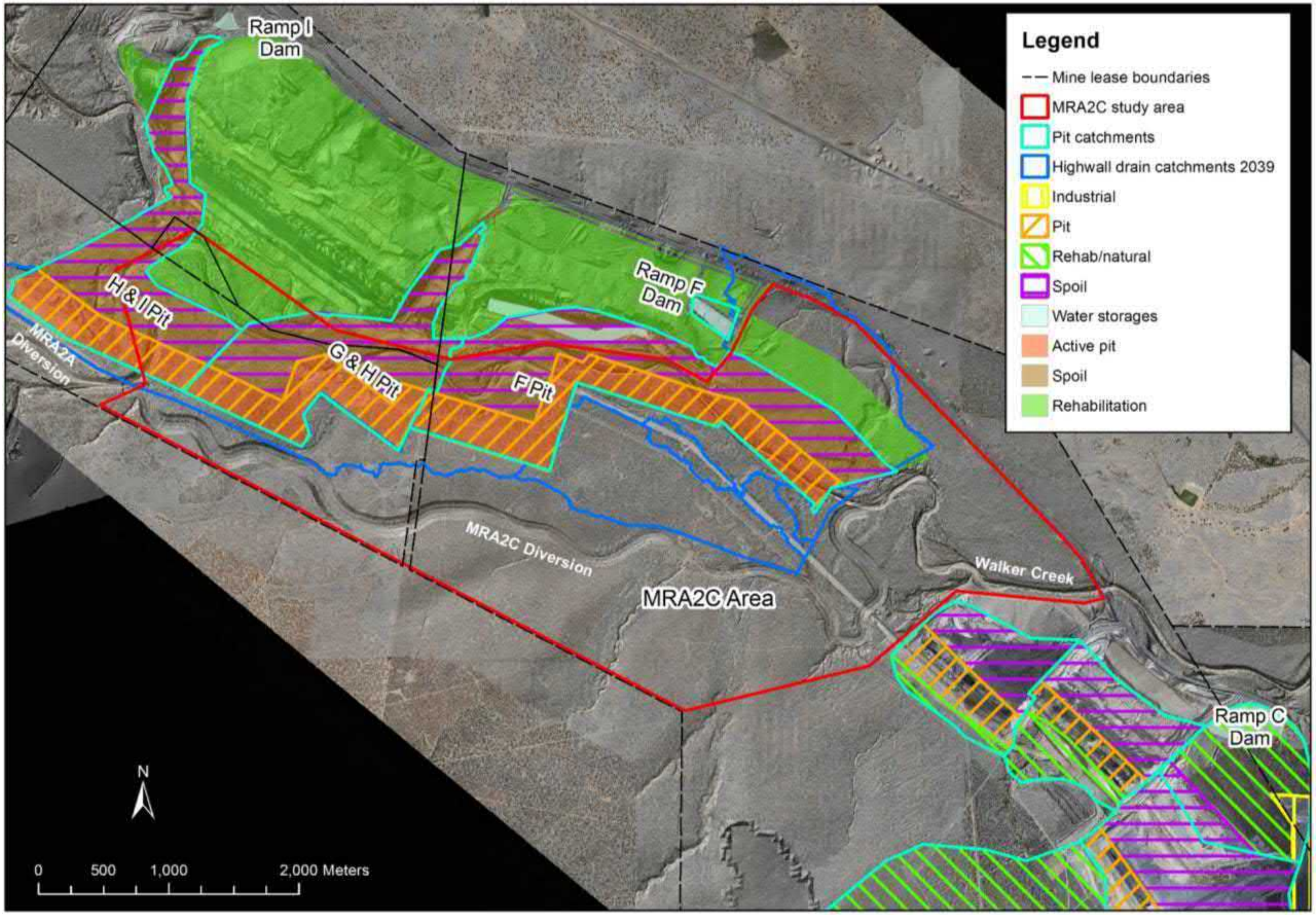


Figure 9. MRA2C Project Pit Catchments and land use as at 2039

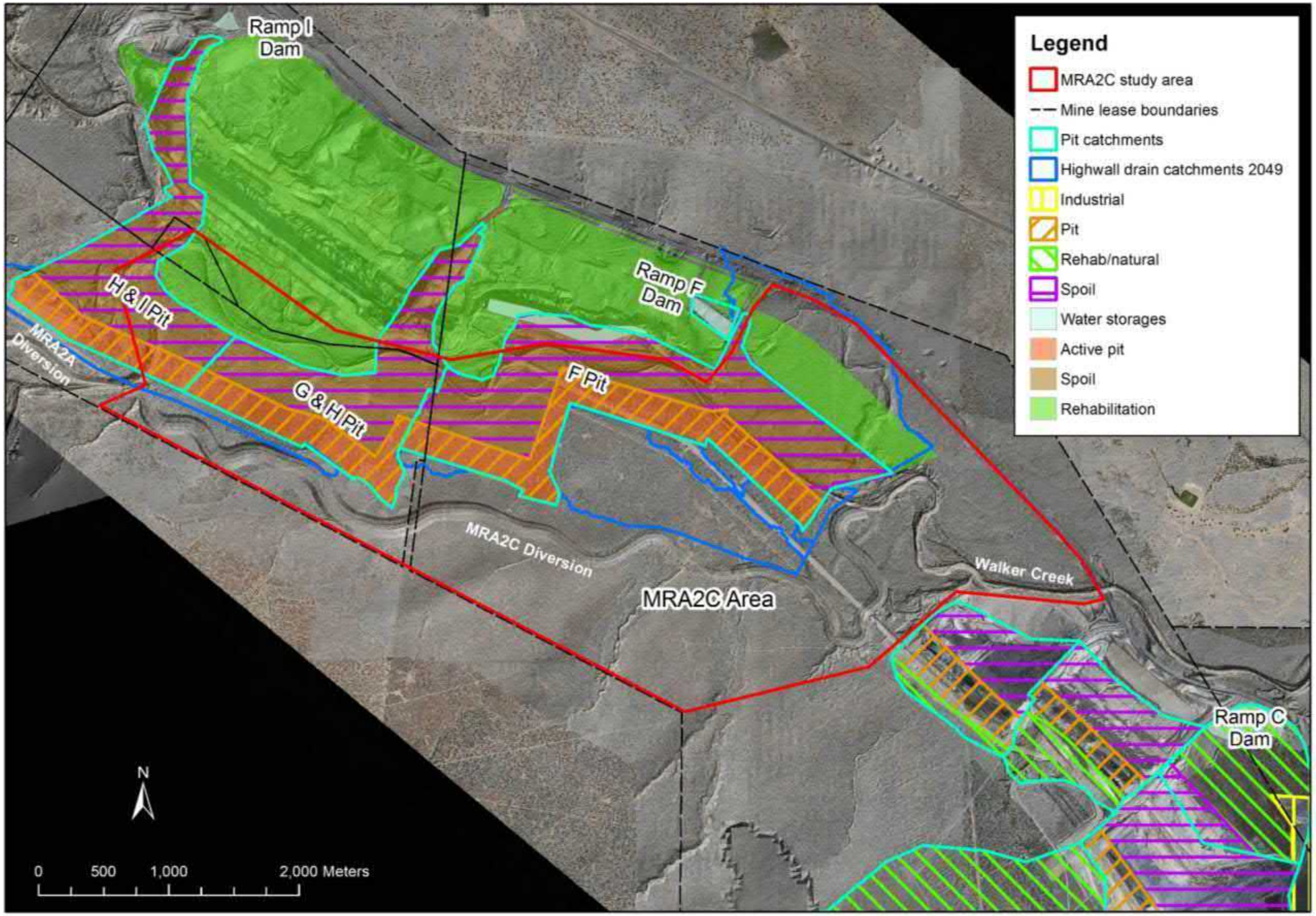


Figure 10. MRA2C Project Pit Catchments and land use as at 2049

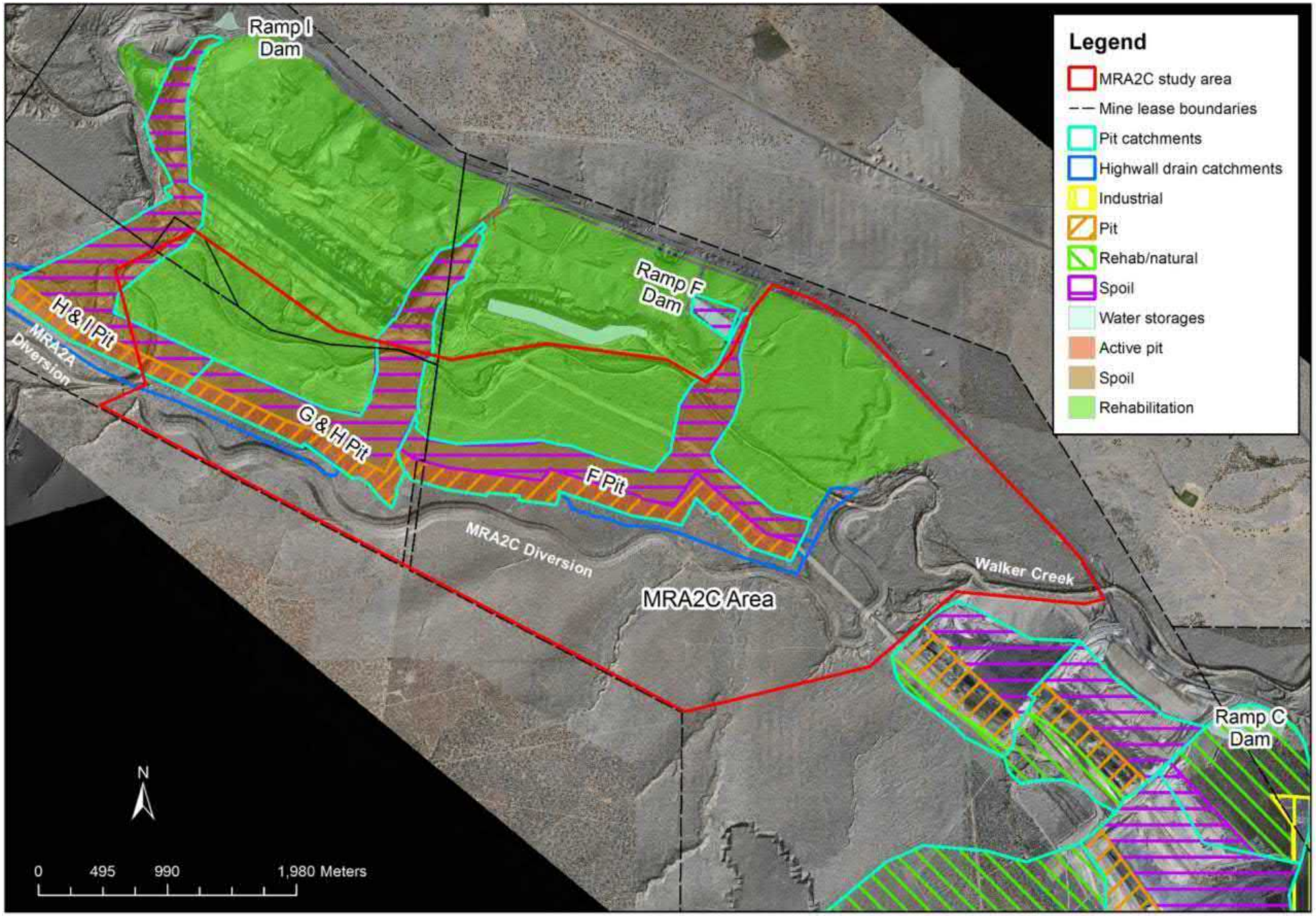


Figure 11. MRA2C Project Pit Catchments and land use as at 2065

Storage capacity and water management

At the time of preparing this report, the site water management system utilises the inactive void of F Pit as a water storage. Water from F Pit is periodically pumped to C Dam or F Dam from where it is used for site water requirements or released to Walker Creek under current EA conditions. Once the MRA projects are developed, F Pit will no longer be available as a water storage. A number of alternative arrangements have been considered by BHP. The selected option is to replace F Pit as a storage by constructing two new dams: the 500 ML Northern Dam and 2 GL Southern Dam (the locations of which are shown in Figure 3), these will then act as water storage with sufficient capacity to hold mine affected water for site water use and for release to Walker Creek under EA conditions.

The modified option of decommissioning storage in F, G, H & I Pits and constructing the Northern and Southern Dams are also shown as the future storage volume in Table 1. For this study the site water balance model was initially reconfigured to assess the option of removing F Pit as a storage and modifying C Dam to increase its capacity by 1.5 GL. That option was replaced with a new option of constructing the Northern and Southern Dams (with an increased combined capacity as the initial C Dam modification option) as a replacement for storage in F Pit. The model shows that the combined volumes peak in 2049 with the 1% exceedance probability equivalent to 1.232 GL. These figures do not allow for controlled and accidental releases (estimated to be very small). However, assuming those two variables remain unchanged, this demonstrates that constructing the Northern and Southern Dams with a combine storage of 2.5 GL should provide sufficient storage so that in any particular year there is less than a 1% chance of the volume being inadequate.

Table 1: Current and future water storage capacity relevant to the MRA2C Project

Dam	Storage Capacity (ML)	Scenario 1: Southern Dam Capacity (ML)	Scenario 2: Northern and Southern Dam Capacity (ML)
F Pit	1,700	None due to mining of the Project	None due to mining of the Project
Northern Dam	Not constructed	Not constructed	500
Southern Dam	Not constructed	2,000	2,000
F Dam - Estimated	150	-	-

4 Hydrological setting of the Project

The location of the Project study area within the Walker Creek catchment, Bee Creek catchment and broader Fitzroy River catchment is shown in Figure 12. These local and regional catchments areas are presented in Table 2.

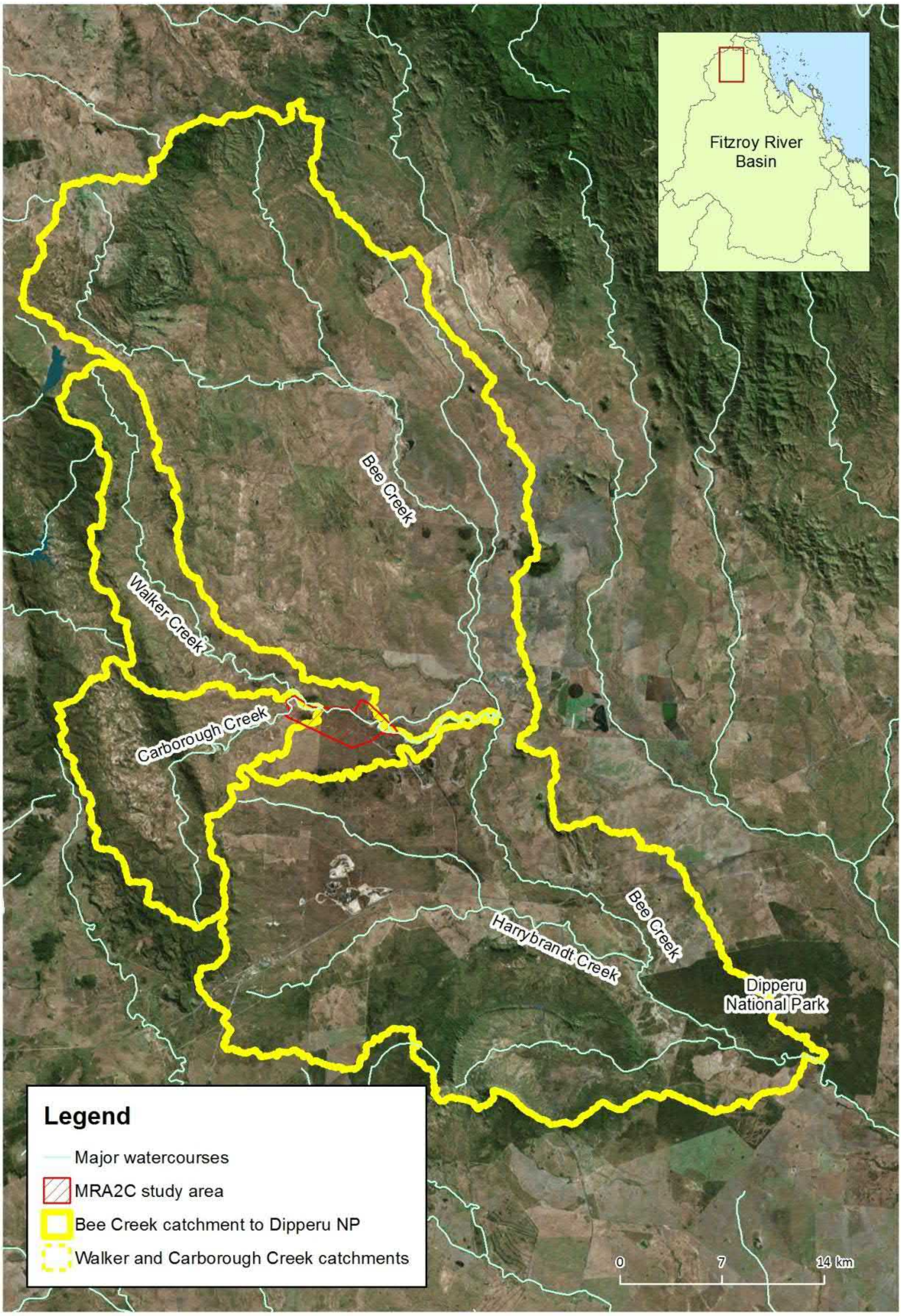


Figure 12. Location of Project study area within local and regional catchments

Table 2. Catchment areas

Sub-catchment level 1	Sub-catchment level 2
Bee Creek to Dipperu National Park: 1,945.4 km^2	Walker Creek to the confluence with Bee Creek (excluding Carborough Creek) 185.9 km^2
	Carborough Creek 163.6 km^2
	Bee Creek excluding Walker and Carborough Creeks 1,595.9 km^2

5 Condition of the surface water resources

The receiving waterways have been described previously in *"South Walker Creek and Poitrel Mines – Salt Assimilation Studies: Environmental Values and Water Quality Objectives"* (BMT WBM 2011). Additional descriptions are available for Walker Creek within the mine site in diversion monitoring reporting, the most recently available being 2017 (Neilly Group Engineering, 2017).

Bee Creek
Bee Creek extends from its headwaters, located approximately 40 km north of SWC, to Funnel Creek, which eventually flows into the Connors River. Hail Creek Mine and SWC are both located in the Bee Creek catchment. At a waterway distance of approximately 39 km south-east of SWC, Bee Creek forms the western border of Dipperu National Park. The east bank of Bee Creek forms the boundary of Dipperu National Park with the west bank being an operational grazing property. Both banks were identified in 2011 as being disturbed by cattle access tracks to a similar extent of the banks observed farther upstream, beyond the National Park.

Stream sediments are typically comprised of coarse sand, although boulders and cobble are present in places, with occasional bedrock exposures. Several of the sites on Bee Creek, surveyed in 2011, had moderate levels of instream micro-habitat diversity, mostly in the form of log jams and scour holes around tree roots. There was little leaf litter and small woody debris, with most instream habitat consisting of tree roots and scours, large woody debris and sandy banks.

Some of the larger scour holes are up to 2 m deep in places, and may represent dry season refugia for fish and macroinvertebrates during non-flow periods. These more complex habitats typically occur at river bends. The straighter sections of Bee Creek are relatively shallow and contain more simplified and homogenous instream run type habitats. In 2011, these areas did not contain waterholes and are unlikely to support water during non-flow periods. The riparian upper story vegetation of Bee Creek is mostly intact (confirmed by analysis in 2016 of aerial photography) and composed of large eucalypts, Casuriana and occasional *Callistemon*. Dawson River gums and forest red gums sometimes exceeded 30 m in height. The creek banks are benched in places, and typically have a tow of unconsolidated sandy sediment. Cattle access tracks constitute bank disturbance although steeper banks are free of cattle access tracks and typically have a high cover of grass and shrubs.

In 2011, rapid fish surveys were undertaken in Bee Creek at the junction of Harry Brandt Creek near Dipperu National Park. The most abundant species were Agassizii's glassfish (*Ambassis agassizii)*, eastern rainbowfish (*Melanotaenia splendida splendida*) and spangled perch (*Leiopotherapon unicolor*), which are all common and widely distributed species. It was identified as highly likely that greater survey effort would reveal more fish species. However, given the lack of permanency of waterholes between MRA2C and Dipperu National Park, any fish habitat in those reaches would only be temporary.

Based on the instream and riparian habitat conditions, Bee Creek is considered to be in a slightly to moderately disturbed condition (BMT WBM 2011).

Walker Creek
The headwaters of Walker Creek begin approximately 25 km north-west of SWC. Within the mine site, reaches of Walker Creek have previously been diverted to accommodate SWC mining activities, the most recent being MRA stage 2A, which creates a new confluence with Carborough Creek and became operational in 2016. Under strict flow and quality conditions as set out the EA, SWC may release mine-affected discharge into Walker Creek via controlled release processes from C-dam or F dam. The distance from the release points to Walkers Creeks' confluence with Bee Creek is 8.1 km. Dipperu National Park is a further 30 km channel length downstream with an additional 1,596 km^2 of catchment, a 457% increase in catchment area.

Walker Creek is a sand dominated waterway with little instream aquatic habitat, intermittent seasonal flows and few pools, none of which approach permanency. The riparian upper story vegetation of Walker Creek is mostly intact in the non-diverted reaches of the creek and composed of large eucalypts, casuarinas and occasional *Callistemon*, and eucalypts occasionally exceeding 30 m in height. The upper banks are benched with slight to near vertical grade on the lower banks. Cattle grazing occurs upstream and downstream from the mine site. Banks generally have a high cover of grasses and occasional shrubs. There is some notable bank erosion on Walker Creek on cleared agricultural land just upstream from the confluence with Bee Creek as shown in Figure 13 and in many other locations in the catchment such as in Figure 14.

Figure 13. Bank erosion on Walker Creek upstream from the confluence with Bee Creek (ESRI imagery)

Figure 14. Common bank erosion on Walker Creek upstream of SWC, unaffected by mining activity (Alluvium)

Based on the degree of modification to its catchment, quality of aquatic habitat, and overall stream condition, Walker Creek is considered to be in slightly to moderately disturbed condition (BMT WBM 2011).

Carborough Creek

BMT WBM (2011) stated that "based on the likely regularity of inundation, modification to its catchment, quality of aquatic habitat and overall stream condition, Carborough Creek is considered to be in a moderately disturbed condition".

With the completion of the MRA2A project diversion of Walker Creek, the confluence with Carborough Creek was moved upstream, just outside the MRA2C Project area. Consequently impacts to Carborough Creek are restricted to limited changes in flood extents and depths as discussed in Section 7. There are no expected impacts to the condition of Carborough Creek resulting from the MRA2C Project and as such it is not considered further. The current condition (as shown in Figure 15) of Carborough Creek and its influence on the MRA2C diversion has been considered in its design.

Figure 15. Severe alluvial gully erosion in the Carborough Creek terrace, upstream of SWC, unaffected by mining (Alluvium)

6 Users/environmental values of the water resource

Under the EPBC Act, an action which involves a large coal mining development now requires approval from the Australian Government Environment Minister if the action has, will have, or is likely to have a significant impact on a water resource. This includes a coal mine in its own right or when considered with other developments, whether past, present or reasonably foreseeable developments. This section of the report identifies the users (including third party and environmental values) of the water resource as they relate to the EPBC Act, including their condition and their reliance upon the water resource that may be impacted. Particular reference is made to the "Significant impact guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources" (Australian Government Department of Environment, 2013). These guidelines were developed to assist proponents to decide whether the action has or is likely to have a significant impact on a water resource

The following assessment has been done as a desktop assessment of: existing data and water quality objectives; and receiving water values.

6.1 Matters of National Environmental Significance

Matters of National Environmental Significance (MNES) identified as occurring or likely to occur within the Project study area are described in Eco Logical Australia (2017), *Mulgrave Stage 2C Ecological Impact Study*. Of relevance to this surface water study are:

- Black Ironbox (*Eucalyptus raveretiana),* which is listed as a threatened species, and
- Marginal migratory species habitat, including a highly disturbed ephemeral wetland.

Black Ironbox

Black Ironbox occurs in patches along Walker Creek, including in the project area and in areas further downstream. The density of mature Black Ironbox individuals along Walker Creek is approximately 76 individuals / km, which is significantly lower than Bee Creek at 165 individuals / km. The large and denser population along Bee Creek provides a greater source a reproductive output (pollen) and plays a critical role in maintaining genetic diversity. At a catchment level scale, the Walker Creek Black Ironbox population is a localised occurrence of the species on a more minor tributary system, with the Bee Creek population being the main source population for the drainage system (Eco Logical Australia, 2017).

Migratory species

Wetland migratory species habitat in the vicinity of the Project area includes an ephemeral wetland that has been heavily disturbed by the current grazing land use and riparian areas along Carborough Creek and Walker Creek. Habitats are not considered important as similar quality habitat and habitat resources is abundantly available in the surrounding area. Better quality breeding habitat also occurs outside but in close proximity to the study area, including Pink Lagoon, Funnel Creek and the Connors and Isaac River. Due to this, the study area is also not considered to support an ecological significant proportion of the migratory species, which are locally common throughout the region (Eco Logical Australia, 2017).

It is noted that EPBC Act controlling provision Section 20 & 20A for Listed Migratory Species is not nominated as a controlling provision for the MRA2C Project (EPBC 2017/7957).

6.2 Consideration of Environmental Values as per the "Significant impact guidelines 1.3"

The key factor considered relevant in determining the environmental value (EV) of a water resource is its utility for all third party uses, including third party uses and environmental and other public benefit outcomes. Such outcomes include:

- provisioning services (e.g. use by other industries and use as drinking water)
- regulating services (such as the climate regulation or the stabilisation of coastal systems)
- cultural services (including recreation and tourism, science and education)
- supporting services (e.g. maintenance of ecosystem function).

The ecosystem function of a water resource includes the ecosystem components, processes and benefits or services that characterise the water resource, including support for the biological diversity or species composition of the water resource.

The guidelines state that "If there is evidence, based on data, modelling and engagement with potentially affected stakeholders, that the action would not materially affect (either by increasing or decreasing) the availability and quality of water for all third party users, including environmental and other public benefit outcomes and including at a future time or in another place, then that would reduce the likelihood of the action having a significant impact".

6.3 Defining EVs for the surface water resources potentially impacted by MRA2C

Support documents
The definition of Environmental Values is primarily provided from "South Walker Creek and Poitrel Mines – Salt Assimilation Studies: Environmental Values and Water Quality Objectives" (WBM, October 2011) and updated with additional reference to the "Significant impact guidelines 1.3", which post-date the WBM report. Consideration is also given to:

- "Environmental Values for the Fitzroy: Community Consultation" (Prepared by Fitzroy Basin Association Incorporated June 2010, updated July 2011) in which EVs are identified for the Northern Connors Range Tributaries, which include Bee Creek and its tributaries, Walker and Carborough Creeks, although these watercourses are not specifically referred to. In that report Environmental Values are identified as "all Human uses have EVs. Farm use and Stock Watering have high values whilst Aquaculture is low. Industrial uses occur near the town of Nebo". Stock watering is acknowledged as a use downstream of the mine and there are no known aquaculture developments planned and as such EVs for aquaculture and industry are not considered further.
- Kemmis II – impacts on water quality and hydrology (Texel Solutions, August 2013), which identifies High Environmental Value (HEV) waters for Bee Creek.

Surface water usage
Surface water uses are identified as:

- Ecosystem function
- Stock watering
- Anecdotal reports of non-regulated surface water extraction (illegal) for drinking throughout the region (BMT WBM 2011)

Waterways may provide temporary habitat and aquatic fauna movement corridors during flow events. Deeper waterholes, if present, may persist for extended periods into the dry season but there are no permanent waterholes on Walker Creek between the mine and the Bee Creek confluence, approximately 10 kms waterway length from the Project area. The catchment area of Walker Creek (including Carborough Creek) is approximately 349.5 km^2. The deep scours at bends in Bee Creek are likely to approach permanency in wetter years, but probably dry out in periods of drought (WBM 2011). The first observable waterholes that may approach permanency, on Bee Creek downstream of the mine, are at Dipperu National Park, approximately 39 km waterway length downstream of the Project area. The catchment area of Bee Creek to the National Park is approximately 1,945 km^2as shown in Figure 12.

Surface water is also a primary necessity for riparian ecosystem function and values. Such values include but are not limited to: channel stability, nutrient and sediment trapping, habitat, aesthetic and cultural values.

Areas of conservation significance
A review of WBM (2011) identifies that the key feature of conservation significance is Dipperu National Park located approximately 39 kms waterway length downstream of SWC (see Figure 12), which is identified as High Environmental Value (HEV) under the Environment Protection (Water) Policy Act 2009. The NP has been classified as a slightly to moderately disturbed (SMD) ecosystem based on ANZECC/ARMCANZ (2000) criteria. It

should also be noted that cattle grazing has previously been identified as occurring in the National Park (WBM 2011), which supports its classification of a SMD ecosystem. However, its status as a National Park suggests it requires a higher level of protection than other waterways in and adjacent to the mine.

Wetlands of national or international significance were considered as part of this assessment, however, no wetlands of national significance as listed by the Directory of Important Wetlands in Australia (DIWA) (Environment Australia 2001) occur within the waterways in or adjacent to SWC, or the wider study region. The closest of DIWA wetlands include Fitzroy River Floodplain wetlands and Fitzroy River Delta wetlands, which are located in the lower Fitzroy River catchment near Rockhampton. Furthermore, no wetlands of international significance (also known as Ramsar sites) occur in the Fitzroy River basin. Therefore, no further consideration is given in this report to impacts on wetlands of national or international significance.

The Fitzroy River, into which the Connors River flows, ultimately discharges into the Great Barrier Reef World Heritage Area (GBRWHA) and Marine Park (GBRMP). Both GBRWHA and GBRMP are protected matters of national environmental significance under the EPBC Act 1999. The Project is located approximately 335 km waterway distance from the Fitzroy River mouth and, due to the conclusions of no water quality impacts over the current situation (see section 9.3), impacts to the GBRWHA and GBRMP are not likely and are not considered further.

Other areas identified, through review of the environmental values and water quality objectives for the Fitzroy Basin (DERM 2010), to have important ecological characteristics include Eungy (77 km south-east of SWC), Yatton waterholes (116 km south-east of SWC) and Lake Plattaway (83 km south-east of SWC). These areas are remote from the activities of SWC and are not considered further.

Environmental Values

DERM (2010) set out Draft Environmental Values (EVs) for the Fitzroy River Basin, which were refined by WBM (2011) based on more detailed site-specific information. Those previously identified values are shown alongside the values identified for the broader sub-region in “Environmental Values for the Fitzroy: Community Consultation” (Fitzroy Basin Association, July 2011) in which Environmental Values are identified for the Northern Connors Range Tributaries (sub-region 10a), which include Bee Creek and its tributaries, Walker and Carborough Creeks as shown in Table 3.

Given that the scale of the potential impacts would at most be confined to Walker and Carborough Creeks it is considered that the EVs identified in WBM (2011) for Walker and Bee Creeks are the most appropriate to use. However, the EVs for the Connors River and Northern Connors Range tributaries are also provided to show that they have been considered, given that the Fitzroy Basin Association (July 2011) EVs were published after the WBM 2011 EVs.

Table 3. Human uses and environmental value SWC Mine receiving waters

Environmental Value		EVs from WBM (2011)			EVs from FBA (July 2011)
		Walker Creek	Bee Creek	Connors River	Northern Connors Range Tributaries (sub-region 10a)
Protection of ecosystem		✓	✓	✓	✓
Suitability for crop irrigation		x	x	✓	✓
Suitability for farm supply/use		✓	✓	✓	✓(H)
Suitability for stock water		✓	✓	✓(H)	✓(H)
Suitability for aquaculture		x	x	x	✓(L)

Environmental Value		EVs from WBM (2011)			EVs from FBA (July 2011)
		Walker Creek	Bee Creek	Connors River	Northern Connors Range Tributaries (sub-region 10a)
Suitability for human consumers of wild or stocked fish, shellfish or crustaceans		x	x	✓	✓
Suitability for primary contact recreation (i.e. swimming)		x	x	✓	✓
Suitability for secondary recreation (i.e.) boating)		x	x	✓	✓
Suitability for visual recreation (i.e. no contact)		x	✓	✓	✓
Suitability for drinking water		x	✓	x	✓
Suitability for industrial use (including manufacturing, plants, mining and power generation)		✓	✓	✓	✓
Protection of cultural and spiritual values, including traditional owner values of water		✓	✓	✓	✓

Users

For Walker Creek and Bee Creek the users identified in the EVs are:

- Aquatic and riparian ecosystem
- Farms (for water supply) (However, it should be noted that there are no identified extraction points directly from Bee or Walker Creek downstream from the Project)
- Stock (drinking water) (It should also be noted that there are no identified stock watering points directly from Walker Creek downstream from the Project and that alternative off stream stock watering is used, which is supplied with water by South Walker Creek mine from the Braeside borefield, approximately 60 km distant)
- General public (visual recreation)
- Limited local drinking water supply (none known on Walker Creek or Bee Creek in the study area to Dipperu National Park)
- Industrial use (mining) (Whilst this is theoretically possible, there is however no known mining extractive use from Bee or Walker Creeks)
- Cultural custodians/users (including traditional owners).

The assessment in this report considers to what extent any “significant” impacts to users may be expected.

7 Change to hydrology resulting from the Project

As discussed in Section 4, the maximum change in catchment area to Walker Creek as a result of the Project development is a reduction of 1.65km^2, which is -0.47% of the 349.54km^2 Walker Creek catchment (Walker Creek including Carborough Creek) and -0.08% of the 1,945.39 km^2 Bee Creek catchment to Dipperu National Park.

7.1 Hydrological analysis of Walker and Carborough Creeks

Hydrological analysis for this site has been undertaken for previous studies conducted by Alluvium (2014 and 2015) and the functional design of the MRA2C diversion (Alluvium 2016). Peak discharge estimates for 2 year and 50 year ARI events of the 2A diversion, Carborough Creek and the reach downstream of the confluence used in hydraulic modelling to assess existing conditions are presented in Table 4.

Table 4. Peak discharge estimates and catchment areas for Walker and Carborough Creeks

	Walker Creek upstream (excludes that component of Walker Creek catchment downstream from the start of the diversion)	**Carborough Creek upstream**	**Confluence**
Catchment area (km^2)	~130km^2	~160km^2	~300km^2
2 year ARI peak discharge (m^3/s)	100	121	217
50 year ARI peak discharge (m^3/s)	442	554	998

The maximum impact on flows in Walker Creek as a direct result of the increasing catchment areas of F, G & H and H & I Pits is a decrease of 0.47% and 0.08% of the Bee Creek catchment at Dipperu National Park by 2049. This is a conservative estimate that does not consider any flows released from storage under EA conditions, which are minor compared to discharges form the upstream catchment. It is reasonable to consider the conservative scenario as at pit closure the catchments of F, G & H and H & I Pits will become terminal (i.e. there will be no pumping from the pits and they will not contribute any runoff to Walker Creek).

7.2 Changes in flood extent

There will be changes to the extent of floodplain inundation as a result of the development of the Project. The primary change is the result of the replacement of a reach of Walker Creek channel with a diversion. This will result in the loss of channel and floodplain in one area and its replacement in another. Changes have been modelled as part of the MRA2C Diversion Functional Design (Alluvium, 2016) from which the following is summarised.

Hydrodynamic modelling was undertaken to assess the flood behaviour of the 2 and 50 year ARI, and the 1% and 0.1% AEP design events for the existing and diverted scenarios for Walker Creek. The model outfalls on Walker Creek, approximately 2km downstream of the confluence on the diversion tie in to Walker Creek, and extends upstream past the limit of the mining activities (refer Figure 16).

Design hydrographs were input into the model at the locations shown in Figure 16 to represent inputs from both the catchments (Walker and Carborough) external to the area. Some nodes used for existing conditions were removed from the diverted scenario model to reflect the reduction in contributing area resulting from planned pit progression. These areas will be terminal catchments or will discharge downstream from the diversion following construction.

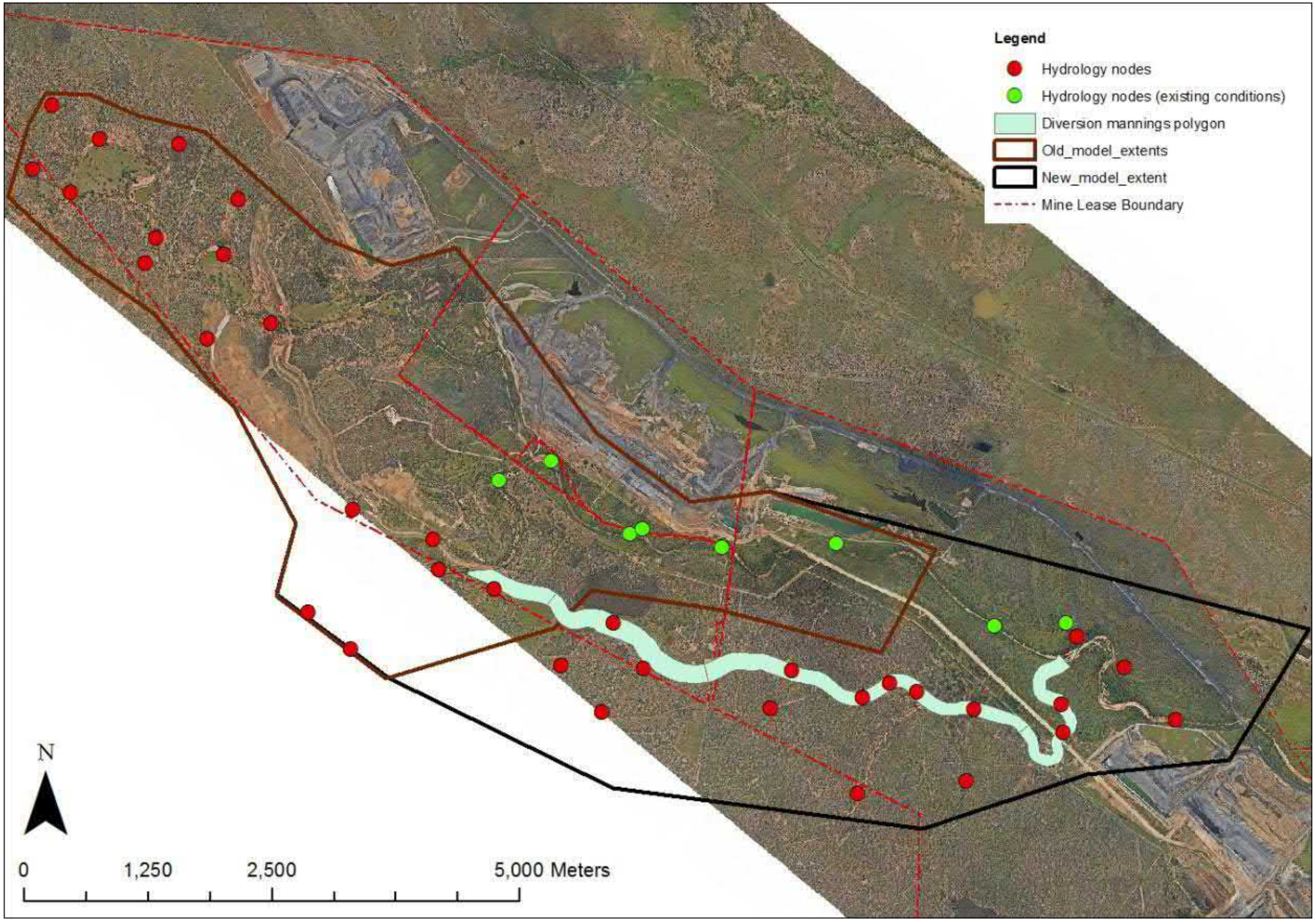


Figure 16. 2D hydrodynamic 0.1% AEP model set up (existing conditions) (Alluvium, 2016)

2D hydrodynamic modelling results

This section presents the hydrodynamic modelling results for depth and extent for existing and post diversion scenarios. As can be seen, there is a geographical change in the location and extents of flows following development of MRA2C. Flows through the diversion become confined between high ground and constructed levees before returning to the original channel and floodplain. All impacts will be limited to the SWC Mine lease and other BHP owned land to the south east. There or no expected impacts upstream or downstream of the diversion to third party users, including environmental and other public benefit outcomes.

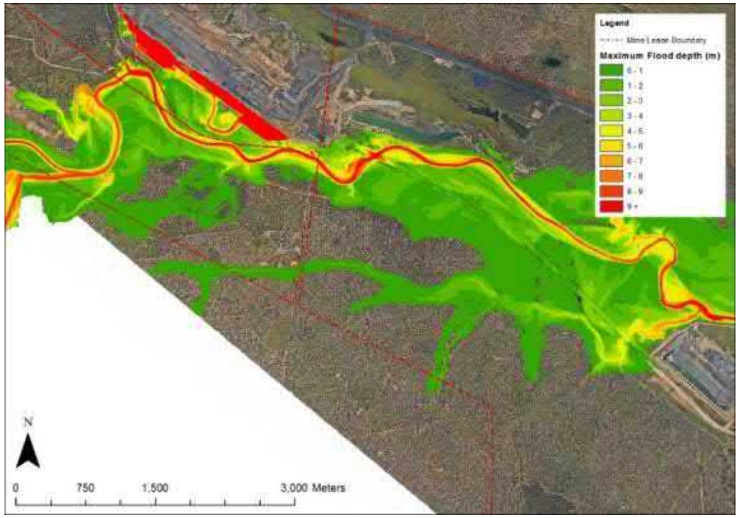


Figure 17. Existing conditions 0.1% AEP maximum flood depths (Alluvium, 2016)

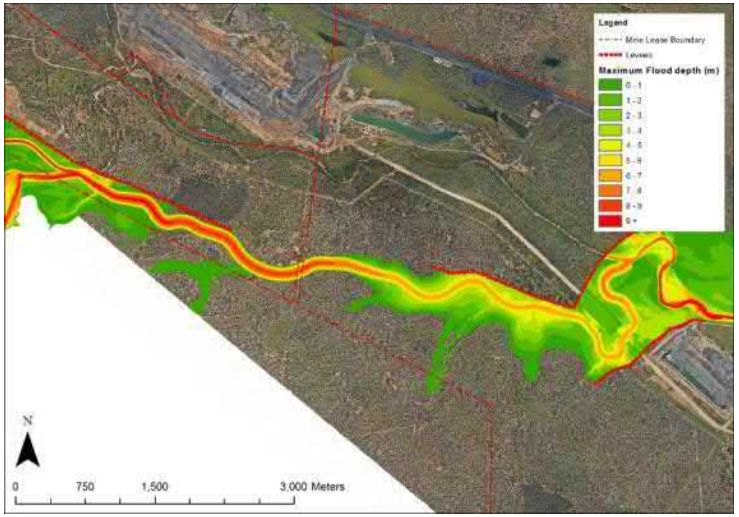


Figure 18. Post diversion 0.1% AEP maximum flood depths (Alluvium, 2016)

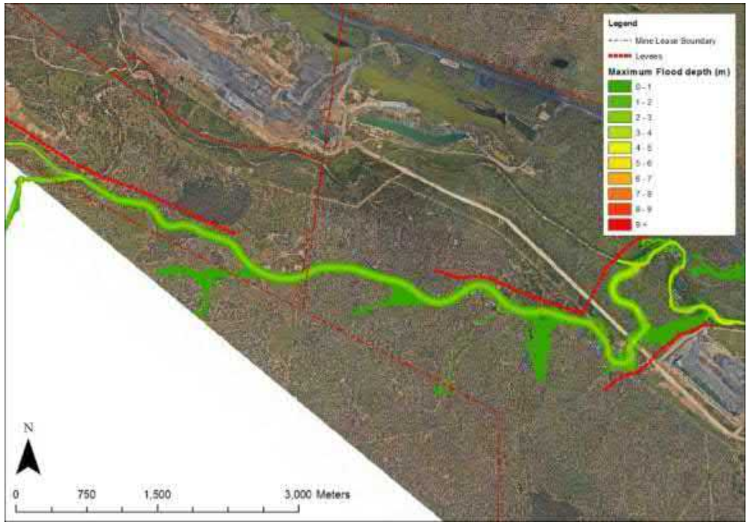


Figure 19. Post diversion 2 year ARI maximum flood depths (Alluvium, 2016)

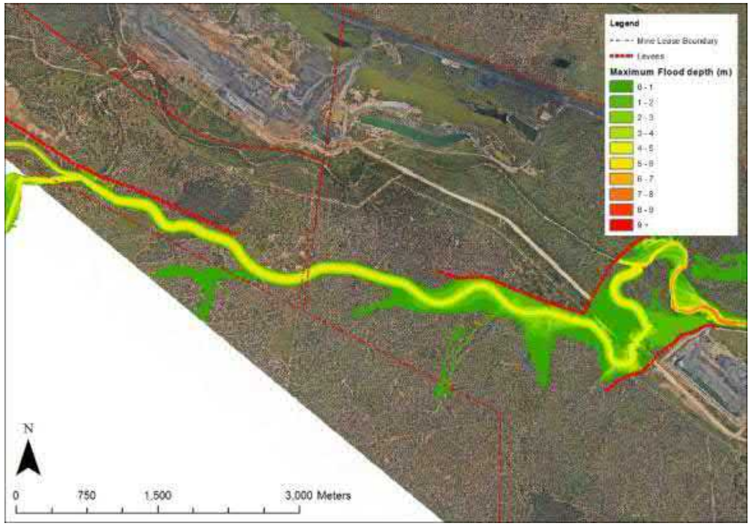


Figure 20. Post diversion 50 year ARI maximum flood depths (Alluvium, 2016)

8 Change to water quality resulting from the Project

The assessment of potential impacts to water quality has been undertaken with reference to:

- Environmental Authority – South Walker Creek Mine (Permit No. EPML00712313) (DEHP August 2015) (provided as Attachment A of this report)
- BMC South Walker Creek Mine: Receiving Environmental Monitoring Program Design Document (GHD, November 2012)
- Report for South Walker Creek Mine - Receiving Environment Monitoring Report (GHD, August 2012)
- South Walker Creek and Poitrel Mines – Salt Assimilation Studies: Environmental Values and Water Quality Objectives (BTM WBM, October 2011)
- South Walker Creek Mine: Receiving Environment Monitoring Program 2015 (FRC Environmental, 2015)
- South Walker Creek Mine: Receiving Environment Monitoring Program 2016 (FRC Environmental, 2016)
- South Walker Creek Mine: Receiving Environment Monitoring Program 2017 (FRC Environmental, 2017)
- South Walker Creek Mine Calculation of Maximum Affected Waters Release Discharge (BMT WBM, October 2011)
- Water quality data obtained from the Queensland Government Water Monitoring Portal for Bee Creek (and for Nebo Creek and Connors River for comparison purposes)
- Water quality monitoring data provided by BMC for the existing C Dam.

The primary focus of this assessment has been on the need for SWC to periodically return water (collected from the catchments of F, G & H and H & I Pits which are currently collected in F Pit) back into the natural system. As discussed previously, F Pit will be reactivated for mining as part of the development of the Project, which requires, dewatering of F Pit, use and/or disposal of that water, and in the future the need for a replacement storage capacity, which is expected to be the construction of one or two new dams: Northern and Southern (refer Section 3.3).

In addition, consideration is also given to surface water collected on site from areas disturbed by mining that generate stormwater runoff and associated sediment generation and transport. These areas will be treated in accordance with EA conditions and the Erosion and Sediment Control Plan (ESCP). It is not expected that the current EA conditions will need to be revised as they already adequately cover the treatment and discharge of stormwater runoff. The ESCP will require updating over the project lifespan to reflect the changing site configuration.

8.1 Background

There are two sources of water that will be discharged from site: stormwater released after treatment in accordance with the ESCP; and mine water collected from the catchments of F, G & H and H & I Pits, which are currently collected in F Pit.

The controlled release of mine-affected water from site is only permissible in accordance with strict conditions outlined in the EA. These release conditions have been carefully and scientifically determined, and are in accordance with Queensland Government requirements, so as to protect downstream environmental values. The release conditions are based on the ability to dilute discharges with natural flow rates to ensure that the constituent concentrations of dissolved salts are not likely to produce a downstream environmental impact. These have been determined in relation to typical runoff flow rates experienced at the discharge points.

Under the EA conditions, monitoring is required of the quality of receiving waters at specific locations (EA Table 6), and for various parameters, different frequencies (EA Table 5). All monitoring is undertaken under the umbrella of the site Receiving Environment Monitoring Program (REMP), which under EA condition W20 "*must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being released. For the purposes of the REMP, the receiving* *environment is the waters of Bee Creek and connected or surrounding waterways with 15km downstream of the release…*"

The design of the REMP was completed in 2012 and revised in 2015. The REMP requires:

- monitoring of stream flow, water quality, sediment quality, aquatic habitat and macroinvertebrates during natural flow conditions and when mine-affected water is being discharged
- an assessment of monitoring components at potentially impacted (i.e. receiving environment) sites and background sites (i.e. sites that are not affected by the release of mine-affected water), and comparison of monitoring results against guidelines levels as defined in the REMP, and
- an assessment of the potential impact of releases of mine-affected water on the environmental values of the receiving environment, including discussion regarding the suitability of current discharge limits for protecting the environmental values of the receiving environment.

A copy of the REMP design document is provided as Attachment F.

8.2 Findings of 2017 REMP reporting

REMP reporting has been completed annually, the most recently available of which is 2017 (FRC Environmental) (provided as Attachment F), which reported findings with reference to the current requirements of EA - EPML00712313.. The suitability of current discharge limits to protect downstream environmental values was also discussed.

REMP 2017 conclusions and recommendations

As there was no evidence of an impact on the macroinvertebrate communities, it is considered very unlikely that any changes in water quality associated with the discharge of mine-affected water resulted in environmental harm. Based on these results, the current discharge limits appear suitable to protect downstream environmental values. However, the limits for some parameters were often exceeded at reference sites in 2016–2017, which suggests they may be more stringent than required.

Recommendations based on the outcomes of the 2016–2017 REMP (FRC Environmental 2017) include:

- reviewing all water quality data collected from reference sites to set more applicable local guidelines for water quality and macroinvertebrates.

Potential changes to water quality due to the development of MRA2C

As discussed in Section 7, The maximum change in catchment area to Walker Creek as a result of the Project development is 1.65km^2, which is 0.47% of the 349.54km^2 Walker Creek catchment (Walker Creek including Carborough Creek) and 0.08% of the 1,945.39 km^2 Bee Creek catchment to Dipperu National Park. Potential changes to water quality over current conditions are considered to be very limited due to the limited increase in the scale of the project. As the Project develops the land previously mined will be progressively rehabilitated resulting in a limited overall increase in disturbed ground or pit extent. Consequently, the potential for significant changes to water quality over the current mining configuration is considered to be very low given that the 2017 REMP report (FRC) has not identified any evidence of impacts from mine water releases (which include F Pit,) under current EA conditions and states that "*it is considered very unlikely that any changes in water quality associated with the discharge of mine-affected water resulted in environmental harm. Based on these results, the current discharge limits appear suitable to protect downstream environmental values*".

Consideration of what, if any, impacts to water quality there may be from the development of the Project is discussed in Section 9.

The water quality results from the REMP program for the period 2016-2017 is reproduced below (FRC 2017)

Table 5. Reproduced table 4.1 from REMP 2016-2017

frc environmental

Table 4.1 Summary of water quality data collected from 1 April 2016 to 15 June 2017 for parameters that did not comply with the water quality objective.

Parameter	Units	WQO	Reference Sites						Receiving Environment Sites					
			Count	Min	Max	Median	Mean	95th %ile	Count	Min	Max	Median	Mean	95th %ile
Physical-Chemical														
electrical conductivity (in situ)	µS/cm	720[a]	13	348	1660	1420	1203	1624	20	122	1076	602	593	1023
pH (in situ)	–	6.5–8.0	13	7.4	8.8	8.6	8.5	8.7	20	7.9	8.8	8.3	8.3	8.6
turbidity (in situ)	NTU	50	13	3	153	39	42	100	20	7	4380	63	296	533
turbidity (logger)	NTU	50	103085	0	1737	90	203	814	110905	0	1754	3	143	735
total suspended solids (TSS)	mg/L	10	13	3	49	23	24	48	20	9	2900	29	197	474
Nutrients														
total nitrogen	µg/L	500	5	120	11000	200	2382	8892	5	190	7000	940	2874	6720
ammonia	µg/L	20	8	<5	89	24	32	86	10	<5	150	63	66	132
Major Cations and Anions														
sodium (total)	mg/L	30	13	26	331	280	220	331	20	10	220	96	96	182
sodium (dissolved)	mg/L	30	5	25	300	35	87	249	5	9	200	62	93	196
sulfate	mg/L	25	13	<5	132	89	67	113	20	<5	83	37	40	78
Total Metals and Metalloids														
aluminium	µg/L	55	8	33	2140	455	601	1724	10	23	50200	445	6703	32785
chromium	µg/L	1	8	<0.5	2	1	1	2	10	<0.5	41	1	6	27
copper	µg/L	1.4	8	<0.5	5	3	3	5	10	1	72	4	12	47
iron	µg/L	200	8	38	2280	465	627	1818	10	46	54200	545	7386	35840
lead	µg/L	3.4	8	<0.1	1	0	0	1	10	<0.1	33	1	5	21
mercury	µg/L	0.2	8	<0.1	0.4	<0.1	<0.1	0.3	10	<0.1	<0.1	<0.1	<0.1	<0.1
nickel	µg/L	11	8	<0.1	3	<0.1	1	3	10	<0.1	54	1	7	35
uranium	µg/L	1	8	1	4	2	2	4	10	0	2	1	1	2
vanadium	µg/L	10	8	0	10	5	4	9	10	1	90	6	16	63
zinc	µg/L	8	8	<5	9	<5	<5	9	10	<5	119	<5	18	78
Dissolved Metals and Metalloids														
aluminium (ph>6.5)	µg/L	55	8	<5	150	51	64	143	10	<5	260	33	97	247
copper	µg/L	1.4	8	<0.5	4	2	2	4	10	1	4	2	2	3
uranium	µg/L	1	8	0	3	2	2	3	10	0	2	1	1	2

[a] WQO for base flow conditions applied

Shading denotes values that are greater than the WQO

< value is below laboratory limit of reporting

8.3 Existing water quality within surface waters relevant to SWC

There are no current gauges in Carborough, Walker or Bee Creeks however a gauge was previously situated in Bee Creek just downstream of the confluence with Walker Creek which provides an indication of surface water response and quality. The gauge was opened between 1972 and 1988 prior to any significant mining operations in the catchment and therefore indicative of baseline water quality. Table 6 below shows water quality monitoring data for this gauge in addition the nearby Nebo Creek gauge and the nearest downstream gauge from SWC on the Connors River.

Table 6. Water quality monitoring data for comparative purposes

Variable (*location)*	Minimum	Median	Maximum	Mean	Start Date	End Date
Bee Ck (130411A closed station)						
Conductivity @ 25C (uS/cm)	93	245	840	306.6	17/02/1972	13/04/1988
Turbidity (NTU)	69	–	100	94.8	15/12/1983	13/04/1988
pH (pH units)	6.8	7.6	8.2	7.5	17/02/1972	13/04/1988
Sulphate as SO4 (mg/L)	2	–	6	3.2	17/12/1975	13/04/1988
Nebo Ck (130407A open station)						
Conductivity @ 25C (uS/cm)	66	414	982	413.1	30/10/1962	11/07/2017
Turbidity (NTU)	1	3	100	11.4	30/07/1981	11/07/2017
pH (pH units)	6.7	7.8	8.5	7.8	30/10/1962	11/07/2017
Sulphate as SO4 (mg/L)	1	2	30	3.8	23/06/1967	11/07/2017
Connors R (130404A open station)						
Conductivity @ 25C (uS/cm)	82	334	752	353.0	09/07/1963	05/07/2017
Turbidity (NTU)	1	7	4850	70.3	31/07/1981	05/07/2017
pH (pH units)	6.9	7.7	9.3	7.7	09/07/1963	05/07/2017
Sulphate as SO4 (mg/L)	0	3	19	3.4	09/07/1963	05/07/2017

What is very obvious from the above data and the 2017 REMP results is that there is little difference in the mean values for all of the constituents relevant to the EA though there is some variability in maximum concentrations between the historical Bee Creek data and the Connors River data for turbidity only. Both Nebo Creek and the historical Bee Creek results are indicative of areas undisturbed by significant mining activities and when compared to the Connors River data there is good agreement with all values except the maximum turbidity results. From the conclusions in the REMP and this data, it would suggest that downstream impacts from areas disturbed by mining are likely to be more strongly related to good erosion and sediment controls, however with the lack of vegetation cover in the overall catchments outside of mining areas, it would be expected that high turbidity values would occur during significant runoff events in any of these catchments.

9 Conditions of the final void post closure

9.1 Final Void water balance modelling

An assessment of the water balance and water quality conditions in the final void likely to remain in F pit has been examined through hydrologic modelling. A water balance model was created by considering rainfall, evaporation, contributing catchment area and hydrogeologic characteristics of the area.

In undertaking this assessment, the assumption is that the current disturbance areas are indicative of the final form of the site, albeit with rehabilitation and some internal reconfiguration of the drainage. Ultimately, the form of the final void post mining is therefore likely to be similar to the existing void and we have used the characteristics of the existing void and surrounding catchment to develop the model. The model was developed with the following inputs:

- Daily rainfall - Nebo Station 033054 from 01/01/1900 – 31/12/2017
- Mean monthly pan evaporation – Nebo Station 33054
- F Pit Catchment area – 54.23 ha (measured through GIS of final proposed pit area)
- F Pit final void area – 13.45 ha (measured through GIS based on existing pit area to void area ratio)
- Volumetric runoff coefficient for surface waters 0.35
- Depth 175m (from Golders 2018)
- Recharge rate 0.5% of rainfall (from Golders 2018)

The model was developed in Excel building on previous water balance studies for lakes, ponds and wetlands which have been conducted by Alluvium staff over the past 16 years. The model uses the inputs noted above to calculate inflows from surface and groundwaters and subtract losses through evaporation and leakage/exfiltration. Nebo station climatic data was used as it was the longest continuous record available closest to the subject site. This climate is indicative of that at South Walker Creek and shows the significant surplus of evaporation over rainfall that is characteristic of the area.

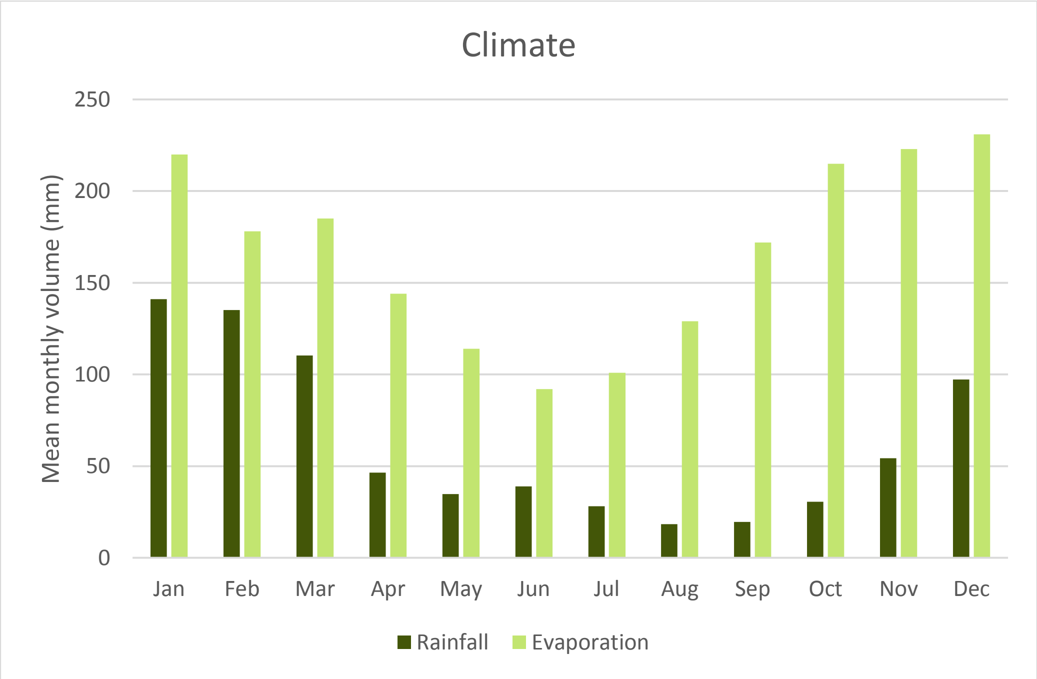


Figure 21. Mean monthly values for rainfall and evaporation at Nebo (033054)

To simulate the impacts on water quality, the salt concentration was derived by accounting for the initial salt concentration in the void, a runoff salt concentration, recharge salt concentration and salt from direct rainfall. The values chosen were relatively arbitrary but set to typical conditions noted in runoff studies (Duncan 1999, Fletcher et al 2004) and from previous modelling (ACARP 2017). These parameters were set as per the following:

- Rainfall salt concentration – 10mg/L
- Runoff salt concentration – 100 mg/L
- Recharge salt concentration – 5,000 mg/L
- Initial void salt concentration – 1,000 mg/L

The model was run over the 117 year climatic period available to gauge the trends of water balance and water quality from these ranges of inputs. It was assumed that the pit would be full at the commencement of the analysis to view the overall trend in the results. Given that the workings are likely to be active immediately prior to closure, this is a conservative assumption, as the void would likely be dry, but this wouldn't show trends easily. The results are presented graphically below.

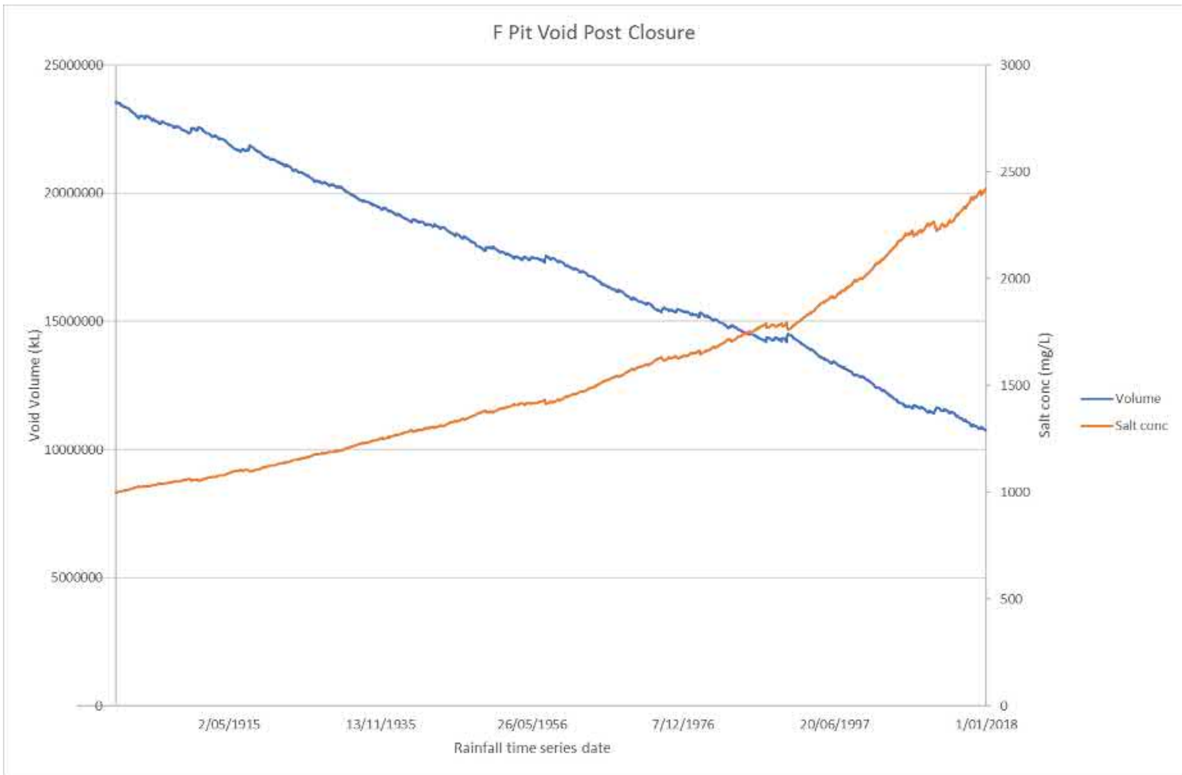
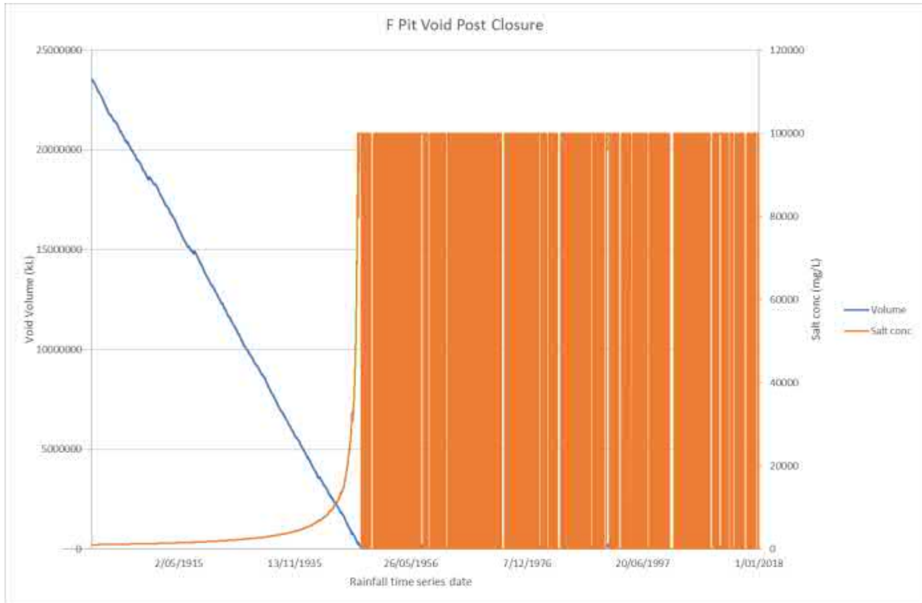


Figure 22. Water balance and salt concentration for simulation of F Pit void post closure

This shows that over the period modelled, the general trend is for the water volume to reduce to less than 50% of the current volume, with a consequential increase in salinity to an end concentration of 2.5 times the existing concentration. This is expected given that the evaporation rate is significantly greater than the rainfall rate, such that even with recharge, the inflows never exceed the losses from the system and it is therefore expected that the final void, if similar in characteristics to the current F pit void in area, depth and contributing catchment, will never overtop, but continue to concentrate salt and other associated water quality criteria.

Sensitivity analysis was also undertaken to investigate the reasonable range of parameters around both hydrology and water quality to see which parameters may have the greatest influence on void conditons. Each parameter set was varied within a range of plausible values. The results of this analysis are presented below:



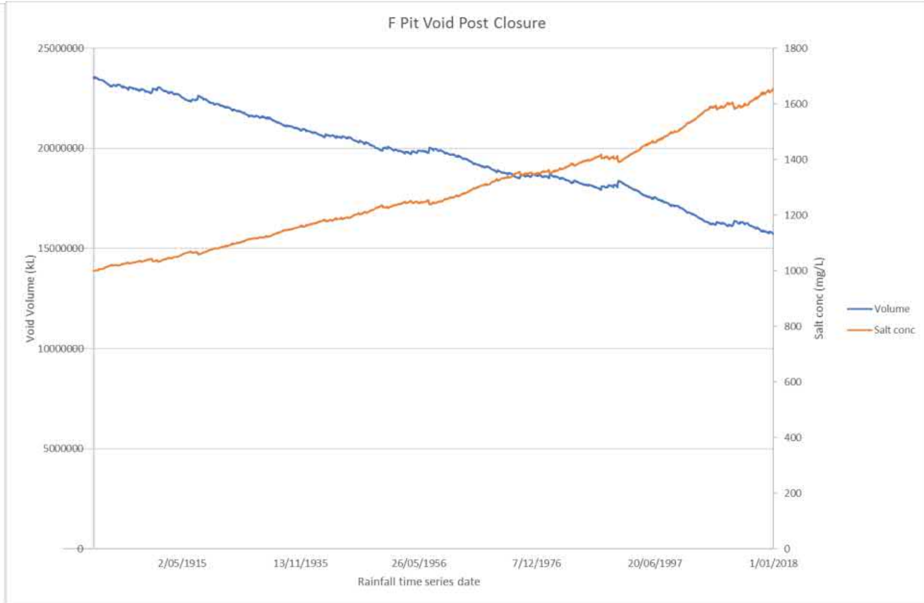


Figure 23. Infiltration rate (varied 1 order of magnitude)

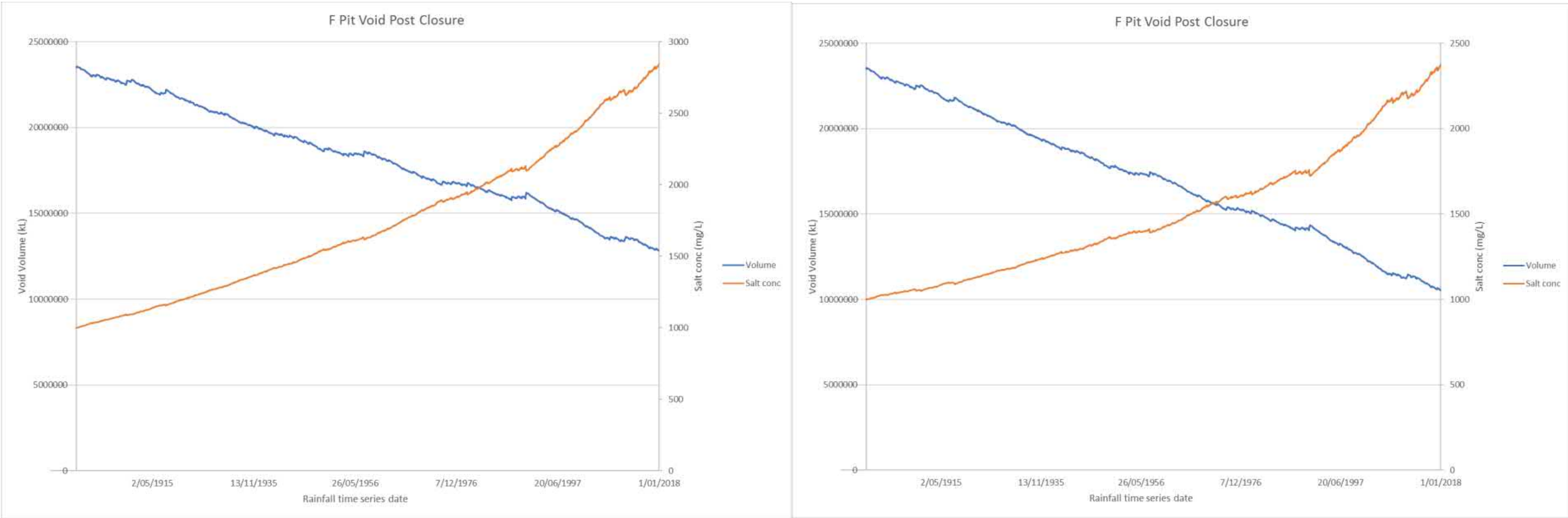
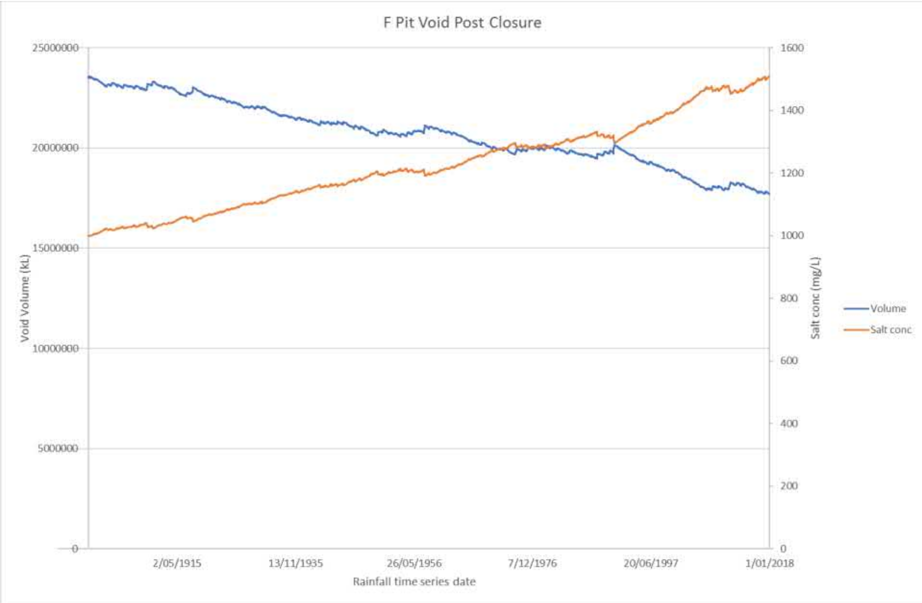


Figure 24. Recharge rate (varied 1 order of magnitude)



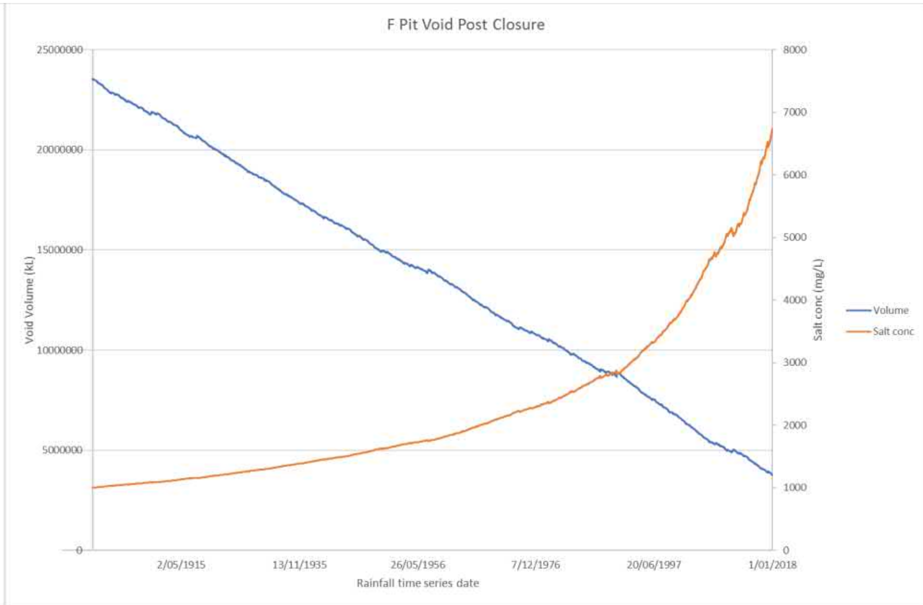
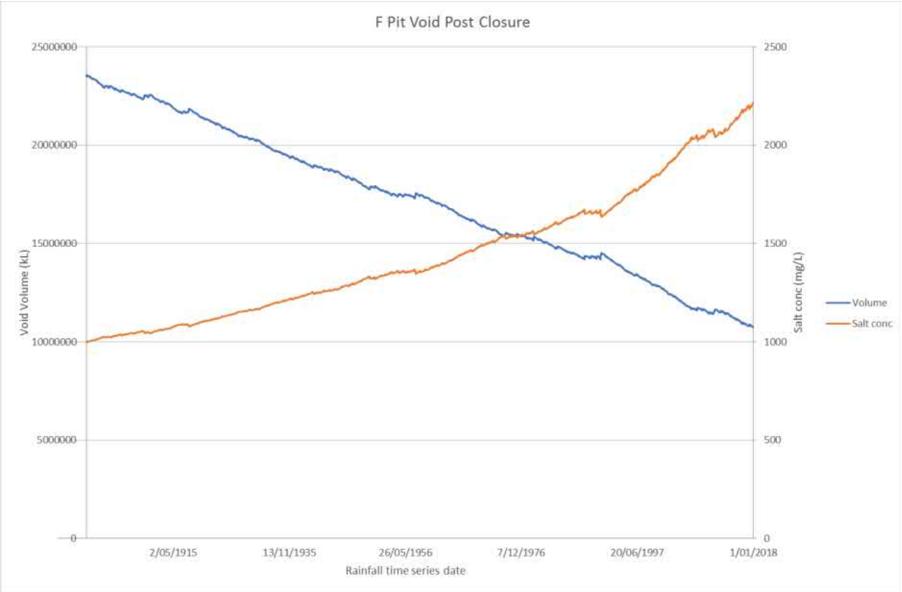


Figure 25. Runoff coefficient (0.55 – 0.15)



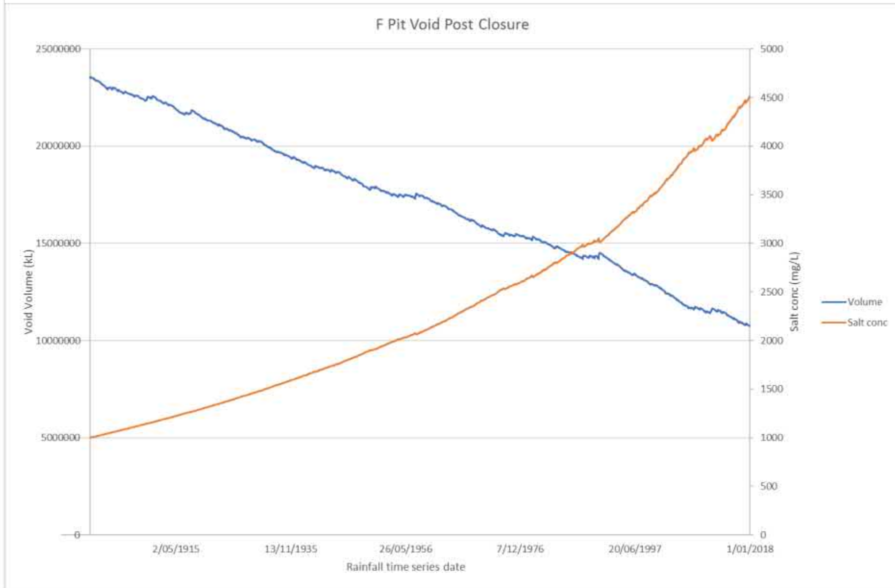


Figure 26. Inflow salt concentrations (1 order of magnitude)

This analysis shows is that the results are relatively insensitive to recharge rate, and salt concentrations, with some sensitivity to runoff coefficients and high sensitivity to leakage/infiltration loss. In all cases however, the model shows a decreasing trend in volume and increasing trend in salt concentration, suggesting that the likely condition of the void post closure is that volumes are not ever likely to overtop but water quality concentrations will increase over time. This means that the default condition of the final void is one that would tend to dry out or be completely dry most of the time, depending on the starting level of the void. Further modelling of the final configuration would be needed to confirm this, but it is highly likely that these conditions would be indicative of most final configurations.

A further variation was conducted to examine the impacts of additional catchment area on the void water balance and water quality. This is shown in the figure below.

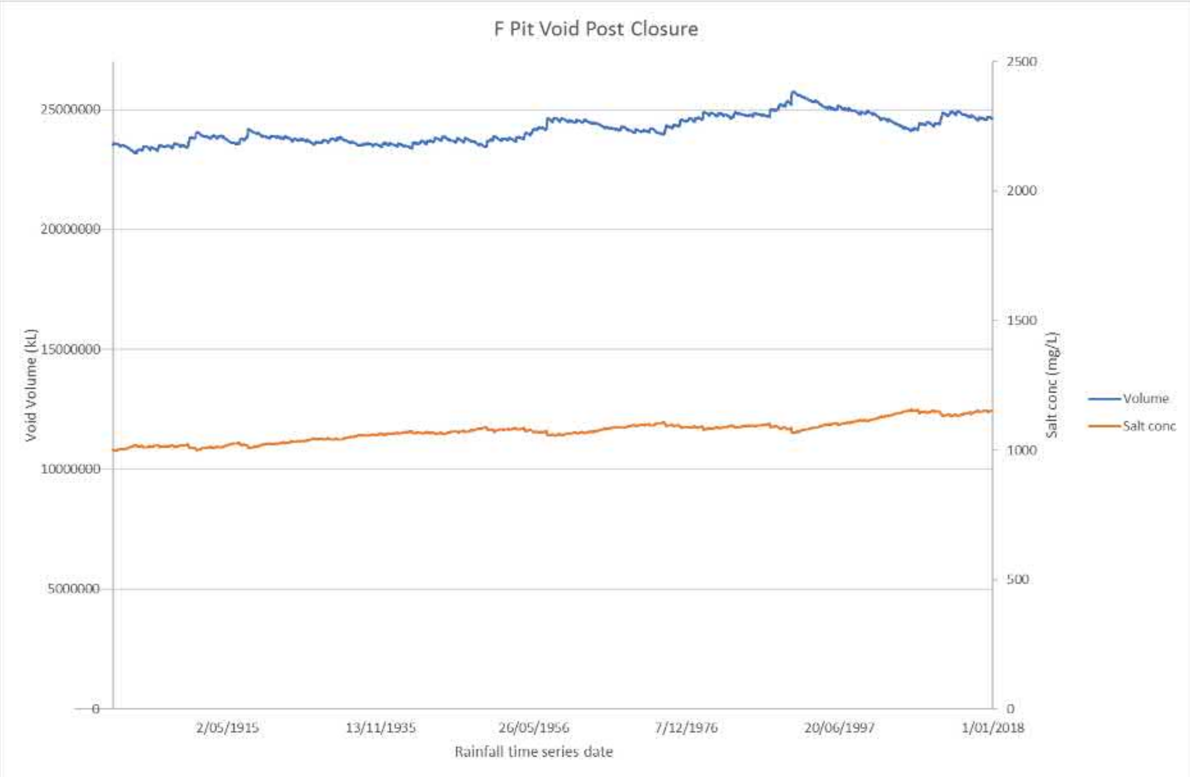


Figure 27. Increased surface water catchment area (100ha rather than 54.23ha)

This result shows that it may be possible to achieve a relatively stable waterbody by increasing the catchment area to void area ratio, but this is based on the assumption of a full void at the time of closure. This is typical of most waterbodies in that there is an optimal size (depending on climate) where inflows can match losses and outflows to achieve consistent volumes and levels. The above chart also shows that the salt concentration may also remain relatively stable in such circumstances. From this, we can therefore anticipate that the final void post closure can be designed to achieve a relatively stable form if the configuration is cognisant of the relationship of runoff and evaporation on the water balance and water quality of the waterbody.

All of this analysis shows that the catchment area draining to the final void is one of the most influential factors on whether a waterbody would exist post closure, as all modelling demonstrates that the most likely scenario is a void where the losses significantly exceed the inflows and hence the system would tend to dryness or be completely dry if the starting condition was also an empty void.

9.2 Final void configuration

Final void would be relinquished in a safe, stable, and sustainable manner, in accordance with Queensland Govt requirements. The high wall would be battered back to a safe angle and the high wall and end walls would include a berm and trench design for safety purposes.

Where beneficial use to post-mining land use is not viable, storage structures would be decommissioned so as to minimise post-mining management requirements. Decommissioning would be in accordance with standard industry practice and legislative requirements. Within this, dams would have mud removed, walls breached and recontoured to a safe grade.

10 Significance of impacts upon water resources

10.1 Definition under Significant impact guidelines 1.3

A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the water resource which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.

To be 'likely', it is not necessary for a significant impact to have a greater than 50 per cent chance of happening. Under the 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.
>
> For further information on the utility of a water resource for third party uses, see section 5.2.1 on value of a water resource".

Hydrology
A significant impact on the hydrological characteristics of a water resource may occur where there are, as a result of the action:

a) changes in the water quantity, including the timing of variations in water quantity
b) changes in the integrity of hydrological or hydrogeological connections, including substantial structural damage (e.g. large scale subsidence)
c) changes in the area or extent of a water resource.

Where these changes are of sufficient scale or intensity as to significantly reduce the current or future utility of the water resource for third party users, including environmental and other public benefit outcomes. The following aspects have been considered when assessing changes in hydrological characteristics related to surface water resources related to the Project:

- flow regimes (volume, timing, duration and frequency of surface water flows)
- river-floodplain connectivity.

Water quality
Consideration of a "significant impact on a water resource" was undertaken with reference to actions from the development of the Project where it could result in:

a) a risk to the ability to achieve relevant local or regional water quality objectives would be materially compromised, and as a result the action:
    i. the change in water quality creates risks to human or animal health or to the condition of the natural environment as a result of the change in water quality
    ii. substantially reduces the amount of water available for human consumptive uses, including environmental uses, which are dependent on water of the appropriate quality
    iii. causes persistent organic chemicals, heavy metals, salt or other potentially harmful substances to accumulate in the environment
    iv. seriously affects the habitat or lifecycle of a native species dependent on a water resource, or
    v. causes the establishment of an invasive species (or the spread of an existing invasive species) that is harmful to the ecosystem function of the water resource, or

b) there is a significant worsening of local water quality (where current local water quality is superior to local or regional water quality objectives), or
c) high quality water is released into an ecosystem which is adapted to a lower quality of water.

For water-dependent ecosystems, a significant impact is likely if the predicted change in water quality is greater than that required for ‘moderately to slightly disturbed’ systems as described in the relevant local or regional water quality objectives (typically the 80% to 95% ecosystem protection guideline values listed in the Australian Water Quality Guidelines). Note that other thresholds may apply where changes in water quality may impact on other matters of national environmental significance, such as threatened species or ecological communities.

Local or regional water quality objectives that have been considered include:

- the Queensland Water Quality Guidelines (DEHP, 2009)
- the ‘Australian and New Zealand Guidelines for Fresh and Marine Water Quality’, as outlined in the National Water Quality Management Strategy (ANZECC/ARMCANZ, 2000). These guidelines are used where an action may impact on a water resource for which there are no relevant local or regional water quality objectives.

The proponent may propose water quality objectives for the impacted water resource in accordance with the appropriate guidelines under the National Water Quality Management Strategy and in consultation with a relevant local authority.

Other considerations
Consideration has also been given to:

- Cumulative impacts - ‘when considered with other developments, whether past, present or reasonably foreseeable developments’. Where a significant impact on water resources may be caused by one large coal mining development, or the cumulative impact of other developments in the area.
- Timing - on hydrology and water quality with regard to duration flows and timing of releases
- Scale - distance downstream and impact on local and regional catchment.

10.2 Significance of the Project on hydrology of Walker Creek and Bee Creek

Hydrology of Walker and Bee Creeks
The maximum impact on flows in Walker Creek as a direct result of the increasing catchment areas of F, G & H and H & I Pits is a decrease of 0.08% of the Bee Creek catchment at Dipperu National Park by 2049. This is considered to be a conservative estimate as it does not include any flows returned to the natural system from storages (in F Pit and/or the new Northern and Southern Dams) under EA conditions. It is reasonable to consider the conservative scenario as at pit closure the catchments of F, G & H and H & I Pits will become terminal i.e. there is no pumping planned from the pits and they will not contribute any runoff to Walker Creek.

<u>This percentage reduction in catchment area and flows is well within any margin of error in calculations and is not considered to represent any significant impact on the hydrology of Walker and Carborough Creeks and is therefore considered to have no significant impacts to users.</u>

Highwall drain catchments
The highwall drain catchments will generate runoff that will initially drain to the remnant Walker Creek channel from where it must be pumped out due to impoundment by the downstream diversion plug, or drained via a one-way valve. This is considered ‘clean’ water and can be pumped/drained directly to Walker Creek under EA conditions. As the mine develops between 2019 and 2065 the highwall drain catchments reduce as the pits progress. The remnant Walker Creek channel will be cut and a number of subcatchments will be created, which can be joined by drainage or managed separately. By the time the development is completed in 2065 the highwall drain catchments will be minimal and the remaining catchments’ topography can be graded and/or built up to prevent ponding behind levees.

This will be clean water runoff, released to Walker Creek under EA conditions and with no identified significant impacts to users.

Flood flows and extents

There will be changes to flood flows and extents as described in Section 7.2, however, those changes are localised to the diversion and the immediate reaches of Walker and Carborough Creeks upstream and downstream from the diversion on the SWC mine lease and recently purchased (by BHP) adjacent land. There are no identified significant impacts to users.

10.3 Significance of the Project on water quality

The catchment areas of the pits comprising the Project have been identified and how they are predicted to change over the mine life. From commencement of mining in 2019 until 2034 there is predicted to be very little change in the catchment areas and land use (spoil and pit void) compared to the current, base case. The site's water management system including release of mine affected water operates effectively under current EA conditions. Given that the catchment areas of the pits changes little over the period 2019 to 2034 it can be expected that it can continue to operate effectively under the current EA without the need for amended water quality release conditions.

From 2034 to 2049 the catchment area increases by 163.4 Ha (40% greater than the current base case), which will result in a greater volume of water being required to be removed from the pits to alternative storage dam/s prior to discharge. SWC will need to ensure that appropriate storage and discharge infrastructure is constructed to enable discharges to continue to be undertaken in line with EA conditions. This will require periodic reviews of the mine water management system and water balance model.

10.4 Significance of the Project on groundwater supply

No affected bores are located off BMC owned land. Where BMC has entered into agistment licences, these include make good agreements for loss of water access.

10.5 Cumulative impacts

The major landuses that could affect the quantity and quality of water within the Bee Creek catchment above Dipperu National Park are:

- Grazing – the predominant landuse, which contributes to land disturbance and the generation of elevated sediment loads via reduced vegetation cover catchment-wide but particularly in riparian zones. Grazing also contributes to nutrient input from livestock.
- Mining at Hail Creek Mine – located in the upper catchment of Bee Creek.
- Mining at Coppabella Mine – located on Harrybrandt Creek, which discharges to Bee Creek immediately upstream from Dipperu National Park.
- Mining at South Walker Creek Mine.

The location of the mines is shown in Figure 28.

Given the existing catchment wide disturbance from grazing and the existing mines of Hail Creek, Coppabella and South Walker Creek, the Project can be considered to have a very minor additional potential cumulative impact. As has been stated previously in this report, the limited additional increase in disturbed area over the base case and management of water discharges under existing EA conditions will result in no significant impacts to users.

10.6 Summary of significance of impacts

Under the definitions detailed in "Significant impact guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources" and described in Section 10.2 of this report, the development of MRA2C will not result in any significant impacts to users.

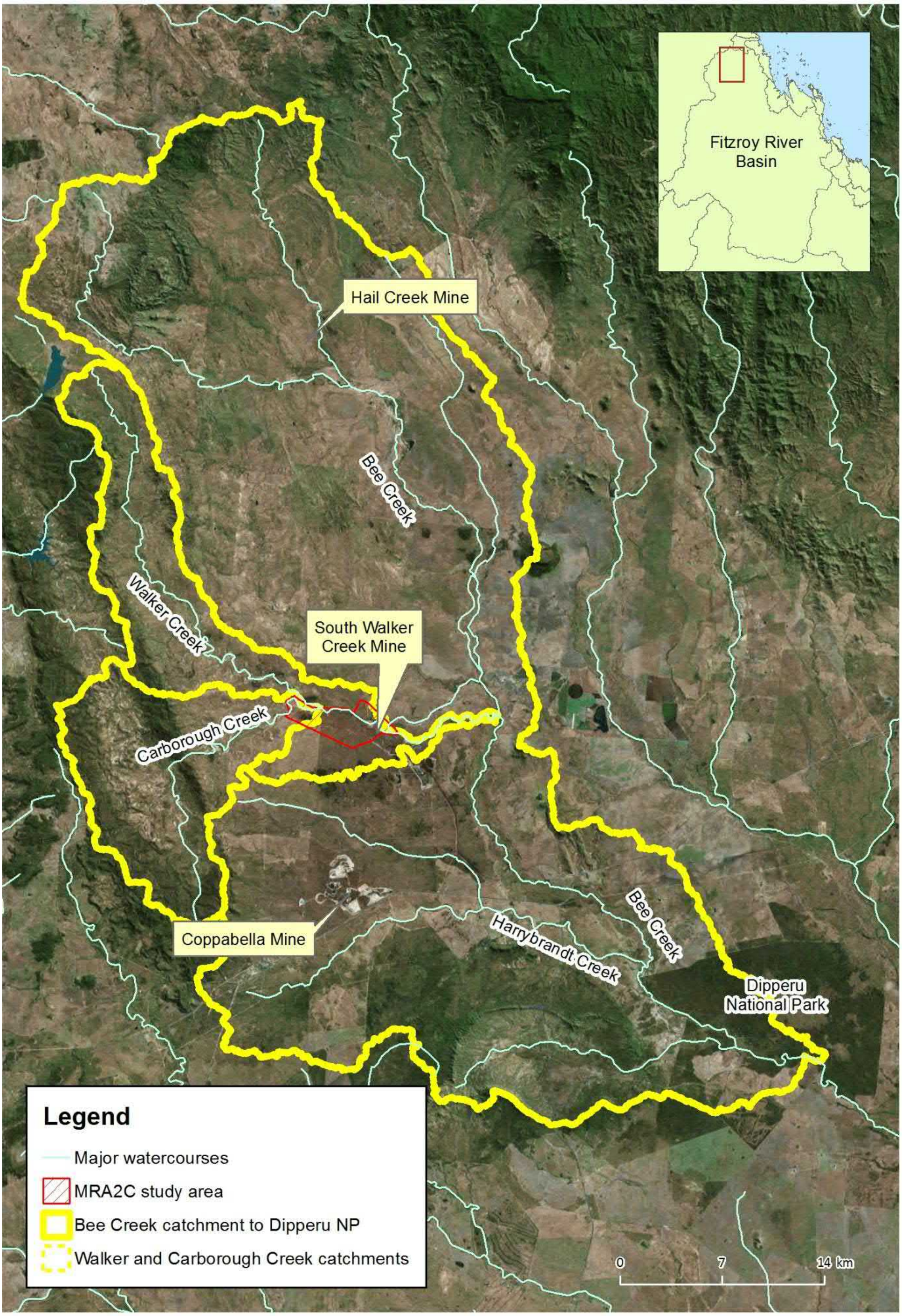


Figure 28. Location of Mines within Bee Creek catchment above Dipperu National Park

11 Responses to request for additional information

The following sections detail responses to request for additional information.

11.1 Information and monitoring results of previous stream diversions that may provide details of the effectiveness of the proposed diversion or potential impacts

The performance of stream diversions in the Bowen Basin has been the subject of a number of research projects through the Australian Coal Association Research Program (ACARP). The initial research projects from 1999-2002 (ACARP projects C8030 and C9068) established the condition and performance issues in response to a moratorium imposed by the Queensland Government on new diversions. Once condition and performance issues were understood, the development of design and rehabilitation criteria for diversions were developed. Those criteria have formed the basis of Queensland Government approval of diversions since 2004.

An evaluation of the performance of diversions built to the criteria developed in ACARP C9068 was undertaken in *Criteria for functioning river landscape units in mining and post mining landscapes* (ACARP C20017, Alluvium, 2014). This project demonstrated that the performance of those diversions built in accordance with the criteria of C9068 was substantially better than those constructed prior. In addition to better performance, the condition trajectory of those diversions was trending toward a suitable state for mine closure at a rate that should be expected. The older diversions were generally not on an improving condition trajectory.

Following ACARP project C20017 and in conjunction with ACARP project C23030 (*Collaborative performance trajectories for diversion approvals relinquishment*, Alluvium, 2015) it has been demonstrated that from a sample set of over 50 diversions, the diversions constructed and operated in accordance with ACARP C9068 can reach a condition suitable for mine closure/approvals relinquishment within 15 years of construction (as shown in Figure 29.

The results of monitoring of MRA2A diversion (Neilly Group Engineering, 2017) (provided ass attachment E) also supports the effectiveness of the diversion design, whilst early in the monitoring regime of that diversion it shows an early increase in Index of Diversion Condition score, with a range of management actions to improve condition.

Before (1999)

After (2014)

Figure 29. Diversion considered suitable for relinquishment 15 years after rehabilitation to current criteria (Alluvium)

11.2 Details of the diversion design and how it adheres to the Queensland Guidelines on watercourse diversions

The MRA2C diversion has been designed to meet Queensland Government Guidelines on watercourse diversions as per its approval through the Queensland Water Act. The diversion has also been designed to be in accordance with improvements identified in ACARP C20017. The diversion was authorised by the Queensland Government under an amendment to Water Licence (613491) (refer Attachment D).

11.3 Monitoring programs that will be undertaken in relation to erosion and/or sedimentation of watercourses

The development of a monitoring program specific to diversions in the Bowen Basin was developed as part of ACARP C9068. This monitoring program has formed part of licence conditions for diversions for over a decade and is common practice across all diversions in the area. The monitoring program includes a semi-quantitative condition assessment scoring system known as Index of Diversion Condition. This is made up of geomorphic and riparian vegetation indices. The geomorphic index will assess erosion and/or sedimentation of the watercourse.

This monitoring program has been in place on the diversions at SWC for 10 years and will be further adapted to suit MRA2C as per *Monitoring Program: Mulgrave Resource Access Walker Creek Diversion Stage 2C* (Alluvium, 2017) (refer Attachment E).

Monitoring sites are already established on Walker and Carborough Creeks upstream and downstream of the diversions that reflect the condition of the waterway as influenced by agricultural activity in the area that has produced very high sediment loads in the waterways.

11.4 Agency responsible for endorsing or approving each mitigation measure or monitoring program

The monitoring program is an explicit component of the Queensland *Water Act* 2000 approval granted by the Department of Natural Resources, Mines and Energy.

11.5 Mitigation measures that will be implemented to minimise impact to the controlling provisions during mining activities

The diversion will be constructed some distance from the active operations. A minimum stand off of ultimate high wall position is also imposed as part of the design. The diversion will have minimal interaction with mining activities.

The diversion has a comprehensive revegetation program (*Revegetation Plan: Mulgrave Resource Access Walker Creek Diversion – Stage 2C*, Alluvium, 2017) designed that will be implemented immediately following construction, with scheduled maintenance during establishment phase. Such revegetation programs have demonstrated successful performance on diversions at other mine sites in the area.

12 References

Alluvium (2015) *Criteria for Functioning River Landscape Units in the Mining and Post Mining Landscapes.* Australian Coal Association Research Program Project C20017.

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DEHP (2009) Queensland water Quality Guidelines, Queensland Department of Environment and Heritage protection.

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DERM (2010) *Establishing Environmental Values, Water Quality Guidelines and Water Quality Objectives for Fitzroy Basin Waters*. (Draft for Consultation). Queensland Department of Environment and Resource Management.

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GHD, August (2012) *Report for South Walker Creek Mine - Receiving Environment Monitoring Report.*

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Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Devlopment (IESC) (2015) *Information Guidleines for the Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals "IESC INFORMATION GUIDELINES"* . IESC.

Jacobs (October 2014) Memo QN10417-5000-ESN-ME-0001 Revision E: Water Balance Kemmis II and MRA - Initial Assessment - Updated.

Neilly Group Engineering, 2017, *MRA Walker Creek Diversion – Stage 2A IDC Operations Monitoring Report June 2017*, prepared by Neilly Group Engineering for BMC South Walker Creek Mine.

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Texel Solutions (2013) Mulgrave Pit – Surface Water Aspects.

Attachment A
Environmental Authority – South Walker Creek Mine

Permit[1]

Environmental Protection Act 1994

Environmental Authority – South Walker Creek Mine

This draft environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

Permit[1] number: EPML00712313

Environmental authority takes effect on 26 August 2015

Anniversary Day: **17 August**

Environmental authority holder(s)

Name	Registered address
BHP Billiton Mitsui Coal Pty Ltd	Level 23, Riparian Plaza 71 Eagle Street BRISBANE QLD 4000

Environmentally relevant activity and location details

Environmentally relevant activity(ies)	Location(s)
Mining black coal (Schedule 2A, *Environmental Protection Regulation 2008*)	ML4750 including Surface Area 1, 2, 3, 4 & 5 ML 70131
31-2(b) Mineral Processing – processing, in a year, more than 100000t of mineral products, other than coke (Schedule 2, *Environmental Protection Regulation 2008*)	
56 Regulated waste storage – receiving and storing regulated waste (Schedule 2, *Environmental Protection Regulation 2008*)	
63-1(b)(i) Sewage treatment – operating sewage treatment works, other than no-release works, with a total daily peak design capacity of more than 100 but not more than 1500EP, where treated effluent is discharged from the works to an infiltration trench or through an irrigation system (Schedule 2, *Environmental Protection Regulation 2008*)	

[1] Permit includes licences, approvals, permits, authorisations, certificates, sanctions or equivalent/similar as required by legislation

Additional information for applicants

Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority is issued is a restatement of the ERA as defined by legislation at the time the approval is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an environmental authority as to the scale, intensity or manner of carrying out an ERA, then the conditions prevail to the extent of the inconsistency.

An environmental authority authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the authority specifically authorises environmental harm.

A person carrying out an ERA must also be a registered suitable operator under the *Environmental Protection Act 1994* (EP Act).

Contaminated land

It is a requirement of the EP Act that if an owner or occupier of land becomes aware a notifiable activity (as defined in Schedule 3 and Schedule 4) is being carried out on the land, or that the land has been, or is being, contaminated by a hazardous contaminant, the owner or occupier must, within 22 business days after becoming so aware, give written notice to the chief executive.

Signature	Date
	26 August 2015

Christopher Loveday
Department of Environment and Heritage Protection
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Department of Environment and Heritage Protection
PO Box 3028
EMERALD QLD 4720
Phone: (07) 4987 9320
Fax: (07 4987 9399
Email: CRMining@ehp.qld.gov.au

Obligations under the *Environmental Protection Act 1994*

In addition to the requirements found in the conditions of this environmental authority, the holder must also meet their obligations under the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443)

Department Interest: General	
Condition number	**Condition**
A1	**Financial Assurance** Provide financial assurance in the amount and form required by the administering authority prior to the commencement of activities proposed under this environmental authority. Note: *The calculation of financial assurance for condition A1 must be in accordance with the administering authority's Guideline – Financial assurance under the* Environmental Protection Act 1994*, and may include a performance discount. The amount is defined as the maximum total rehabilitation cost for complete rehabilitation of all disturbed areas, which may vary on an annual basis due to progressive rehabilitation. The amount required for the financial assurance must be the highest total rehabilitation cost calculated for any year of the Plan of Operations and calculated using the formula: (Financial Assurance = Highest total annual rehabilitation cost x Percentage required).*
A2	The financial assurance is to remain in force until the administering authority is satisfied that no claim on the assurance is likely.
A3	**Prevent and /or minimise likelihood of environmental harm** In carrying out the environmentally relevant activities, you must take all reasonable and practicable measures to prevent and/or to minimise the likelihood of environmental harm being caused. Any environmentally relevant activity, that, if carried out incompetently, or negligently, may cause environmental harm, in a manner that could have been prevented, shall be carried out in a proper manner in accordance with the conditions of this authority. Note: *This authority authorises the environmentally relevant activity. It does not authorise environmental harm unless a condition contained within this authority explicitly authorises that harm. Where there is no condition or the authority is silent on a matter, the lack of a condition or silence shall not be construed as authorising harm.*

A4	**Maintenance of measures, plant and equipment** The environmental authority holder must ensure: a) that all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority are installed; b) that such measures, plant and equipment are maintained in a proper condition; and c) that such measures, plant and equipment are operated in a proper manner.
A5	**Monitoring and records** Record, compile and keep for a minimum of **five (5) years** all monitoring results required by this environmental authority and make available for inspection all or any of these records upon request by the administering authority.
A6	Where monitoring is a requirement of this environmental authority, ensure that a competent person(s) conducts all monitoring.
A7	**Notification of emergencies, incidents and exceptions** All reasonable actions are to be taken to minimise environmental harm, or potential environmental harm, resulting from any emergency, incident or circumstances not in accordance with the conditions of this environmental authority.
A8	As soon as practicable after becoming aware of any emergency, incident or information about circumstances which results or may result in environmental harm not in accordance with the conditions of this environmental authority, the administering authority must be notified in writing.
A9	Not more than **ten (10) business days** following the initial notification of an emergency, incident or information about circumstances which result or may result in environmental harm, written advice must be provided to the administering authority in relation to: a) proposed actions to prevent a recurrence of the emergency or incident; b) the outcomes of actions taken at the time to prevent or minimise environmental harm; and c) proposed actions to respond to the information about circumstances which result or may result in environmental harm.
A10	As soon as practicable, but not more than **six (6) weeks** following the initial notification of an emergency, incident or information about circumstances which result or may result in environmental harm, environmental monitoring must be performed and written advice must be provided of the results of any such monitoring performed to the administering authority.
A11	**Definitions** Words and phrases used throughout this environmental authority are defined in the Definitions section of this authority. Where a definition for a term used in this environmental authority is sought and the term is not defined within this environmental authority, the definitions in the *Environmental Protection Act 1994*, its regulations and policies must be used.

Department Interest: Air	
Condition number	**Conditions**
B1	**Dust nuisance** The release of dust or particulate matter or both resulting from the mining activity must not cause an environmental nuisance, at any nuisance sensitive or commercial place.
B2	When requested by the administering authority or as a result of a complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer), dust and particulate monitoring must be undertaken, and the results thereof notified to the administering authority within **fourteen (14) days** following completion of monitoring. Monitoring must be carried out at a place(s) relevant to the potentially affected dust sensitive place. Dust and particulate matter must not exceed the following levels when measured at any nuisance sensitive or commercial place: a) Dust deposition of 120 milligrams per square metre per day, when monitored in accordance with *Australian Standard AS 3580.10.1 of 2003* (or more recent editions); and b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometre (µm) (PM10) suspended in the atmosphere of 50 micrograms per cubic metre over a 24 hour averaging time, at a nuisance sensitive or commercial place downwind of the site, when monitored in accordance with: i. Australian Standard AS 3580.9.6 of 2003 (or more recent editions) Ambient air - Particulate matter - Determination of suspended particulate PM10 high-volume sampler with size-selective inlet -Gravimetric method; or ii. any alternative method of monitoring PM10 which may be permitted by the *Air Quality Sampling Manual* as published from time to time by the administering authority.
B3	If monitoring indicates exceedance of the relevant limits in Condition B2, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement dust abatement measures so that emissions of dust from the activity do not result in further environmental nuisance.
B4	**Odour Nuisance** The release of noxious or offensive odour(s) or any other noxious or offensive airborne contaminant(s) resulting from the mining activity must not cause an environmental nuisance at any nuisance sensitive or commercial place.
B5	When requested by the administering authority, odour monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within **fourteen (14) days** to the administering authority following completion of monitoring.
B6	If the administering authority determines the odour released to constitute an environmental nuisance, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement odour abatement measures so that emissions of odour from the activity do not result in further environmental nuisance.

Department Interest: Water	
Condition number	**Condition**
W1	**Contaminant Release** Contaminants that will, or have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of the authorised mining activities, except as permitted under the conditions of this environmental authority.
W2	Unless otherwise permitted under the conditions of this environmental authority, the release of mine affected water to waters must only occur from the release points specified in Table 1 and depicted in Figure 1 attached to this environmental authority.
W3	The release of mine affected water to internal water management infrastructure that is installed and operated in accordance with a water management plan that complies with conditions W30 to W35 inclusive is permitted.

Table 1 (Mine Affected Water Release Points, Sources and Receiving Waters)

Release Point (RP)	Latitude (decimal degree, GDA94)	Longitude (decimal degree, GDA94)	Mine Affected Water Source and Location	Monitoring Point	Receiving waters description
RP1	7594807 (-21.744107)	648486 (148.4358555)	Ramp F Dam	Dam spillway or sampling point on discharge pipe	Bee Creek (via Walker Creek)
RP2	7591840 (-21.77060)	652610 (148.47600)	Ramp C Dam	Dam spillway or sampling point on discharge pipe	Bee Creek (via Walker Creek)
RP3	7589096 (-21.7951814)	654400 (148.4935631)	Eastern Sediment Dam	Dam spillway or sampling point on discharge pipe	Bee Creek (via Sandy Creek)
RP4	7588528 (-21.8003038)	654487 (148.4944577)	Cleanside Bidgerly Tailings Dam	Dam spillway or sampling point on discharge pipe	Bee Creek (via Sandy Creek)
RP5	7589305 (-21.7935753)	651145 (148.4620651)	Mine affected waters mixed in pipe with Down Dip Dam waters [1]	End of pipe only when being mixed with mine water	Bee Creek (via Sandy Creek)
RP6	7597462 (-21.7205536)	643262 (148.3851249)	Kemmis Dam Pipe Line	Sampling point on discharge pipe	Bee Creek (via Walker Creek)

[1] *Down Dip Dam is typically a non-mine affected water dam. Its entire catchment has not been disturbed by mining activity and thus contains natural runoff water that should be allowed to spill from the dam without the need for compliance or monitoring. The overflow channel of Down Dip Dam may be used to release a pre-mixed blend of mine water with Down Dip Dam water to achieve required water quality characteristics and in which case this site becomes a compliance release point.*

W4	The release of mine affected water to waters in accordance with condition W2 must not exceed the release limits stated in Table 2 when measured at the monitoring points specified in Table 1 for each quality characteristic.

Table 2 (Mine Affected Water Release Limits)

Quality Characteristic	Release Limits	Monitoring Frequency [1]	Comment
Electrical conductivity (μS/cm)	Release limits specified in Table 4 for variable flow criteria.	Daily during release (the first sample must be taken within 2 hours of commencement of release)	
pH (pH Unit)	Release limits specified in Table 4 for variable flow criteria.	Daily during release (the first sample must be taken within 2 hours of commencement of release)	
Turbidity (NTU) [1]	500	Daily during release* (first sample within 2 hours of commencement of release)	Turbidity is required to assess ecosystems impacts and can provide instantaneous results.
Suspended Solids (mg/L)	N/A	At commencement and prior to cessation of release (at a minimum) and weekly during a release [2]	Suspended solids are required to measure the performance of sediment and erosion control measures.
Sulphate (SO_4^{2-}) (mg/L)	Release limits specified in Table 4 for variable flow criteria.	At commencement and prior to cessation of release (at a minimum) and weekly during a release [2]	Drinking water environmental values from NHMRC 2006 guidelines OR ANZECC.

Note:

1. *While all endeavours are taken to collect the necessary data, manual sampling work will not be conducted in the event of unsafe access to locations or infrastructure. Should such access limitations arise, the administering authority will be notified as soon as practicable.*
2. *The determination of suitability for release of water should be informed by monitoring undertaken prior to release.*

W5	The release of mine affected water to waters from the release points must be monitored at the locations specified in Table 1 for each quality characteristics and at the frequency specified in Table 2 and Table 3. Note: *the administering authority will take into consideration any extenuating circumstances prior to determining an appropriate enforcement response in the event condition W5 is contravened due to a temporary lack of safe or practical access. The administering authority expects the environmental authority holder to take all reasonable and practicable measures to maintain safe and practical access to designated monitoring locations.*

Table 3 (Release Contaminant Trigger Investigation Levels) Potential Contaminants

Quality Characteristic	Trigger Levels (µg/L)	Comment on Trigger Level	Monitoring Frequency
Aluminium	55	*For aquatic ecosystem protection, based on SMD guideline*	Commencement of release and thereafter weekly during release
Arsenic	13	*For aquatic ecosystem protection, based on SMD guideline*	
Cadmium	0.2	*For aquatic ecosystem protection, based on SMD guideline*	
Chromium	1	*For aquatic ecosystem protection, based on SMD guideline*	
Copper	2	*For aquatic ecosystem protection, based on LOR for ICPMS*	
Iron	300	*For aquatic ecosystem protection, based on low reliability guideline*	
Lead	4	*For aquatic ecosystem protection, based on SMD guideline*	
Mercury	0.2	*For aquatic ecosystem protection, based on LOR for CV FIMS*	
Nickel	11	*For aquatic ecosystem protection, based on SMD guideline*	
Zinc	8	*For aquatic ecosystem protection, based on SMD guideline*	
Boron	370	*For aquatic ecosystem protection, based on SMD guideline*	
Cobalt	90	*For aquatic ecosystem protection, based on low reliability guideline*	
Manganese	1900	*For aquatic ecosystem protection, based on SMD guideline*	
Molybdenum	34	*For aquatic ecosystem protection, based on low reliability guideline*	
Selenium	10	*For aquatic ecosystem protection, based on LOR for ICPMS*	
Silver	1	*For aquatic ecosystem protection, based on LOR for ICPMS*	
Uranium	1	*For aquatic ecosystem protection, based on LOR for ICPMS*	
Vanadium	10	*For aquatic ecosystem protection, based on LOR for ICPMS*	
Ammonia	900	*For aquatic ecosystem protection, based on SMD guideline*	
Nitrate	1100	*For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for TN*	
Petroleum hydrocarbons (C6-C9)	20		
Petroleum hydrocarbons (C10-C36)	100		
Fluoride (total)	2000	*Protection of livestock and short term irrigation guideline*	
Sodium	TBA		

Notes: *1. All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.*

2. The quality characteristics required to be monitored as per Table 3 can be reviewed once the results of two years monitoring data is available, or if sufficient data is available to adequately demonstrate negligible environmental risk, and it may be determined that a reduced monitoring frequency is appropriate or that certain quality characteristics can be removed from Table 3 by amendment.

3. SMD – slightly moderately disturbed level of protection, guideline refers ANZECC & ARMCANZ (2000).

4. LOR – typical reporting for method stated. ICPMS/CV FIMS – analytical method required to achieve LOR.

5. While all endeavours are taken to collect the necessary data, manual sampling work will not be conducted in the event of unsafe access to locations or infrastructure. Should such access limitations arise, the administering authority will be notified as soon as practicable.

W6	If quality characteristics of the release exceed any of the trigger levels specified in Table 3 during a release event, the environmental authority holder must compare the downstream results in the receiving waters to the trigger values specified in Table 3 and: 1. where the trigger values are not exceeded then no action is to be taken; or 2. where the downstream results exceed the trigger values specified in Table 3 for any quality characteristic, compare the results of the downstream site to the data from background monitoring sites and; (a) if the result is less than the background monitoring site data, then no action is to be taken; or (b) if the result is greater than the background monitoring site data, complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining: (i) details of the investigations carried out; and (ii) actions taken to prevent environmental harm. Note: *Where an exceedance of a trigger level has occurred and is being investigated, in accordance with W6 2(b) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.*
W7	If an exceedance in accordance with condition W6 2(b) is identified, the holder of the authority must notify the administering authority within 14 days of receiving the result.
W8	**Mine Affected Water Release Events** The holder must ensure a stream flow gauging station/s is installed, operated and maintained to determine and record stream flows at the locations and flow recording frequency specified in Table 4.
W9	Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with condition W2 must only take place during periods of natural flow events in accordance with the receiving water flow criteria for discharge specified in Table 4 for the release point(s) specified in Table 1.
W10	The release of mine affected water to waters in accordance with condition W2 must not exceed the Electrical Conductivity and Sulphate release limits or the Maximum Release Rate (for all combined release point flows) for each receiving water flow criteria for discharge specified in Table 4 when measured at the monitoring points specified in Table 1.

Table 4 (Mine Affected Water Release during Flow Events)

Receiving waters/ stream	Release Point (RP)	Gauging station	Gauging Station Latitude (decimal degree, GDA94)	Gauging Station Longitude (decimal degree, GDA94)	Receiving Water Flow Recording Frequency	Receiving Water Flow Criteria for discharge (m^3/s)	Maximum release rate (for all combined RP flows)	Electrical Conductivity and Sulphate Release Limits
Bee Creek via Walker Creek and Sandy Creek	All release points (RP1 to RP7)	Bee Creek Upstream Monitoring Point (MP4)	7594860 (-21.7428218)	657810 (148.5259897)	Daily as a minimum (Continuous monitoring, where possible)	**Low Flow** < 3.5 m^3/s for a period of 28 days after natural flow events that exceed 3.5 m^3/s	<1.5 m^3/s	Electrical conductivity 700 (µS/cm) pH (pH unit): 6.5 (minimum) - 9.2 (maximum) Sulphate (SO_4^{2-}) 250 mg/L
						Medium Flow (Low) > 3.5m^3/s	< 1.3 m^3/s	Electrical conductivity 1500 µS/cm pH (pH unit) 6.5 (minimum) - 9.2 (maximum) Sulphate (SO_4^{2-}) 500 mg/L
							< 0.6 m^3/s	Electrical conductivity 2500 µS/cm pH (pH unit) 6.5 (minimum) - 9.2 (maximum) Sulphate (SO_4^{2-}) 500 mg/L
							< 0.4 m^3/s	Electrical conductivity 3500 µS/cm pH (pH unit) 6.5 (minimum) - 9.2 (maximum) Sulphate (SO_4^{2-}) 500 mg/L
						Medium Flow (High) > 10.0 m^3/s	< 3.6 m^3/s	Electrical conductivity 1500 µS/cm pH (pH unit) 6.5 (minimum) - 9.2 (maximum) Sulphate (SO_4^{2-}) 750 mg/L

							< 1.7 m^3/s	Electrical conductivity 2500 µS/cm pH (pH unit) 6.5 (minimum) - 9.2 (maximum) Sulphate (SO_4^{2-}) 750 mg/L
							< 1.1 m^3/s	Electrical conductivity 3500 µS/cm pH (pH unit) 6.5 (minimum) - 9.2 (maximum) Sulphate (SO_4^{2-}) 750 mg/L
Bee Creek via Walker Creek and Sandy Creek	All release points (RP1 to RP7)	Bee Creek Upstream Monitoring Point (MP4)	7594860 (-21.7428218)	657810 (148.5259897)	Daily as a minimum (Continuous monitoring, where possible)	**High Flow** > 24.2 m^3/s	< 8.8 m^3/s	Electrical conductivity 1500 µS/cm pH (pH unit) 6.5 (minimum) - 9.6 (maximum) Sulphate (SO_4^{2-}) 750 mg/L
							< 4.2 m^3/s	Electrical conductivity 2500 µS/cm pH (pH unit) 6.5 (minimum) - 9.6 (maximum) Sulphate (SO_4^{2-}) 750 mg/L
							< 2.0 m^3/s	Electrical conductivity 4500 µS/cm pH (pH unit) 6.5 (minimum) - 9.6 (maximum) Sulphate (SO_4^{2-}) 750 mg/L
							< 1.2 m^3/s	Electrical conductivity 7500 µS/cm pH (pH unit) 6.5 (minimum) - 9.6 (maximum) Sulphate (SO_4^{2-}) 750 mg/L
						Very High Flow > 121 m^3/s	< 8.2 m^3/s	Electrical conductivity 5500 µS/cm pH (pH unit) 6.5 (minimum) - 9.6 (maximum) Sulphate (SO_4^{2-}) 750 mg/L

W11	The daily quantity of mine affected water released from each release point must be measured and recorded at the monitoring points in Table 1.
W12	Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build up of sediment in such waters.
W13	**Notification of Release Event** The environmental authority holder must notify the administering authority as soon as practicable and no later than 24 hours after commencing to release mine affected water to the receiving environment. Notification must include the submission of written advice to the administering authority of the following information: a) release commencement date/time; b) expected release cessation date/time; c) release point/s; d) release volume (estimated); e) receiving water/s including the natural flow rate; and f) any details (including available data) regarding likely impacts on the receiving water(s). Note: *Notification to the administering authority must be addressed to the Manager and Project Manager of the local Administering Authority via email or facsimile.*
W14	The environmental authority holder must notify the administering authority as soon as practicable (nominally within twenty-four (24) hours after cessation of a release event) of the cessation of a release notified under Condition W13 and within 28 days provide the following information in writing: a) release cessation date/time; b) natural flow volume in receiving water; c) volume of water released; d) details regarding the compliance of the release with the conditions of Department Interest: Water of this environmental authority (i.e. contamination limits, natural flow, discharge volume); e) all in-situ water quality monitoring results; and f) any other matters pertinent to the water release event. Note: *Successive or intermittent releases occurring within twenty-four (24) hours of the cessation of any individual release can be considered part of a single release event and do not require individual notification for the purpose of compliance with conditions W13 and W14, provided the relevant details of the release are included within the notification provided in accordance with conditions W13 and W14.*
W15	**Notification of Release Event Exceedance** If the release limits defined in Table 2 are exceeded, the holder of the environmental authority must notify the administering authority within twenty-four (24) hours of receiving the results.

W16	The authority holder must, within twenty-eight (28) days of a release that exceeds the conditions of this authority, provide a report to the administering authority detailing: a) the reason for the release; b) the location of the release; c) all water quality monitoring results; d) any general observations; e) all calculations; and f) any other matters pertinent to the water release event.
W17	**Water Storage access by Livestock** Where practicable, the holder of this environmental authority must implement measures to prevent access by livestock to water storages which are associated with the release points listed in Table 1 (Mine Affected Water Release Points, Sources and Receiving Waters).
W18	**Receiving Environment Monitoring and Contaminant Trigger Levels** The quality of the receiving waters must be monitored at the locations specified in Table 6 for each quality characteristic and at the monitoring frequency stated in Table 5.

Table 5 (Receiving Waters Contaminant Trigger Levels)

Quality Characteristic	Trigger Level	Monitoring Frequency
pH	6.5 – 8.5	Daily during the release
Electrical Conductivity (μS/cm)	1000	
Turbidity (NTU)	750	
Suspended solids (mg/L)	To Be Determined [1]	At commencement and prior to cessation of release (at a mimimum) and weekly during a release
Sulphate (SO_4^{2-}) (mg/L)	250	
Sodium (mg/L)	To Be Determined [2]	

Notes:

1. *Insufficient historical analysis of suspended solid concentration prevents the establishment of a site specific trigger. Future monitoring of suspended solid concentrations will enable a trigger level to be determined. Turbidity is proposed to be used as a surrogate in the interim.*

2. *Insufficient analysis of sodium concentration prevents the establishment of a site specific trigger. Future monitoring of sodium concentrations will enable a trigger level to be determined.*

3. *While all endeavours are taken to collect the necessary data, manual sampling work will not be conducted in the event of unsafe access to locations or infrastructure. Should such access limitations arise, the administering authority will be notified as soon as practicable.*

Table 6 (Receiving Water Upstream Background Sites and Downstream Monitoring Points)

Monitoring Points	**Receiving Waters Location Description**	**Latitude (decimal degree, GDA94)**	**Longitude (decimal degree, GDA94)**
Upstream Background Monitoring Points			
Walker Creek Upstream Monitoring Point (MP1) [1]	Walker Creek 4,280m upstream of confluence with Carborough Creek	7597278 (-21.722412)	640954 (148.361860)
Bee Creek Upstream Monitoring Point (MP4)	Bee Creek 1500 metres upstream of confluence with Walker Creek	7594860 (-21.7428218)	657810 (148.5259897)
Downstream Monitoring Points			
Walker Creek Downstream Monitoring Point (MP7) [1]	Walker Creek 130m upstream from Hail Creek Mine railway spur	7592323 (-22.307996)	653571 (148.490911)
Sandy Creek Downstream Monitoring Point (MP8) [1]	Sandy Creek 900m upstream from confluence with Bee Creek	7587185 (-21.812349)	655445 (148.503849)
Bee Creek Downstream Monitoring Point (MP9)	Bee Creek 3600 metres downstream of confluence with Sandy Creek	7584875 (-21.8330107)	657714 (148.5260161)

Note:

[1] *Requires only in situ samples taken using electronic sampling equipment. Data obtained from Monitoring Points 1, 7 and 8 is for information purposes only, and is not subject to condition W19.*

a) *The upstream monitoring point should be within 2km the release point (Walker Creek confluence with Bee Creek).*

b) *The downstream point should not be greater than 4km from the release point (Sandy Creek confluence with Bee Creek).*

c) *The data from background monitoring points must not be used where they are affected by releases from other mines.*

d) *While all endeavours are taken to collect the necessary data, manual sampling work will not be conducted in the event of unsafe access to locations or infrastructure. Should such access limitations arise, the administering authority will be notified as soon as practicable.*

W19	If quality characteristics of the receiving water at the downstream monitoring point MP9 exceed any of the trigger levels specified in Table 5 during a release event the environmental authority holder must compare the downstream results to the upstream results in the receiving waters and: (1) where the downstream result is the same or a lower value than the upstream value for the quality characteristic then no action is to be taken; or (2) where the downstream results exceed the upstream results, complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining: (i) details of the investigations carried out; and (ii) actions taken to prevent environmental harm. Note: *Where an exceedance of a trigger level has occurred and is being investigated in accordance with W19(2) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.*
W20	**Receiving Environment Monitoring Program (REMP)** The environmental authority holder must develop and implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. This must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site. For the purposes of the REMP, the receiving environment is the waters of Bee Creek and connected or surrounding waterways within 15km downstream of the release. The REMP should encompass any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.

W21	The REMP must: a) Assess the condition or state of receiving waters, including upstream conditions, spatially within the REMP area, considering background water quality characteristics based on accurate and reliable monitoring data that takes into consideration temporal variation (e.g. seasonality); and b) Be designed to facilitate assessment against water quality objectives for the relevant environmental values that need to be protected; and c) Include monitoring from background reference sites (e.g. upstream or background) and downstream sites from the release (as a minimum, the locations specified in Table 6); and d) Specify the frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site specific background reference values in accordance with the *Queensland Water Quality Guidelines* 2006. This should include monitoring during periods of natural flow irrespective of mine or other discharges; and e) Include monitoring and assessment of dissolved oxygen saturation, temperature and all water quality parameters listed in Table 2 and 3; and f) Include, where appropriate, monitoring of metals/metalloids in sediments (in accordance with ANZECC & ARMCANZ 2000, BATLEY and/or the most recent version of AS5667.*1 Guidance on Sampling of Bottom Sediments*); and g) Include, where appropriate, monitoring of macroinvertebrates in accordance with the AusRivas methodology, and h) Apply procedures and/or guidelines from ANZECC & ARMCANZ 2000 and other relevant guideline documents; and i) Describe sampling and analysis methods and quality assurance and control; and j) Incorporate stream flow and hydrological information in the interpretations of water quality and biological data.
W22	A REMP Design Document that addresses each criterion presented in Conditions W20 and W21 must be maintained and submitted to the administering authority on request. Due consideration must be given to any comments made by the administering authority on the REMP Design Document and subsequent implementation of the program.
W23	A report outlining the findings of the REMP, including all monitoring results and interpretations in accordance with conditions W20 and W21 must be prepared annually and made available on request to the administrating authority. This must include an assessment of background reference water quality, the condition of downstream water quality compared against water quality objectives, and the suitability of current discharge limits to protect downstream environmental values.
W24	**Water Reuse** Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as farm dams or tanks, or used directly at properties owned by the environmental authority holder or a third party for the purpose of: i) supplying stock water subject to compliance with the quality release limits specified in Table 7; or ii) supplying irrigation water subject to compliance with quality release limits in Table 8; or iii) supplying water for construction and/or road maintenance in accordance with the conditions of this environmental authority.

Table 7 (Stock Water Release Limits)

Quality characteristic	Units	Minimum	Maximum
pH	pH units	6.5	8.5
Electrical Conductivity	µS/cm	N/A	5000

Table 8 (Irrigation Water Release Limits)

Quality characteristic	Units	Minimum	Maximum
pH	pH units	6.5	8.5
Electrical Conductivity	µS/cm	N/A	Site specific value to be determined in accordance with ANZECC & ARMCANZ (2000) Irrigation Guidelines

W25	Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as dams or tanks, for the purpose of supplying water to Coppabella Mine or neighbouring pastoral properties. The volume, pH and electrical conductivity of water transferred to Coppabella Mine or neighbouring pastoral properties must be monitored and recorded.
W26	If the responsibility for mine affected water is given or transferred to another person in accordance with conditions **W24 or W25:** a) the responsibility for the mine affected water must only be given or transferred in accordance with a written agreement (the third party agreement); and b) the third party agreement must include a commitment from the person utilising the mine affected water to use it in such a way as to prevent environmental harm or public health incidents and specifically make the persons aware of the General Environmental Duty (GED) under section 319 of the *Environmental Protection Act 1994,* environmental sustainability of the water disposal and protection of environmental values of waters; and c) the third party agreement must be signed by both parties to the agreement.
W27	**Water General** All determinations of water quality and biological monitoring must be: a) performed by a person or body possessing appropriate experience and qualifications to perform the required measurements; b) made in accordance with methods prescribed in the latest edition of the Department of Environment and Heritage Protection's Monitoring and Sampling Manual; c) collected from the monitoring locations identified within this environmental authority, within ten hours of each other where possible; d) carried out on representative samples; and e) analysed at a laboratory accredited (e.g. NATA) for the method of analysis being used. Note*: Condition W27 requires the Monitoring and Sampling Manual to be followed and where it is not followed because of exceptional circumstances this should be explained and reported with the results.*

W28	The release of any contaminants as permitted by this environmental authority, directly or indirectly to waters, other than internal water management infrastructure that is installed and operated in accordance with a water management plan that complies with conditions W31 to W36 inclusive: a) must not produce any visible discolouration of receiving waters; and b) must not produce any slick or other visible or odorous evidence of oil, grease or petrochemicals nor contain visible floating oil, grease, scum, litter or other objectionable matter.
W29	**Annual Water Monitoring Reporting** The following information must be recorded in relation to all water monitoring required under the conditions of this environmental authority and submitted to the administering authority in the specified format with each annual return: a) the date on which the sample was taken; b) the time at which the sample was taken; c) the monitoring point at which the sample was taken; d) the measured or estimated daily quantity of mine affected water released from all release points; e) the release flow rate at the time of sampling for each release point; f) the results of all monitoring and details of any exceedances of the conditions of this environmental authority; and g) water quality monitoring data must be provided to the administering authority in the specified electronic format upon request.
W30	**Water Management Plan** A Water Management Plan must be developed by an appropriately qualified person and implemented by 1 February 2012.
W31	The Water Management Plan must: a) provide for effective management of actual and potential environmental impacts resulting from water management associated with the mining activity carried out under this environmental authority; and b) be developed in accordance with Department of Environment and Resource Management guideline *Preparation of water management plans for mining activities* and include: i. a study of the source of contaminants; ii. a water balance model for the site; iii. a water management system for the site; iv. measures to manage and prevent saline drainage; v. measures to manage and prevent acid rock drainage; vi. contingency procedures for emergencies; and vii. a program for monitoring and review of the effectiveness of the water management plan.
W32	The Water Management Plan must be reviewed each calendar year and a report prepared by an appropriately qualified person. The report must: a) assess the plan against the requirements under condition W31; b) include recommended actions to ensure actual and potential environmental impacts are effectively managed for the coming year; and c) identify any amendments made to the water management plan following the review.

W33	The holder of this environmental authority must attach to the review report required by condition W32, a written response to the report and recommended actions, detailing the actions taken or to be taken by the environmental authority holder on stated dates: a) to ensure compliance with this environmental authority; and b) to prevent a recurrence of any non-compliance issues identified.
W34	The review report required by condition W32 and the written response to the review report required by condition W33 must be submitted to the administering authority with the subsequent annual return under the signature of the appointed signatory for the annual return.
W35	A copy of the Water Management Plan must be provided to the administering authority on request.
W36	**Saline Drainage** The holder of this environmental authority must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of saline drainage.
W37	**Acid Rock Drainage** The holder of this environmental authority must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of acid rock drainage.
W38	**Stormwater and Water Sediment Controls** An Erosion and Sediment Control Plan must be developed by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and contamination of stormwater.
W39	Stormwater, other than mine affected water, is permitted to be released to waters from: i) erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by condition W38; and ii) water management infrastructure that is installed and operated, in accordance with a Water Management Plan that complies with conditions W30 to W35 inclusive, for the purpose of ensuring water does not become mine affected water.
W40	The maintenance and cleaning of any vehicles, plant or equipment must not be carried out in areas from which contaminants can be released into any receiving waters.
W41	Any spillage of wastes, contaminants or other materials must be cleaned up as quickly as practicable to minimise the release of wastes, contaminants or materials to any stormwater drainage system or receiving waters.
W42	**Sewage effluent** All effluent released from the sewage treatment facilities must be monitored at the frequency and for the parameters specified in Table 9 (Sewage effluent quality targets).

Table 9 (Sewage effluent quality targets)

Quality characteristics	Release limit	Units	Limit type	Monitoring frequency
5 day Biochemical Oxygen Demand	50	mg/l	max	Monthly
pH	6.0 to 9.0	pH Units	range	Monthly
Free Chlorine Residual	1	mg/l	max	Monthly
Thermotolerant coliforms	<100	Cfu/100mL[2]	max	Monthly

W43	Sewage effluent used directly from the sewage treatment facilities for dust suppression or irrigation must not exceed sewage effluent release limits defined in Table 9 (Sewage effluent quality targets).
W44	Sewage effluent used for dust suppression or irrigation must not cause spray drift or over spray to any sensitive or commercial place.
W45	Sewage effluent from sewage treatment facilities not used for dust suppression or irrigation must be reused or evaporated.
Groundwater	
W46	The holder of this environmental authority must not release contaminants to groundwater.
W47	All determinations of groundwater quality and biological monitoring must be performed by a suitably qualified person.
W48	The holder of the environmental authority must implement a groundwater monitoring program which has been developed by a suitably qualified person. The program must be able to detect a significant change to ground water quality values and standing water levels (consistent with the current suitability of the groundwater for domestic and agricultural use) due to activities that are part of this mining project.
W49	The holder of the environmental authority must report the results and analysis of groundwater monitoring to the administering authority on request.
W50	Groundwater affected by the mining activities must be monitored at compliance bores within the nominated geologies and minimum frequencies defined in Table 10.

Table 10 (Groundwater monitoring locations and frequency)

Geology Units [1 and 2]	Minimum number of monitoring locations [1 and 2]	Minimum Monitoring Frequency [1 and 2]
Alluvium and upper tertiary	2 compliance bores	Monthly until trigger levels are set for all parameters in Table 11, then quarterly.

Note:
1 *To be completed within 3 months from the date of grant of this EA.*
2 *Relevant geology units, number of bores and monitoring frequencies to be determined by a suitably qualified person.*

W51	If the groundwater contaminant trigger levels defined in Table 11 are exceeded then the environmental authority holder must complete an investigation into the potential for environmental harm and notify the administering authority within twenty-eight (28) days of receiving the analysis results. An action plan to mitigate potential harm must be developed by a suitably qualified person.

Table 11 (Groundwater contaminant trigger levels)

Parameter	Unit	Trigger Levels		Limit Type
		Walker Creek Alluvial/Tertiary Zone	**Bee Creek Alluvial/Tertiary Zone**	
Groundwater Level	RL	Greater than 2 metre drawdown from the background level.	Greater than 2 metre drawdown from the background level.	Maximum
pH	pH Units	TBA as per condition W52	TBA as per condition W52	
Electrical Conductivity	µS/cm	TBA as per condition W52	TBA as per condition W52	
Total Dissolved Solids	mg/L	TBA as per condition W52	TBA as per condition W52	
Calcium	mg/L	TBA as per condition W52	TBA as per condition W52	
Magnesium	mg/L	TBA as per condition W52	TBA as per condition W52	
Sodium	mg/L	TBA as per condition W52	TBA as per condition W52	
Potassium	mg/L	TBA as per condition W52	TBA as per condition W52	
Chloride	mg/L	TBA as per condition W52	TBA as per condition W52	
SO4	mg/L	TBA as per condition W52	TBA as per condition W52	
CO3	mg/L	TBA as per condition W52	TBA as per condition W52	
HCO3	mg/L	TBA as per condition W52	TBA as per condition W52	
PO_4	mg/L	TBA as per condition W52	TBA as per condition W52	
NO_3	mg/L	TBA as per condition W52	TBA as per condition W52	
Iron	mg/L	TBA as per condition W52	TBA as per condition W52	
Aluminium	mg/L	TBA as per condition W52	TBA as per condition W52	
Arsenic	mg/L	TBA as per condition W52	TBA as per condition W52	
Mercury	mg/L	TBA as per condition W52	TBA as per condition W52	
Antimony	mg/L	TBA as per condition W52	TBA as per condition W52	
Total Petroleum Hydrocarbons	mg/L	TBA as per condition W52	TBA as per condition W52	

W52	**Determining Contaminant Trigger Level and Limit Type** The background groundwater quality for each geology must be determined from hydraulically isolated background bore(s) that have not been affected by any mining activities. The groundwater contaminant trigger levels and limit type as per Table 11 must be determined and submitted to the administering authority by **1 March 2016**.

W53	**Bore construction and maintenance and decommissioning** The construction, maintenance and management of groundwater bores (including background and compliance groundwater monitoring bores) must be undertaken in a manner that prevents or minimises impacts to the environment and ensures the integrity of the bores to obtain accurate monitoring. Construction and decommissioning must be in accordance with the "Minimum Construction Standard for Water Bores in Australia".
Department Interest: Noise and vibration	
Condition number	**Condition**
D1	**Noise nuisance** Noise from activities must not cause an environmental nuisance at any noise sensitive or commercial place.
D2	All noise from activities must not exceed the levels specified in Table 12 (Noise limits) at any noise affected place.
D3	**Noise monitoring** When requested by the administering authority, noise monitoring must be undertaken to investigate any complaint of noise nuisance, and the results notified within fourteen (14) days to the administering authority. Monitoring must include: a) $L_{A\ 10,\ adj,\ 10\ mins}$ b) $L_{A\ 1,\ adj,\ 10\ mins}$ c) the level and frequency of occurrence of impulsive or tonal noise; d) atmospheric conditions including wind speed and direction; e) effects due to extraneous factors such as traffic noise; and f) location date and time of recording.
D4	Noise is not considered to be a nuisance under condition D1 if monitoring shows that noise does not exceed the following levels in the time periods specified in Table 12 (Noise limits).

Table 12 (Noise limits)

Noise level dB(A)	Monday to Saturday			Sundays and public holidays		
	7am - 6pm	**6pm - 10pm**	**10pm - 7am**	**9am - 6pm**	**6pm - 10pm**	**10pm - 9am**
	Noise measured at a 'Noise sensitive place'					
$L_{A10,\ adj,\ 10\ mins}$	B/g + 5	B/g + 5	B/g + 0	B/g + 5	B/g + 5	B/g + 0
$L_{A1,\ adj,\ 10\ mins}$	B/g + 10	B/g + 10	B/g + 5	B/g + 10	B/g + 10	B/g + 5
	Noise measured at a 'Commercial place'					
$L_{A10,\ adj,\ 10\ mins}$	B/g + 10	B/g + 10	B/g + 5	B/g + 10	B/g + 10	B/g + 5
$L_{A1,\ adj,\ 10\ mins}$	B/g + 15	B/g + 15	B/g + 10	B/g + 15	B/g + 15	B/g + 10

D5	The method of measurement and reporting of noise levels must comply with the administering authority's *Noise Measurement Manual, Third Edition, 1 March 2000*, or more recent editions or supplements to that document as they become available.
D6	If monitoring indicates exceedance of the relevant limits in condition D4, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement noise abatement measures so that emissions of noise from the activity do not result in further environmental nuisance.
Vibration nuisance	
D7	Vibration from the licensed activities must not cause an environmental nuisance, at any sensitive or commercial place.
D8	When requested by the administering authority, vibration monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within fourteen (14) days to the administering authority following completion of monitoring.
Airblast overpressure nuisance	
D9	The airblast overpressure level from blasting operations on the premises must not exceed the limits defined in Table 13 (Airblast overpressure level) at any nuisance sensitive or commercial place.

Table 13 (Airblast overpressure level)

Location	Airblast Overpressure Measured
Sensitive or commercial place	Air blast overpressure level of 115 dB (Linear peak) for nine (9) out of ten (10) consecutive blasts initiated and not greater than 120 dB (Linear peak) at any time.

D10	When requested by the administering authority, airblast overpressure monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within fourteen (14) days to the administering authority following completion of monitoring.

D11	Airblast overpressure monitoring must include the following descriptors, characteristics and conditions: a) location of the blast(s) within the mining area (including which bench level); b) atmospheric conditions including temperature, relative humidity and wind speed and direction; and c) location, date and time of recording.
D12	If monitoring indicates exceedance of the relevant limits in Table 13 (Airblast overpressure level), then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement airblast overpressure abatement measures so that airblast overpressure from the activity does not result in further environmental nuisance.
D13	The method of measurement and reporting of airblast overpressure levels must comply with the latest edition of the administering authority's *Noise Measurement Manual*.
Department Interest: Waste	
Condition number	**Condition**
E1	**Storage of tyres** Scrap tyres stored awaiting disposal or transport for take-back and recycling, or waste-to-energy options must be stored in stable stacks and at least ten (10) meters from any other scrap tyre storage area, or combustible or flammable material, including vegetation.
E2	All reasonable and practicable fire prevention measures must be implemented, including removal of grass and other materials within a ten (10) meters radius of the scrap tyre storage area.
E3	Disposing of scrap tyres resulting from the authorised activities in spoil emplacements is acceptable, provided tyres are placed as deep in the spoil as reasonably practicable.
E4	Scrap tyres resulting from the mining activities disposed within the operational land must not impede saturated aquifers or compromise the stability of the consolidated landform.
E5	**Waste Management** A Waste Management Plan, in accordance with the waste and resource management hierarchy in the *Waste Reduction and Recycling Act 2011,* must be implemented and must cover: a) a program for safe recycling or disposal of all wastes - re-using and recycling where possible; b) a disposal procedure for hazardous wastes; and c) a staff awareness and induction program that encourages re-use and recycling.

E6	Waste must not be burned or allowed to be burned on the licensed site unless by approval of the administering authority.
E7	A designated area must be set aside for the segregation of economically viable, recyclable solid and liquid waste.
E8	Records must be kept for five years, and must include the following information: i. date of pickup of waste; ii. description of waste; iii. cross reference to relevant waste transport documentation; iv. quantity of waste; v. origin of the waste; vi. destination of the waste; and vii. intended fate of the waste, for example, type of waste treatment, reprocessing or disposal. Note: *Records of documents maintained in compliance with a waste tracking system established under the Environmental Protection Act 1994 or any other law for regulated waste will be deemed to satisfy this condition.*
E9	Records of trade and regulated wastes or material leaving the mining lease for recycling or disposal, including the final destination and method of treatment, must be in accordance with the *Environmental Protection (Waste Management) Regulation 2000.*
E10	All regulated waste received at and removed from the site must be transported by a person who holds a current authority to transport such waste under the provisions of the *Environmental Protection Act 1994.*
E11	Except as otherwise provided by the conditions of this authority, all waste removed from the site must be taken to a facility that is lawfully allowed to accept such waste under the provisions of the *Environmental Protection Act 1994*.
Department Interest: Land and rehabilitation	
Condition number	**Condition**
F1	**Topsoil** Topsoil must be strategically stripped ahead of mining in accordance with a topsoil management plan.
F2	A topsoil inventory which identifies the topsoil requirements for the South Walker Creek Mine project and availability of suitable topsoil on site must be detailed in the Plan of Operations
F3	**Rehabilitation landform criteria** All areas significantly disturbed by mining activities must be rehabilitated to a stable landform with a self-sustaining vegetation cover.

F4	Progressive rehabilitation must commence within three (3) years when areas become available within the operational land.
F5	Complete an investigation into rehabilitation of disturbed areas and submit a report to the administering authority proposing acceptance criteria by **30 June 2008**. The rehabilitation management plan must, at a minimum: a) map existing areas of rehabilitation; b) detail rehabilitation methods applied to areas; c) identify success factors for areas; d) detail future rehabilitation actions to be completed on areas; e) identify three (3) reference and three (3) rehabilitation sites to be used to develop rehabilitation success criteria; f) contain landform design criteria including end of mine design; g) detail how landform design will be consistent with the surrounding topography; h) specify future planned rehabilitation methods for disturbed areas; i) explain planned native vegetation rehabilitation areas and corridors; j) describe rehabilitation monitoring and maintenance requirements to be applied to all areas of disturbance; k) itemise revegetation criteria; l) describe end of mine landform design plan and post mining land uses across the mine; m) specify spoil characteristics, soil analysis, soil separation for use on rehabilitation; n) include a cost benefit analysis / triple bottom line assessment (or an alternative assessment method) of the proposed final landform design criteria and alternatives; and o) identify potential problems and how they will be addressed.
F6	**Residual void outcomes** Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself and subject to any other condition within this environmental authority.
F7	Complete an investigation into residual voids and submit a report to the administering authority proposing acceptance criteria to meet the outcomes in F6 and landform design criteria by **30 June 2008**. The investigation must at a minimum include the following: a) a study of options available for minimising final void area and volume; b) a void hydrology study, addressing the long-term water balance in the voids, connections to groundwater resources and water quality parameters in the long term; c) a pit wall stability study, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events; d) a study of void capability to support native flora and fauna; and e) a proposal/s for end of mine void rehabilitation success criteria and final void areas and volumes. These studies will be undertaken during the life of the mine, and will include detailed research and modelling.
F8	**Preventing contaminant release to land** Contaminants must not be released to land.

F9	**Storage and handling of flammable and combustible liquids** All flammable and combustible liquids must be contained within an on-site containment system and controlled in a manner that prevents environmental harm and maintained in accordance with the current version of *AS 1940 – Storage and Handling of Flammable and Combustible Liquids*.
F10	Spillage of all flammable and combustible liquids must be controlled in a manner that prevents environmental harm.
F11	**Storage and handling of chemicals** All chemicals must be contained within an on-site containment system and controlled in a manner that prevents environmental harm and maintained in accordance with the current version of the relevant Australian Standard.
F12	Spillage of all chemicals must be controlled in a manner that prevents environmental harm.
F13	**Infrastructure** All infrastructure, constructed by or for the environmental authority holder during the licensed activities including water storage structures, must be removed from the site prior to surrender, except where agreed in writing by the post mining land owner / holder. Note: *This is not applicable where the landowner / holder is also the environmental authority holder.*
Department Interest: Structures	
Condition number	**Condition**
G1	**Assessment of consequence category** The consequence category of any structure must be assessed by a suitably qualified and experienced person in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635) at the following times: a) prior to the design and construction of the structure, if it is not an existing structure; or b) if it is an existing structure, prior to the adoption of this schedule; or c) prior to any change in its purpose or the nature of its stored contents.
G2	A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.
G3	Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)*.
G4	**Design and construction of a regulated structure** Conditions G5 to G9 inclusive do not apply to existing structures.
G5	All regulated structures must be designed by, and constructed under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)*. Note: *Construction of a dam includes modification of an existing dam – see definitions. Certification of design and construction may be undertaken by different persons.*

G6	Construction of a regulated structure is prohibited unless the holder has submitted a consequence category assessment report and certification to the administering authority has been certified by a suitably qualified and experienced person for the design and design plan and the associated operating procedures in compliance with the relevant condition of this authority.
G7	Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)*, and must be recorded in the Regulated Dams/Levees register.
G8	Regulated structures must: a) be designed and constructed in accordance with and conform to the requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635);* b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of: i. floodwaters from entering the regulated dam from any watercourse or drainage line; and ii. wall failure due to erosion by floodwaters arising from any watercourse or drainage line.
G9	Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that: a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure; b) construction of the regulated structure is in accordance with the design plan.
G10	**Operation of a regulated structure** Operation of a regulated structure, except for an existing structure, is prohibited unless: a) the holder has submitted to the administering authority: i) one paper copy and one electronic copy of the design plan and certification of the 'design plan' in accordance with condition G7, and ii) a set of 'as constructed' drawings and specifications, and iii) certification of those 'as constructed drawings and specifications' in accordance with condition G9, and iv) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, a copy of the certified system design plan. v) the requirements of this authority relating to the **construction** of the regulated structure have been met; vi) the holder has entered the details required under this **authority**, into a Register of Regulated Dams; and vii) there is a current operational plan for the regulated structures.
G11	For existing structures that are regulated structures: a) where the existing structure that is a regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, the holder must submit to the administering authority within within 12 months of the commencement of this condition a copy of the certified system design plan including that structure; and b) There must be a current operational plan for the existing structures.

G12	Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in a manner that is consistent with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.
G13	**Mandatory Reporting Level and Design Storage Allowance** Conditions G14 to G21 inclusive only apply to Regulated Structures which have not been certified as low consequence category for 'failure to contain – overtopping'.
G14	The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable.
G15	The holder must, as soon as practical and within forty-eight (48) hours of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL.
G16	The holder must, immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.
G17	The holder must record any changes to the MRL in the Register of Regulated Structures.
G18	The holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to 1 July of each year.
G19	By 1 November of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems).
G20	The holder must, as soon as possible and within forty-eight (48) hours of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, notify the administering authority.
G21	The holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.
G22	**Annual inspection report** Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.
G23	At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include recommended actions to ensure the integrity of the regulated structure.
G24	The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)*.

G25	The holder must: a) Within 20 business days of receipt of the annual inspection report, provide to the administering authority: i) The recommendations section of the annual inspection report; and ii) If applicable, any actions being taken in response to those recommendations; and b) If, following receipt of the recommendations and (if applicable) actions, the administering authority requests a full copy of the annual inspection report from the holder, provide this to the administering authority within 10 business days**6** of receipt of the request.
G26	**Transfer arrangements** The holder must provide a copy of any reports, documentation and certifications prepared under this authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.
G27	**Decommissioning and rehabilitation** Dams must not be abandoned but be either: a) decommissioned and rehabilitated to achieve compliance with condition G28; or b) be left in-situ for a **beneficial use(s)** provided that: i) it no longer contains contaminants that will migrate into the environment; and ii) it contains water of a quality that is demonstrated to be suitable for its intended beneficial use(s); and iii) the administering authority, the holder of the environmental authority and the landholder agree in writing that the dam will be used by the landholder following the cessation of the environmentally relevant activity(ies).
G28	After decommissioning, all significantly disturbed land caused by the carrying out of the environmentally relevant activity(ies) must be rehabilitated to meet the following final acceptance criteria: a) the landform is safe for humans and fauna; b) the landform is stable with no subsidence or erosion gullies for at least three (3) years; c) any contaminated land (e.g. contaminated soils) is remediated and rehabilitated d) not allowing for acid mine drainage; or e) there is no ongoing contamination to waters (including groundwater); f) rehabilitation is undertaken in a manner such that any actual or potential acid sulfate soils on the area of significant disturbance are treated to prevent or minimise environmental harm in accordance with the Instructions for the treatment and management of acid sulfate soils (2001) g) all significantly disturbed land is reinstated to the pre-disturbed soil suitability class; h) for land that is not being cultivated by the landholder: a. groundcover, that is not a declared pest species is established and self-sustaining b. vegetation of similar **species richness** and **species diversity** to pre-selected **analogue sites** is established and self-sustaining, and c. the maintenance requirements for rehabilitated land is no greater than that required for the land prior to its disturbance caused by carrying out the mining activity(ies). i) for land that is to be cultivated by the landholder, cover crop is revegetated, unless the landholder will be preparing the site for cropping within 3 months of mining activities being completed.

G29	**Register of Regulated Dams** A Register of Regulated Dams must be established and maintained by the holder for each regulated dam.
G30	The holder must provisionally enter the required information in the Register of Regulated Dams when a design plan for a regulated dam is submitted to the administering authority.
G31	The holder must make a final entry of the required information in the Register of Regulated Dams once compliance with condition G10 and G11 has been achieved.
G32	The holder must ensure that the information contained in the Register of Regulated Dams is current and complete on any given day.
G33	All entries in the Register of Regulated Dams must be approved by the chief executive officer for the holder of this authority, or their delegate, as being accurate and correct.
G34	The holder must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Dams, in the electronic format required by the administering authority.
Department Interest: Community	
Condition number	**Condition**
H1	**Complaint response** All complaints received must be recorded including investigations undertaken, conclusions formed and action taken. This information must be made available to the administering authority on request.
H2	The holder of this environmental authority must record the following details for all complaints received and provide this information to the administering authority on request: a) time, date, name and contact details of the complainant; b) reasons for the complaint; c) conclusions formed; and d) any actions taken.
H3	In consultation with the administering authority, cooperate with and participate in any community environmental liaison committee established in respect of either the licensed place specifically or the industrial estate where the licensed place is located.

END OF CONDITIONS

Definitions

Words and phrases used throughout this licence are defined below except where identified in the *Environmental Protection Act 1994* (*EP Act 1994*) or subordinate legislation. Where a word or term is not defined, the ordinary English meaning applies, and regard should be given to the Macquarie Dictionary.

acceptance criteria means the measures by which the actions implemented to rehabilitate the land are deemed to be complete. The acceptance criteria indicate the success of the rehabilitation outcome or remediation of areas which have been significantly been disturbed by the mining activities. Acceptance criteria may include information regarding:

a) vegetation establishment, survival and succession;
b) vegetation productivity, sustained growth and structure development;
c) fauna colonisation and habitat development;
d) ecosystem processes such as soil development and nutrient cycling, and the recolonisation of specific fauna groups such as collembola, mites and termites which are involved in these processes;
e) microbiological studies including recolonisation by mycorrhizal fungi, microbial biomass and respiration;
f) effects of various establishment treatments such as deep ripping, topsoil handling, seeding and fertiliser application on vegetation growth and development;
g) resilience of vegetation to disease, insect attack, drought and fire; and
h) vegetation water use and effects on ground water levels and catchment yields.

acid rock drainage means any contaminated discharge emanating from a mining activity formed through a series of chemical and biological reactions, when geological strata is disturbed and exposed to oxygen and moisture as a result of mining activity.

administering authority means the Department of Environment and Heritage Protection or its successor.

airblast overpressure means energy transmitted from the blast site within the atmosphere in the form of pressure waves. The maximum excess pressure in this wave, above ambient pressure is the peak airblast overpressure measured in decibels linear (dBL).

ambient (or total) noise at a place, means the level of noise at the place from all sources (near and far), measured as the Leq for an appropriate time interval.

Annual Exceedance Probability or **AEP** means the probability that at least one event in excess of a particular magnitude will occur in any given year.

annual inspection report means an assessment prepared by a suitably qualified and experienced person containing details of the assessment against the most recent consequence assessment report and design plan (or system design plan);
(a) against recommendations contained in previous annual inspections reports;
(b) against recognised dam safety deficiency indicators;
(c) for changes in circumstances potentially leading to a change in consequence category;
(d) for conformance with the conditions of this authority;
(e) for conformance with the 'as constructed' drawings;
(f) for the adequacy of the available storage in each regulated dam, based on an actual observation or observations taken after 31 May each year but prior to 1 November of that year, of accumulated sediment, state of the containment barrier and the level of liquids in the **dam** (or network of linked containment systems);
(g) for evidence of conformance with the current operational plan.

ANZECC means the Australian and New Zealand Guidelines for Fresh Marine Water Quality 2000.

appropriately qualified person means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods or literature.

assessed and **assessment** by a suitably qualified and experienced person in relation to a consequence assessment of a dam, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit of the assessment:

a) exactly what has been assessed and the precise nature of that determination;
b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;

c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and
d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

associated works in relation to a dam, means:

a) operations of any kind and all things constructed, erected or installed for that dam; and
b) any land used for those operations.

authority means an environmental authority or a development approval.

bed and banks for a waters, river, creek, stream, lake, lagoon, pond, swamp, wetland or dam means land over which the water of the waters, lake, lagoon, pond, swamp, wetland or dam normally flows or that is normally covered by the water, whether permanently or intermittently; but does not include land adjoining or adjacent to the bed and banks that is from time to time covered by floodwater.

beneficial use in respect of dams means that the current or proposed owner of the land on which a dam stands, has found a use for that dam that is:

a) of benefit to that owner in that it adds real value to their business or to the general community,
b) in accordance with relevant provisions of the *Environmental Protection Act 1994*,
c) sustainable by virtue of written undertakings given by that owner to maintain that dam, and
d) the transfer and use have been approved or authorised under any relevant legislation.

blasting means the use of explosive materials to fracture-

a) rock, coal and other minerals for later recovery; or
b) structural components or other items to facilitate removal from a site or for reuse.

brine means saline water with a total dissolved solid concentration greater than 40,000 mg/L.

certification means assessment and approval must be undertaken by a suitably qualified and experienced person in relation to any assessment or documentation required by the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)* or this environmental authority, including design plans, 'as constructed' drawings and specifications, construction, operation or an annual report regarding regulated structures, undertaken in accordance with the Boart of Professional Engineers of Queensland Policy Certification by RPEQs (ID: 1.4 (2A)).

certifying, certify or **certified** have a corresponding meaning as "certification".

chemical means –

a) an agricultural chemical product or veterinary chemical product within the meaning of the *Agricultural and Veterinary Chemicals Code Act 1994* (Commonwealth); or
b) a dangerous good under the dangerous goods code; or
c) a lead hazardous substance within the meaning of the *Workplace Health and Safety Regulation 1997*; or
d) a drug or poison in the *Standard for the Uniform Scheduling of Drugs and Poisons* prepared by the Australian Health Ministers' Advisory Council and published by the Commonwealth; or
e) any substance used as, or intended for use as –
   i. a pesticide, insecticide, fungicide, herbicide, rodenticide, nematocide, miticide, fumigant or related product; or
   ii. a surface active agent, including, for example, soap or related detergent; or
   iii. a paint solvent, pigment, dye, printing ink, industrial polish, adhesive, sealant, food additive, bleach, sanitiser, disinfectant, or biocide; or
   iv. a fertiliser for agricultural, horticultural or garden use; or
f) a substance used for, or intended for use for –
   i. mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater; or
   ii. manufacture of plastic or synthetic rubber.

commercial place means a work place used as an office or for business or commercial purposes, which is not part of the mining activity and does not include employees accommodation or public roads.

competent person means a person with the demonstrated skill and knowledge required to carry out the task to a standard necessary for the reliance upon collected data or protection of the environment.

consequence in relation to a structure as defined, means the potential for environmental harm resulting from the collapse or failure of the structure to perform its primary purpose of containing, diverting or controlling flowable substances.

consequence category means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635).*

construction or **constructed** in relation to a dam includes building a new dam and modifying or lifting an existing dam, but does not include investigations and testing necessary for the purpose of preparing a design plan.

contaminate means to render impure by contact or mixture.

contaminated means the substance has come into contact with a contaminant.

contaminant a contaminant can be –

a) a gas, liquid or solid; or
b) an odour; or
c) an organism (whether alive or dead), including a virus; or
d) energy, including noise, heat, radioactivity and electromagnetic radiation; or
e) a combination of contaminants.

control measure means any action or activity that can be used to prevent or eliminate a hazard or reduce it to an acceptable level.

dam means a land-based structure or a void that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and **associated works.**

Dam crest volume means the volume of material (liquids and/or solids) that could be within the walls of a dam at any time when the upper level of that material is at the crest level of that dam. That is, the instantaneous maximum volume within the walls, without regard to flows entering or leaving (for example, via spillway).

Design plan is a document setting out how all identified consequence scenarios are addressed in the planned design and operation of a regulated structure.

design storage allowance or **DSA** means an available volume, estimated in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)* published by the administering authority, that must be provided in a dam as at 1 November each year in order to prevent a discharge from that dam to an annual exceedance probability (AEP) specified in that manual.

development approval means a development approval under the *Integrated Planning Act 1997* or the *Sustainable Planning Act 2009* in relation to a matter that involves an environmentally relevant activity under the *Environmental Protection Act 1994.*

domestic waste means waste, other than domestic clean-up waste, green waste, recyclable waste, interceptor waste or waste discharged to a sewer, produced as a result of the ordinary use or occupation of domestic premises.

dwelling means any of the following structures or vehicles that is principally used as a residence –

a) a house, unit, motel, nursing homer or other building or part of a building; or
b) a caravan, mobile home or other vehicle or structure on land; or
c) a water craft in a marina.

effluent means treated waste water discharged from sewage treatment plants.

emergency action plan means documentation forming part of the operational plan held by the holder or a nominated responsible officer, that identifies emergency conditions that sets out procedures and actions that will be followed and taken by the dam owner and operating personnel in the event of an emergency. The actions are to minimise the risk and consequences of failure, and ensure timely warning to downstream communities and the implementation of protection measures. The plan must require dam owners to annually update contact details that are part of the plan, and to comprehensively review the plan at least every five years.

end of pipe means the location at which water is released to waters or land.

environmental authority means an environmental authority granted in relation to an environmentally relevant activity under the *Environmental Protection Act 1994.*

environmental authority holder means the holder of this environmental authority.

environmentally relevant activity means an environmentally relevant activity as defined under Section 18 of the *Environmental Protection Act 1994*.

existing structure means a structure that was in existence prior to 2 July 2014 (that is, prior to the adoption of this schedule of conditions) under the authority.

Extreme Storm Storage – means a storm storage allowance determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)* published by the administering authority

financial assurance means a security required under the *Environmental Protection Act 1994* by the administering authority to cover the cost of rehabilitation or remediation of disturbed land or to secure compliance with the environmental authority.

floodwater means water overflowing, or that has overflowed, from waters, river, creek, stream, lake, pond, wetland or dam onto or over riparian land that is not submerged when the watercourse or lake flows between or is contained within its bed and banks.

flowable substance means matter or a mixture of materials which can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids, fluids or solids, or a mixture that includes water and any other liquids, fluids or solids either in solution or suspension.

foreseeable future is the period used for assessing the total probability of an event occurring. Permanent structures and ecological sustainability should be expected to still exist at the end of a 150 year foreseeable future with an acceptable probability of failure before that time.

general waste means waste other than regulated waste.

hazardous waste means a substance, whether liquid, solid or gaseous that, if improperly treated, stored, disposed of or otherwise managed, is likely to cause environmental harm.

holder means:

(a) where this document is an environmental authority, any person who is the holder of, or is acting under, that environmental authority; or

(b) where this document is a development approval, any person who is the registered operator for that development approval.

hydraulic performance means the capacity of a regulated dam to contain or safely pass flowable substances based on the design criteria specified for the relevant consequence category in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)*.

infrastructure means water storage dams, roads and tracks, buildings and other structures built for the purpose of mining activities but does not include other facilities required for the long term management of mining impacts or the protection of potential resources. Such other facilities include dams, waste rock dumps, voids, or ore stockpiles and buildings as well as other structures whose ownership can be transferred and which have a residual beneficial use for the next owner of the operational land or the background land owner.

$L_{A\,10,\,adj,\,10\,mins}$ means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 10% of any 10-minute measurement period, using Fast response.

$L_{A\,1,\,adj,\,10\,mins}$ means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 1% of any 10-minute measurement period, using Fast response

$L_{A,\,max\,adj,\,T}$ means the average maximum A-weighted sound pressure level, adjusted for noise character and measured over any 10 minute period, using Fast response.

lake includes –

a) lagoon, swamp or other natural collection of water, whether permanent or intermittent; and
b) the bed and banks and any other element confining or containing the water.

land in the Land and Rehabilitation schedule of this document means land excluding waters and the atmosphere.

land use describes the selected post mining use of the land, which is planned to occur after the cessation of mining operations.

levee means an embankment that only provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of water or flowable substances at any other times.

low consequence dam means any dam that is not a high or significant consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635).*

mandatory reporting level or MRL means a warning and reporting level determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)* published by the administering authority.

manual means the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)* published by the administering authority.

mg/L means milligrams per litre.

mine affected water means the following types of water:
- i) pit water, tailings dam water, processing plant water;
- ii) water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the *Environmental Protection Regulation 2008* if it had not formed part of the mining activity;
- iii) rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage runoff containing sediment only, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water;
- iv) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated;
- v) groundwater from the mine's dewatering activities;
- vi) a mix of mine affected water (under any of paragraphs i)-v)) and other water.

mineral means a substance which normally occurs naturally as part of the earth's crust or is dissolved or suspended in water within or upon the earth's crust and includes a substance which may be extracted from such a substance, and includes—

- a) clay if mined for use for its ceramic properties, kaolin and bentonite;
- b) foundry sand;
- c) hydrocarbons and other substances or matter occurring in association with shale or coal and necessarily mined, extracted, produced or released by or in connection with mining for shale or coal or for the purpose of enhancing the safety of current or future mining operations for coal or the extraction or production of mineral oil there from;
- d) limestone if mined for use for its chemical properties;
- e) marble;
- f) mineral oil or gas extracted or produced from shale or coal by in situ processes;
- g) peat;
- h) salt including brine;
- i) shale from which mineral oil may be extracted or produced;
- j) silica, including silica sand, if mined for use for its chemical properties;
- k) rock mined in block or slab form for building or monumental purposes;

But does not include—
- l) living matter;
- m) petroleum within the meaning of the *Petroleum Act 1923*;
- n) soil, sand, gravel or rock (other than rock mined in block or slab form for building or monumental purposes) to be used or to be supplied for use as such, whether intact or in broken form;
- o) water.

modification or **modifying** – see definition of "construction".

natural flow means the flow of water through waters caused by nature.

nature includes:

- a) ecosystems and their constituent parts; and
- b) all natural and physical resources; and

c) natural dynamic processes.

noxious means harmful or injurious to health or physical well being.

offensive means causing reasonable offence or displeasure; is disagreeable to the sense; disgusting, nauseous or repulsive, other than trivial harm.

operational land means the land associated with the project for which this environmental authority has been issued.

operational plan includes:
(a) normal operating procedures and rules (including clear documentation and definition of process inputs in the DSA allowance);
(b) contingency and emergency action plans including operating procedures designed to avoid and/or minimise environmental impacts including threats to human life resulting from any overtopping or loss of structural integrity of the regulated structure.

protected area means -

a) a protected area under the *Nature Conservation Act 1992*; or
b) a marine park under the *Marine Parks Act 1992*; or
c) a World Heritage Area.

progressive rehabilitation means rehabilitation (defined below) undertaken progressively or a staged approach to rehabilitation as mining operations are ongoing.

process water means water used or produced during the mineral development activities.

receiving environment means all groundwater, surface water, land, and sediments that are not disturbed areas authorised by this environmental authority.

receiving waters means all groundwater and surface water that are not disturbed areas authorised by this environmental authority.

reference site (or analogue site) may reflect the original location, adjacent area or another area where rehabilitation success has been completed for a similar biodiversity. Details of the reference site may be as photographs, computer generated images and vegetation models etc.

Register of Regulated Dams includes:
(a) Date of entry in the register;
(b) Name of the dam, its purpose and intended/actual contents;
(c) The consequence category of the dam as assessed using the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635);
(d) Dates, names, and reference for the design plan plus dates, names, and reference numbers of all document(s) lodged as part of a design plan for the dam;
(e) Name and qualifications of the suitably qualified and experienced person who certified the design plan and 'as constructed' drawings;
(f) For the regulated dam, other than in relation to any levees –
    i. The dimensions (metres) and surface area (hectares) of the dam measured at the footprint of the dam;
    ii. Coordinates (latitude and longitude in GDA94) within five metres at any point from the outside of the dam including its storage area
    iii. Dam crest volume (megalitres);
    iv. Spillway crest level (metres AHD).
    v. Maximum operating level (metres AHD);
    vi. Storage rating table of stored volume versus level (metres AHD);
    vii. Design storage allowance (megalitres) and associated level of the dam (metres AHD);
    viii. Mandatory reporting level (metres AHD);
(g) The design plan title and reference relevant to the dam;
(h) The date construction was certified as compliant with the design plan;
(i) The name and details of the suitably qualified and experienced person who certified that the constructed dam was compliant with the design plan;
(j) Details of the composition and construction of any liner;
(k) The system for the detection of any leakage through the floor and sides of the dam;
(l) Dates when the regulated dam underwent an annual inspection for structural and operational adequacy, and to ascertain the available storage volume for 1 November of any year;
(m) Dates when recommendations and actions arising from the annual inspection were provided to the administering authority;
(n) Dam water quality as obtained from any monitoring required under this authority as at 1 November of each year.

Regulated dam means any dam in the significant or high consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)* published by the administering authority.

regulated waste means non-domestic waste mentioned in schedule 7 of the *Environmental Protection Regulation 1998* (whether or not it has been treated or immobilised), and includes –

a) for an element – any chemical compound containing the element; and
b) anything that has contained the waste.

regulated structure includes land-based containment structures, levees, bunds and voids, but not a tank or container designed and constructed to an Australian Standard that deals with strength and structural integrity.

rehabilitation is the process of reshaping and revegetating land to restore it to a stable landform and in accordance with the acceptance criteria set out in this environmental authority and, where relevant, includes remediation of contaminated land.

representative means a sample set which covers the variance in monitoring or other data either due to natural changes or operational phases of the mining activities.

residual void means an open pit resulting from the removal of ore and/or waste rock which will remain following the cessation of all mining activities and completion of rehabilitation processes.

saline drainage is the movement of waters, contaminated with salt(s), as a result of the mining activity.

self sustaining means an area of land which has been rehabilitated and has maintained the required acceptance criteria without human intervention for a period nominated by the administering authority.

sensitive place means:

a) a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or
b) a motel, hotel or hostel; or
c) an educational institution; or
d) a medical centre or hospital; or
e) a protected area under the *Nature Conservation Act 1992*, the *Marine Parks Act 1992* or a World Heritage Area; or
f) a public park or gardens.

sewage means the used water of persons to be treated at a sewage treatment plant.

spillway means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges from the dam, normally under flood conditions or in anticipation of flood conditions.

stable in relation to land, means land form dimensions are or will be stable within tolerable limits now and in the foreseeable future. Stability includes consideration of geotechnical stability, settlement and consolidation allowances, bearing capacity (trafficability), erosion resistance and geochemical stability with respect to seepage, leachate and related contaminant generation.

storm water means all surface water runoff from rainfall.

structure means dam or levee.

suitably qualified and experienced person in relation to regulated structures means a person who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Engineers Act 2002* , and has demonstrated competency and relevant experience:

- for regulated dams, an RPEQ who is a civil engineer with the required qualifications in dam safety and dam design;
- for regulated levees, an RPEQ who is a civil engineer with the required qualifications in the design of flood protection embankments.

Note: It is permissible that a suitably qualified and experienced person obtain subsidiary certification from an RPEQ who has demonstrated competence and relevant experience in either geomechanics, hydraulic design or engineering hydrology.

system design plan means a plan that manages an integrated containment system that shares the required DSA and/or ESS volume across the integrated containment system.

trackable waste means a waste or combination of waste stated in Schedule 1 of the *Environmental Protection (Waste Management) Regulation 2000.*

trivial harm means environmental harm which is not material or serious environmental harm and will not cause actual or potential loss or damage to property of an amount of, or amounts totalling more than $5,000.

tolerable limits means a range of parameters regarded as being sufficient to meet the objective of protecting relevant environmental values. For example, a range of settlement for a tailings capping, rather than a single value, could still meet the objective of draining the cap quickly, preventing pondage and limiting infiltration and percolation.

void means any constructed, open excavation in the ground.

waste as defined in section 13 of the *Environmental Protection Act 1994*.

waste and resource management hierarchy has the meaning given by the *Waste Reduction and Recycling Act 2011*.

waste and resource management principles has the meaning given by the *Waste Reduction and Recycling Act 2011*.

waste water means used water from the activity, process water or contaminated storm water.

water means –

a) water in waters or spring;
b) underground water;
c) overland flow water; or
d) water that has been collected in a dam.

water quality means the chemical, physical and biological condition of water.

water year means the 12-month period from 1 July to 30 June.

watercourse has the meaning in Schedule 4 of the *Environmental Protection Act 1994* and means a river, creek or stream in which water flows permanently or intermittently—
(a) in a natural channel, whether artificially improved or not; or
(b) in an artificial channel that has changed the course of the watercourse.

Watercourse includes the bed and banks and any other element of a river, creek or stream confining or containing water.

waters includes all or any part of a river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water in natural or artificial watercourses, bed and banks of a watercourse, dams, non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and groundwater.

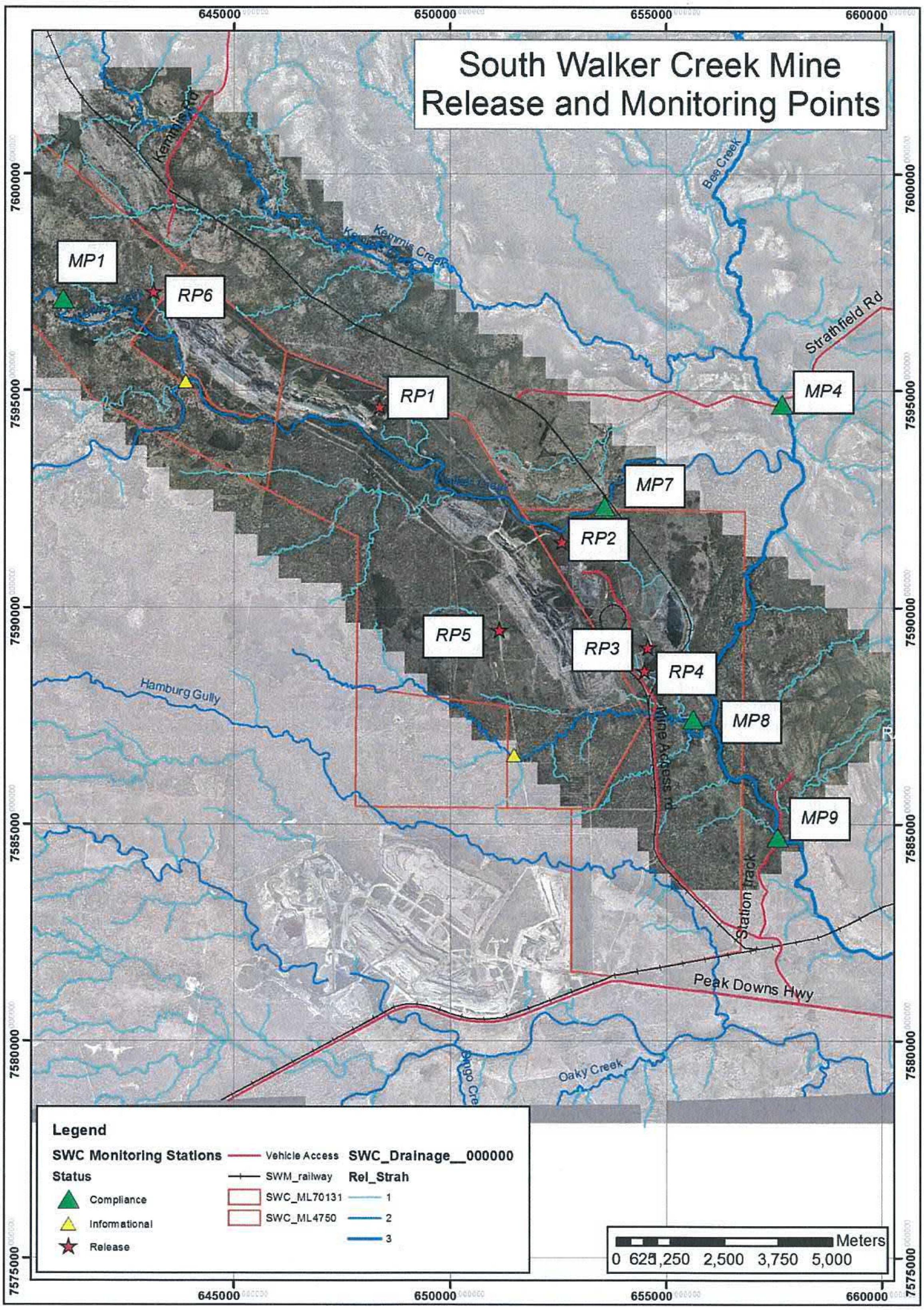
wet season means the time of year, covering one or more months, when most of the average annual rainfall in a region occurs. For the purposes of DSA determination this time of year is deemed to extend from 1 November in one year to 31 May in the following year inclusive.

µg/L means micrograms per litre.

µS/cm^{-1} means microsiemens per centimetre.

END OF DEFINITIONS

Figure 1 – South Walker Creek Mine Monitoring and Release Points



END OF PERMIT

Attachment B
Cross reference table addressing "Appendix A: Additional information for assessment by preliminary documentation"

Table 7. Cross references for additional information required for assessment by preliminary documentation – relevant to surface water impacts

Additional information required	Section number
1: Impact assessment	
Groundwater/surface water interactions	
Detailed descriptions of what structures are likely to remain post operation. Details on the infrastructure, long term stability, and potential interactions with surface and groundwater from the dams and final void are required.	9 (this report) and Golders Associates (2018)
Undertake and provide details of assessment of long term water levels and quality within voids - using a combination of water balances, surface water models, water quality models, groundwater models and long-term climate variability models.	9
Provide an estimate of ongoing annual water loss from voids (due to evaporation) and describe and proposed offset measures associated with this perpetual take.	9 & 10.4
Discuss the management of final voids post-mining.	9 (this report) and Golders Associates (2018)
Surface water	
Details and results of studies of the predicted groundwater and surface water interactions that are likely to result from the creek diversion.	Golders Associates (2018)
Information and monitoring results of previous stream diversions that may provide details of the effectiveness of the proposed diversion or potential impacts.	10.1
Details of the diversion design and how it adheres to the Queensland Guidelines on watercourse diversions.	10.2
Details on the baseline data and modelling to appropriately identify, quantify and therefore manage likely impacts to surface and groundwater resources.	8.3
Discussion of cumulative impacts to surface waters including Bee Creek and Walker Creek.	9.4
An assessment of the likely impacts of mine affected water on surface water as a result of proposed treated water management measures.	9.3
An assessment of the likely impacts of the proposed action on groundwater dependent species and ecosystems within the project site, including from groundwater drawdown and the creek diversion.	Groundwater report
Detailed mapping of the known and potential suitable habitat for Black Ironbox *(Eucalyptus raveretiana)* within and downstream of the project site to determine possible impacts from the proposed action, including removal of the alluvial aquifer, changes to the availability of groundwater and impacts associated with the final void.	Eco Logical Australia (2018)
Details of the mitigation and monitoring measures that will be implemented to ensure that the impacts of the proposed action on species and ecosystems are appropriately managed.	Eco Logical Australia (2018)
Mitigation measures	
Details of thresholds or triggers for the implementation of management responses	Section 8 &

	Attachment F
An assessment of the expected or predicted effectiveness of the mitigation measures.	Section 8 & Attachment F
Details of the mitigation and monitoring measures that will be implemented to ensure that impacts from mine affected water on receiving waters are appropriately managed.	Section 8 & Attachment F
Referral to the IESC	
IESC INFORMATION GUIDELINES (IESC, 2015) have been considered when compiling this report and responses developed as appropriate.	This report
2: Avoidance, safeguards and mitigation measures	
Details of any monitoring programs that will be undertaken in relation to surface water and groundwater quality and quantity.	Attachment F
Details of any monitoring programs that will be undertaken in relation to erosion and/or sedimentation of watercourses.	11.3 & Attachment E
The name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.	11.4
Details of the mitigation measures that will be implemented to minimise impact to the controlling provisions during mining activities.	10.

Attachment C

Alluvium (2016). Mulgrave Resource Access Walker Creek Diversion – Stage 2C. Functional Design Report by Alluvium Consulting Australia for BHP Billiton Mitsui Coal Pty Ltd.)

FUNCTIONAL DESIGN REPORT:

Mulgrave Resource Access Walker Creek Diversion – Stage 2C

May 2016

Document history

Revision:

Revision no.	3.0
Author/s	Luke Sunner Rohan Lucas
Checked	Jason Carter
Approved	Rohan Lucas (RPEQ)
Revision no.	4.0
Author/s	Luke Sunner
Checked	Luke Sunner
Approved	Luke Sunner

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Ref:
T:\Projects\2016\P216009_MRA_stage_2c_functional_design\1_Deliverables\P216009_R01_v4.0_MRA2C_Functional_Design_Report.docx

Summary

BHPB Coal Projects (BHPBCP) are undertaking a selection phase study for proposed diversion of Walker Creek at the South Walker Creek Mine (SWCM) site as part of the Mulgrave Resource Access (MRA) Project. The Mulgrave pit will soon be constrained by the Walker and Carborough Creek systems and therefore diversion is required.

There are two existing diversions of Walker Creek at SWCM: Walker Creek Mulgrave Pit diversion; and Walker Creek Walker Pit diversion. Coal reserves made accessible by the Mulgrave Pit diversion will soon be consumed and hence further diversion is required. This is being undertaken in stages:

- 2A, which has received regulatory approval, and
- 2C, which is being brought forward in the SWCM mine plan.

At the time of preparing this report, stage 2A was in the final stages of construction, with the upstream diversion plug being removed, and once complete will supersede the existing Walker Creek Mulgrave Pit diversion and hence forms the existing conditions (or base case) considered for Stage 2C. Stage 2C is now planned to follow on from Stage 2A and is the subject of this report. A functional level design of the preferred conceptual alignment option for Stage 2C has been undertaken to:

- demonstrate the technical feasibility of diverting the watercourse
- provide for regulatory approvals application
- provide earthworks quantity estimates for development of capital cost estimates by BHPBCP.

The proposed diversion has been developed in consultation with BHPBCP and has been designed to be a permanently functioning and sustainable diversion that meets regulatory requirements, utilises the latest research undertaken into diversion design in Queensland, limits impacts to adjoining waterways, ensures no adverse environmental impacts beyond the life of mine and is likely to achieve stakeholder acceptance of the landforms. A summary of proposed channel geometry is provided in Table S1-1 and levee geometry in Table S1-2.

Table S1-1. Summary of proposed channel geometry

Diversion Geometry item	Stage 2C
Channel length (m)	8010
Average channel grade (m/m)	0.00152
Bed width (m)	35
Maximum top width (m)	195
Maximum depth of cut (m)	13
Cut volume (m^3)	5,043,610

Table S1-2. Summary of proposed levee geometry

Diversion Geometry item	Levee 1	Levee 2	Levee 3
Length (m)	3,000	3,112	1,395
Crest width (m)	5	5	5
Batter slopes (m:m)	1v:4h	1v:4h	1v:4h
Maximum height (m)	11	8	7.4
Fill volume (m^3) (above surface)	110,224	183,755	55,636

alluvium

Form of certification (functional design)

Name of Registered Professional Engineer providing certification:
Rohan Lucas (RPEQ number 8111)

Address of Registered Professional Engineer providing certification:
Level 1, 412 Flinders Street
PO BOX 1581
Townsville
QLD 4810

Statement of relevant experience:
I hereby state that I am a Registered Professional Engineer of Queensland and meet the requirements of the definition of 'suitably qualified and experienced person' as defined in the guideline for *Works that interfere with water in a watercourse – watercourse diversions* published by the administering authority.

Statement of certification
All relevant material relied upon by me, where required by the environmental authority, is provided in the attached functional design report, '*Mulgrave Resource Access Walker Creek Diversion – Stage 2*' dated May 2016.

I hereby certify the functional design, '*Mulgrave Resource Access Walker Creek Diversion – Stage 2*' dated May 2016, as follows:

- The design has been prepared in accordance with current leading practice for watercourse diversion design, including the findings of ACARP C20017.
- The design has been prepared such that the watercourse should function in alignment with general environmental authority principles of safe, stable and non-polluting
- The revegetation plan design has a subsidiary certification. The vegetation outcomes required for compliance with the guideline are reliant on the design and execution of an appropriate current leading practice revegetation program that may be staged over many years during operation of the diversion.

I, Rohan Lucas, declare that the information provided as part of this certification is true to the best of my knowledge. I acknowledge that it is an offence under section 480 of the *Environmental Protection Act 1994* to give the administering authority a document containing information that I know is false, misleading or incomplete in a material particular.

Signed:

Rohan Lucas (RPEQ number 8111)

Date: 22 July 2016

Contents

Figures

Tables

Abbreviations

Alluvium	Alluvium Consulting Australia Pty Ltd
AEP	Annual Exceedance Probability. The probability that a given rainfall total accumulated or peak flow rate for a given duration will be exceeded in any one year. See Table A-1-3 for conversion to ARI.
AHD	Australian Height Datum
ARI	Average Recurrence Interval. The average, or expected, value of the periods between exceedances of a given rainfall total accumulated or peak flow rate for a given duration. See below for conversion to AEP.
MRA	Mulgrave Resource Access
PMF	Probably maximum flood
Stage 2A	MRA Walker Creek Diversion Stage 2A
Stage 2C	MRA Walker Creek Diversion Stage 2C
SWCM	South Walker Creek Mine

Glossary

TUFLOW	1D/2D Hydrodynamic modelling software package
XPSWMM	1D/2D Hydrodynamic modelling software package

In accordance with the Bureau of Meteorology guidance, the Annual Exceedance Probability (AEP) has been used in this report in preference to Average Recurrence Interval (ARI) wherever possible. However, as ARI is used throughout the ACARP criteria for assessing hydraulic parameters of channels, it is necessary to use ARI for this component of work.

As shown in Table A-1-3, ARIs of greater than 10 years are very closely approximated by the reciprocal of the AEP. However, for higher probability events (eg. The 2 year ARI) the corresponding AEP is an awkward percentage.

To try to reduce confusion, the following approach has been adopted when using ARI and AEP:

- ARI has been used for the smaller (higher probability) storm and flood events up to the 50 year, which are considered in the hydraulic assessment of stream parameters.
- For higher magnitude (lower probability) events the AEP has been adopted for the discussion of flood risk.

Table A-1-3. ARI to AEP conversion table

ARI (years)	AEP	AEP expressed as percentage (%)
2	0.393	39
5	0.181	18
10	0.095	10
20	0.049	5
50	0.020	2
100	0.010	**1**
200	0.005	**0.5**
500	0.002	**0.2**
1000	0.001	**0.1**
2000	0.0005	**0.05**

1 Introduction

South Walker Creek Mine (SWCM) is an open cut coal mining operation owned by BHP Billiton Mitsui Coal (BMC). It is located approximately 35km west of the Nebo Township in the Bowen Basin, approximately 125km south-west of Mackay in Central Queensland.

There are two existing diversions at SWCM: Walker Creek Mulgrave Pit diversion; and Walker Creek Walker Pit diversion (or 'old diversion) (see Figure 1-2). The Walker Creek Mulgrave Pit diversion was the first to be constructed at SWCM in the mid 1990's and was required to enable development of Walker Pit. The Walker Creek Mulgrave Pit diversion was the second diversion of Walker Creek, which was constructed in 2006 as a temporary diversion to enable expansion of Mulgrave Pit. This diversion at the time of design was considered to be a temporary short term option, due to be superseded by a further diversion upstream and to the west (nearly completed).

To enable further access to the Mulgrave Pit resource, BHPB Coal Projects conducted a study on creek diversion options and identified that further diversion of Walker Creek adds significant value to the SWCM operation. Two creek diversions are proposed and are being undertaken in two stages known as Stage 2A and Stage 2C. Historically, these have been termed:

- Mulgrave Resource Access (MRA) Walker Creek Diversion Stage 2A
- Mulgrave Resource Access (MRA) Walker Creek Diversion Stage 2C

From heron they will be referred to as Stage 2A and Stage 2C in this report.

Stage 2A is currently in the final stages of construction and once complete will replace the temporary Mulgrave Pit diversion. The inclusion of the completed Stage 2A forms the base case (existing conditions) for this assessment of Stage 2C.

BHPBCP have commissioned Alluvium Consulting Australia Pty Ltd (Alluvium) to develop the preferred conceptual option for Stage 2C to a functional design level enabling generation of a capital cost estimate and application for regulatory approvals. The proposed alignment commences at the confluence of Stage 2A and Carborough Creek, diverting flows to the south-east through hillslope and connecting back in to Walker Creek.

1.1 MRA development overview

The MRA development at SWCM involves a progression of existing open cut mining operations of the Mulgrave Resource in a general south-westerly direction over an estimated 50 year time period, with the planned pit progression intercepting Walker Creek. Alternative mining methodologies/approaches were considered to avoid a diversion, but these options were considered less favourable and offered no overall improvement in reducing environmental impact. The option of leaving Walker Creek in situ and mining either side was a higher risk of failure over the long term with a greater risk of environmental harm than a diversion. Hence the identification of the Stage 2C diversion as the preferred approach.

1.2 Functional design objectives

The objectives for this functional design are to develop a diversion for Stage 2C through the SWCM lease that:

- is sustainable in the long term (safe, stable and non-polluting)
- is wholly contained on lease
- is acceptable to the relevant regulatory authorities
- where possible and economically viable, avoids areas of both environmental and cultural heritage significance
- can be safely constructed where possible with conventional earthmoving equipment

- does not pose a mine closure liability.

The functional design provides estimates of quantities and costs involved and will aid in any regulatory approvals process that may be required and allow for engagement with any affected stakeholders.

1.3 Scope of works

The scope of works for this project is to undertake functional level diversion design of the preferred Stage 2C alignment option at SWCM. Functional design includes a number of tasks:

1. Program logic, review and risk analysis
2. Review of previous design and hydrological analysis for site
3. Undertake hydraulic and sediment transport assessment for existing conditions
4. Functional design of diversion channel for Stage 2C
5. Functional design of associated arrangements including flood protection levees and overland flow measures
6. Undertake hydraulic and sediment transport assessment for design conditions
7. Undertake 2D hydrodynamic flood modelling of existing and functional design arrangements
8. Development of diversion revegetation plan (provided in a separate report)
9. Design diversion operational monitoring program (provided in a separate report)

1.4 Data management and design limitations

Data for this functional design project was supplied by BHPB Coal Projects staff. A summary of data used to undertake the project is provided in Table 1-1.

Accuracy of design assessments, modelling and quantity estimates are limited to the accuracy and level of detail provided by the survey data used. Overland flow design considerations are quite sensitive to data detail and accuracy. The data used is considered appropriate for functional level assessments however new data will be required for detailed design.

Table 1-1. Data supplied and used for the SWCM MRA Stage 2C diversion project

Data	Provider	Details
Aerial imagery	BHPB Coal Projects	Format: ECW. Filename: South_Walker_50cm_Ortho_20160326.ecw
Aerial LiDAR survey data	BHPB Coal Projects	Filename: C_D_Pit_LiDAR_20160326_SWC84z55.xyz Kemmis_Pit_LiDAR_20160326_SWC84z55.xyz Mulgrave_Pit_East_LiDAR_20160326_SWC84z55.xyz Mulgrave_Pit_Extension_LiDAR_20160326_SWC84z55.xyz Mulgrave_Pit_LiDAR_20160326_SWC84z55.xyz A number of data sets previously supplied by SWCM were also used to create a DTM of the project area.
Mining lease	SWCM	ML used for previous projects since 2013.
Proposed pit and spoil dump outlines	BHPB Coal Projects	Digital boundaries for possible open cut mining and spoil dumps in .dxf format.

Data	Provider	Details
Tertiary/Permian boundary	SWCM	Boundary model supplied for the feasibility study.
Geological data	BHPB Coal Projects	A data base of geological drilling records in the project area in .xls format.
NASA Shuttle Radar Topography Mission (SRTM) 1 arcsec data	Geosciences Australia	This 30m cell size grid data Digital Elevation Model (DEM) was used for hydrological modelling.

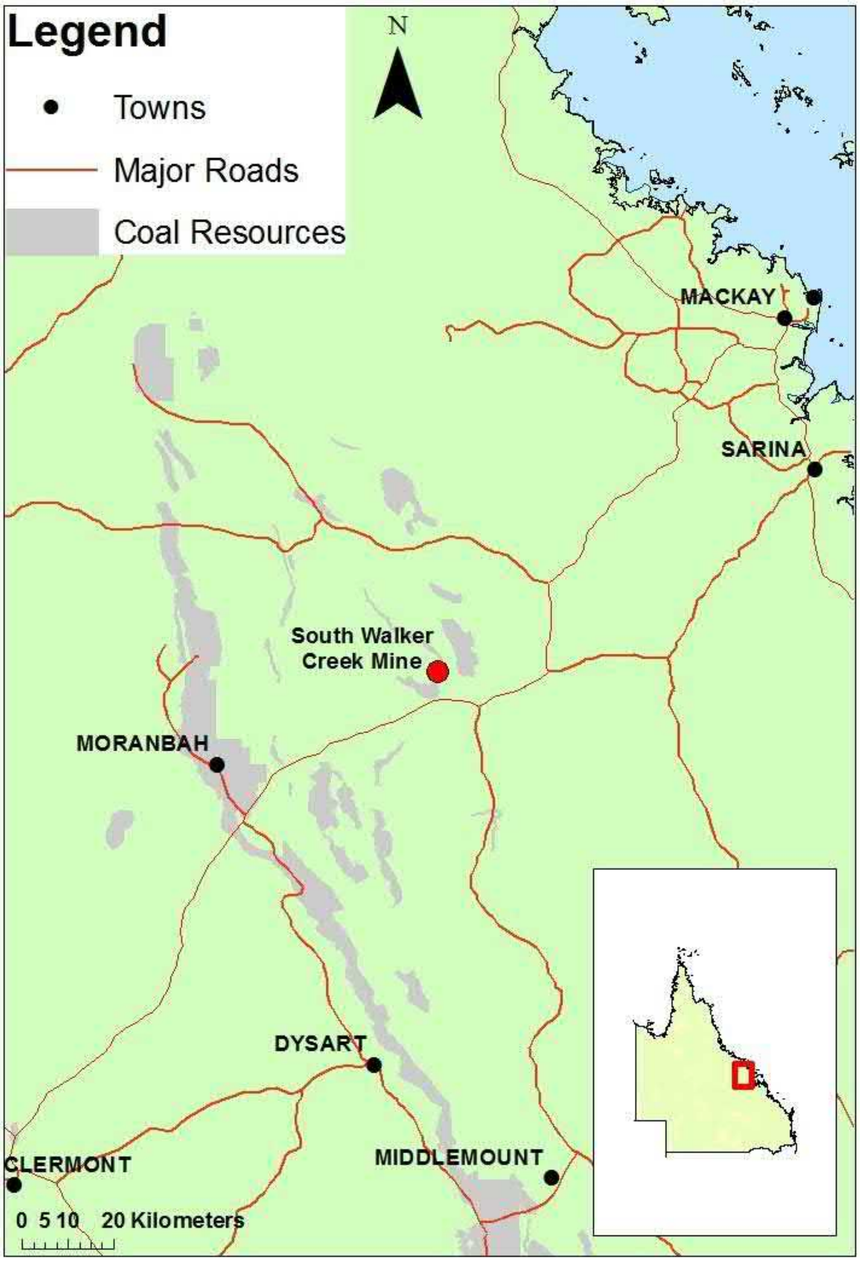


Figure 1-1. South Walker Creek Mine location map

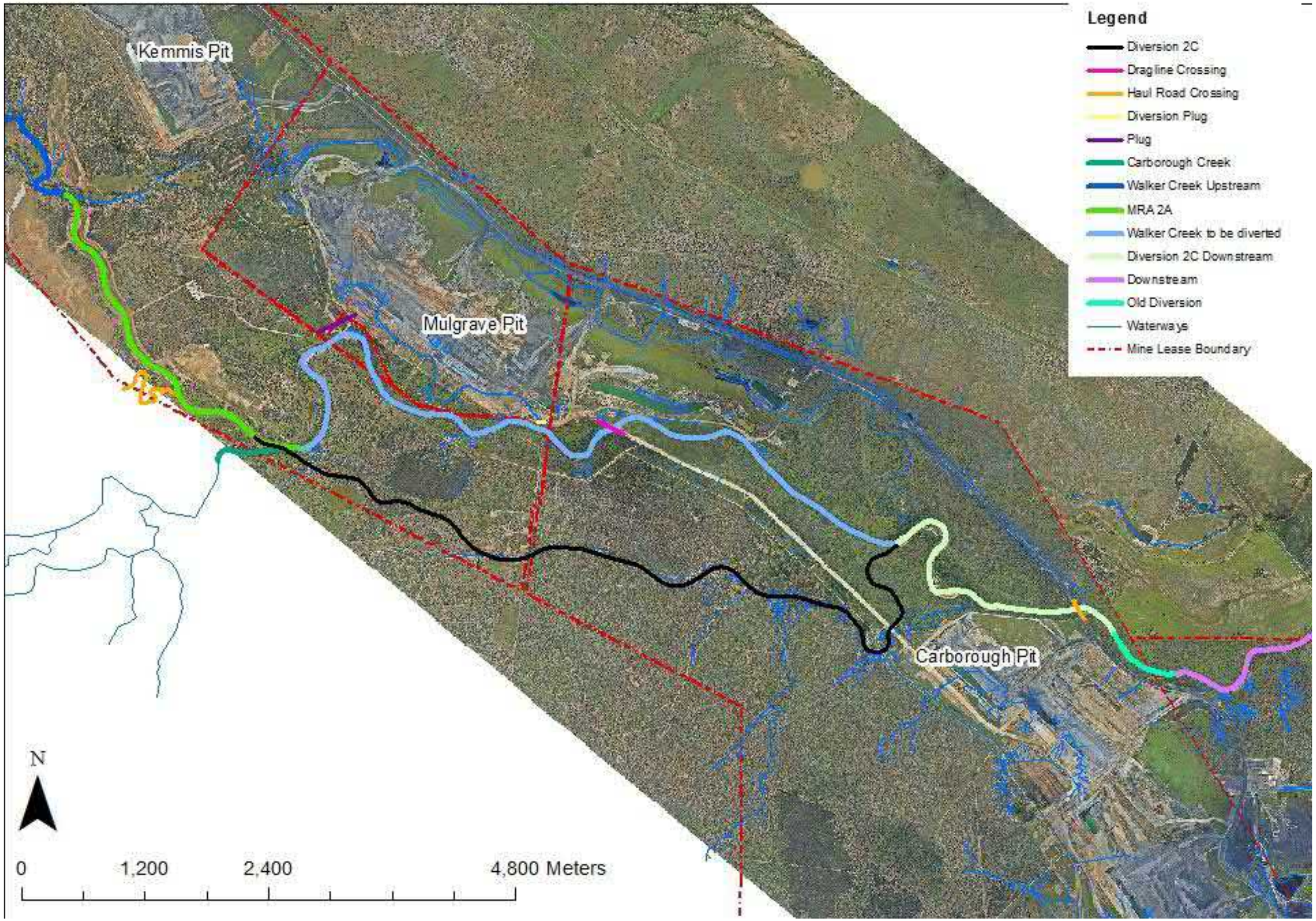


Figure 1-2. Overview of site watercourses and proposed infrastructure

2 Regulatory and legislative requirements

This section provides a brief summary of the potential approvals requirements associated with the proposed MRA Walker Creek Diversion Stage 2C. Alluvium is aware SWCM will be seeking approvals through the following legislation::

- watercourse diversions regulated through the *Water Act 2000* and the *Sustainable Planning Act 2009 (SPA)*
- levees regulated through the *Environmental Protection Act 1994.*

A description of the regulatory requirements for diversions and levees is included below in section 2.1 and 2.2 respectively.

Separate to the requirements for watercourse diversions and levees, there may be other regulatory approvals SWCM needs to obtain.

2.1 Watercourse diversions

SWCM hold a water licence for the MRA Walker Creek Diversion Stage 2A (currently under construction) and will be seeking to amend the water licence to include the proposed Stage 2C diversion. An alternative approval process through the Environmental Protection Act is also available but will not be used for this diversion.

Regardless of whether approvals are sought through the EA or Water Licence process, the diversion design is to be prepared in accordance with *Guideline: Works that interfere with water in a watercourse – watercourse diversions*, DNRM (2014), which states the following key objectives:

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

The design and construction of diversions are to be developed to incorporate the following outcome requirements in reference to DNRM (2014):

- **Outcome 1:** The permanent watercourse diversion incorporates natural features (including geomorphic and vegetation) present in the landscape and in local watercourses.
- **Outcome 2:** The permanent watercourse diversion maintains the existing hydrologic characteristics of surface water and groundwater systems.
- **Outcome 3:** The hydraulic characteristics of the permanent watercourse diversion are comparable with other local watercourses and are suitable for the region in which the watercourse diversion is located.
- **Outcome 4:** The permanent watercourse diversion maintains sediment transport and water quality regimes that allow the watercourse diversion to be self-sustaining, while minimising any impacts to upstream and downstream reaches.
- **Outcome 5:** The permanent watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.

These outcome requirements reflect the content of conditions for inclusion in the Water Licence , relevant to watercourse diversions, for the design, construction, operation and maintenance of the diversion prior to surrender of the Water Licence.

For functional design, DNRM (2014) states that the design is to provide sufficient detail to demonstrate that the final design will meet the stated outcomes above. The functional design documentation is to conceptually show how the outcomes will be achieved, by inclusion of the following:

- geomorphic and vegetation assessment of the existing watercourse
- hydrologic conditions of the existing watercourse
- the proposed watercourse diversion route
- details of any temporary diversions that may be required as part of a staged process towards the final permanent watercourse diversion.
- hydraulic conditions of the existing watercourse and proposed watercourse diversion
- details of the substrate on which the watercourse diversion will be constructed
- a statement of how the watercourse diversion meets the outcomes.

Certification of the diversion design is to be made by a suitably qualified and experienced person (SQEP). The certifier is also required to be a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Engineers Act 2002*, with appropriate qualifications and levels of expertise.

2.2 Levees

This section provides a brief summary of the legislative requirements for levees associated with the proposed diversions.

Levees that are constructed as part of environmentally relevant activities pursuant to the *Environmental Protection Act 1994* require authorisation from the administering authority prior to operation of the structure.

At the design stage a consequence category assessment must be conducted to determine if the structure is a 'regulated structure' for the purpose of the administering authority. This consequence category assessment must be undertaken by a 'suitably qualified and experienced person' (SQEP) in conjunction with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DEHP, 2013). Regulated structures require certified design plans to be submitted to the administering authority and are subject to annual inspection and reporting by a SQEP.

It should be noted that where the levee is intended to protect mining operations from ingress of flood waters originating from a waterway declared to be a *watercourse* according to the definitions of the *Water Act 2000* and *Water Regulation 2002,* and as determined by an officer of the Queensland Government, the levee is to be classified as a regulated structure.

A certified design plan for a regulated structure must address the following:

- the consequence scenario that has been used in undertaking consequence assessment
- the hydrology and hydraulics used to estimate and deal with flood events, internal and external to the regulated structure, at probabilities appropriate to address identified consequence scenarios
- seepage and stability issues
- any assumptions relating to the design and safety of the regulated structure.

A levee that is a regulated structure must provide the following minimum requirements:

- flood ingress protection to a flood level of a 1:1000 AEP
- in at least one place in the levee crest, there must be a restricted length of lower crest, limiting the freeboard at that point, such that a flood exceeding the design protection level of the levee will be directed to a planned area or areas within the zone to be protected.

Commissioning of a new levee into operation (i.e. construction) cannot occur until the consequence category and design plan are certified, and in some cases an EA amendment has been submitted to DEHP. However, for SWCM amendment of the EA will not be required. SWCM will simply need to update the site register of regulated structures.

2.3 Regional planning interest act and regulation 2014

This legislation does not apply to SWCM because according to the DA Mapping System on the Department of Infrastructure, Planning and Local Governments website, SWCM is not located within any designated areas of regional interest under this legislation.

2.4 Federal requirements

The project will also require assessment for Matters of National Environmental Significance (MNES) under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and if required refer the matter to the Australian Government Department of the Environment for approval.

3 Waterway diversion design practice

This section provides an outline of watercourse diversion design practice in the state of Queensland, providing brief historical comments, details of the current criteria adopted by the Queensland Government and provides findings of the latest research. The latest research presented here has been applied to the proposed MRA Walker Creek Diversion Stage 2C.

3.1 Alluvium's waterway diversion design principles

When undertaking designs for new or rehabilitation of old diversions it is our aim to demonstrate current leading practice for design, construction, rehabilitation and management of waterway diversions. This is achieved, wherever practical, by adhering to a number of fundamental principles:

- inclusion of natural locally and/or regionally occurring geomorphic and habitat features
- creation of a stream where the diversion and adjoining reaches establish a state of dynamic equilibrium
- creation of a diversion that operates as part of a self-sustaining stream system and promotes nutrient processing, ecological connectivity and facilitates sediment storage and transport
- whenever practical, avoid the use of artificial grade control structures or other structures that are likely to require maintenance beyond life of mine.

Alluvium understands that use of these principles will create a stable stream requiring minimal management in the short and medium term, with no on-going management in the extended term beyond mining operations. Diversions adhering to these principles will also, over time, replace the geomorphic and ecological features lost from the original creek as a result of mining activity.

3.2 Current design hydraulic criteria adopted by the Queensland Government for waterway diversions

The Australian Coal Association Research Program (ACARP) has funded a series of projects (initially projects C8030 and C9068) related to river diversions. This research was undertaken in the Bowen Basin in Central Queensland and culminated in a set of design and rehabilitation criteria that has since been adopted by the Queensland Government. The key hydraulic parameters for which values were derived in this study are:

Stream Power

Stream power is a product of channel slope and discharge that represents the excess energy available to do work in and on the channel. Equilibrium and/or recovery usually involve a balance of deposition and erosion. If the flow is too powerful then the channel would typically erode. Alternatively, if the stream power is too low, aggradation will occur.

Stream Power (ω) $= \dfrac{\rho g Q S}{W}$

ρ = density of water (kg/m^3)

g = gravitational acceleration constant (m^2/s)

Q = discharge (m^3/s)

S = hydraulic gradient (m/m)

W = water surface top width (m)

Stream Velocity

Velocity is the speed at which water flows through the stream. It is a product of discharge and cross-sectional area.

$$\text{Velocity (v)} = \frac{Q}{A}$$

Q = discharge (m^3/s)

A = cross sectional area (m^2)

Shear Stress
Shear stress, otherwise known as tractive force, is described as the force exerted on the channel bed and banks by the action of flowing water. It is also a function of channel slope and discharge.

$$\text{Shear Stress } (\tau) = (\rho g d s)$$

ρ = density of water (kg/m^3)

g = gravitational acceleration constant (m^2/s)

d = depth of water (m)

s = water surface slope (m/m)

The diversion design hydraulic criteria currently adopted by the Queensland Government are shown in Table 3-1. They represent the upper limits (average over a reach) within which natural stable streams of the Bowen Basin operate.

Table 3-1. Watercourse diversion hydraulic criteria currently adopted by the Queensland Government (DNRM, 2014)

Parameter	Units	ARI	ACARP criteria for Bowen Basin diversions (reach average)
Shear Stress	N/m2	2 year	<40
		50 year	<80
Stream Power	N/m.s	2 year	No vegetation <35 with vegetation <60
		50 year	<150*
Velocity	m/s	2 year	No vegetation <1.0 with vegetation <1.5
		50 year	<2.5

3.3 Current research for watercourse diversion design guidelines

There are two recently completely ACARP projects undertaken by Alluvium that update and extend guidance in relation to waterway diversion design, performance evaluation and relinquishment management:

- *Criteria for functioning river landscape units in mining and post mining landscapes* (project C20017) (Alluvium 2014)
- *Collaborative performance trajectories for diversion approvals relinquishment* (project C23030) (Alluvium 2015)

One of the outcomes of project C20017 is an updated approach to diversion design and development of design parameters for alluvial and threshold channel design. Note these design parameters represent current leading practice and have not yet been incorporated into any government guidelines or legislation.

In addition to the existing design guidelines adopted by the Queensland Government (see Section 3.2), Alluvium has applied outcomes from the current research to functional level design of the MRA Walker Creek Diversion Stage 2C. This will increase the likelihood of positive outcomes from this project for BHPBCP at SWCM.

Alluvial channel design parameters: Alluvial channel design parameters based on systems with high and low sediment supply are presented in Table 3-2. A key update in these design numbers is the explicit differentiation between systems with high bedload sediment supply (transport limited) and those that have low bedload but still may have high suspended load (supply limited). Based on geomorphic assessment of the two waterways, Walker Creek and Carborough Creek fall into the transport limited category presented in Table 3-2.

Table 3-2. Alluvial channel design parameters

Stream type	Sediment transport group	Stream power (W/m^2)	
		2 year ARI	50 year ARI
Alluvial	Supply limited	15 – 35	50 – 100
	Transport limited	35 – 60	80 – 150
Bedrock controlled	n/a	50 – 100	100 – 350

In addition, the research specifies the following for stream power:

- cross sections within a constructed waterway are not to vary by greater than 50% of the mean reach stream power
- the 25th to 75th percentile range of stream power is to be within the range shown in Table 3-2. No stream power value shall be more than 30% greater than the maximum value shown in Table 3.2.

Shear stress thresholds for vegetation: shear stress thresholds for vegetation types and communities used in constructed watercourse diversions in Central Queensland are presented in Table 3-3.

Table 3-3. Design shear stress thresholds for constructed watercourses in the Bowen Basin, Queensland

Vegetation type	Design shear stress (N/m^2) for constructed waterways in Bowen Basin Qld
Buffel grass	40
Structurally diverse suite of established native vegetation	120

Design flood events for long term performance: Design flood events for long term stability against extreme floods (e.g. protection of levees from scour) are presented in Table 3-4.

Table 3-4. Threshold design events

Consequence of channel scour	Proposed design event	
	During mine life	Post mining
Scour that threatens mine infrastructure	To be determined by mine operator	NA
Scour that threatens public infrastructure	To be determined in consultation with relevant stakeholder (asset owner)	To be determined in consultation with relevant stakeholder (asset owner)
Scour that threatens capture of watercourse into open cut pit	1 in 1000	Probable Maximum Flood

4 Overview of Walker Creek existing conditions

4.1 Geomorphic character, behaviour and condition

Walker Creek upstream of 2A

The reach of Walker Creek upstream of 2A diversion is in moderate to poor condition (at the reach scale) applying the standard stream health metrics used for diversion monitoring at mine sites (this is different to the assignment of environmental values at the broad catchment scale). To date this reach is largely unaffected by mining activity, land use in the catchment is dominated by cattle grazing. The catchment is bounded to the west by sandstone escarpment that will naturally contribute elevated sand loads to the waterway. Land use activities have increased sediment contributions, resulting in the infilling of pools on resistant strata controlled bends as shown in Figure 4-1.

The channel is partly confined by low hill slopes in this reach with discontinuous floodplain pockets which have been cleared for grazing. In those floodplain pockets accelerated bank erosion is prevalent. Highly weathered bedrock outcrops in lower banks mean channel planform is reasonably fixed at the reach scale. The impacts on the stream in this reach are primarily associated with heavy grazing activity on inherently unstable soils.

	Straight section at impingement on bedrock (lower right). Excess sediment inputs from upstream agricultural land uses smother all bed forms.

	Substantial existing bank erosion in alluvial sections with very limited riparian vegetation under cattle grazing land use.
	Excess sediment from upstream agricultural land uses has infilled a pool on a bend that impinges on resistant terrace sediments

Figure 4-1. Walker Creek upstream of 2A diversion

Stage 2A diversion

Walker Creek Stage 2A diversion has not yet been commissioned, however 90% of the diversion reached practical completion prior to the 2015-16 wet season, allowing establishment of a cover crop to assist with initial batter stabilisation. Figure 4-2 provides an example of similar geometric form that will be adopted for Stage 2C.

Figure 4-2. Walker Creek 2A diversion

Carborough Creek upstream of the proposed 2C off take
The reach of Carborough Creek upstream of the proposed 2C diversion has similar character and behaviour to the upstream Walker Creek reach and the reaches to be diverted. The waterway is transport limited due to oversupply from natural conditions and upstream land use induced gully erosion. This sediment smothers nearly all bed forms and infills pools. Conditions are typified by the photos in Figure 4-3.

Riparian overstorey vegetation in the reach appears in good condition with near continuous coverage and the dominant riparian species present that are expected.

	Aggraded straight section with near continuous riparian overstorey coverage

	High angle bend at bedrock impingement that would inherently maintain a deep pool. The pools is infilled with the high sediment inputs from upstream.
	Gully and bank erosion of dispersive Tertiary terrace sediments

Figure 4-3. Carborough Creek upstream of 2C

Walker/Carborough Creek to be diverted

The extent of Walker and formerly Carborough Creek (upstream of the confluence prior to the existing diversion and 2A diversion) that will be abandoned by the diversion and which is on mine lease is in moderate to good condition. Excess sediment loads from upstream limit morphologic diversity through bed aggradation which is the main detractor from condition. Isolated meander migration processes are occurring where banks are alluvial, however at the reach scale the channel planform is controlled by bedrock. Several high angle bends are directly controlled by bedrock.

Ground cover vegetation is dense though predominantly exotic, riparian overstorey remains generally in good condition while mid storey is limited, likely a result of prior grazing and the density of exotic grasses.

	Good riparian vegetation, stable banks and sand bed infilled with excess inputs from upstream
	Good riparian vegetation, stable banks and sand bed infilled with excess inputs from upstream

Figure 4-4. Walker/Carborough Creek reach to be diverted

Walker Creek downstream of 2C

Downstream of the proposed 2C diversion tie-in to Walker Creek geomorphic and riparian condition is very similar to that in the reach that will be abandoned by the diversion. Several kilometres downstream of the proposed 2C tie-in is the Walker Pit diversion of Walker Creek constructed in the mid-1990's. This diversion is subject to ongoing adjustment due to its configuration with a positive trajectory following recent works in the creek.

	Good riparian vegetation, stable banks and sand bed infilled with excess inputs from upstream

Figure 4-5. Walker/Carborough Creek reach to be diverted

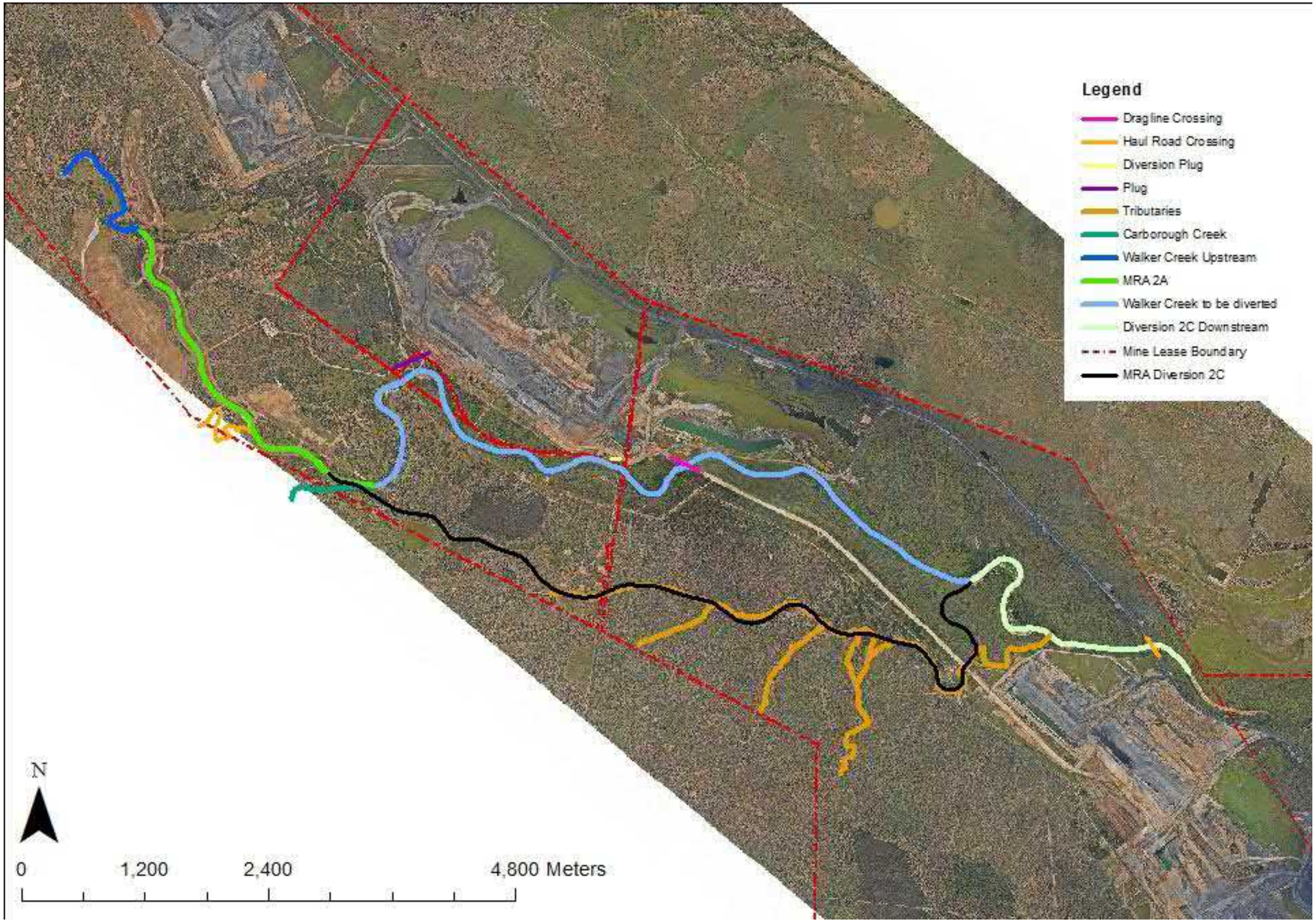


Figure 4-6. Walker and Carborough Creek reach breakdown

4.2 Catchment hydrology

Hydrological analysis for this site has been undertaken for previous studies conducted by Alluvium (2014 and 2015). A review of that analysis has been conducted and has resulted in slight modification of the previous hydrologic outputs to include additional output locations for this study. Details of the hydrological analyses are provided in Alluvium, 2014 and Alluvium, 2015.

Peak discharge estimates for 2 year and 50 year ARI events of the 2A diversion, Carborough Creek and the reach downstream of the confluence used in hydraulic modelling to assess existing conditions are presented in Table 4-1.

Table 4-1. Peak discharge estimates and catchment areas for Walker and Carborough Creeks used in hydraulic modelling

	Walker Creek upstream and Diversion 2A	Carborough Creek upstream	Confluence
Catchment area (km^2)	~130km^2	~160km^2	~300km^2
2 year ARI peak discharge (m^3/s)	100	121	217
50 year ARI peak discharge (m^3/s)	442	554	998

4.3 Existing conditions 1D hydraulic assessment

1D steady-state hydraulic modelling using HEC-RAS was undertaken to assess existing in-channel conditions in Walker and Carborough Creek. A single model was made starting approximately 1.5km downstream of the Walker Pit diversion, extending approximately 13.5 km upstream along Walker Creek to the confluence of Carborough Creek and MRA WCD S2A. The model also extends approximately 3.4 km through MRA WCD S2A and 1.5 km upstream along Walker Creek, and, approximately 0.8 km of Carborough Creek. The model consists of a series of cross-sections which extend across the channel and onto the floodplain. Although existing conditions hydraulics has been assessed previously, this project is using new survey of the site and this update of existing conditions is required to enable a meaningful pre and post diversion comparison.

Downstream boundary conditions were set as the existing bed grade immediately downstream of the model. Channel roughness, represented by Manning's n value, was set as 0.05 in the remnant channels for both streams, and 0.035 in the diversion channels. Peak flow rate estimates presented in Section 4.2 were used to evaluate flow conditions in comparison to ACARP diversion guidelines (Section 3).

Hydraulic conditions are summarised for the seven reaches of the study area. Results are presented in comparison to ACARP criteria to provide a means of comparing pre- and post-diversion conditions when evaluating diversion designs against design criteria.

It should be noted that the accuracy of hydraulic modelling is dependent on the accuracy of the DTM provided and the hydrologic estimates. The general relationship between channel shape and hydraulics should not be greatly affected by limited accuracy; however, the magnitude of hydraulic parameters may be significantly influenced. The data used is considered adequate for this assessment.

A summary of the geometric characteristics of the existing Walker Creek and Carborough Creek is detailed in Table 4-2.

Table 4-2. Estimate of channel variables for existing Walker and Carborough Creek

Reach	Average Channel Grade (m/m)	Channel length (m)	Approximate Bed Width (metres)
Carborough Creek	0.00203	900	20-30
Walker Creek upstream reach	0.00174	1533	15-20
Walker Creek Stage 2A diversion	0.00109	3756	10
Walker Creek reach to be replaced	0.00142	8160	20-30
Walker Creek downstream of Stage 2C	0.00191	3133	20-30

Results

Hydraulic conditions vary throughout the system with energy conditions broadly increasing in a downstream direction. Parameters are generally below threshold values of the 2001 and 2014 ACARP criteria (Table 4-3) for all reaches upstream of and including the Walker Creek reach to be diverted. However, downstream of this many parameters are above threshold values. Graphs of hydraulic parameters and water surface profiles for existing conditions are provided in Attachment A and reach average values are presented in Table 4-3.

The graphs of each parameter must be understood in context of local and reach scale geomorphic characteristics due to the dramatic appearance of spikes that exceed threshold levels. If these spikes are localised and not in consecutive cross sections then they do not necessarily represent an area of potential instability. In addition to locations of high parameter values there are a similar number of cross-sections where the parameter values drop below threshold values.

Table 4-3. Walker and Carborough Creek 1D hydraulic modelling results

Hydraulic Parameter	Units	ARI	2001 ACARP Criteria (reach average)	2014 ACARP Criteria (reach average)	Carborough Ck	Walker Creek Upstream	MRA WCD S2A	Walker Creek to be diverted	Walker Creek downstream of 2C
Shear Stress	(N/m^2)	2 year	<40	<40	18.14	21.88	20.02	35.04	44.79
		50 year	<80	<80	30.78	29.60	32.79	64.56	55.36
Stream Power	(W/m^2)	2 year	No vegetation <35 With vegetation <60	35-60	18.18	23.83	29.03	51.02	78.38
		50 year	<150	80-150	46.32	42.59	66.91	146.18	129.35
Velocity	(m/s)	2 year	No vegetation <1.0 With vegetation <1.5	<1.5	0.95	1.03	1.43	1.36	1.58
		50 year	<2.5	<2.5	1.4	1.31	2.02	2.01	1.94

4.4 Sediment supply, transport and fate assessment

Sediment transport modelling included in diversion design represents one element of current leading practice for design. Sediment transport modelling has been undertaken for existing conditions of the modelled reaches using HEC-RAS for the purposes of comparison with post diversion conditions.

Sediment supply

Walker and Carborough Creeks have high supply of both sand and finer sediment from upstream catchment areas. There are two temporally distinct sources of sediment. The first is the geologic units of the catchment upstream and the second is the contemporary erosional adjustments occurring due to post European catchment disturbance overlying the geologic evolution of the catchment. Over geologic time scales and independent of human influences in the catchment, the waterways will have inherently elevated sand loads from the Triassic sandstones which form the Carborough Range to the west of SWCM (Figure 4-7) in which the headwaters of both Walker and Carborough Creeks originate.

The Permian coal bearing sedimentary bedrock units which underlie the Triassic Sandstone and are dominant throughout the Bowen Basin have deeply weathered and developed a variable depth Tertiary horizon with substantial dispersive clay at the land surface. It is these clay dominated horizons that provide a further elevation in sediment supply to the waterways due to contemporary human disturbance in the catchment. These horizons are extremely sensitive to alterations in overland flow conditions such as concentration of flow energy. Concentration of flow energy by a small track or cattle pad can lead to large gully network development (Figure 4-8). The same types of disturbance can also trigger large terrace scarp erosion (Figure 4-9). These erosion mechanisms have not reached the bottom of their condition trajectory and are likely to continue to input elevated sediment loads to the waterways. At some point in the future they will reach the bottom of their condition trajectory and start a recovery process when sediment exports may reduce. The time to the bottom of condition trajectory or any management intervention to reduce the elevated sediment exports is not known. Understanding these sediment supply characteristics of the system[s] informs diversion design considerations and is important for successful stream diversions.

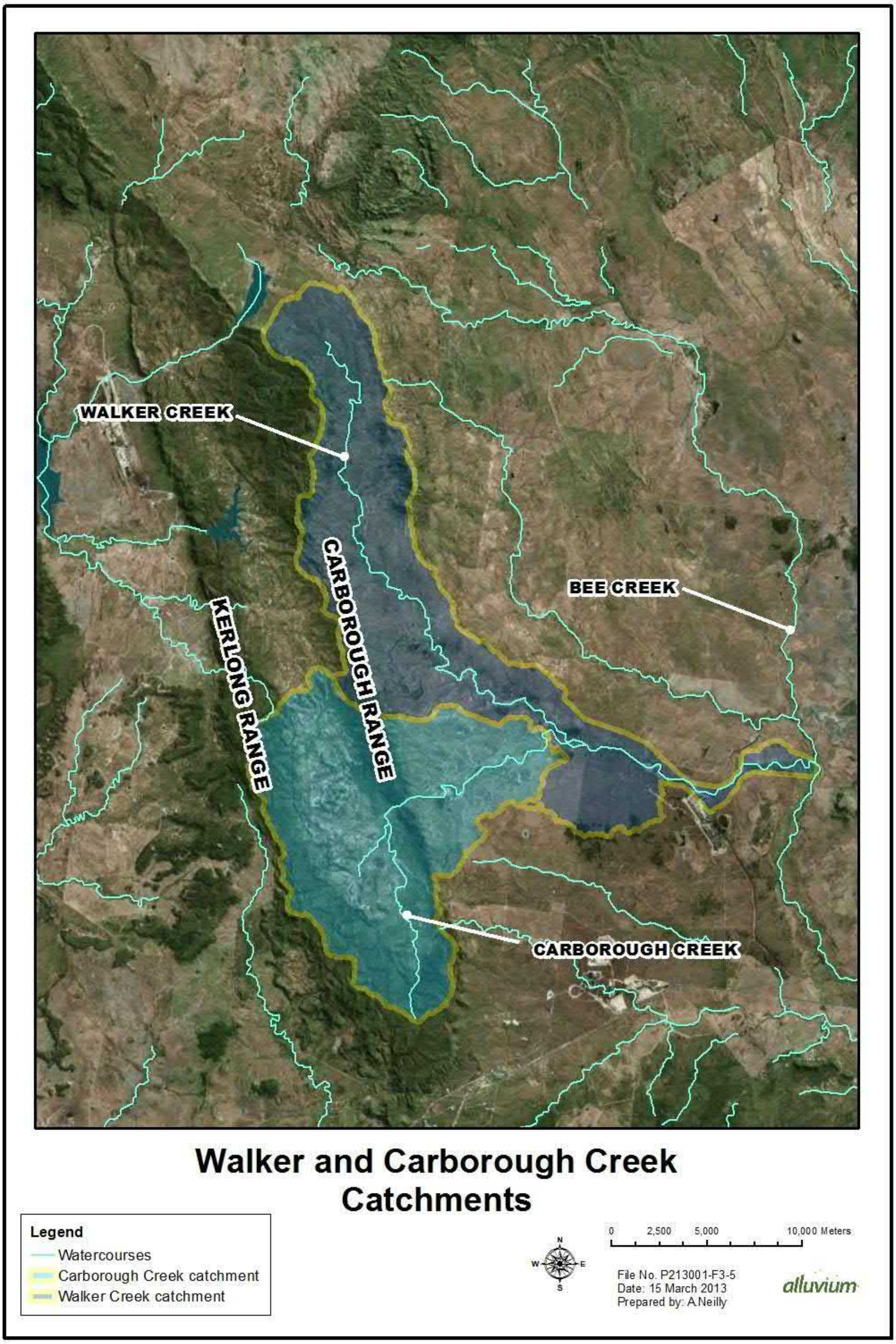


Figure 4-7. Triassic sandstone range (Carborough Range) through catchment

Figure 4-8. Contemporary gully erosion network development in Walker Creek catchment

Figure 4-9. Contemporary terrace scarp erosion in Carborough Creek catchment

Sediment Transport Modelling

Modelling enables a prediction of sediment transport capacity based on the existing hydraulic parameters and known bed sediment properties. Sediment transport capacity does not take into account sediment inflow, erosion or deposition in the computations; however the results can be used to determine reach average sediment transport capacities, which assist in understanding the fluvial processes occurring now and predicting future conditions.

There are five different total load functions for estimating transport capacity incorporated into HEC-RAS. The use of these functions can give a wide range of results, depending on the characteristics of the waterway. Ackers-White and Toffaletti are the preferred functions for sand bed streams. This assessment has used the Ackers-White function as it has been successfully utilised for other studies on sand bed streams in the region, in particular, the *Isaac River Cumulative Impact Assessment of Mine Developments* (Alluvium, 2008).

Sediment gradation information is entered into HECRAS as particle sizes with an associated percentage value that indicates the amount of material within the sediment mixture that is finer by volume. Sediment transport rates are computed on the basis of the hydraulic parameters for each grain size as if it comprised 100% of the sediment load. The transport capacity for that size group is then multiplied by the fraction of the total sediment that it represents. It follows, that the total sediment transport capacity is the sum of the transport capacities calculated for each particle size fraction. In the absence of particle size data specific to Walker Creek, the particle size data for Bee Creek, of which Walker Creek is a tributary, was utilised as its bed has similar characteristics (Table 4-4).

Table 4-4. Sediment gradation of Bee Creek (ACARP, 2002)

Particle diameter (mm)	Percent finer (%)
4.75	100
2.36	99
1.18	95
0.600	77
0.425	26
0.300	5
0.150	3
0.075	2

To obtain an estimate of the sediment transport capacity for the five reaches described in Section 4.1, the sediment transport capacity was computed for each cross-section of the HEC-RAS model for the 2 and 50 year ARI events detailed in Section 4.2. The reach average sediment transport capacity for each reach was then calculated for each flow.

Values for reach average sediment transport capacity for existing conditions of Walker and Carborough Creek reaches were calculated for the 2 and 50 year ARI events and are presented in Table 4-5.

Table 4-5. Reach average sediment transport capacity for existing conditions

Reach	Reach average sediment transport capacity (m^3/s)	
	2 year ARI	50 year ARI
Carborough Creek	0.02	0.10
Walker Creek upstream	0.02	0.09
Stage 2A	0.03	0.20
Walker Creek to be diverted	0.08	0.72
Walker Creek downstream of 2C	0.12	0.42

Based on geomorphic assessment and modelling results, both Walker and Carborough Creeks can be classified as 'transport limited' systems. In contemporary times this has led to both channel bed aggradation and oblique accretion of the channel banks. Under these conditions the waterway generally shows limited capacity for fluvial erosion where there is established riparian vegetation and the oblique accretion, which deposits a 'mud drape' of fine sediments on banks, has had chance to occur. Examples of mud drape deposition in a successful diversion under similar sediment supply conditions are provided in Figure 4-10 and Figure 4-11.

Figure 4-10. Mud drape deposition layers and bench development in Cherwell Creek diversion ~12 years post construction

Figure 4-11. Cherwell Creek diversion conditions ~12 years post construction

4.5 2D hydrodynamic modelling

2D hydrodynamic modelling has been undertaken of the estimated 0.1% AEP flood event of existing conditions for Walker and Carborough Creeks at the SWC site for the purposes of comparing pre and post diversion conditions. Alluvium has undertaken modelling of this event at SWC in the past for design of the Stage 2A diversion. However, the area requiring modelling for the Stage 2C diversion is larger and this project is using a new LiDAR survey for some areas of the mine. Details of the modelling method and results are provided in Attachment B. Results of maximum flood depth is provided in Figure 4-12 (and Attachment B) and maximum shear stress is also in Attachment B.

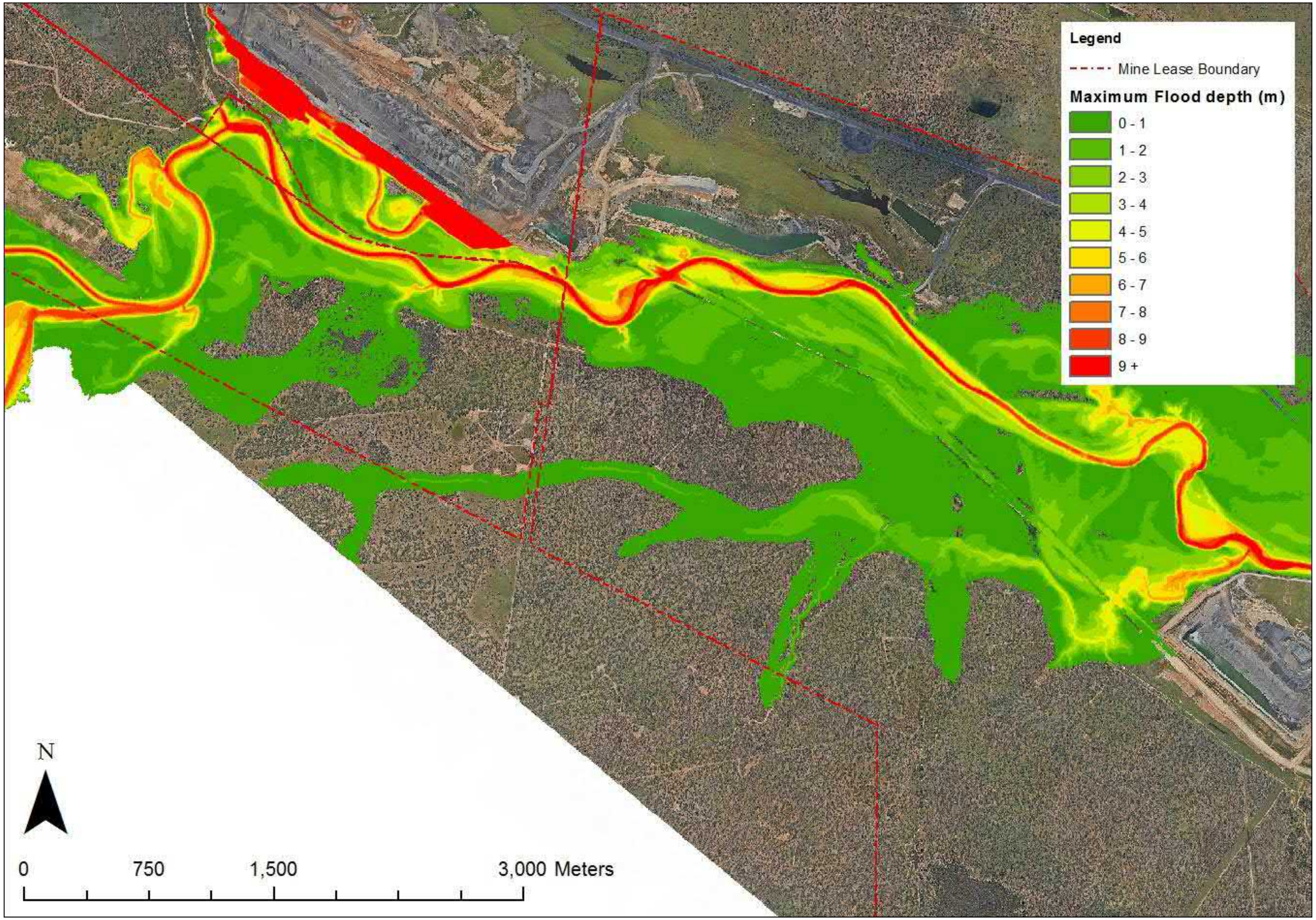


Figure 4-12. Existing conditions 0.1% AEP maximum flood depths

5 Functional diversion design

This section provides details of the functional design of the MRA Stage 2C diversion of Walker Creek and associated requirements, including flood protection levees and overland flow measures, an assessment of hydraulic and sediment transport characteristics and a physical impact assessment.

The proposed diversion is a refinement of the preferred concept alignment chosen by BHPBCP. The key design features have been developed to accommodate, as much is as possible, proposed open cut mine plan extents while keeping the diversion within the mine lease. Key features of the diversion alignment include the diversion take-off from the downstream end of the Stage 2A diversion, meanders between proposed mine plans and the ML boundary before following an existing drainage path for the majority of the diversion length before tying back into Walker Creek. Following the existing drainage path substantially reduces the required excavation volumes for the channel (Alluvium 2015). An overview of the diversion alignment is provided in Figure 5-1.

Other features include three flood protection levees to direct out of channel flows into the diversion at the take-off, to prevent flows from backwatering up the abandoned Walker Creek channel and to provide flood mitigation measures for open cut pits during mine site operations; and a number of overland flow drainage measures to intercept and direct overland flow to the base of the diversion channel via rock lined batter drains.

The levees have been designed to meet operational flood immunity requirements (i.e. 0.1% AEP event immunity) and as much as is possible mine planning infrastructure requirements.

<u>The proposed diversion developed to a functional level design as detailed in this report satisfies the Queensland Government's guidelines for watercourse diversions (DNRM, 2014) and incorporates, wherever practical, Alluvium's fundamental design principles outlined in Section 3.1 and the program logic approach below.</u>

5.1 Program logic

A program logic approach was developed for stream diversions as part of Alluvium (2014) and although not included in any government guidelines, represents current leading practice for diversion design. Development of the diversion presented has considered the framework of the diversion program logic (Alluvium, 2014), as illustrated in Figure 5-2. Part of that framework is the development of a program logic approach to determine objectives for the diversions performance, the activities required to set a diversion on trajectory toward those objectives and the outcomes expected at certain points in time. The program logic is founded on the diversion objectives:

- Diversion enables safe and efficient mine operation
- Diversion meets expected environmental and social outcomes during mine operations
    - Diversion is self-sustaining
    - Diversion does not adversely impact on upstream and downstream reaches
- Diversion can be relinquished at the end of mine life
    - Diversion does not require ongoing management.

The program logic then sets out the foundational and immediate activities that should be performed and the expected short term and intermediate outcomes of these activities that lead to the overall diversion objectives being met. The functional design of the diversion in this report has been developed within this program logic approach and includes all of the elements of the foundational activities: flood analysis; design using current recommended design parameters as per ACARP and Queensland Government guidelines (DNRM 2014); design including explicit threshold channel analysis; and design consideration of geotechnical analysis / pit stability and final void. Further refinement of the design will be undertaken during the detailed design stage.

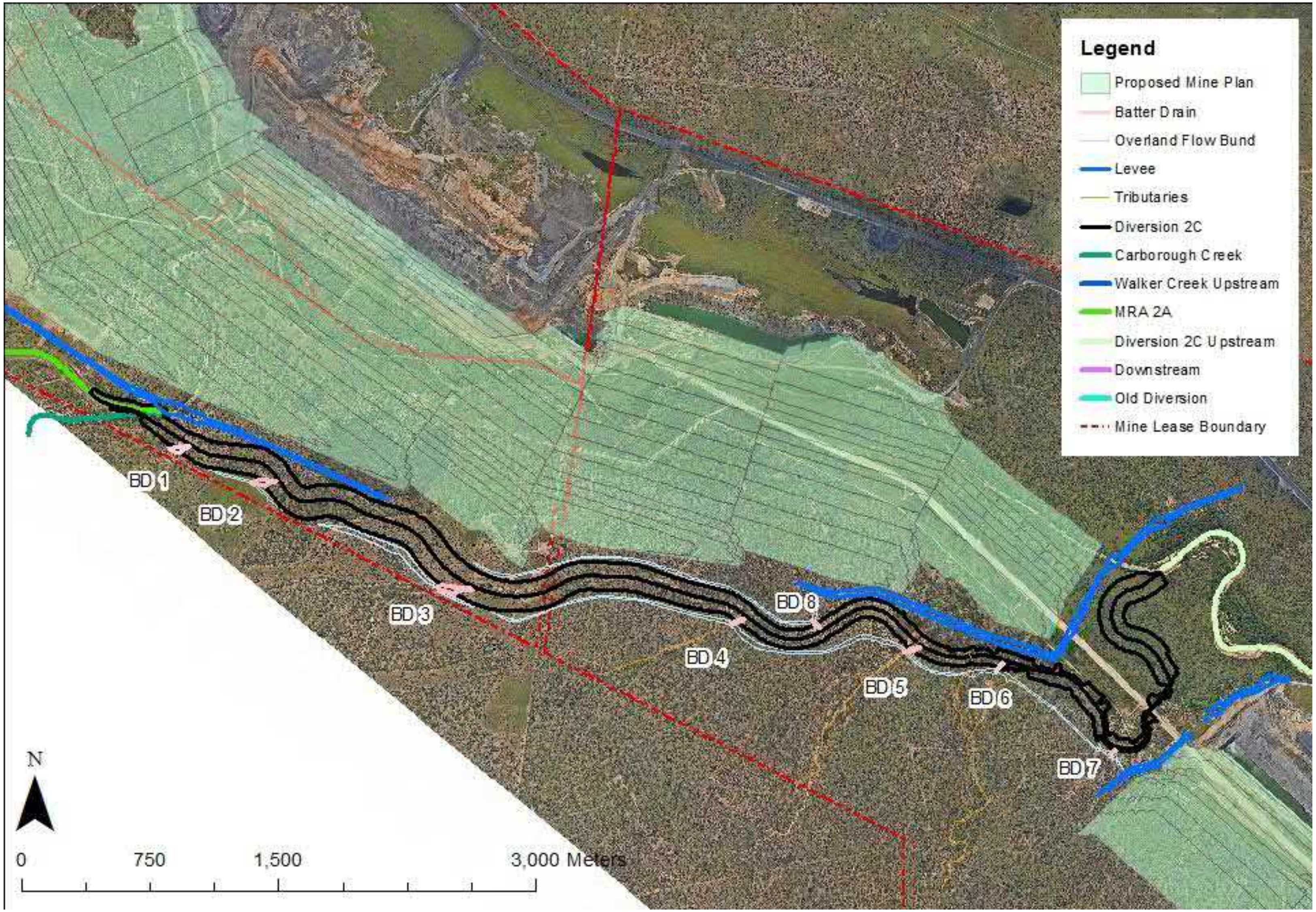


Figure 5-1. MRA Walker Creek Diversion – Stage 2C functional design alignment

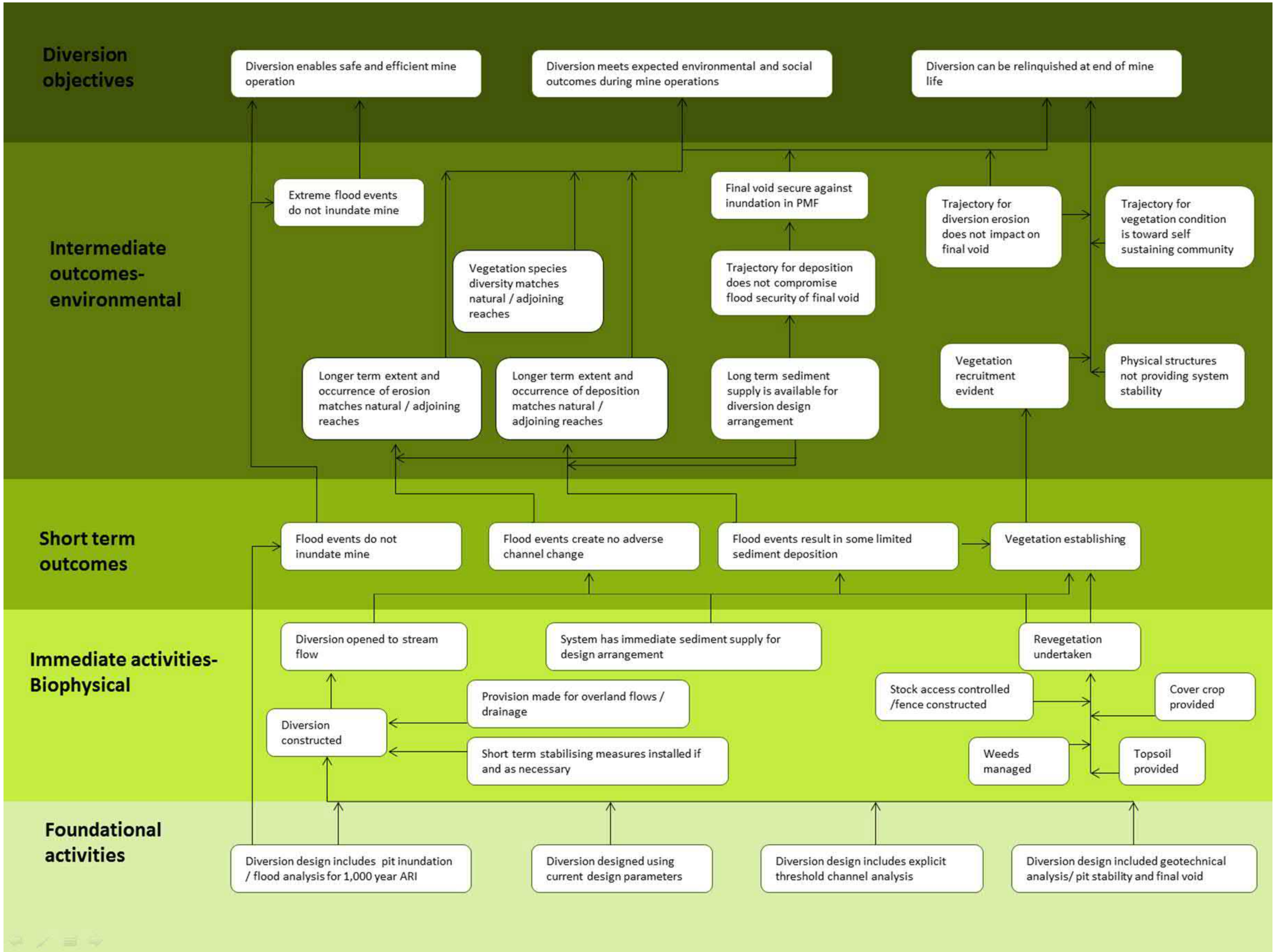


Figure 5-2. Program logic diagram for diversion objectives (current leading practice, not regulatory requirement)

5.2 Functional design features

The proposed Stage 2C diversion and levee designs have been developed in consultation with BHPBCP and where possible are within the corridor defined by BHPBCP. All diversion infrastructure must not be within 15m of the mine lease (ML) and where possible are to be no closer than 70m from the proposed open cut pits to allow for an infrastructure corridor for mining operations and potential closure landforms. Details of the proposed diversion are provided below.

Diversion channel

The diversion design consists of a single bed gradient from take-off to tie-tie. The diversion take-off commences atthe downstream end of the Stage 2A diversion and extends in a general south easterly direction, cut through hillslope, meandering between the ML and proposed mining infrastructure before following the alignment of an existing drainage path in a general east-south-east direction. Along the drainage path the depth of cut becomes progressively less and practically matches the existing drainage path invert elevation before the alignment deviates from this path to make an additional meander before tying back into Walker Creek.

Table 5-1 provides an overview of the diversion channel geometric features in comparison to relevant existing reaches. Details of the proposed diversion are presented graphically in the functional design drawings of Attachment D.

Table 5-1. Diversion channel features and comparison to existing

Reach	Average channel grade (m/m)	Channel length (m)	Bed width (m)	Channel top width (m)	Batter slope	Bench width (m)	Bench height (m above bed)	Depth of cut (m)
Proposed Stage 2C diversion	0.00152	8010	35	Approx. 40 to Max 195	Upper batters 1V:3.5H Lower batter 1V:2.5H	30 (lower bench) 10 (upper bench)	1 (lower bench) 4 (upper bench)	0 – 13 2*
Walker Creek to be replaced	0.00142	8160	20-30	100 - 150	Varies 1V:2H - 1V:3H	0 - 40	0 - 4	NA
Walker Creek (downstream of diversion tie-in)	0.00191	3133	20-30	90 - 140	Varies 1V:2H - 1V:3Hc	0 - 40	0 - 4	NA

*Additional 2m of cut to base of hyporheic zone

Diversion cross-sectional geometry

The diversion cross-section form provides features that are characteristic of incised alluvial/partly confined streams within the Bowen Basin and includes benches that are inundated by flows around the 2 year and 50 year ARI events. There is a prevalent riparian vegetation association with these hydro-geomorphic features. The diversion replicates this by the inclusion of lower benches that are inundated by the 2 year ARI flows and where deeply cut through hillslope, an upper bench that is inundated by the 50 year ARI flows. The benches will act as inset floodplains and facilitate ongoing riparian zone regeneration of dominant species for that zone and provide for longitudinal continuity through the system.

In the downstream end where the depth of cut is shallow the diversion utilises and engages the shape and form of the existing terrain which replicates a floodplain. Where the depth of cut allows, the low level bench continues and is engaged by the 2 year ARI and the existing terrain beyond is engaged by the 50 year ARI event. Levees are used to protect mine infrastructure.

The cross-sectional geometry of the diversion is shown in Attachment D and Figure 5-3 and details of the form are shown in Table 5-1. Features of the design include:

- Bed with of 35m
- Low and higher level benches with 3% cross-fall
- batter slopes of 1v:2.5h below low level bench
- batter slopes of 1v:3.5h elsewhere
- creation of a hyporheic zone below sand bed level to allow for continuity of sediment transport and hyporheic flow

Hydraulic conditions at the diversion take-off require a transitioning of the channel to reduce high energy conditions immediately upstream in Carborough Creek and the Stage 2A diversion. Functional level transitioning has been undertaken and has been successful in reducing elevated energy conditions upstream of the take-off. However, this currently results in increased hydraulic parameter values through the first 600m of the diversion channel and will be subject to further design assessment during detailed design once the geological conditions in this area are known (see Sections 5.4, 5.7 and 5.9 and Attachment C for more information).

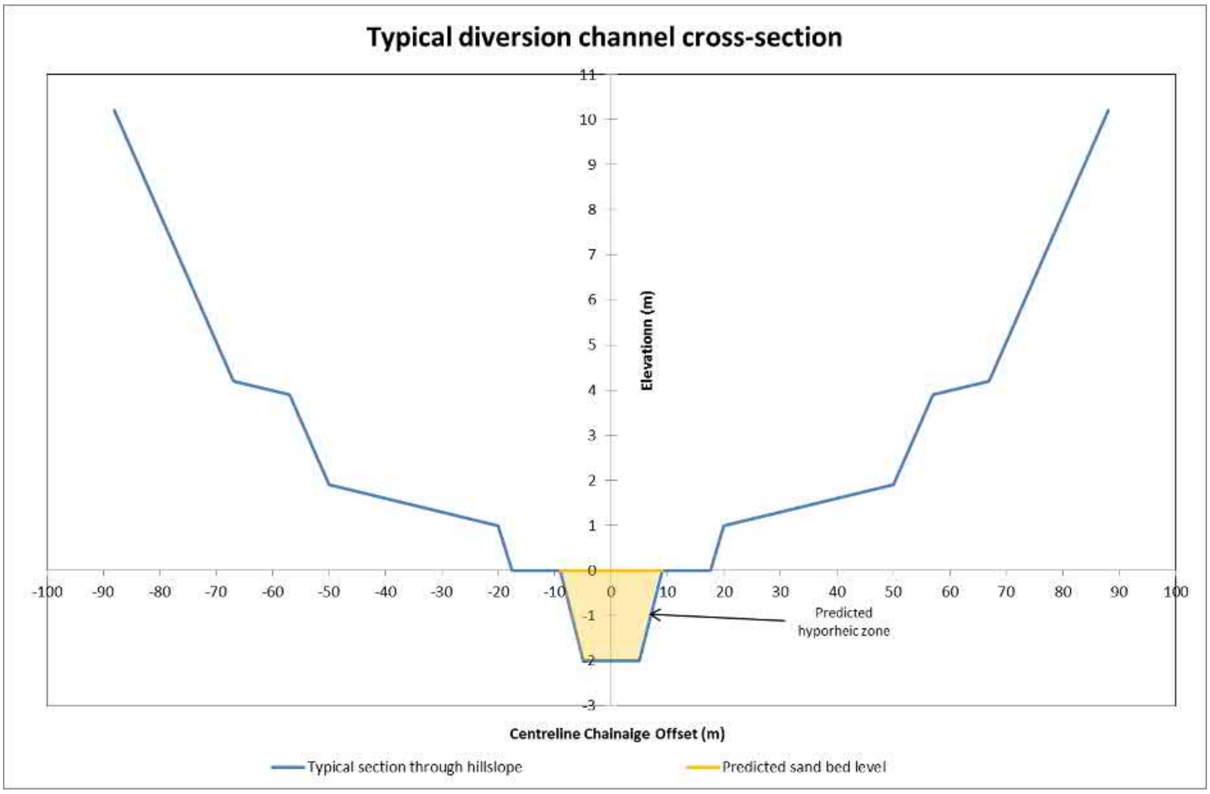


Figure 5-3. Diversion typical section (not shown at a scale of 1:1)

Flood protection levees
Three flood protection levees will be required to prevent the ingress of flood waters into the proposed Mulgrave pit development and existing and proposed Carborough pit developments. The three levees have been designated levee 1, 2 and 3 and are shown in Figure 5-1 and Attachment D.

In cross-section the levees are all the same with a 5m wide crest and side slopes at 1v:4h. The crest elevation is set such that a minimum 0.5m freeboard margin above the 1000 year ARI (0.1% AEP) water surface estimated from 2D hydrodynamic flood modelling.

At this stage it is proposed the levee embankments will be constructed using suitable clayey fill won from diversion channel excavations. Identification of suitable materials will form a key element of a geotechnical investigation required as input to the detailed design.

Levee 1

Levee 1 is a continuation of the Earthen Embankment (combined with a waste rock dump) formed during the Stage 2A project and extends across Walker Creek (located on top of the plug) to maintain flood flows within the Stage 2C diversion corridor. Current modelling indicates the existing earthen embankment may need to be raised slightly, this will be subject to review during detailed design. The length of the new portion of levee is approximately 1,630 m extending in a generally south-easterly direction and where possible is located beyond the 70m offset from proposed pit developments as requested by BHPBCP. It is also located a minimum of 20m from the top of diversion excavation batter.

Where the levee overlies the plug across the existing Walker Creek channel it is proposed that general fill be placed between levee/plug face and diversion channel to manage hydraulic conditions associated with confluence zone expansion and ensure free draining conditions following a flow event.

Levee 2

Levee 2 is located at the downstream end of the proposed diversion and wraps around the proposed Mulgrave pit developments for a length of approximately 3,120 m, between the diversion channel and proposed open cut pits. Due to the diversion alignment following the existing drainage path and the need to maintain a minimum 20m offset between the diversion channel top of bank and levee toe (for stability and access requirements), a relatively short length of the levee extends into the requested 70m offset from proposed mining pits.

Levee 2 crosses the existing Walker Creek overlying the downstream plug across the channel and prevents flows backwatering into the abandoned channel and ultimately proposed open cut pit developments. In the early phases of pit development surface water runoff derived from undisturbed lands between the diversion and mining pits will collect in the abandoned channel against the rear face of the levee. It is not likely that the levee embankment design will allow for water to pool for long periods against the levee for stability reasons. Therefore, this will require a management solution to be implemented by SWCM. Surface water runoff on the rear face of the levee[s] is beyond the scope of this functional design project and is to be discussed further in the surface water management plan being developed by SWCM. Possible solutions could include pumping, drainage valves and/or channels and combinations thereof.

The levee alignment also crosses a smaller tributary near to and north-east of the plug. A spoil dump is proposed to be built over the tributary but until that occurs SWCM will need to manage water that collects on the rear face of the levee. This could be managed separately or in conjunction with the site described above and possible solutions would be similar.

Levee 3

Levee 3 is also located at the downstream end of the proposed Stage 2C diversion but on the opposite side of the channel and wraps around the existing and proposed Carborough Pit developments for a length of approximately 1,340 m. The area for the proposed levee appears to be highly modified as it follows alongside pit ramp infrastructure and consequently the levee embankment cross section will significantly vary along the proposed alignment.

Specialist geotechnical advice will be required to determine if the substrate conditions of the proposed alignment are suitable for providing flood protection, or, if the proposed alignment should be altered. Specialist geotechnical advice will also be required for determining ‘secure ground’ for the levee tie-in to the pit access ramp.

Where the levee is adjacent proposed Carborough Pit developments the requested 70m offset is deliberately not maintained so that the levee is built on higher ground to reduce the risk to levee stability and integrity posed by diversion flows. This also reduces the required earthworks volumes and hence cost to build the levee.

Where the levee wraps around existing pit ramp infrastructure it is situated between this and an existing tributary channel of Walker Creek (the same drainage feature utilised by much of the proposed Stage 2C diversion alignment but not used in this location). As part of the design arrangement this channel is proposed to be filled to top of bank levels to the extent required to reduce the risk of meander cut-off to suitable levels. Further design assessment will be undertaken during detailed design to optimise the extent of filling required.

The levee also intercepts some overland flow paths to the south-west of the existing Carborough Pit which will collect on the rear face of the levee until such time as the catchment is mined out. In the interim this will require management by SWCM and/or further design assessment during detailed design.

Overland flow measures
The proposed Stage 2C diversion channel alignment intercepts a number of minor tributaries and overland flow catchments originating in the low relief hillslopes to the south of the diversion. Without management intervention, runoff from these catchments would cause instabilities on the diversion batters and back upstream on the flow paths. There is also one catchment on the northern side (mining side) of the diversion channel requiring management.

To manage this surface water runoff a series of low level earthen bunds and rock lined batter drains are proposed to intercept and convey surface water flows to the base of the diversion channel. In total, eight batter drains and five earthen bunds are proposed. The design intent of a batter drain is to use rock beaching to provide an erosion resistant passage for concentrated overland flow. During life of the drain vegetation will become established on all surfaces and ongoing monitoring will be required during mining operations. .

The batter drains will typically have a trapezoidal cross-section with 1v:2.5h abutment batters and 1v:3.5h upper batters. Rock beaching will be required, which must be placed over a layer of granular filter material. The larger rock provides resistance to flows and the granular filter material helps to prevent slaking of underlying material out through the larger rock. The loose interface provides more stability for rock placement with less chance of slippage occurring in comparison with a geotextile fabric layer which can act more like a rigid boundary.

It should be noted that the earthen bunds and batter drains have been designed to a functional level and further refinement of the configuration will be required at the detail design stage. This includes consideration on the amount of the batter drain[s] that would be on Tertiary sediments and the amount on Permian bedrock. The Tertiary-Permian boundary within the diversion channel will be an important output from a geotechnical ground investigation required as input to the detailed design.

Volume estimates for the batter drain excavation and rock beaching are detailed in Section 6.

Filling locations
There are locations in the downstream zone of the proposed diversion where general fill is proposed to manage risk of potential meander cut-off. One area involves filling approximately 850 m of the tributary to Walker Creek commencing from where the proposed diversion alignment departs the tributary alignment, downstream to the confluence with Walker Creek. It is proposed to fill this to near top of bank levels.

The second area proposed for filling involves raising the existing terrain along and adjacent the dragline walk road, the area that is situated in front of Levee 2 and extends between the large meander of the proposed diversion. The aim with this is to reduce the frequency of overtopping of this area and therefore reduce the risk of a meander cut-off developing.

The design of these areas will be subject to refinement during detailed design.

5.3 Design flow estimates

The peak design flow estimates adopted for diversion design are the same as those provided in Section 4.2 for existing conditions. This is largely the result of the majority of the contributing catchment being located upstream of the site for diversion and therefore realignment of the creek via the Stage 2C diversion does not change the peak flows of the system.

5.4 1D hydraulic assessment

Hydraulic assessment of the proposed diversion arrangement has been undertaken using 1D steady state hydraulic modelling. A HEC-RAS model was set up, similar to that used for existing conditions assessment, with flows now passing through the proposed diversion. Results of the diverted scenario are shown alongside pre-diversion (existing conditions) results for the adjoining upstream and downstream reaches.

Results

Results show that DNRM (2014) criteria are satisfied for both flow events through the diversion (Table 5-2). The reach averaged hydraulic parameter values for the diversion typically fall within the reach average for the adjoining upstream reaches and the reach average of the adjoining downstream reach for the 2 year and 50 year ARI flows. This is a good outcome as the existing conditions show a general increase in energy of the downstream reaches compared with those upstream, so the diversion reach average fits into this trend.

At the diversion take-off, all hydraulic parameter values are elevated for a distance of approximately 600m which is associated with a transition zone. The development of the transition zone at a functional level aimed to reduce the increase in hydraulic parameter values through the upstream reaches to acceptable levels, this has been achieved. However, the resulting elevated hydraulic parameters values through the diversion transition zone will be subject to further refinement during detailed design. Geotechnical investigation is being undertaken to determine robustness of existing material and provide input to assessment of final design solutions.

The hydraulic parameter values are generally constant throughout the majority of the section that is cut through hillslope. Moving downstream as the diversion enters the existing drainage feature, from approximate chainage 10,000 m (hydraulic model chainage) the 50 year ARI flow begins to engage the existing terrain like a floodplain as the capacity of the channel reduces. So, downstream through this area there is some variability of hydraulic parameter values that directly relates to the natural variability of the existing terrain. In the very downstream end of the diversion the hydraulic energy is quite low which is attributable to a backwater effect from the downstream reaches.

The introduction of the current diversion design slightly increases hydraulic parameter values in the adjacent upstream reaches, however the increases are relatively small and the reach averaged values all remain below threshold criteria values. In the case of Carborough Creek, this is a positive result as Carborough Creek is very much transport limited, i.e. it has an over-supply of bed load sediments and increases in hydraulic energy will help to redistribute sediment. In the case of the Stage 2A diversion, only the 2 year ARI velocity begins to exceed the threshold criteria value towards the downstream end. Work done at this functional design level has partially addressed this issue and it is expected that further design assessment during detailed design will produce satisfactory design conditions. There is no change to hydraulic values upstream of the Stage 2A diversion.

Downstream of the proposed Stage 2C diversion, hydraulic parameter values are virtually unchanged as expected due to no net change in peak flow rates. There is a very small change in values immediately downstream of the diversion tie-in location due to the introduction of the levee into the landscape which slightly reduces the available flow area in this zone.

Table 5-2 presents reach average values of hydraulic parameter values and graphs of hydraulic parameters and water surface profiles for pre- and post-diversion are provided in Attachment C.

Table 5-2. 1D hydraulic modelling results of the proposed Stage 2C diversion

Hydraulic Parameter	Units	ARI	2001 ACARP Criteria (reach average)	2014 ACARP Criteria (reach average)	Carborough pre diversion	Carborough post diversion	Stage 2A pre diversion	Stage 2A post diversion	DIV	D/S of 2C pre diversion	D/S of 2C post diversion
Shear Stress	(N/m^2)	2 year	<40	<40	18.14	23.30	20.02	20.62	20.65	44.79	45.00
		50 year	<80	<80	30.78	44.6	32.79	36.75	41.42	55.36	56.68
Stream Power	(W/m^2)	2 year	No vegetation <35 With vegetation <60	35-60	18.18	26.05	29.03	30.34	30.27	78.38	78.81
		50 year	<150	80-150	46.32	79.19	66.91	79.13	99.00	129.35	131.69
Velocity	(m/s)	2 year	No vegetation <1.0 With vegetation <1.5	<1.5	0.95	1.05	1.43	1.45	1.38	1.58	1.59
		50 year	<2.5	<2.5	1.4	1.65	2.02	2.12	2.19	1.94	1.97

5.5 Sediment supply, transport and fate assessment

This section provides a brief summary of the likely sediment dynamics and implications for diversion functional design and potential modifications to be made during the detailed design. Existing conditions with regard to sediment supply are summarised in Section 4.4.

Sediment transport modelling

Sediment transport modelling has been undertaken for the Stage 2C diversion and adjoining reaches as per the project reach breakdown using HEC-RAS.

As HEC-RAS is a backwater model, the downstream reach results for existing conditions and post-diversion conditions are similar and only the existing conditions results are shown.

Values for reach average sediment transport capacity for existing conditions and the diversion reaches were calculated for the 2 and 50 year ARI events and are presented in Table 5-3.

Table 5-3. Reach average sediment transport capacity for existing and design conditions

Reach	Reach average sediment transport capacity (m^3/s)			
	2 year ARI		50 year ARI	
	Existing	Design	Existing	Design
Carborough Creek	0.02	0.02	0.10	0.14
Walker Creek upstream	0.02	0.02	0.09	0.10
Stage 2A	0.03	0.03	0.20	0.25
Walker Creek to be diverted / Stage 2C	0.08	0.10	0.72	0.83
Walker Creek downstream of 2C	0.12	0.12	0.42	0.43

Broadly, sediment supply and transport conditions for the diversion will be the same as for existing conditions (Figure 4-8 and Figure 4-9). Even if the highly elevated contemporary sediment supply reduces through recovery of gully erosion in the catchment (which is likely to take more than half a century), there is inherently elevated sand inputs to the waterways from the geology throughout the catchment, hence it is possible that Carborough and Walker Creeks, including the diversion, will remain 'transport limited' (receiving more sediment than it is able to transfer) for decades or centuries to come. Suspended sediment will continue to be supplied at elevated levels to the diversion, increasing the prospects of mud drape development and oblique accretion which will, over decades, create bank profiles similar to the existing waterway. Such a process is noted for Cherwell Creek diversion at Peak Downs Mine (Figure 4-10). Cherwell Creek has similar sediment supply conditions and geomorphic characteristics to Walker Creek (Figure 4-11).

5.6 2D hydrodynamic modelling assessment

2D hydrodynamic modelling has been undertaken of the estimated 0.1% AEP flood event for the proposed diversion and levee arrangement for this study to satisfy the regulatory requirements of the Queensland Government for levees constructed as part of environmentally relevant activities. Figures of results for maximum flood depths, shear stress and depth afflux (compared to existing conditions) are provided in Attachment B. The modelling results have been used to set the elevation of the proposed levees.

From the results it is apparent there are two zones where bed shear stress is at elevated levels through the proposed diversion: through the off-take zone and the expansion zone where the diversion transitions from being confined through hillslope to utilising the existing drainage path. This aligns with the 1D hydraulic modelling results and will be subject to further design assessment during the detailed design phase to understand all the variables at a detailed level and design suitable solutions. Geotechnical investigation along the alignment with regard to the nature of substrate will provide an important input to those assessments.

Pre and post diversion comparisons for the 0.1% AEP event show only minor changes to depth with practically no change downstream and a slight increase in depth upstream, in the order of plus 300 mm. This correlates with a slight reduction in shear stress upstream. And downstream of the diversion there is some variance with both positive and negative changes in shear stress that can be mostly attributed to changes in flow direction for the large flow event.

Further design refinements will be made during the detailed design phase. 2D hydrodynamic modelling of the design, combined with results of the geotechnical investigation will allow decisions to be made around use of rock beaching. This will be particularly important through the identified areas of high shears stress and the diversion confluence zones.

It is also evident from the post diversion conditions results that the inclusion of the two filling areas at the downstream end has been effective, at a functional level, at reducing shear stress between the meanders and therefore reducing the likelihood of meander cut-offs developing.

5.7 Geotechnical considerations

Useful geological investigation data has been provided for the broader MRA project area in the form of borehole data. This assessment utilises those sites that fall on or near to the proposed diversion alignment for Stage 2C.

The main elements requiring consideration at a functional level includes the substrate likely to be encountered within the diversion channel and substrate below the proposed levee alignments.

Diversion channel

Based on the information provided the diversion is likely to be built through a range of substrate types at varying depths and plan locations, eg, Permian rock (siltstone, mudstone and sandstone) and Tertiary sediments with variation in magnitude of weathering. These substrate types will require assessment based on their properties and location within the diversion.

The upstream zone of the diversion is likely to contain Permian bedrock materials. This may be beneficial for the design of the take-off zone. If Permian bedrock is prevalent this may be used to manage possible elevated hydraulic energy through this area. The current information suggests the Permian/Tertiary interface is quite variable in elevation through this area and should be better defined through geotechnical investigation for detailed design.

The middle and downstream thirds of the diversion are not as likely to encounter Permian bedrock material (based on information provided to date) and are more likely to be built through weathered Tertiary sediments. And the downstream portion of the diversion (in the vicinity of the dragline walk road) will be situated in sand/clayey-sand deposited by Walker Creek as it has meandered around this area over long time scales. Careful design consideration will be required in this area and issues of constructability are likely to feature in design assessments. Previous experience suggests a rock mulching treatment on soft sandy batters will be required for construction traffic and suitability for vegetation establishment. Design of these considerations are to be undertaken at detailed design.

Levee alignments

Identification of suitable levee building material to be won from the diversion channel excavation will form a large component of the geotechnical ground investigation to be undertaken for detailed design.

<u>Levee 1</u>

Levee 1 is situated at the take-off for the proposed Stage 2C diversion. Geological information provided for this study did not include any locations of information along or near to this levee. However, we already know from previous investigations for the Stage 2A diversion project deep sands are likely to be encountered between the earthen embankment built for Stage 2A and where the levee crosses the existing creek channel. To the south-east of the existing channel the substrate conditions at this stage are somewhat unknown. However, a field inspection identified Permian rock expressing at surface levels in some locations.

Levee 1 also currently extends along the alignment of the earthen embankment built for Stage 2A. Decisions around whether this embankment needs to be raised to function as a levee as a result of the 2C diversion are expected to be made during detailed design. It is also expected that design and QA records from construction would provide enough geotechnical information for design purposes.

Levee 2

Levee 2 is located at the downstream end of the proposed Stage 2C diversion and on the northern side of Stage 2C. From the geological and DTM information provided it is likely the substrate will consist of deep sands for the majority of the alignment. In some locations this could be as deep as 15 m from surface elevation. Geotechnical investigation and detailed design will need to take this into account.

Levee 3

The proposed location for Levee 3 is alongside Carborough Pit ramp infrastructure. The aim of the alignment is to minimise required fill volumes for the levee. However, much of the alignment is on previously disturbed ground. and specialist geotechnical ground investigation and assessment is required to determine if this is in fact a suitable alignment for the proposed levee.

A geotechnical assessment of 'secure ground' will also be required to inform suitable tie-in locations for the levee.

Geochemical considerations

Commentary on geochemical considerations is provided in the revegetation report (Alluvium 2016a).

5.8 Assessment of potential physical impacts

Flow regime

The proposed diversion arrangement for MRA Stage 2C will not alter total flow volumes through the system. The proposed arrangement is also not expected to result in any meaningful levels of flow attenuation as is evident by pre and post diversion peak flow estimates being practically the same for the 2 year and 50 year ARI events. Some attenuation associated with low levels of backwater upstream of the take-off for a short time during extreme flow events may occur. This is likely to have negligible impacts on the form and function of the waterways downstream of the site and will not have any impact upon users of the adjacent land.

The proposed open cut mining footprint will provide a slight reduction in catchment area contributing to the watercourse, however this is insignificant at the catchment and sub catchment level.

Geomorphic character and behaviour

The proposed diversion arrangement for MRA Stage 2C is consistent with that of MRA Stage 2A, which provides for characteristics and behaviour that are similar to the partly confined sections of existing Carborough and Walker Creeks with no significant impacts expected to upstream or downstream reaches.

Lower channel boundaries are frequently bedrock controlled and steeper. Alluvial benches may develop in these areas through mud drape deposition. Upper channel banks are lower angle and generally within stiffer Tertiary terrace sediments. Where these conditions aren't met through excavation, re-use of materials won from excavation can reproduce the desired conditions, such as the blending of Permain rubble with uncohesvie sediments in upper batters.

The diversions will provide conditions for similar sediment transport capacity, hence continuity of bedload. This is important for hyporheic flow connectivity and the vegetation that depends on this small alluvial aquifer. There will be an interruption in this process while the zone fills through the diversion, the duration of which is totally dependent on the timing, magnitude and duration of flow events. Analogies can be drawn from subsidence of sand bed streams in the region such as the Isaac River where multiple longwall panel subsidence troughs, in the order of 300m long, 3m deep and 50m wide each can be infilled in a single large (>10 year ARI) flow event. Established climate cycles of wet or dry dominated periods of 5 to 7 years prevail in the Isaac-Connors catchment based on hydrologic records. Probability of infilling may also then be linked to timing of construction relative to that cycle. During this period the natural process of infilling may reduce seidment being transported to reaches downstream of the diversion until levels equalise. Further assessment of the risks of this response is required during detail design. One possible mitigation measure is to 'seed' the diversion with bedload from the reaches to be abandoned.

Riparian corridor
Creation of the diversion will provide a temporary discontinuity in the riparian corridor while revegetation works establish. The design creates conditions that are suitable for re-establishment of the riparian vegetation currently found in the existing channel.

5.9 Potential design modifications and recommendations for detailed design stage

The proposed diversion presented in this report provides a design for a functioning waterway that meets the Queensland Government guidelines. The design also provides a diversion reach that has the potential over time to replicate regional environmental values and not adversely impact on the adjoining reaches.

There are a number of elements of functional design that will require further assessment and refinement prior to or during the detailed design phase.

Mining

The location of proposed levees and diversion channels is dictated firstly by the ML boundary, and secondly by locations and offsets of proposed operational mining infrastructure (such as pits and dumps) and thirdly by suitable offset distances. At the functional design level these offset distances (70 m from pit crests) have been provided by BHPBCP to allow sufficient room for mining operations infrastructure between proposed levees/diversion and pit crests.

Longer term pit wall stability and flood considerations for final voids are likely to dictate these offset distances and they may be different to operational requirements. Given the alignment of the diversion is confined between proposed pits and the ML boundary and follows an existing drainage feature to minimise impacts and costs, it is not likely the diversion would be realigned for closure requirements.

Continued use and interaction of the dragline walk road with Levee 1 and Levee 2 will require further consideration during detailed design of the diversion and levees.

Geotechnical investigations

It is understood that a detailed geotechnical investigation of preferred diversion and levee alignments has been undertaken to inform the detailed design of proposed levees and diversion and allow for more detailed and improved confidence of cost estimates and reduce the risk of construction cost overruns for SWCM.

Stage 2C diversion

Analysis of the functional level design hydraulics show elevated parameter values through the diversion take-off zone and to a lesser extent through the confined to unconfined transition zone. Through the take-off zone, functional level design channel transitioning has been undertaken to reduce the risks associated with elevated hydraulic parameter values upstream of Stage 2C, through Carborough Creek and Stage 2A. Further design iteration and assessment will be undertaken during detailed design. Similarly, this will also be required through the confined to unconfined channel transition zone. It is expected that the detail design will overcome any potential issues with elevations in parameter values identified through the functional design.

Both Walker and Carborough Creek contain bed load sediments that may provide for important ecologic functions by retention of moisture and hyporheic zone flows during dry seasons, hence a hyporheic zone has been deliberately built into the diversion design. This consists of an additional depth of excavation (2 m) in the bed of the diversion that is below the current design and existing bed surface levels. This feature is also necessary to allow for continuity of sediment transport and subsurface water flow processes throughout the system. This approach is consistent with Stage 2A and could be modified during detailed design if ecological assessments determine it necessary.

Flood protection landforms

The flood protection levees produced for this functional design are for operational requirements only at SWCM and are designed to provide immunity for the estimated 0.1% AEP flood event for the diversion and levee arrangement provided herein. Changes to diversion channel features during detailed design may influence estimated elevations of low probability high flow events and influence the required elevation of the levees. Therefore, this will require re-modelling and estimation during detailed design.

<u>Levee 3</u>

The proposed location for Levee 3 is alongside Carborough Pit ramp infrastructure. The aim of the alignment is to minimise required fill volumes for the levee. However, it is noted that it appears the alignment is on 'modified' ground that has been modified by mining activities. Specialist geotechnical ground investigation and assessment is required to determine this is in fact a suitable alignment for the proposed levee.

A geotechnical assessment of 'secure ground' will also be required to inform suitable tie-in locations for the levee.

<u>Surface water behind levee 2 and 3</u>

There are a number of locations where surface water is likely to accumulate on the rear face of levees 2 and 3. Accumulation of surface water behind levee 2 is being considered as part of the surface water impact study (Alluvium, 2016) and may require further consideration during detailed design.

At Levee 3 it may be possible to divert some of the contributing catchment along contour around the proposed levee and into a batter drain. This also requires further consideration by SWCM and levee designer.

Overland flow bunds and batter drains

Functional level design of overland flow bunds and batter drains has been undertaken for this project. Further refinement of these and associated features will be undertaken during detailed design. Depending on results of the geotechnical investigation, an opportunity may exist to alter the design of these elements to utilise suitable Permian bedrock (if/where it exists) and reduce the cost of these features.

6 Earthworks volume estimates

Functional design level estimates of earthworks volumes have been undertaken for the proposed Stage 2C diversion and the associated levees. The estimates are provided in Table 6-1. At this stage of the design process the estimates should be treated as indicative for input to the project feasibility assessments. A more accurate and detailed breakdown of volumes would be issued upon completion of the detailed design of the preferred arrangement.

At this time estimates have not been made for other items that may be required such as varying surface treatments for batters (rock mulching, topsoil blending, etc), revegetation and habitat enhancement. Geotechnical and geochemical investigations and assessments will be required to inform detailed design of these elements.

Calculated quantities are between the design surfaces and the existing surface digital terrain model provided by SWCM. Estimation of quantities for levee construction does not include subsurface requirements such as removal of material to reach foundation levels and filling from foundation levels back up to existing surface levels. This component will be undertaken during detailed design.

For estimation of excavation volumes for Tertiary and Permian materials, a Permian/Tertiary interface provided by SWCM for earlier diversion projects has been utilised. It should be noted that additional geology information was provided by SWCM for this study, however the information provided was not sufficient to create a new Permian/Tertiary interface suitable for design volume estimation. The geotechnical investigation program recently undertaken is expected to provide this information and a more accurate estimate will be provided at that time.

Table 6-1. Estimate of earthworks quantities for the proposed Stage 2C diversion

Item	Description	Unit	Qty Estimate
1	**MRA Stage 2C diversion**		
1.1	Clear and grub diversion channel footprint	m2	1,076,812
1.2	Topsoil strip (nom. 200mm) and cart to stockpile [1]	m3	216,224
1.3	Excavate diversion to design level and cart to stockpile/spoil [4]	m3	5,043,610
	- Excavate tertiary	m3	4,738,616
	- Excavate permian	m3	304,994
1.4	Supply and place approved earth fill material	m3	28,675
1.5	Topsoil placement (nom. 300mm) and ripping (min. 600mm) of diversion benches and batters	m3	246,134
2	**Levee 1**		
2.1	Clear and grub levee footprint	m2	54,902
2.2	Topsoil strip (nom. 200mm) and cart to stockpile [1,4]	m3	10,991
2.3	Excavate to foundation level and prepare foundation [4]	m3	Rate only
2.4	Supply and place approved engineerd earth fill material	m3	110,224
2.5	Topsoil placement (nom. 300mm)	m3	16,842
3	**Levee 2**		
3.1	Clear and grub levee footprint	m2	86,258
3.2	Topsoil strip (nom. 200mm) and cart to stockpile [1]	m3	17,245
3.3	Excavate to foundation level and prepare foundation [4]	m3	Rate only
3.4	Supply and place approved engineerd earth fill material	m3	183,755
3.5	Topsoil placement (nom. 300mm)	m3	26,535
4	**Levee 3**		
4.1	Clear and grub levee footprint	m2	29,311
4.2	Topsoil strip (nom. 200mm) and cart to stockpile [1]	m3	5,874
4.3	Excavate to foundation level and prepare foundation [4]	m3	Rate only
4.4	Supply and place approved engineerd earth fill material	m3	55,636
4.5	Topsoil placement (nom. 300mm)	m3	8,993
5	**Overland flow bunds**		
5.1	Clear and grub bund footprint	m2	121,493
5.2	Topsoil strip (nom. 200mm) and cart to stockpile [1]	m3	24,325
5.3	Supply and place approved earthfill material	m3	83,313
5.4	Topsoil placement (nom. 300mm)	m3	36,716
6	**Batter drains 1-8**		
6.1	Clear and grub batter drain footprint	m2	13,367
6.2	Topsoil strip (nom. 200mm) and cart to stockpile [1]	m3	2,673
6.3	Excavate to design foundation profile and cart to stockpile/spoil [4]	m3	21,569
6.4	Supply and place geofabric material	m2	280
6.5	Supply and place granular filter (d50 25mm)	m3	590
6.6	Supply and place rock rip-rap (d50 200,300,350mm) [2,3]	m3	3,590
7	**General fill**		
7.1	Clear and grub footprint	m2	221,540
7.2	Topsoil strip (nom. 200mm) and cart to stockpile [1]	m3	44,310
7.3	Supply and place approved earthfill material	m3	413,310
7.4	Topsoil placement (nom. 300mm) and ripping (min. 600mm)	m3	66,470

[1] Assumes 200mm of topsoil present throughout entire site

[2] Volumes do not account for bulking.

[3] Hard rock with minimum specific gravity 2.5

[4] Remove and replace unsuitable foundation material as directed

7 References

Alluvium, 2014. *Criteria for functioning river landscape in mining and post mining landscapes* (C20017). Report by Alluvium for Australian Coal Association Research Program (ACARP).

Alluvium, 2015. *Collaborative Performance Trajectories for Diversion Approvals Relinquishment* (C23030). Report by Alluvium for Australian Coal Association Research Program (ACARP).

Alluvium, 2014. *Mulgrave Resource Access Walker Creek Diversion Stage 2A Levee Design Plan*. Report by Alluvium Consulting Australia for BHP Billiton Mitsui Coal.

Alluvium, 2015. *Mulgrave Resource Access Walker Creek Diversion Stage 2 Feasibility*. Report by Alluvium Consulting Australia for BHP Billiton Mitsui Coal.

Alluvium, 2016a. *Mulgrave Resource Access Walker Creek Diversion - Stage 2C Revegetation Plan*. Report by Alluvium Consulting Australia for BHP Billiton.

Alluvium, 2016b. *MRA2C Surface Water Impact Assessment – Water Balance Study*. Report by Alluvium Consulting Australia for BHP Billiton.

Department of Natural Resources and Mines (DNRM) (2014). *Guideline: Works that interfere with water in a watercourse–watercourse diversions.*

Attachment A
Existing conditions 1D hydraulic modelling results

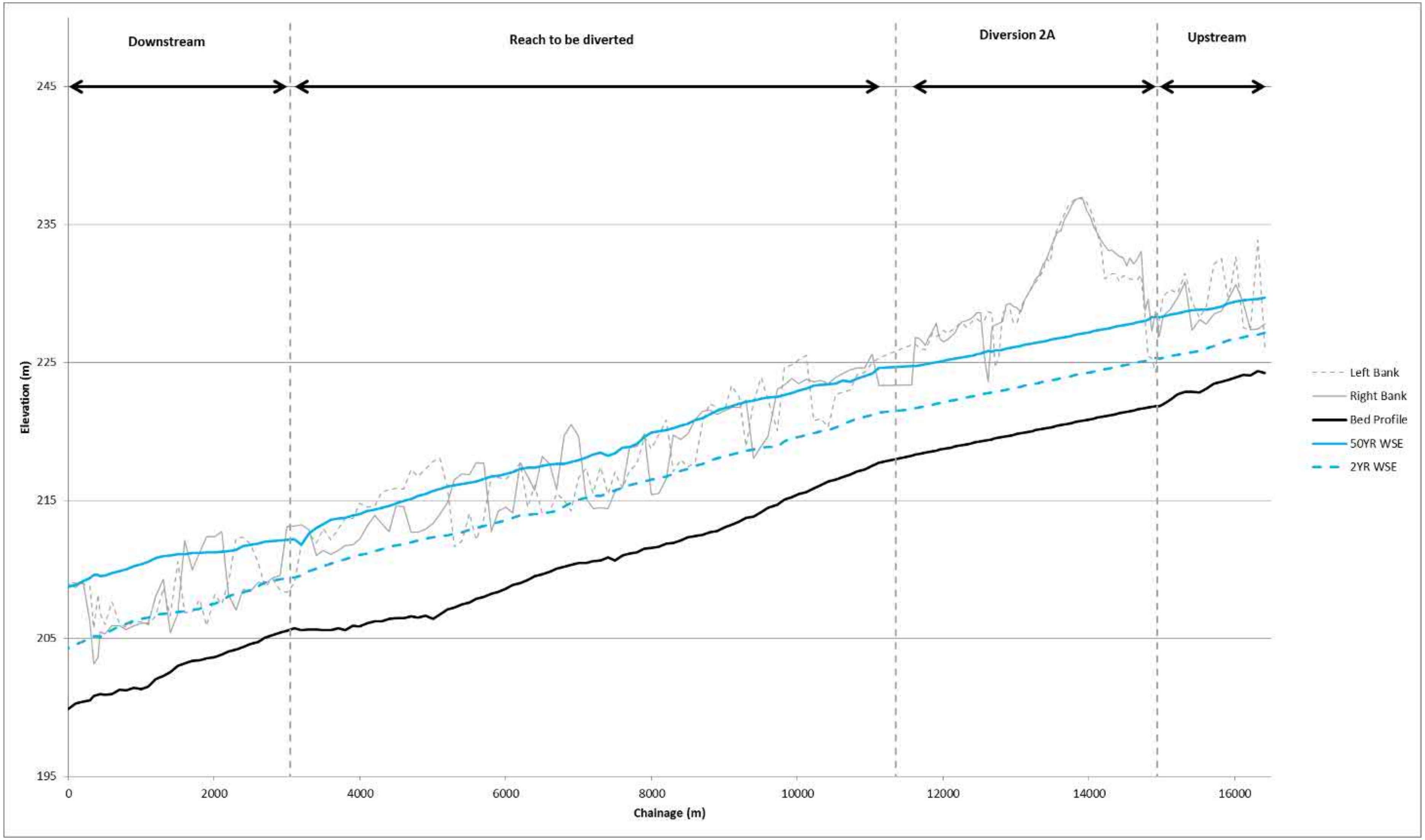


Figure 7-1. Walker Creek existing water surface elevation longitudinal profile for 2 year and 50 year ARI events

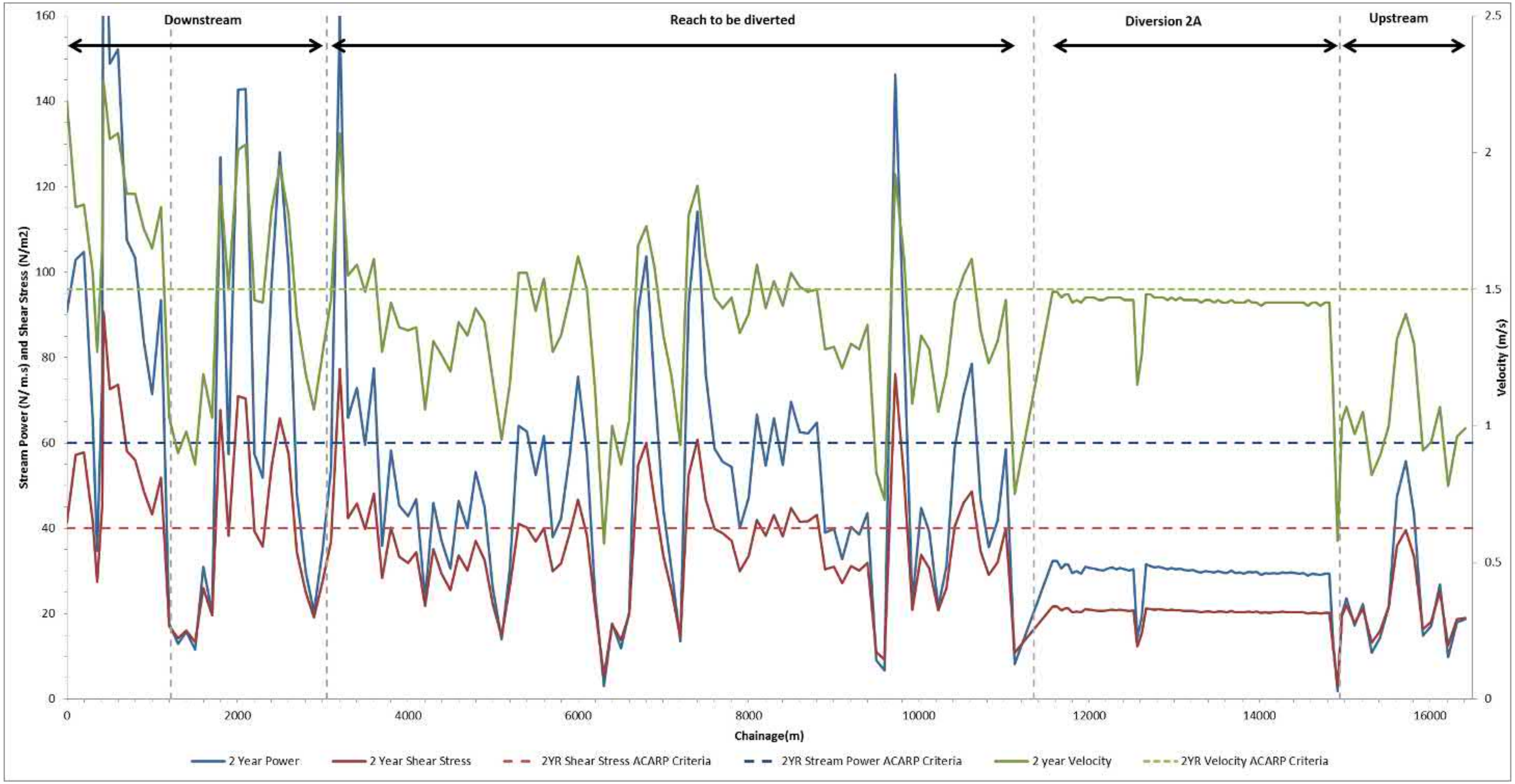


Figure 7-2. Walker Creek existing hydraulic parameter results for the 2 year ARI event

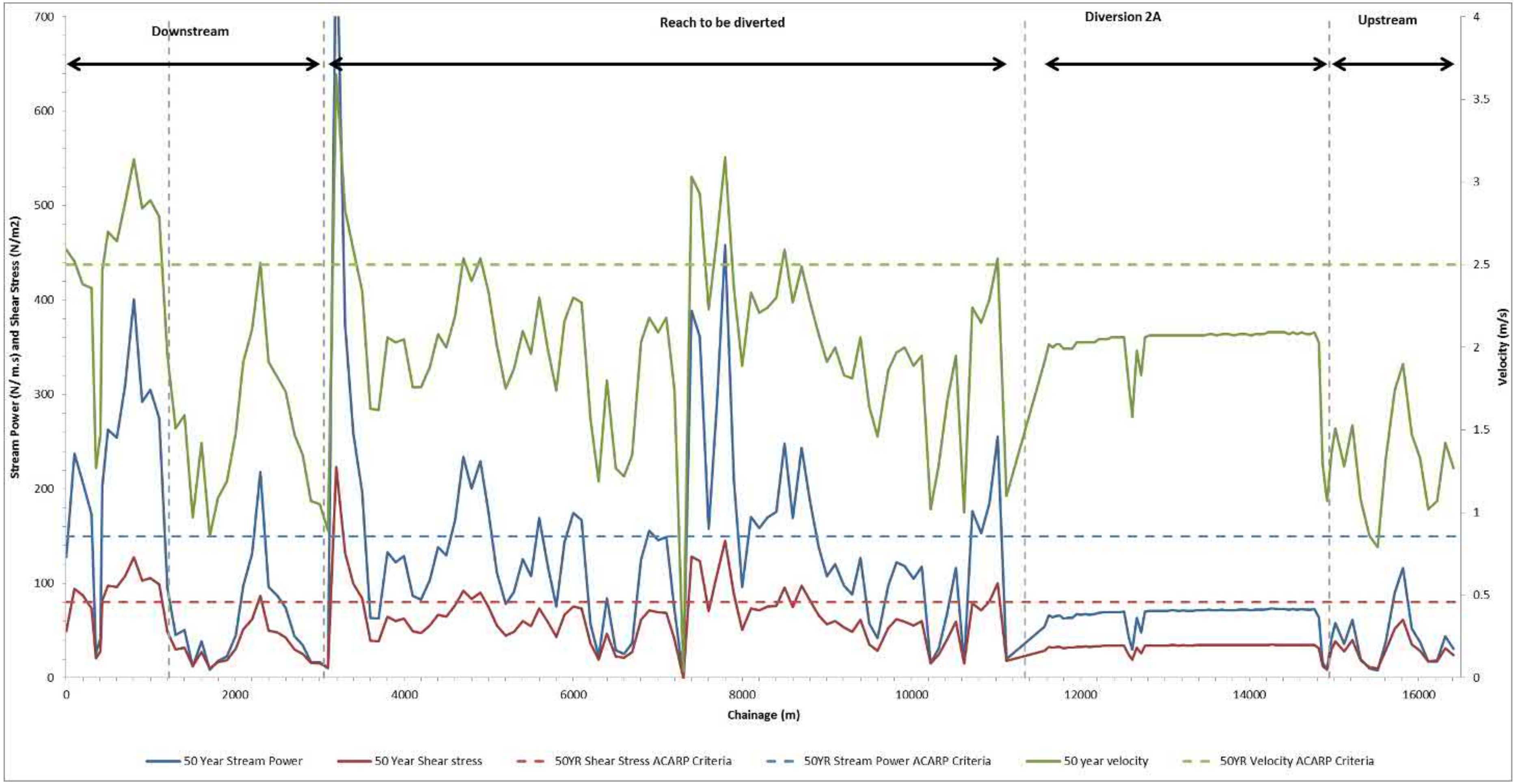


Figure 7-3. Walker Creek existing hydraulic parameter results for the 50 year ARI event

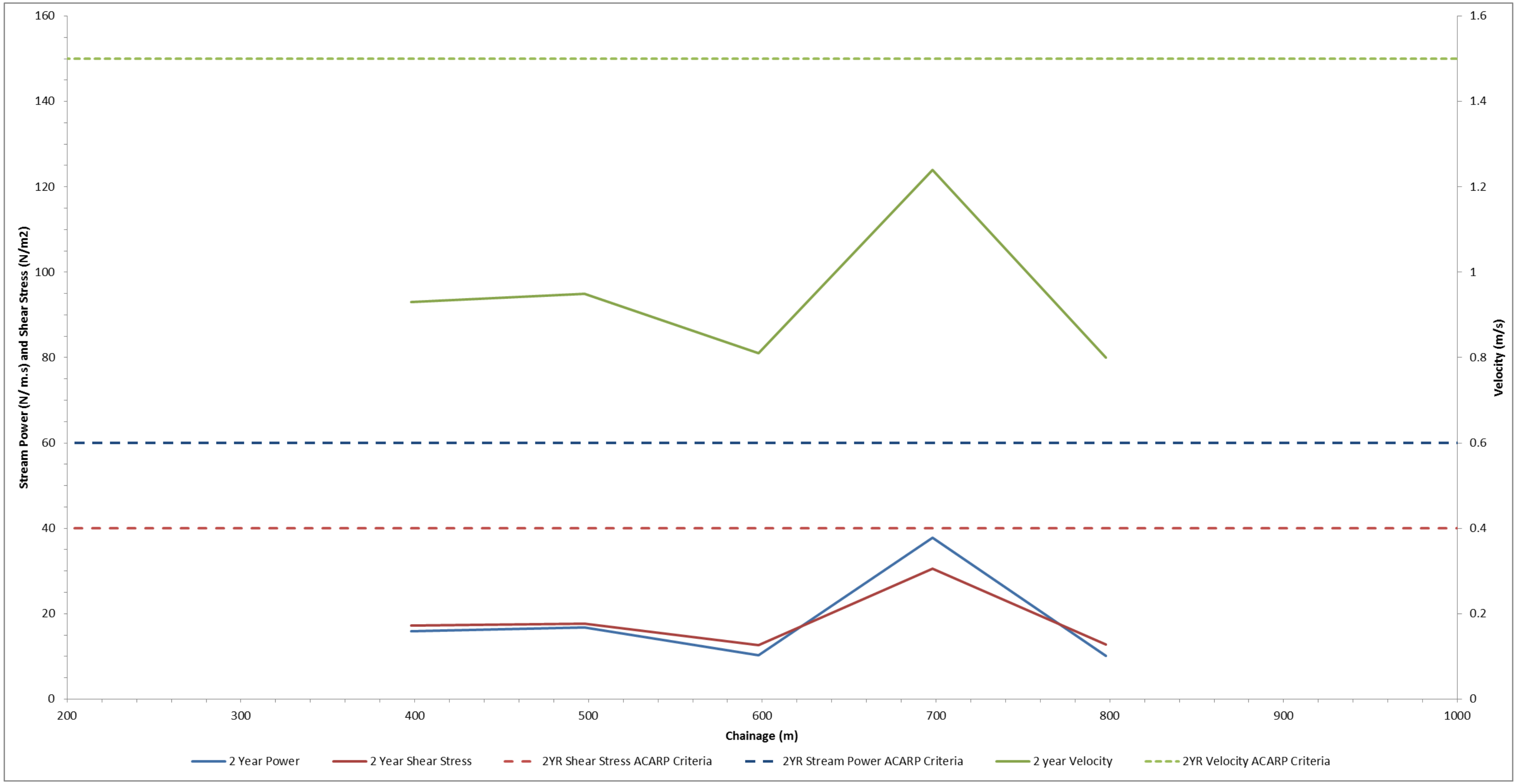


Figure 7-4. Carborough Creek existing hydraulic parameter results for the 2 year ARI event

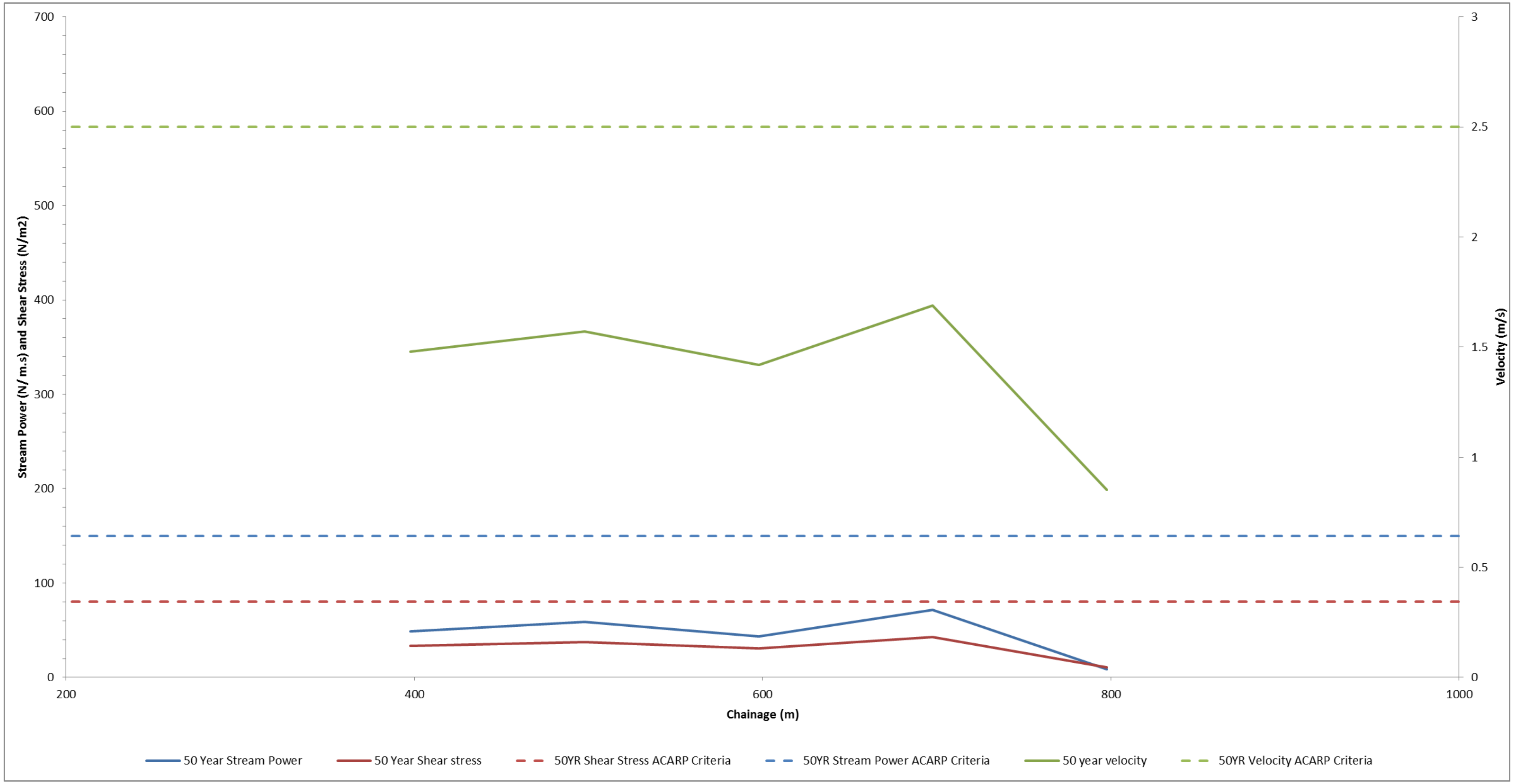


Figure 7-5. Carborough Creek existing hydraulic parameter results for the 50 year ARI event

Attachment B
2D hydrodynamic modelling

8 2D hydrodynamic modelling

8.1 2D hydrodynamic modelling overview

Hydrodynamic modelling was undertaken to assess the flood behaviour of the 2 and 50 year ARI, and the 1% and 0.1% AEP design events for the existing and diverted scenarios for Walker Creek.

The model was updated and modified from earlier studies undertaken by Alluvium for SWCM, particularly the modelling undertaken in 2015 for the feasibility study.

8.2 2D hydrodynamic model set-up

The 2D hydrodynamic model of the catchment within and adjacent to the project area was updated using XPSWMM (v2016), a hydrodynamic modelling software package which couples together the SWMM 1D model and the 2D finite difference model TUFLOW.

The hydrodynamic model outfalls on Walker Creek, approximately 2km downstream of the confluence on the diversion tie in to Walker Creek. The model extends upstream past the limit of the mining activities. See Figure 8-1.

The model was configured using an 8m cell size.

Manning's n roughness coefficients for the model were left unchanged from earlier modelling, with the exception of the provision for the diverted channel. The values adopted for the different land uses are presented in Table 8-1.

Table 8-1. Manning's n roughness values for 2D model

Land use/Vegetation Type	Roughness value
Diversions	0.05
High Density Vegetation	0.09
Medium Density Vegetation	0.06
Low Density Vegetation	0.04
Extra Low Density Vegetation	0.03
Sand bed, no vegetation	0.025
Mining areas	0.025

Design hydrographs were input into the model at the locations shown in Figure 8-1 to represent inputs from both the catchments external to the area. Some nodes used for existing conditions were removed from the diverted scenario model to reflect the reduction in contributing area resulting from planned pit progression.

It should be noted that the XPSWMM hydrodynamic model does not predict erosion and sediment transport impacts. Dam and other embankment failure scenarios have not been modelled in this assessment and therefore results are based on stable topography over the full length of the modelled events.

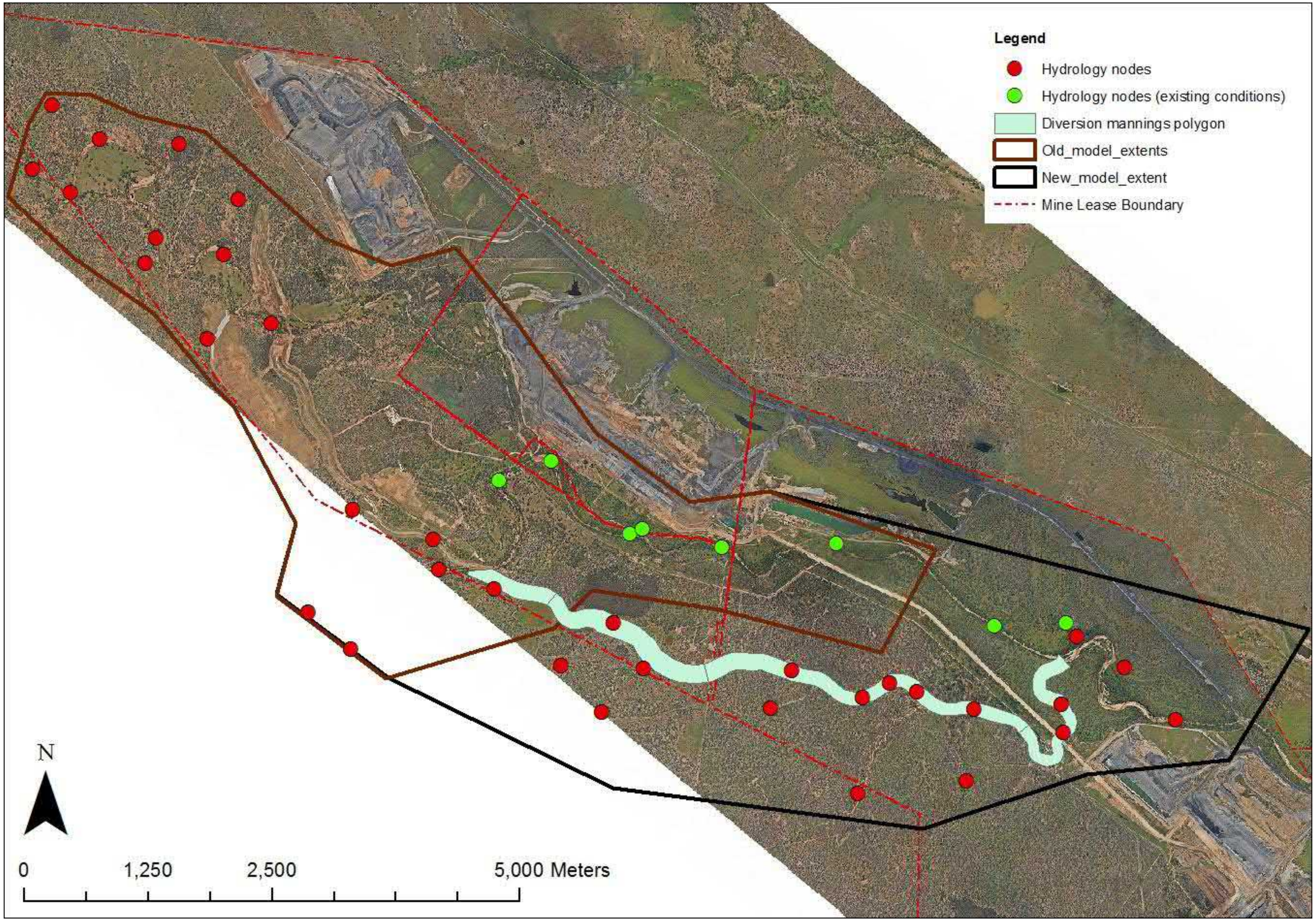


Figure 8-1. 2D hydrodynamic 0.1% AEP model set up (existing conditions)

8.3 2D hydrodynamic modelling results

This section presents the hydrodynamic modelling results for post diversion scenarios. Results presented include depth, shear stress and depth and shear stress afflux.

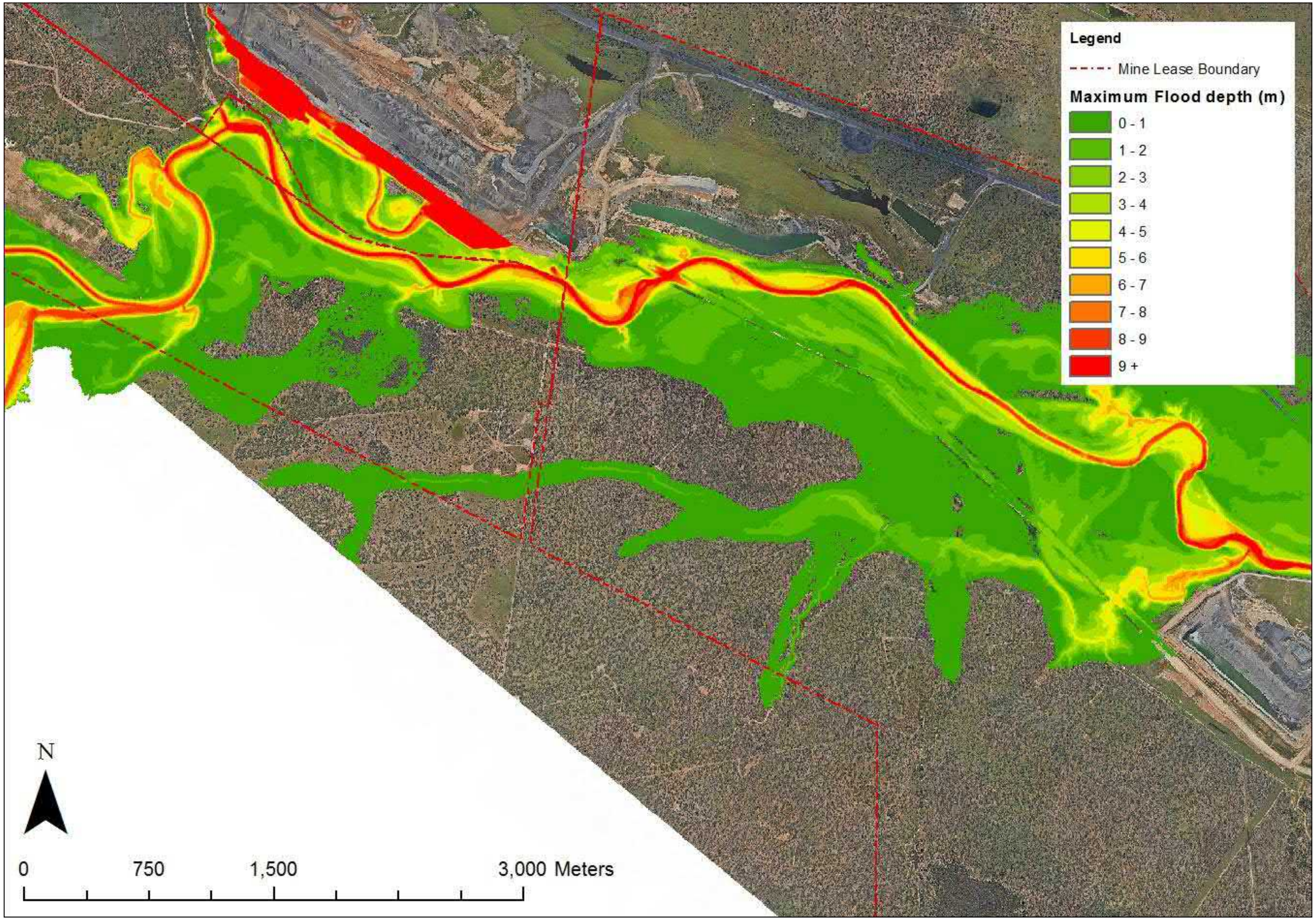


Figure 8-2. Existing conditions 0.1% AEP maximum flood depths

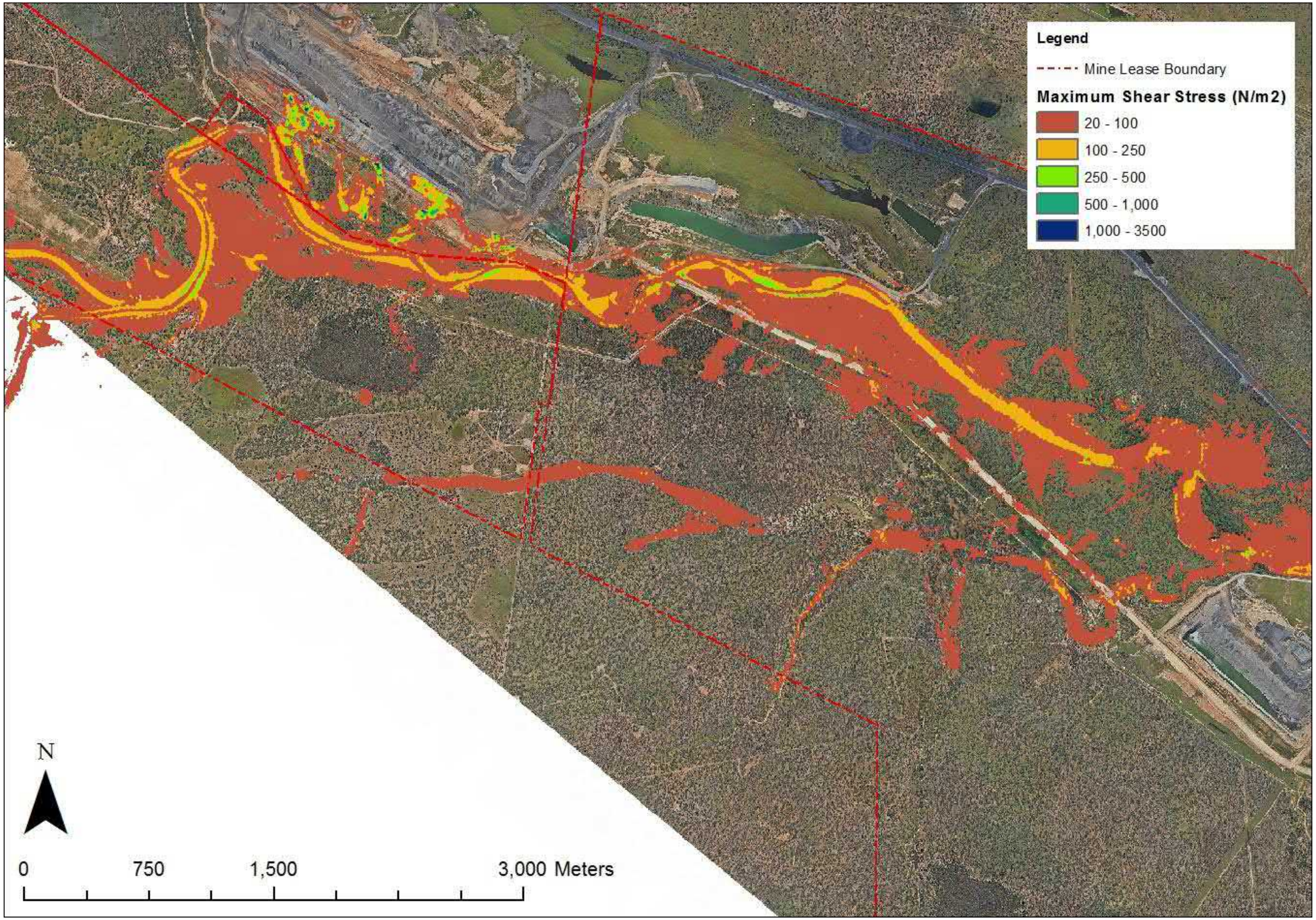


Figure 8-3. Existing conditions 0.1% AEP bed shear stress

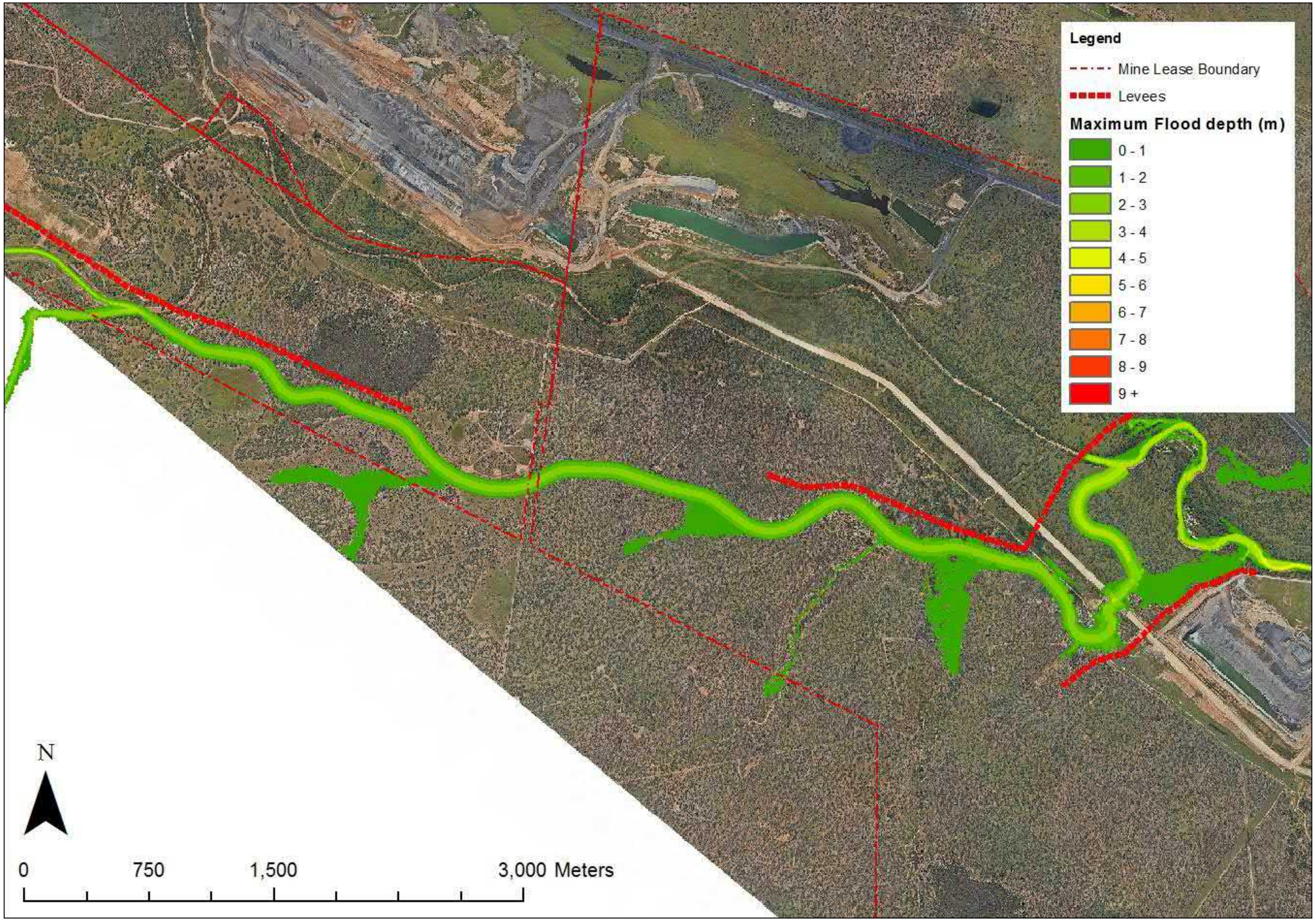


Figure 8-4. Post diversion 2 year ARI maximum flood depths

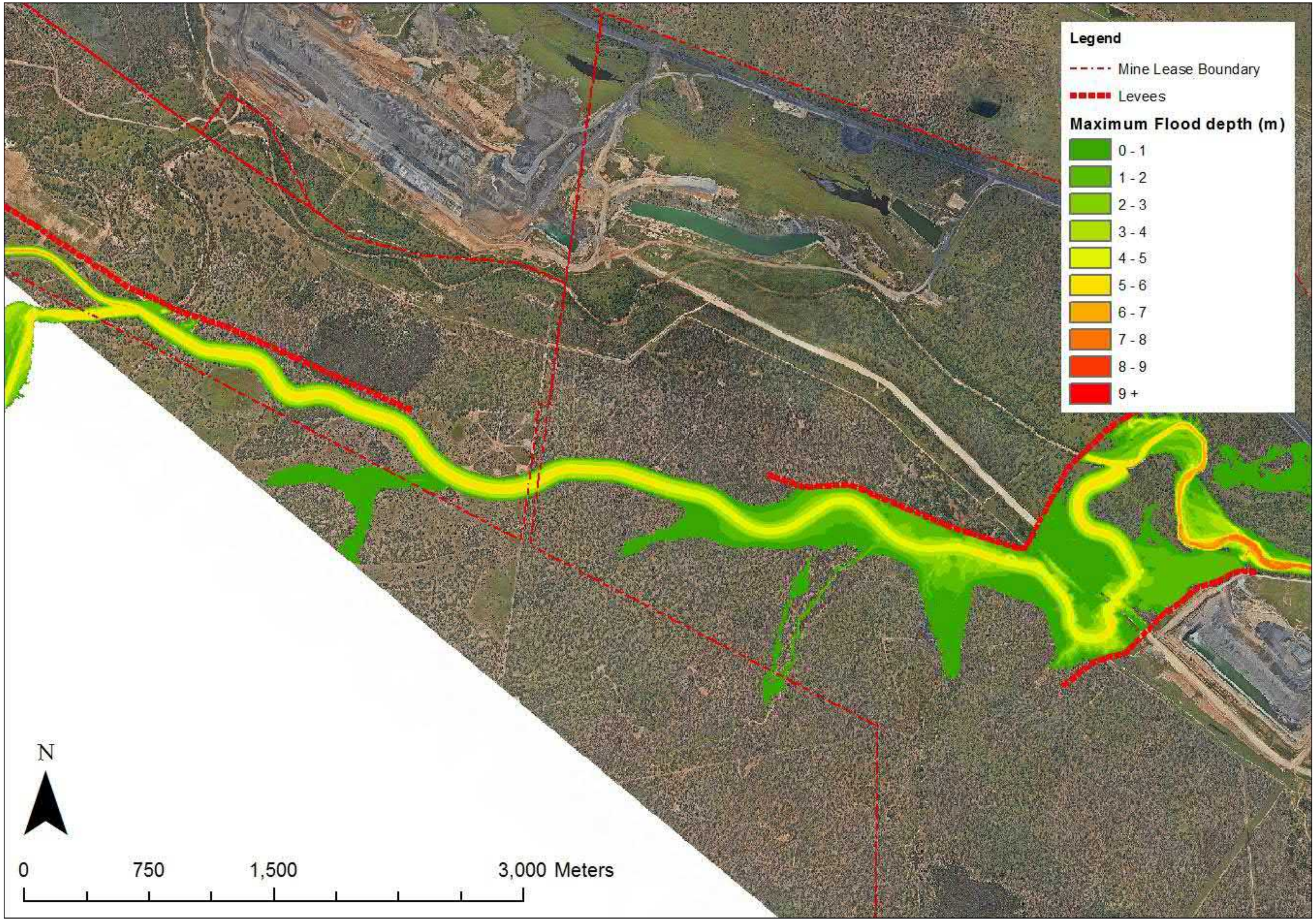


Figure 8-5. Post diversion 50 year ARI maximum flood depths

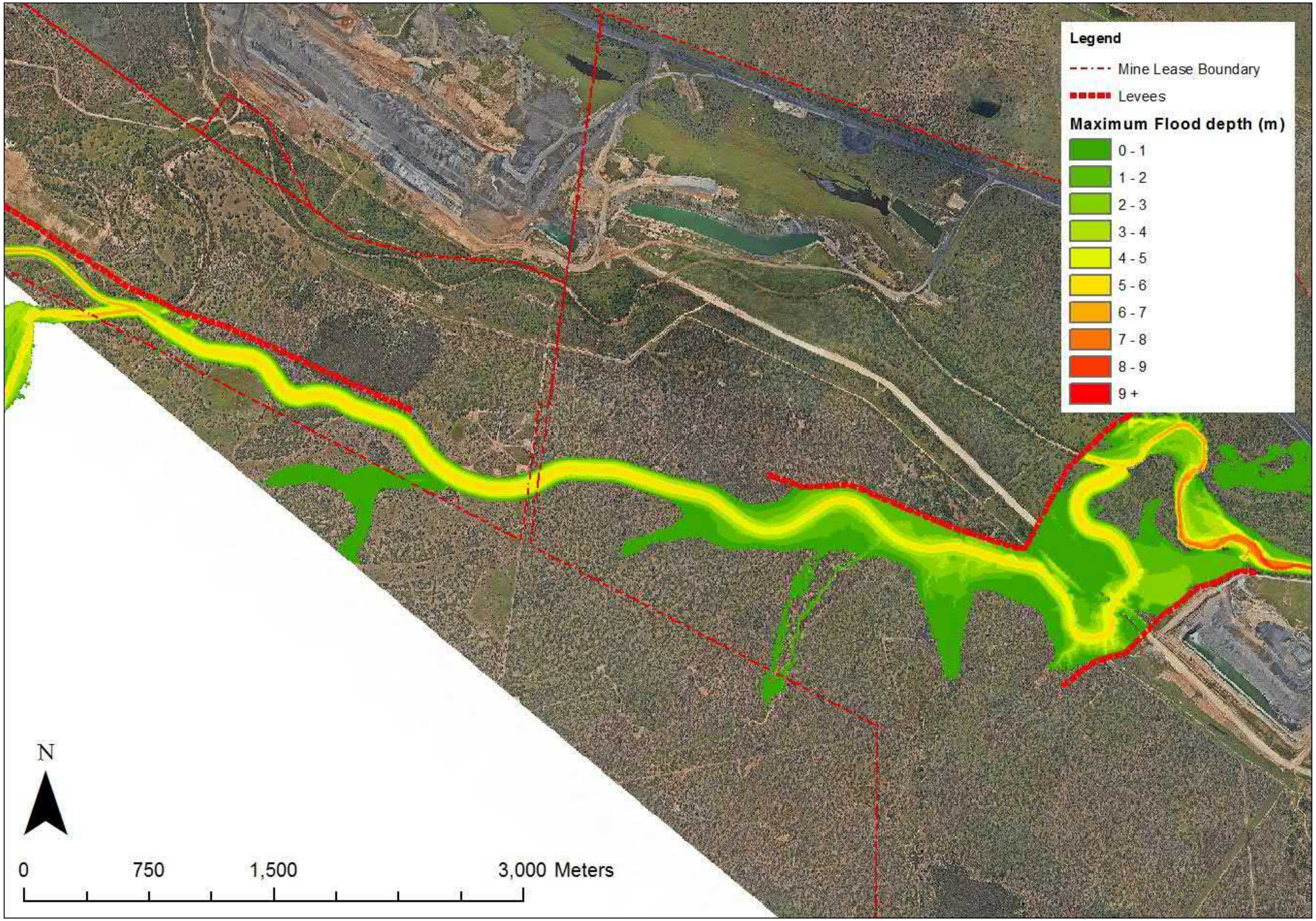


Figure 8-6. Post diversion 1% AEP maximum flood depths

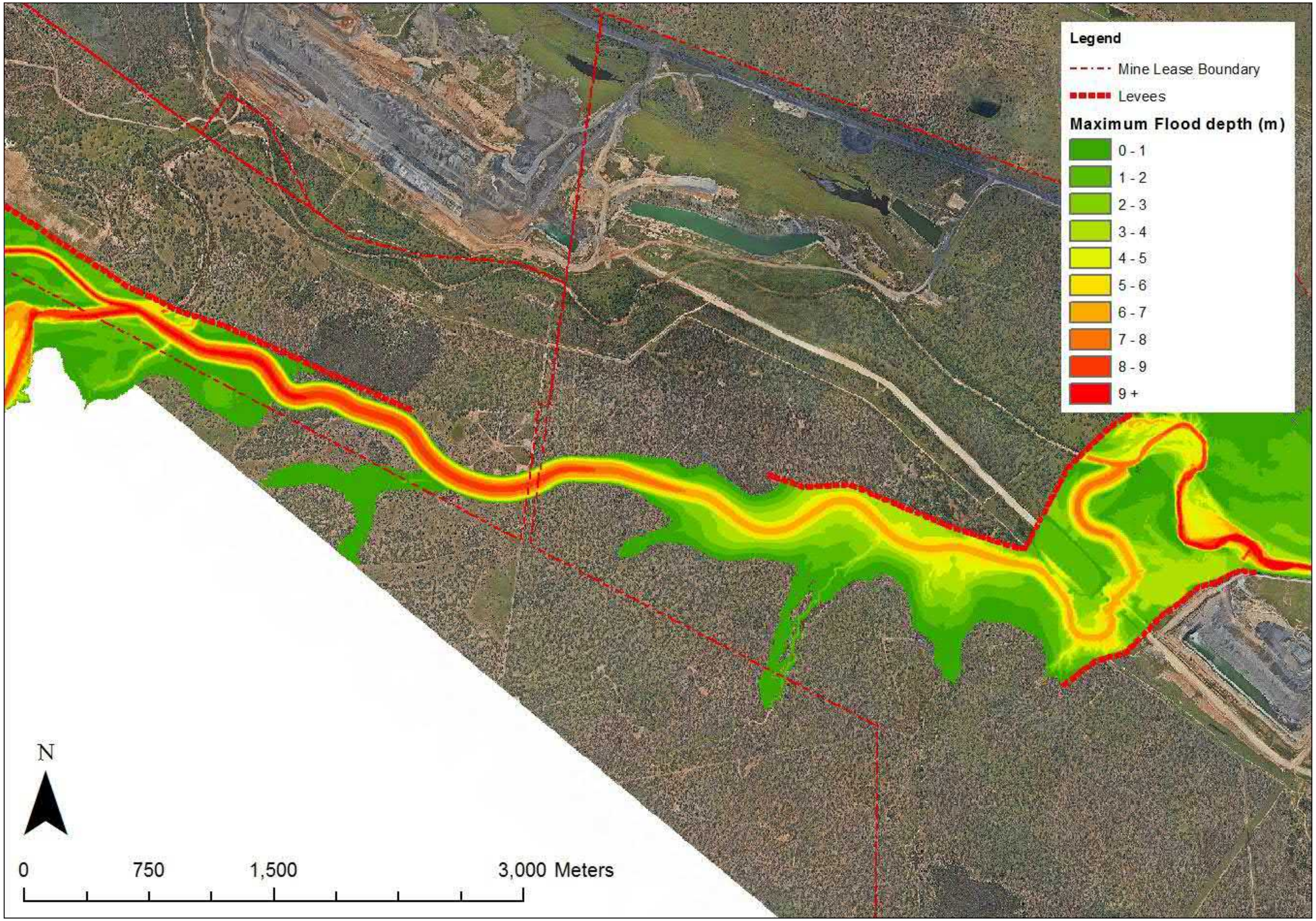


Figure 8-7. Post diversion 0.1% AEP maximum flood depths

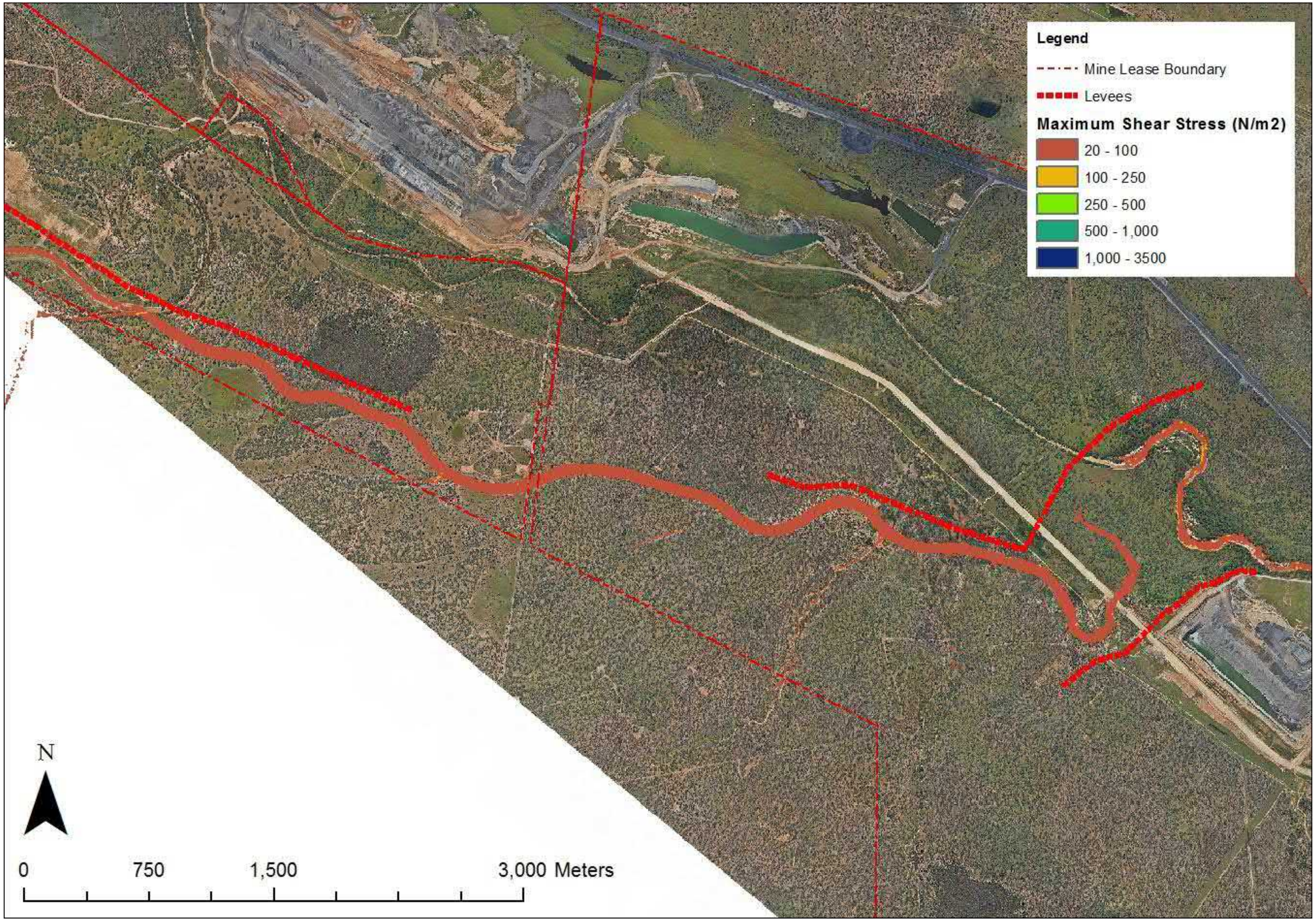


Figure 8-8. Post diversion 2 year ARI bed shear stress

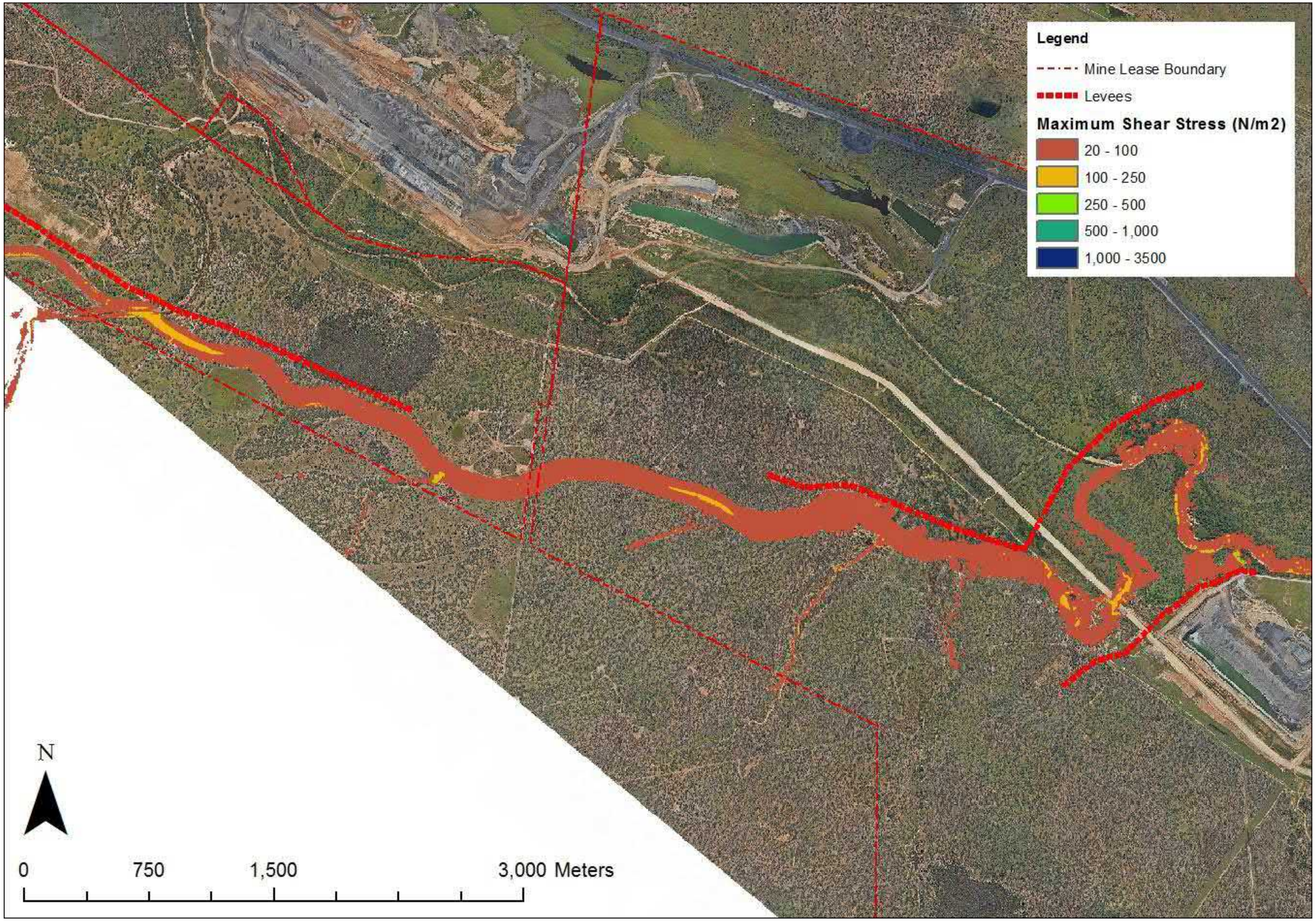


Figure 8-9. Post diversion 50 year ARI bed shear stress

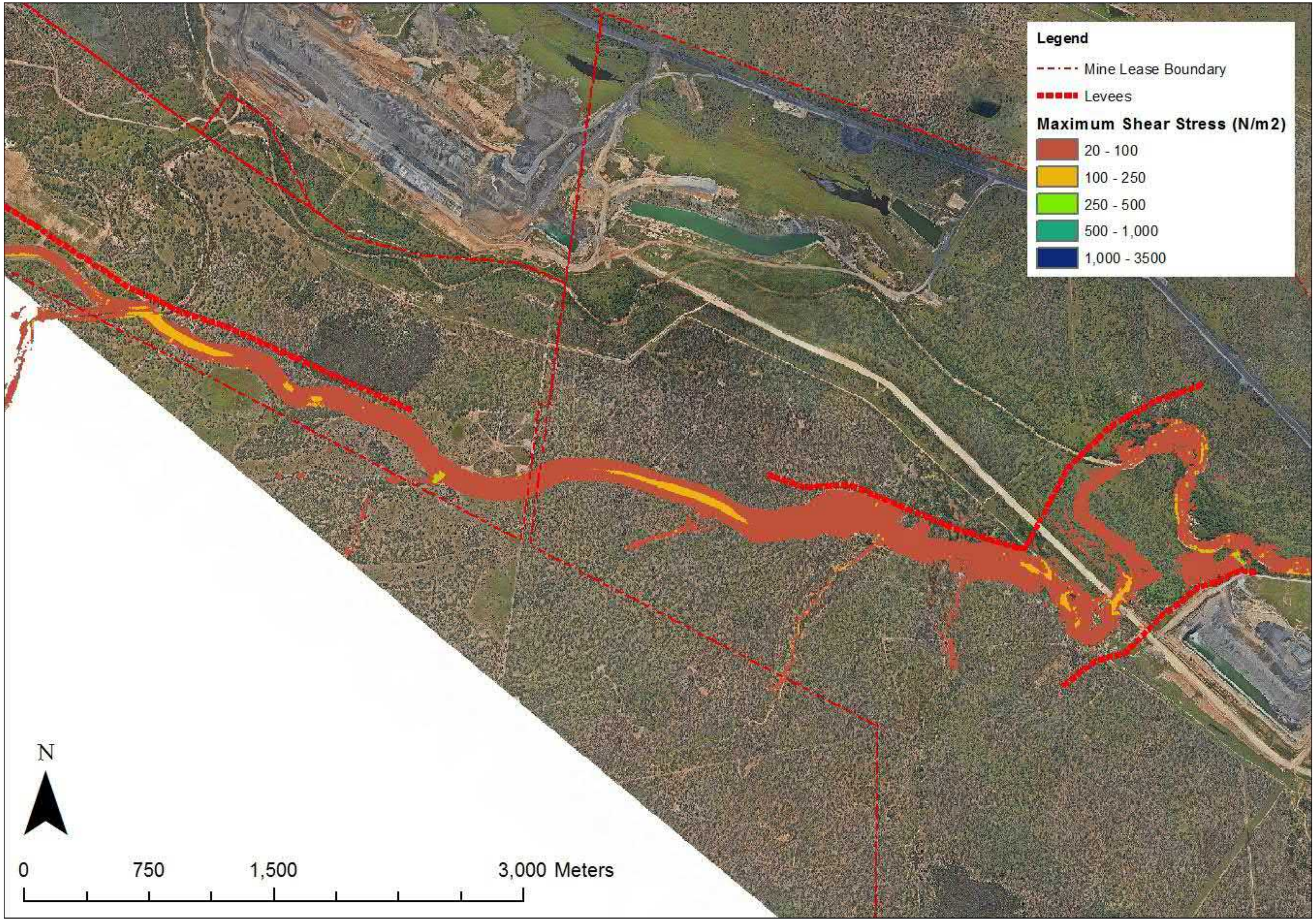


Figure 8-10. Post diversion 1% AEP bed shear stress

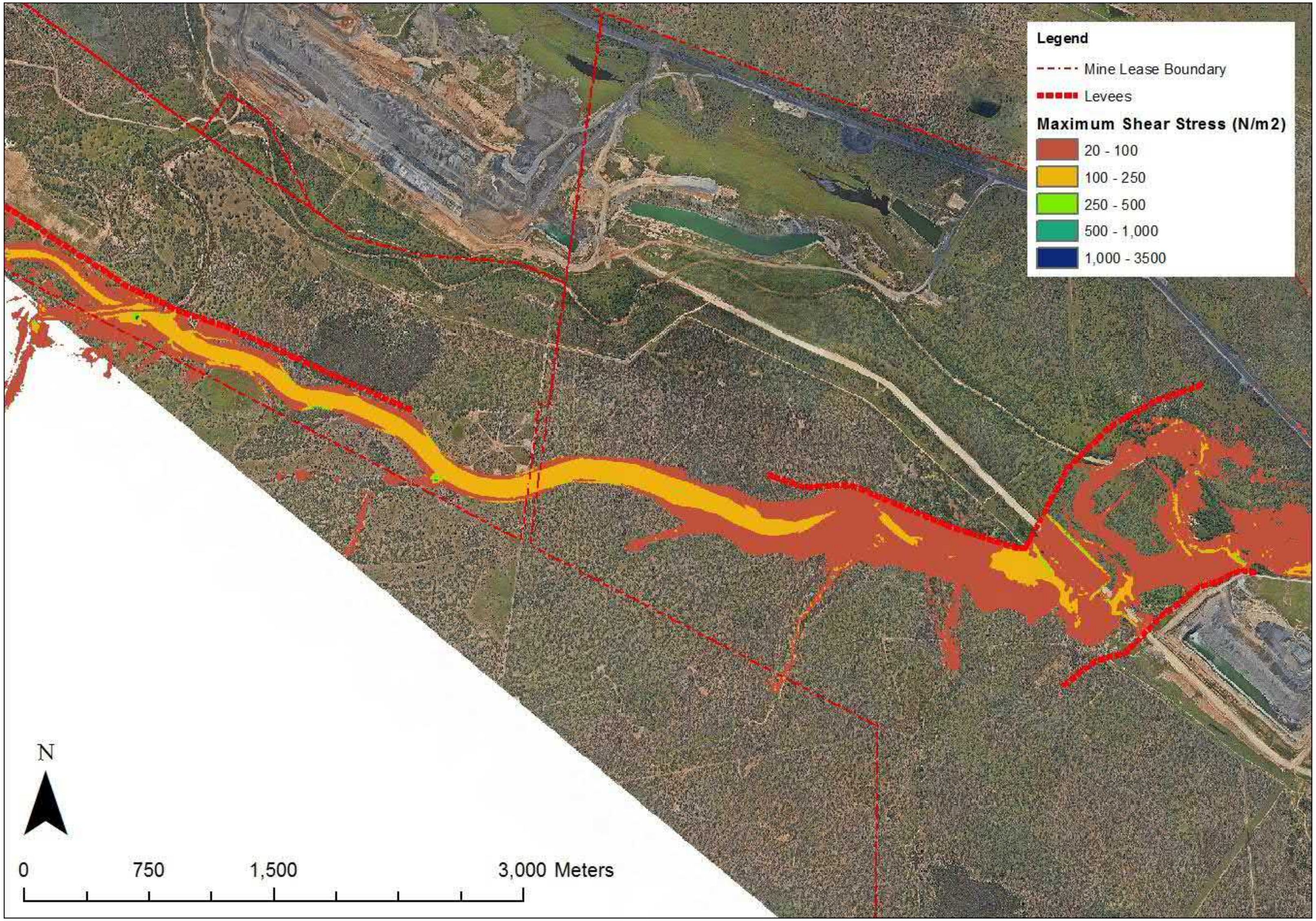


Figure 8-11. Post diversion 0.1% AEP bed shear stress

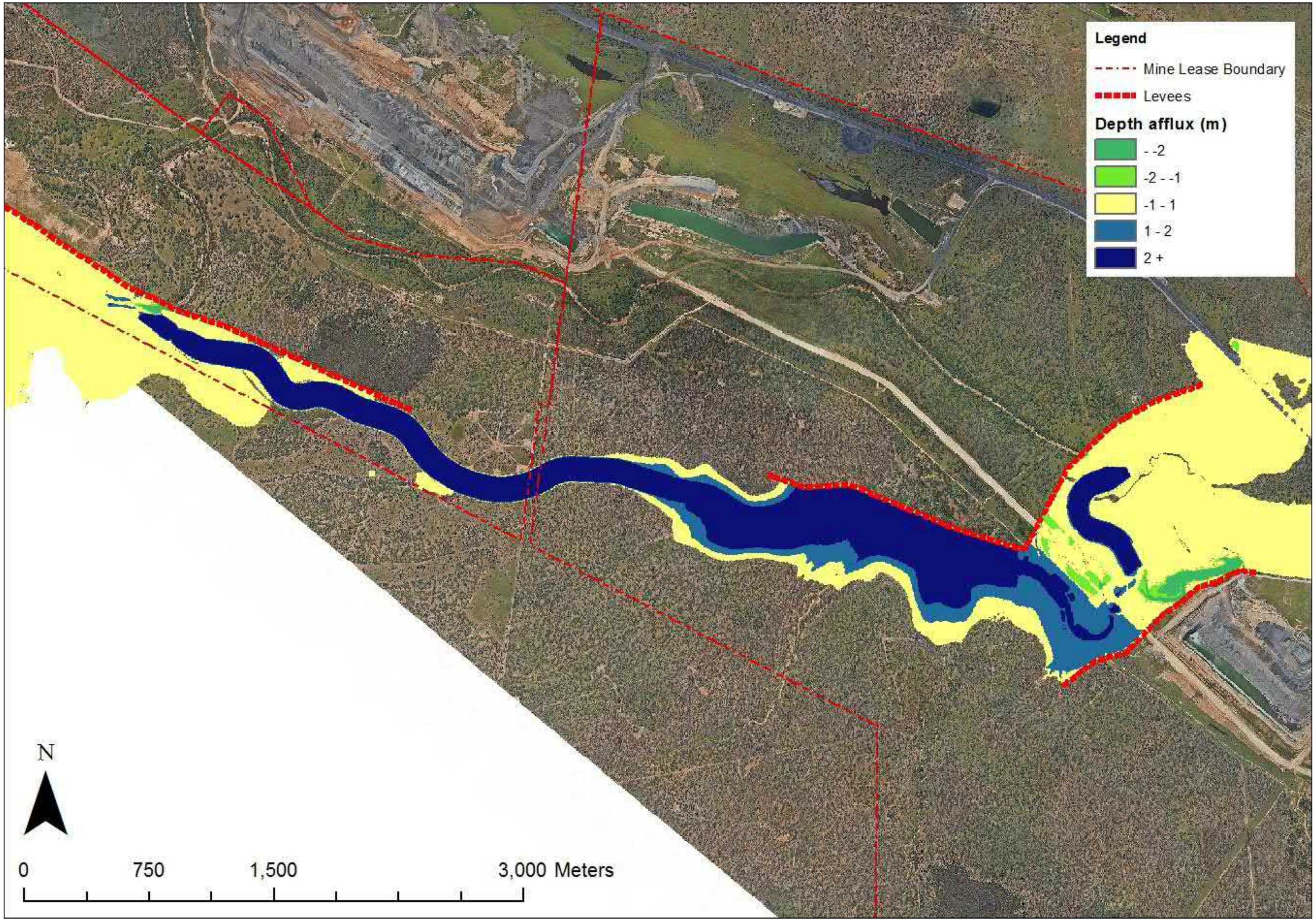


Figure 8-12. Post diversion 0.1% AEP maximum flood depth afflux

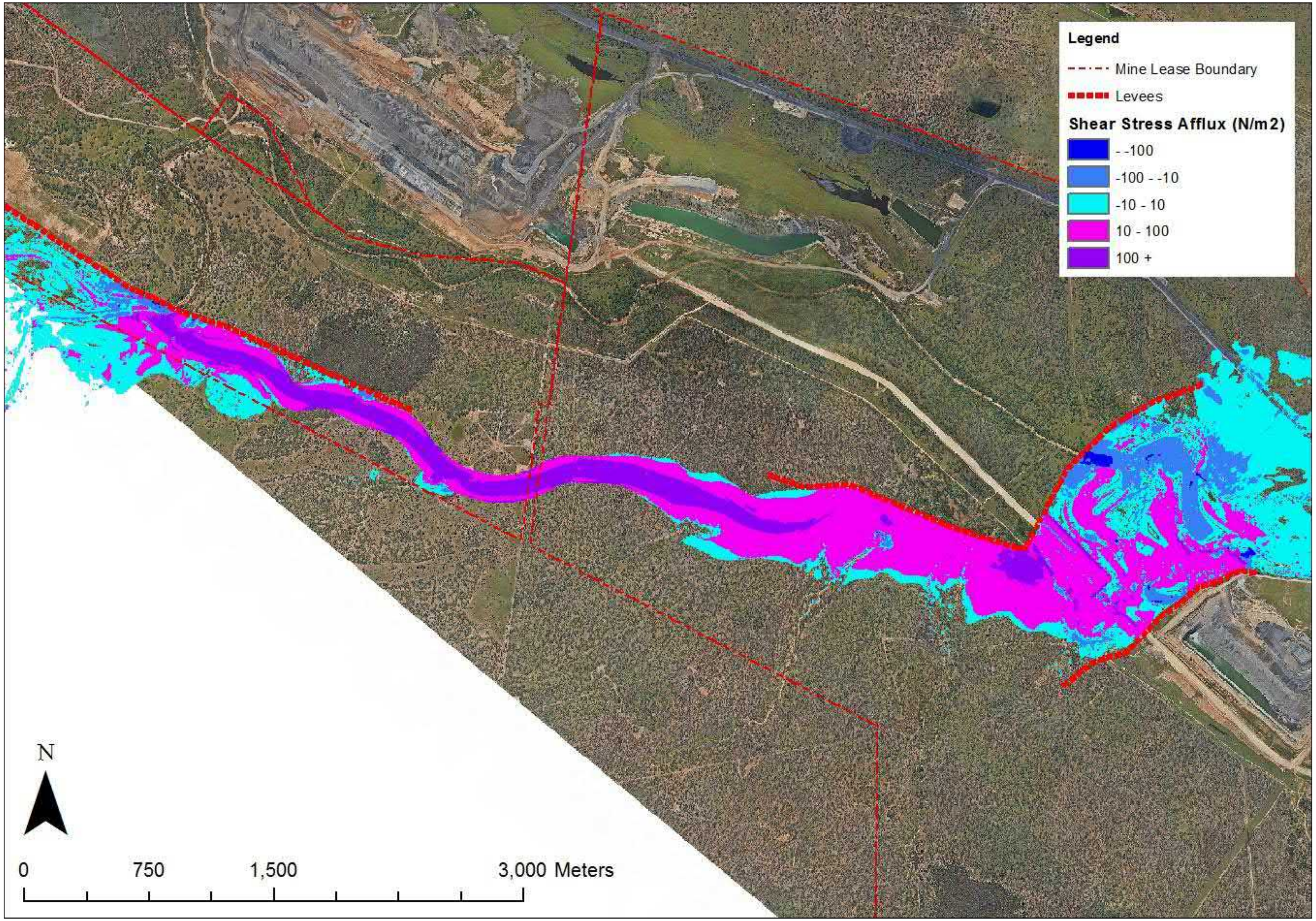


Figure 8-13. Post diversion 0.1% AEP maximum shear stress afflux

Attachment C
Post diversion conditions 1D hydraulic modelling results

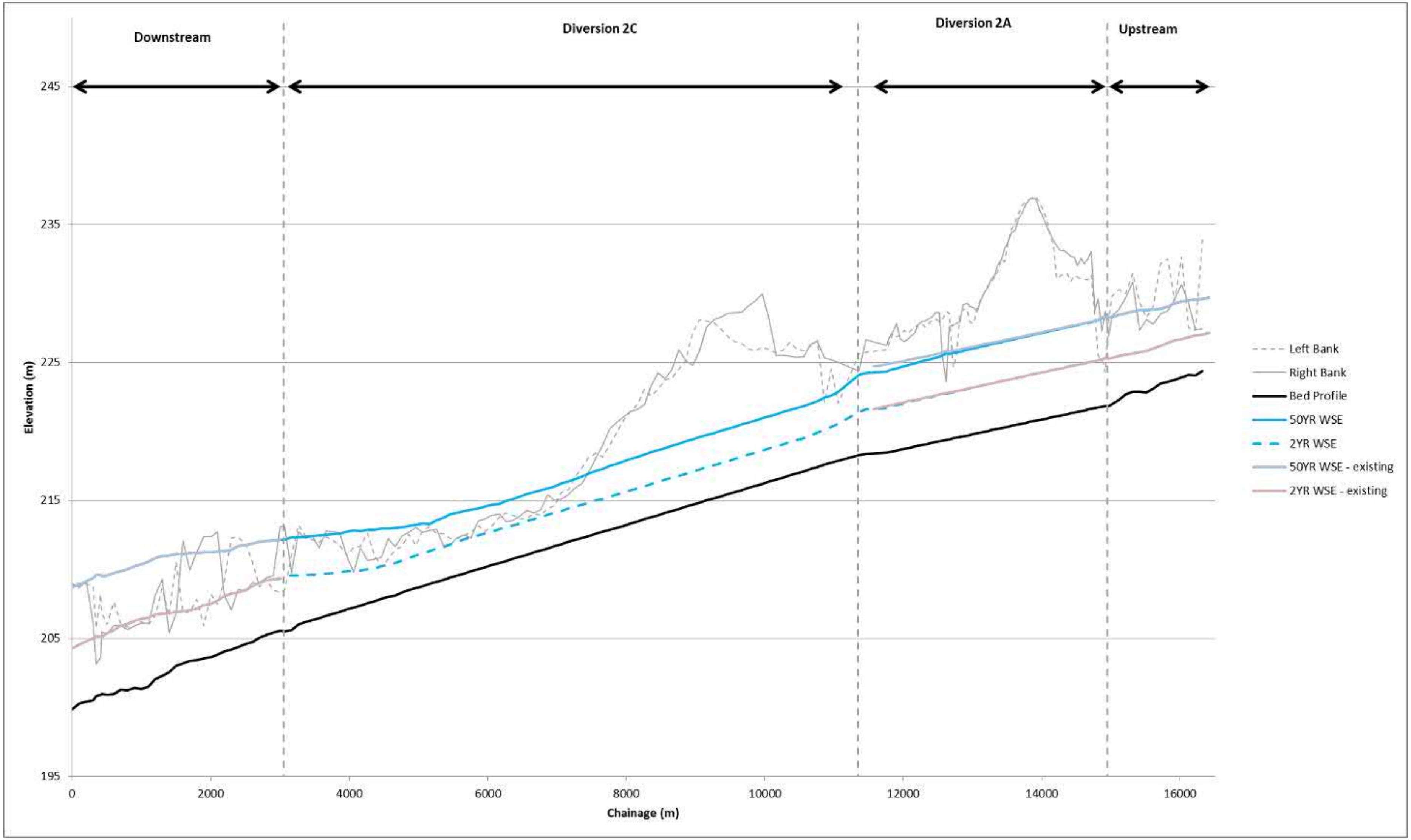


Figure 8-14. MRA Walker Creek Diversion Stage 2C water surface elevation longitudinal profile for 2 year and 50 year ARI events

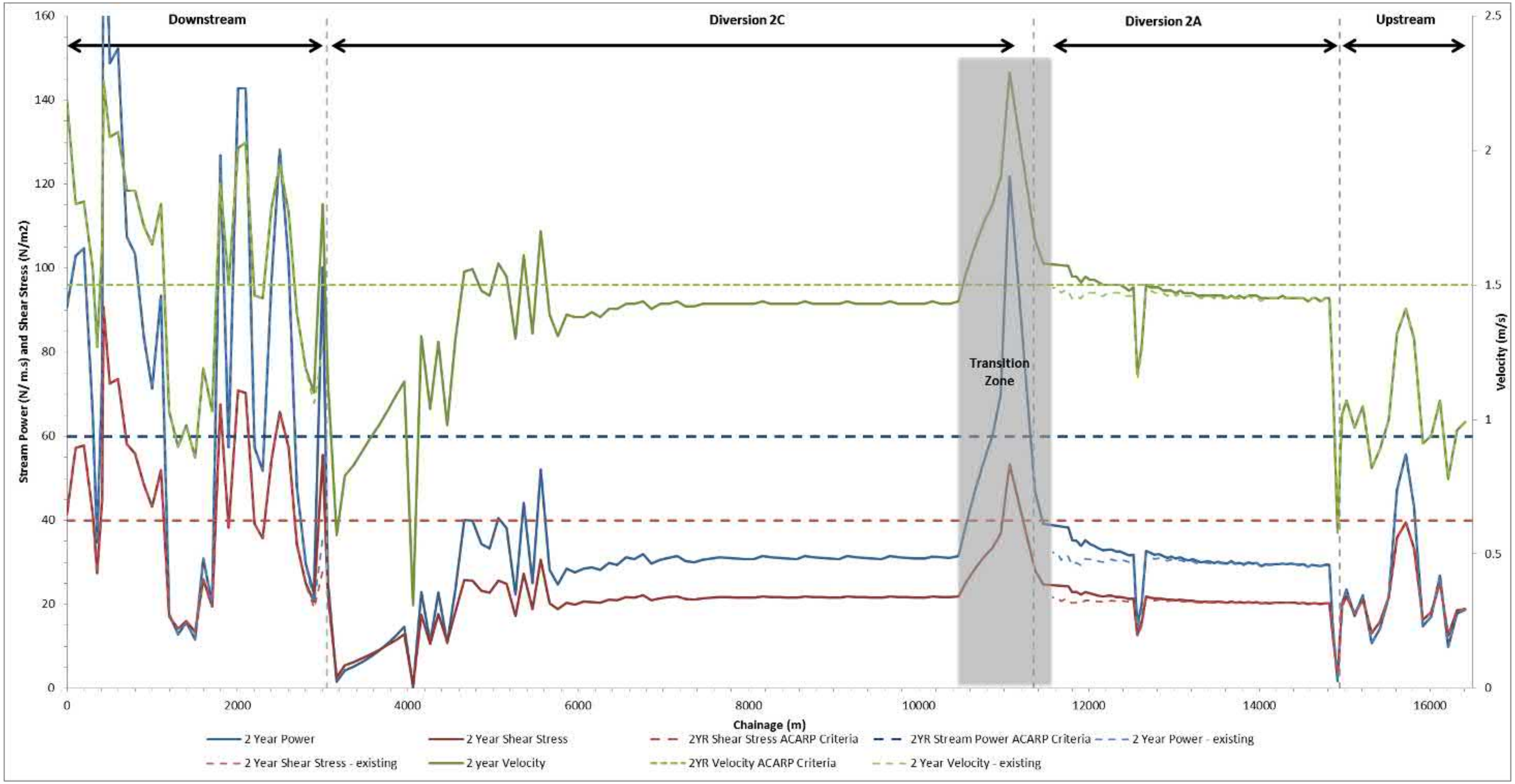


Figure 8-15. MRA Walker Creek Diversion Stage 2C hydraulic parameter results for the 2 year ARI event

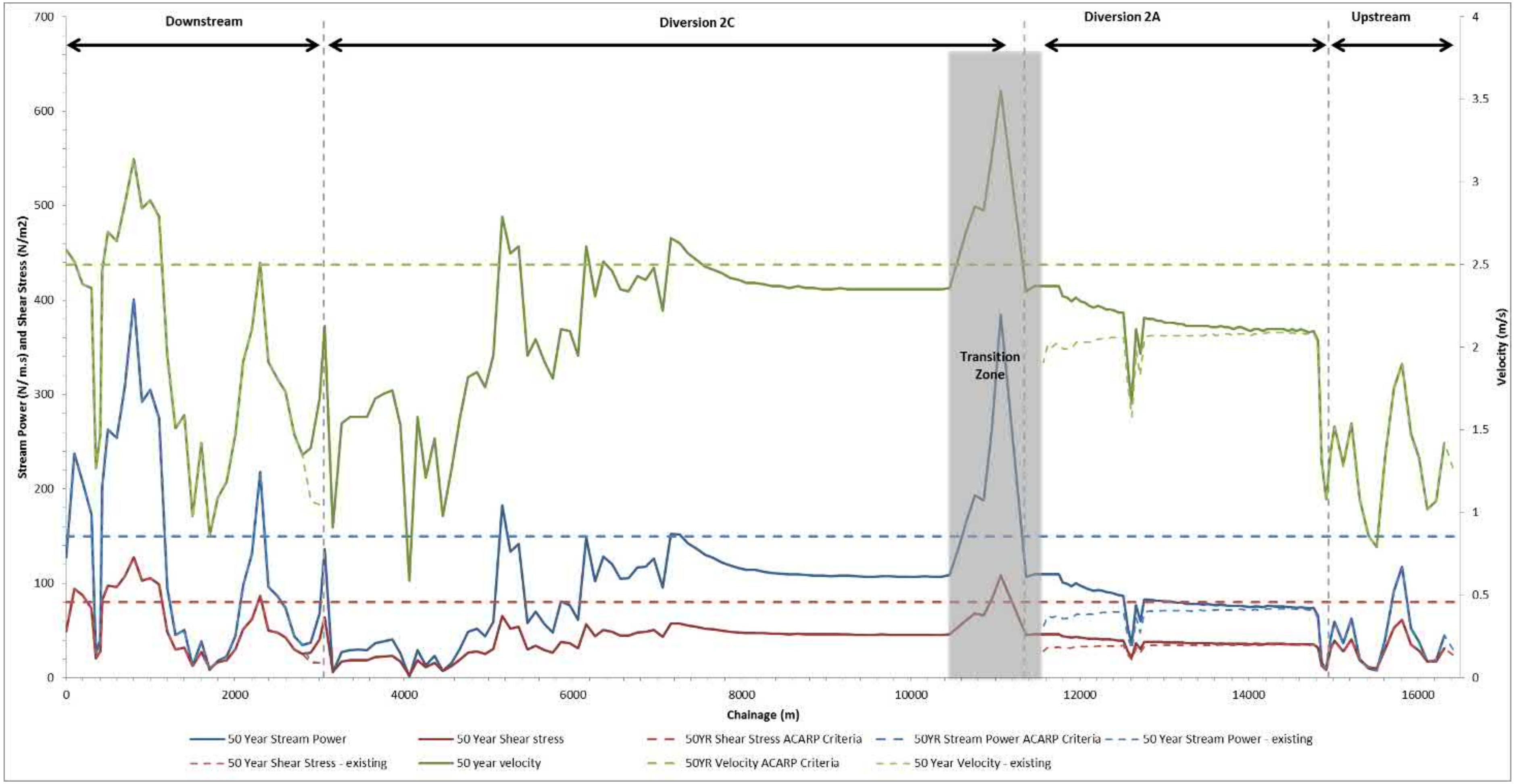


Figure 8-16. MRA Walker Creek Diversion Stage 2C hydraulic parameter results for the 50 year ARI event

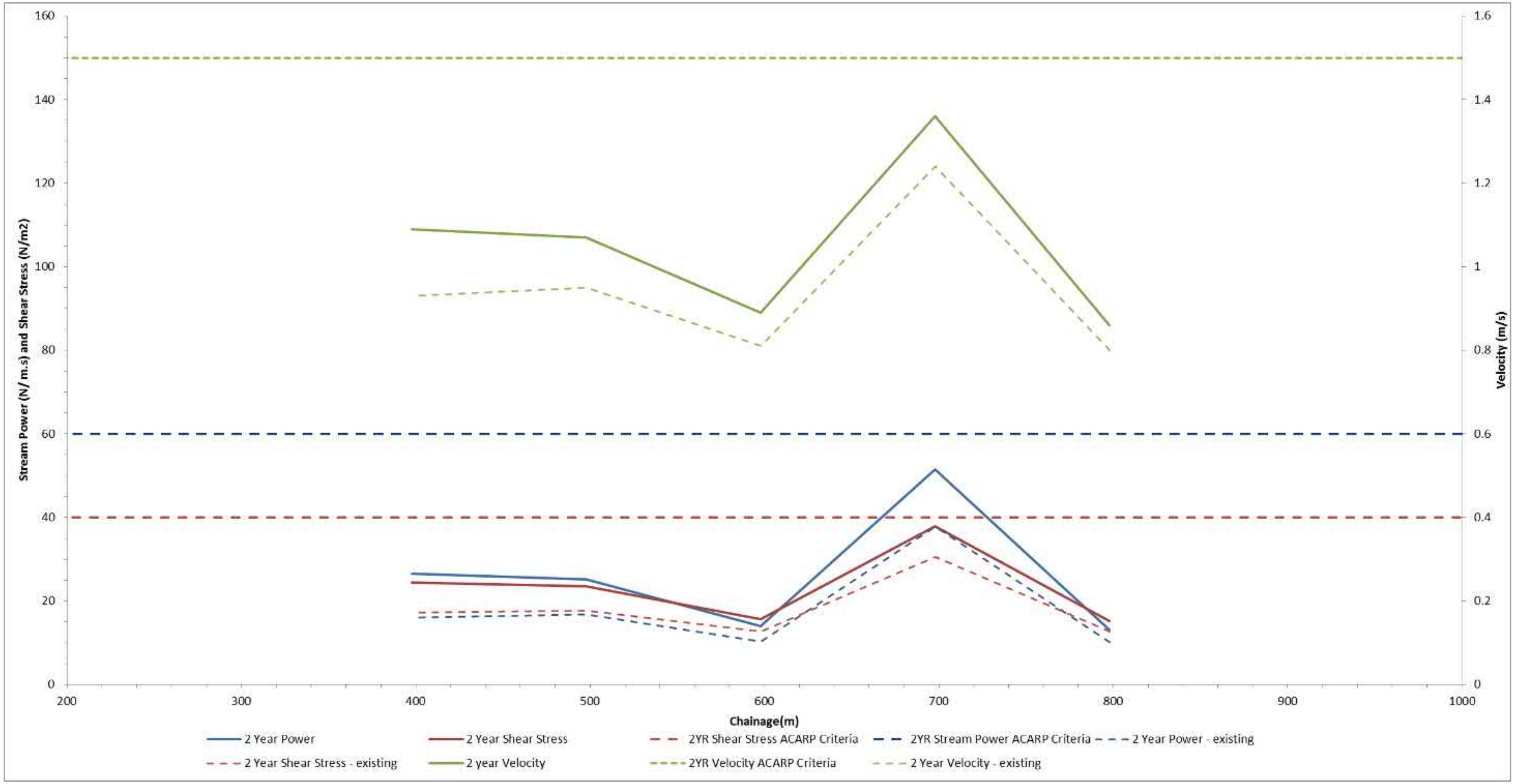


Figure 8-17. MRA Walker Creek Diversion Stage 2C – Carborough Creek hydraulic parameter results for the 2 year ARI event

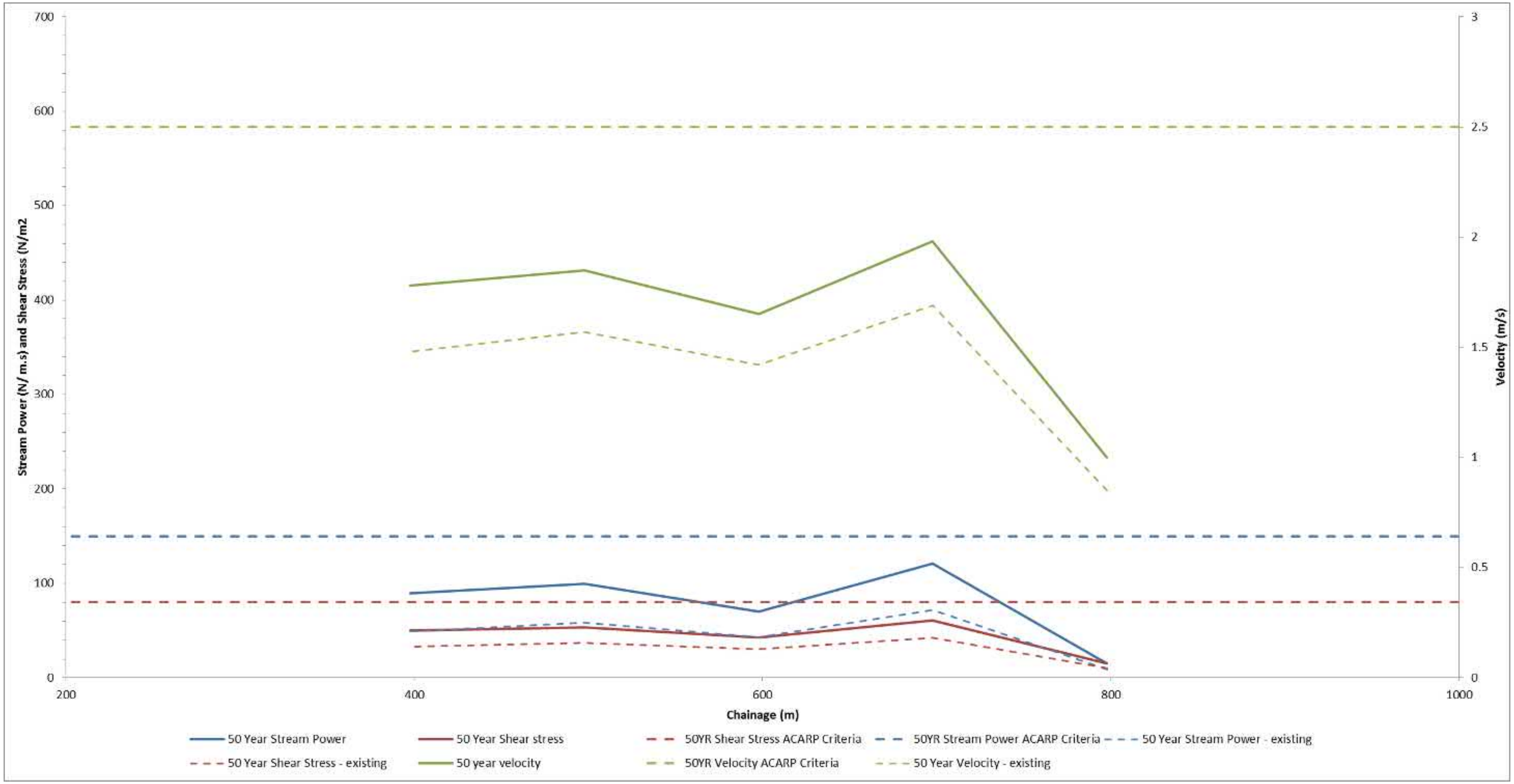
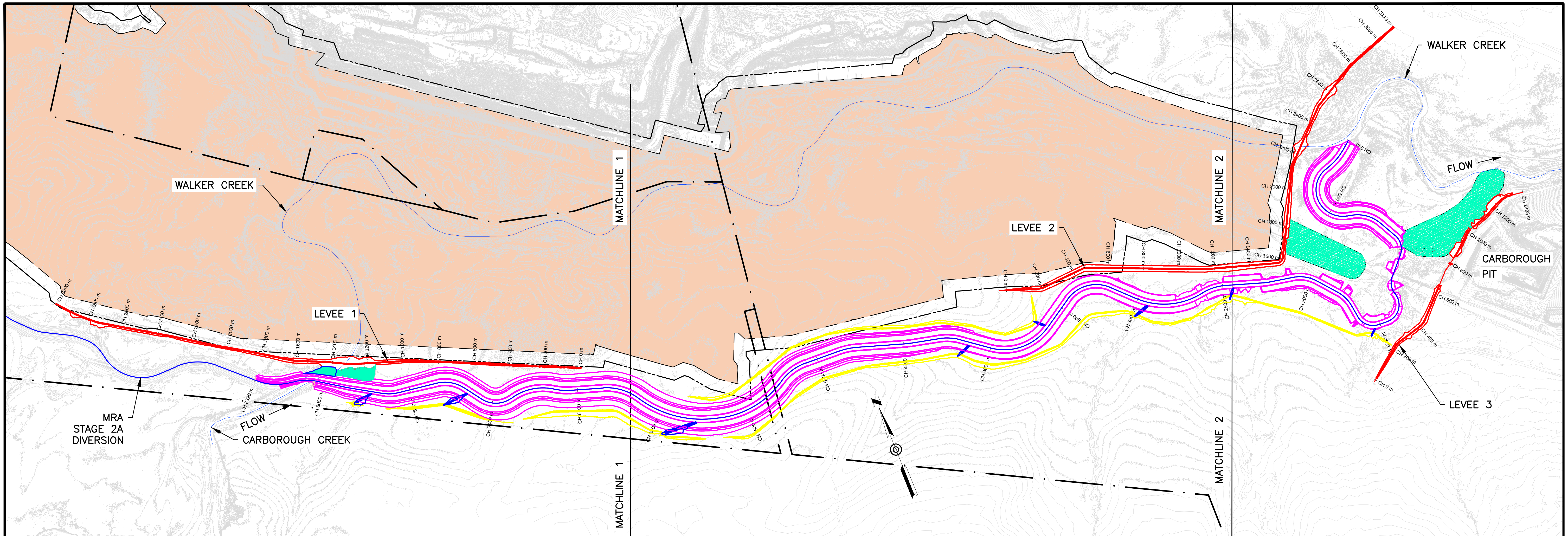


Figure 8-18. MRA Walker Creek Diversion Stage 2C – Carborough Creek hydraulic parameter results for the 50 year ARI event

Attachment D
Functional design drawings



DRAWING NUMBER	REVISION	DRAWING TITLE
P216009-001	B	PLANS, NOTES AND SCHEDULE OF DRAWINGS
P216009-002	A	DETAIL PLAN 1 OF 3
P216009-003	A	DETAIL PLAN 2 OF 3
P216009-004	B	DETAIL PLAN 3 OF 3
P216009-005	A	DIVERSION LONGITUDINAL SECTION 1 OF 3
P216009-006	A	DIVERSION LONGITUDINAL SECTION 2 OF 3
P216009-007	A	DIVERSION LONGITUDINAL SECTION 3 OF 3
P216009-008	A	DIVERSION CROSS SECTION 1 OF 6
P216009-009	A	DIVERSION CROSS SECTION 2 OF 6
P216009-010	A	DIVERSION CROSS SECTION 3 OF 6
P216009-011	A	DIVERSION CROSS SECTION 4 OF 6
P216009-012	A	DIVERSION CROSS SECTION 5 OF 6
P216009-013	A	DIVERSION CROSS SECTION 6 OF 6
P216009-014	A	DIVERSION TYPICAL SECTIONS
P216009-015	A	LEVEE 1 LONGITUDINAL SECTION
P216009-016	A	LEVEE 1 CROSS SECTION 1 OF 2
P216009-017	A	LEVEE 1 CROSS SECTION 2 OF 2
P216009-018	A	LEVEE 2 LONGITUDINAL SECTION
P216009-019	A	LEVEE 2 CROSS SECTION 1 OF 3
P216009-020	A	LEVEE 2 CROSS SECTION 2 OF 3
P216009-021	A	LEVEE 2 CROSS SECTION 3 OF 3
P216009-022	A	LEVEE 3 LONGITUDINAL SECTION
P216009-023	A	LEVEE 3 CROSS SECTION 1 OF 1
P216009-024	A	BATTER DRAIN TYPICAL DETAILS AND SECTIONS
P216009-025	A	BATTER DRAIN SPECIFICATIONS AND DIMENSIONS TABLE

NOTES

1. ALL LEVELS PROVIDED ARE IN METRES TO AUSTRALIAN HEIGHT DATUM.
2. ALL CO-ORDINATES PROVIDED ARE IN METRES TO DATUM AGD84 AND PROJECTION AMG ZONE 55 (SWCM VERSION).
3. ALL DESIGN OFFSETS AND CHAINAGES PROVIDED ARE IN METRES UNLESS NOTED OTHERWISE.
4. THE DTM USED TO CREATE THE DRAWING SET MAY NOT ILLUSTRATE ALL CURRENT FEATURES.
5. THESE DRAWINGS ARE FOR FUNCTIONAL DESIGN ONLY AND SHALL NOT BE USED FOR CONSTRUCTION.

LEGEND

FEATURE	LINETYPE/COLOUR
MAIN DIVERSION	magenta line
LEVEE	red line
BATTER DRAIN	blue line
OVERLAND FLOW BUND	yellow line
PROPOSED PIT EXTENTS	peach fill
PROPOSED GENERAL FILL	cyan hatch
MINING LEASE BOUNDARY	— · — · —
PROPOSED PIT EXTENTS BOUNDARY	— — — —
70 METER OFFSET BOUNDARY	—·—·—

REV	DESCRIPTION	DATE	INTL
B	MINOR REVISION (PROPOSED GENERAL FILL)	19/07/16	MC
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

NOT FOR CONSTRUCTION

	NAME	DATE
DESIGNED:	L. SUNNER	23/05/16
DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE
A B C NOT TO SCALE

alluvium
www.alluvium.com.au
T +61 7 4724 2170 F +61 7 4724 1639

Client: bhpbilliton resourcing the future

SOUTH WALKER CREEK MINE
MRA WALKER CREEK DIVERSION - STAGE 2C
FUNCTIONAL DESIGN
PLAN, NOTES AND SCHEDULE OF DRAWINGS

Drawing No. P216009_001 Revision No. B
Sheet No. 1 File Name: P216009_001.dwg
 ABN 45 653 522 596
A3