APPENDIX J - FLOODING, HYDROLOGY AND GEOMORPHOLOGY ASSESSMENT

Isaac Downs Extension

Flooding Impact Assessment

Stanmore Resources Limited

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For and on behalf of **Hydro**Balance
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Contents

List of Figures

List of Tables

1 Introduction

1.1 Background

Stanmore ID Extension Pty Ltd (ID Extension), a wholly owned subsidiary of Stanmore Resources Ltd (Stanmore) proposes to develop the Isaac Downs Extension (IDE) Project (the Project). Stanmore, through various subsidiary entities, operates mines neighbouring the Project, namely Isaac Downs Mine (IDM), Isaac Plains Mine (IPM), Poitrel Mine and Eagle Downs (Figure 1.1). Isaac Plains Complex (IPC) comprises IDM and IPM. The Project will be an extension to IDM, with mining activities, including the workforce, transitioning from IDM to the Project as operations ramp down at IDM.

The Project requires approvals from the:

- State under the *Environmental Protection Act 1994* (EP Act), for a new environmental authority (EA) and progressive rehabilitation and closure plan (PRCP) schedule.
- Commonwealth through referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The proponent has applied for four mining leases (MLs) for the Project (ML application (MLA) 700081, MLA 700082, MLA 700083 and MLA 700084), together forming the Project area. The proponent is preparing a voluntary environmental impact statement (EIS) under the EP Act which will support the EA, PRCP schedule and Referral for the Project.

HydroBalance was commissioned by Stanmore to undertake a Flooding Impact Assessment (FIA) and Surface Water Impact Assessment (SWIA) for the Project. The FIA addresses the potential flooding and geomorphological impacts resulting from the proposed works. The SWIA addresses the proposed site water management system during operations and post-closure, to assess potential impacts to the to the quality and quantity of water for the receiving environment. The FIA is presented in this report and the SWIA is presented in HydroBalance (2026). These reports should be considered together when interpreting the potential impacts to surface water due to the Project.

1.2 Project overview

The Project activities that will extend the life of mining operations at IPC comprise an open cut coal mine pit and associated infrastructure, primarily mining metallurgical (steel making) coal. Approximately 46 Mt of run of mine (ROM) coal will be mined over 15 years, with approximately 2 – 4.5 Mtpa. The proponent intends to commence construction activities in late 2027 / early 2028, subject to obtaining all required approvals, with mining operations commencing in 2028 and ROM coal extraction in 2029.

The open cut mining methods for the Project will be similar to those at IDM, including:

- clearing of vegetation, stripping and stockpiling of topsoil
- drilling and blasting of pre-strip overburden
- removing the pre-strip overburden using mining equipment at IDM being a dragline and / or truck and shovel fleets and / or dozers
- drilling and blasting of overburden
- drilling and blasting of pit floor for geotechnical stability to allow for in-pit dumping
- overburden removal using the existing dragline at IDM and / or truck and shovel fleets
- coal mining using excavators
- formation of out of pit and in-pit overburden dumps as mining progresses
- progressive rehabilitation of overburden dump areas.

ROM coal will be transported from the Project's ROM coal pad to the coal handling and preparation plant (CHPP) at IPM for washing, utilising existing haul roads at IPC and new haul roads, including a bridge across the Isaac River, constructed in the Project area. The dragline will be walked from IDM to the Project via a temporary crossing of the Isaac River.

A satellite go line and crib area will be constructed at the Project, with the existing mine infrastructure area (MIA) at IDM continuing to service Project activities.

The primary access to the Project for workers and deliveries will be via IDM's existing access road and new access roads connecting with the Project, utilising the bridge to be constructed across the Isaac River. There is potential for a secondary access route to the Project between the Project and Stanmore's Eagle Downs project, utilising new and existing roads to connect with the Peak Downs Mine Road.

During operations, levees will be constructed to protect the open cut pit area from flooding of the Isaac River, Cherwell Creek and Conrock Gully up to a 0.1% annual exceedance probability (AEP) (1:1,000 year) flood event. Conrock Gully will be diverted around the active mining areas into the Isaac River, with the diversion remaining post mining. Any residual void remaining post mine life will not be located within the 0.1% AEP flood event.

A mine affected water dam will store water from the pit, ROM pad, go line and crib area, with the ability to transfer mine affected water to and from IDM and IPM within IPC's integrated water management system, thereby enabling the balancing of water supply and demand. Sediment water drains and dams will be constructed to capture runoff from overburden dumps. Clean water drains and dams will be constructed to separate clean water from mine affected water and sediment water.

IPC has access to external raw water supplied from SunWater and has excess storage capacity for water within existing mined voids and dams. As the Project's water management systems will be integrated with IPC, that the SWIA demonstrates that water supply will be available during dry periods, and storage capacity will be able to receive any excess water during wet periods. Therefore, no new sources of water supply will be required.

Topsoil stockpile areas will be used for storage of topsoil that has been stripped from mining and infrastructure areas, for future use in rehabilitation.

Power for the dragline will be supplied to the Project via powerline connections with existing power supply at IDM. The Project may require additional linear infrastructure at IDM to facilitate the extension of IDM mining activities to the Project, however this will be within areas authorised for disturbance.

The proposed Project layout, MLA areas and proposed disturbance area is shown in Figure 1.2. The proposed disturbance allows for working and construction areas within and around proposed Project activities and infrastructure. The area of the 4 MLAs is 2,707 ha and the proposed disturbance area is 2,080 ha. The disturbance area has been refined to minimise and / or avoid sensitive ecological features (e.g. habitat for listed threatened species and riparian areas). The disturbance area may be subject to further refinement for environmental or operational reasons. The disturbance area excludes approximately 2.5 ha of disturbance on IDM MLs for which an IDM EA and PRCP schedule amendment will be required.

The Project operational workforce will be similar to, but lower than that for current operations at IPC, with around 300 - 400 workers, compared to around 400 - 450 workers. Approximately 100 – 150 workers will be engaged at the Project for infrastructure construction. The Project, being an extension of mining activities at IPC, is therefore important to ensure a near steady state workforce across IPC beyond 2027 and 2028.

Workforce accommodation arrangements will continue in a similar manner to those for the current IPC workforce, being a mix of residences in Moranbah and other local or regional towns, and mine accommodation villages in the region. Through the Project, Stanmore will continue to support local and regional suppliers and contractors, providing additional economic benefits and employment in the region.

The Project is not proposing any novel or unproven resource extraction process, technology or activity.

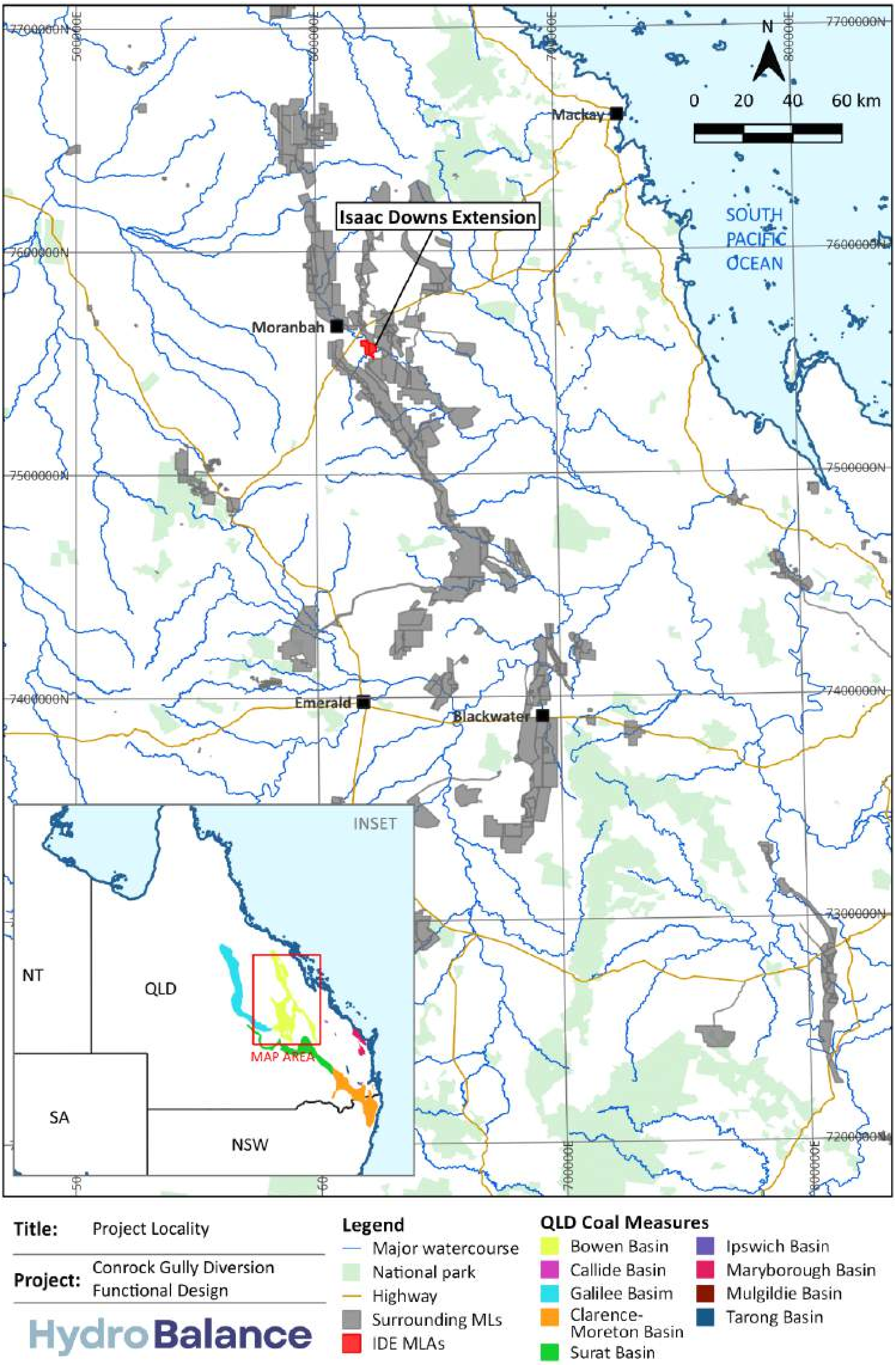


Figure 1.1 - Project locality

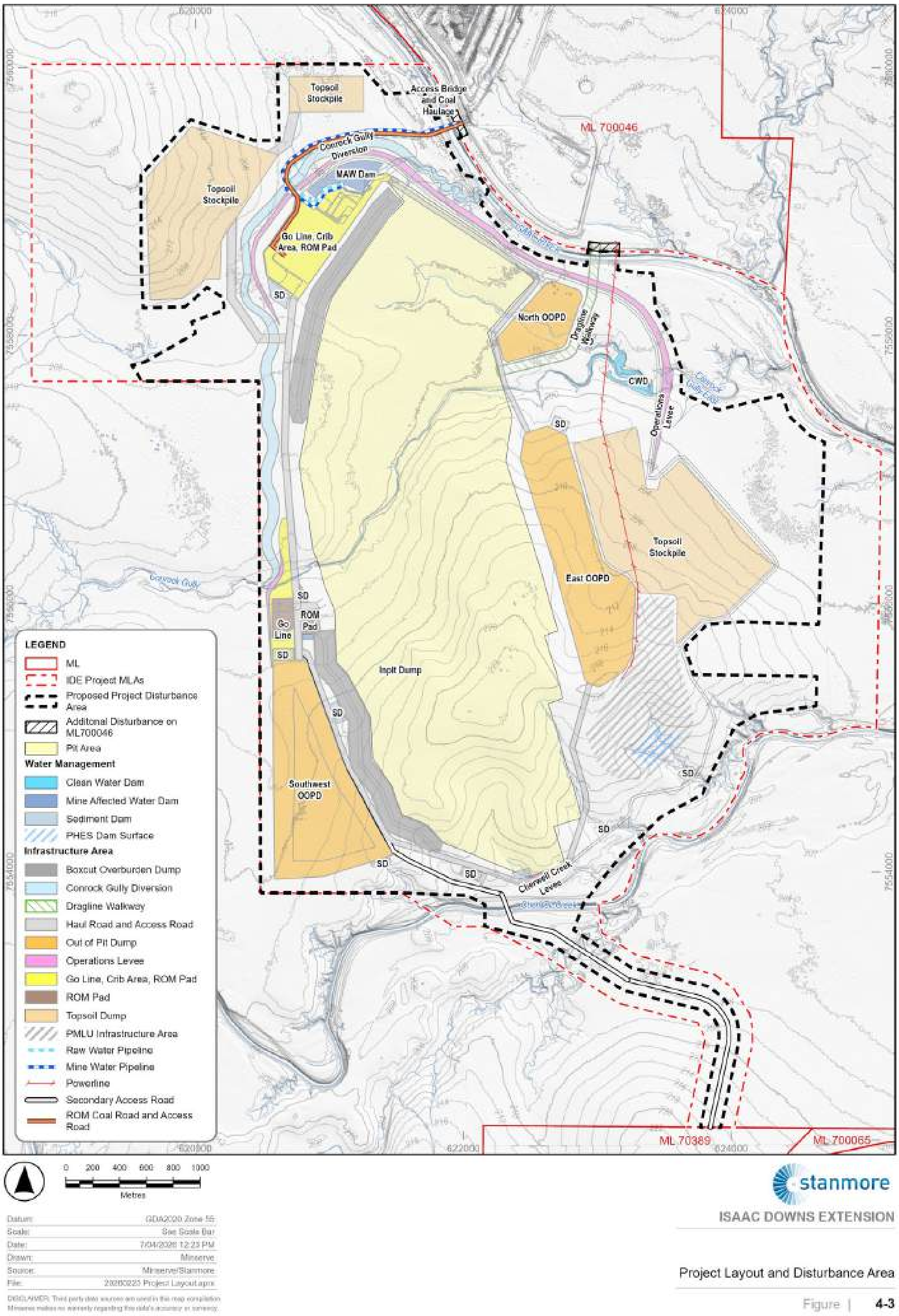


Figure 1.2 – Proposed Project layout

1.3 Terms of Reference

This FIA forms part of an EIS which has been prepared in accordance with Section 40 the EP Act. This assessment has been prepared to satisfy the requirements of *the Terms of reference for an environmental impact statement – Isaac Downs Extension Project* issued by the Department of Environment, Tourism, Science and Innovation (DETSI) on 11 December 2025.

This SWIA addresses the Terms of Reference (ToR) relevant to surface water. Table 1.1 lists the elements of the ToR relevant to this assessment and the sections of this report where those TORs are addressed.

Table 1.1 – Terms of Reference for EIS relevant to surface water

Project specific matters	Requirement	Report Section
Climate		
9.1	Conduct the assessment in accordance with the latest version of the department's *Climate—EIS information guideline* (ESR/2020/5298) (DETSI 2024).	SWIA Section 6.3 (HydroBalance, 2026) Section 5.6
9.2	Describe the project area's climate patterns that are relevant to the environmental impact assessment, particularly the project's discharges to water and air, and propagation of noise. Provide climate data in a statistical form including long-term averages and extreme values.	SWIA Section 6.3 (HydroBalance, 2026)
9.3	Assess the project's vulnerabilities to projected climate change (e.g. changing patterns of temperature, rainfall, hydrology, and extreme weather events). In the assessment of climate hazards and risks, reference relevant climate projection data and employ appropriate risk assessment methodologies.	SWIA Section 7.3.8, Section 8.4.2 (HydroBalance, 2026) Section 5.6
Water		
Water quality		
9.28	Conduct the impact assessment in accordance with the following guidelines: *Water—EIS information guideline* (ESR/2020/5312) (DETSI 2024), *Applications for activities with impacts to water* (ESR/2015/1837) (DETSI 2025), *Water quality guidelines* (DETSI n.d.), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000); (ANZG 2018); 2023), *Queensland Water Quality Guidelines* (DEHP 2009), *Wastewater release to Queensland waters* (ESR/2015/1654) (DETSI 2025), *Monitoring and sampling manual* (DES 2018), *Information guidelines on deriving site-specific guideline values for physico-chemical parameters and toxicants* (IESC 2019) and *Using monitoring data to assess groundwater quality and potential environmental impacts* (DES 2021). Projects in Great Barrier Reef catchments must also undertake an assessment in accordance with the guideline *Reef discharge standards for industrial activities* (ESR/2021/5627) (DESI 2024) and address the relevant information requirements."	SWIA Section 2.1, Section 9.10.1, Section 3.7.2.4, Section 9.7 (HydroBalance, 2026)
9.29	Demonstrate that the project can meet the environmental objectives and performance outcomes in Schedule 8 of the EP Regulation.	SWIA Section 9.8 (HydroBalance, 2026)
9.30	With reference to the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 and section 9 the EP Act, identify the environmental values of surface- and ground- waters within the project area and immediately downstream or downgradient that may be affected by the project, including wetlands, semi-permanent and permanent pools, seagrass beds, corals, any human uses and cultural values of water.	SWIA Section 2, Section 3 (HydroBalance, 2026)

Project specific matters	Requirement	Report Section
9.31	Define the relevant water and sediment quality guidelines applicable to the environmental values and demonstrate how these will be met by the project during construction, operation, decommissioning and following project completion. Locally derived trigger values must be derived in accordance with best practice environmental management including the guidelines listed in *Water—EIS information guideline* (ESR/2020/5312) (DETSI 2024).	SWIA Section 2.1, Section 3.7, Section 9.10 (HydroBalance, 2026)
9.32	Detail the hydrological, hydrogeological, chemical, physical and biological characteristics of surface waters and groundwater within the area that may be affected by the project and at suitable reference locations using sufficient data to define natural variation, including for various water types, and seasonal and spatial variation.	Section 2 SWIA Section 3 (HydroBalance, 2026)
9.33	Describe the quantity, quality, location, duration and timing of all potential and/or proposed releases of contaminants. Releases may include controlled water discharges to surface water streams, uncontrolled discharges when the design capacity of storages is exceeded, spills of products during loading or transportation, contaminated run-off from operational areas of the site (including seepage from waste rock dumps), or run-off from disturbed acid sulfate soils.	SWIA Section 7.3.4, Section 7.3.5, Section 9.6, Section 9.7 (HydroBalance, 2026)
9.34	Assess the potential impact of any releases from point or diffuse sources on all relevant environmental values and water quality objectives of the receiving environment. The impact assessment must consider the resultant quality and hydrology of receiving waters, cumulative impacts, and the assimilative capacity of the receiving environment.	SWIA Section 9.6, Section 9.7, Section 9.9 (HydroBalance, 2026)
9.35	Describe how water quality guidelines and objectives would be achieved and environmental impacts would be avoided or minimised through the implementation of management strategies that comply with the management hierarchy and management intent of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019. Appropriate management strategies may include the use of erosion and sediment control practices, and the separation of clean storm water run-off from the run-off from disturbed and operational areas of the site.	SWIA Section 4, Section 7, Section 9.10 (HydroBalance, 2026)
9.36	Describe how monitoring would be used to demonstrate that objectives were being assessed, audited and met. For example, provide measurable criteria, standards and/or indicators that will be used to assess the condition of the ecological values, environmental values and health of surface- and ground- water environments. Propose detailed corrective actions to be used if objectives are not likely to be met.	SWIA Section 9.10 (HydroBalance, 2026)
<u>Water resources</u>		
9.37	Conduct the impact assessment in accordance with the department's *Water—EIS information guideline*, ESR/2020/5312 (ESR/2020/5312) (DETSI 2024) and DAF *Environmental impact assessment companion guide* (DAF 2024).	This report SWIA Section 9 (HydroBalance, 2026)
9.38	Describe present and potential users and uses of water in areas potentially affected by the project, including municipal, agricultural, industrial, recreational and environmental uses of water.	SWIA Section 3.8, (HydroBalance, 2026)
9.40	Model and describe the inputs, movements, exchanges and outputs of surface water that would or may be affected by the project including potential post-mining land use outcomes. The models used to estimate associated water take must take into account the climatic conditions at the site, assess the potential impacts on water resources and include a site water balance.	SWIA Section 6, Section 7, Section 8 (HydroBalance, 2026)
9.41	Provide a description of the project's impacts including cumulative impacts at the local scale and in a regional context including:	Section 3 and 7

Project specific matters	Requirement	Report Section
	(a) changes in flow regimes from diversions, water take and discharges (c) management of mine affected water (d) alterations to riparian vegetation and bank and channel morphology and stability (e) direct and indirect impacts arising from the development.	SWIA Section 4, Section 4.8, Section 9 (HydroBalance, 2026)
9.43	Provide a water management plan, for the life of the project, which details management strategies of mine-affected water, sediment-affected water and drainage from areas not disturbed by mining activities. Any water taken off site for further use must also be accounted for and must be consistent with the General Use Approval for associated water (including CSG water).	SWIA Section 4 (HydroBalance, 2026)
9.44	Identify any approvals or entitlements that would be needed under the Water Act 2000. Specifically address whether or not the project would take water from, or affect recharge to, aquifers of the Great Artesian Basin. Address the requirement/s for a Riverine Protection Permit (RPP) and/or Quarry Material Allocation Notice (QMAN). Describe the practices and procedures that would be used to avoid or minimise impacts on water resources	SWIA Section 1.5.1 (HydroBalance, 2026)
9.46	Include maps of suitable scale showing the location of diversions and other water-related infrastructure in relation to resource infrastructure. Detail any significant diversion or interception of overland flow, including the effects of subsidence.	Figure 1.2 and Figure 4.2
9.47	Provide the following plans (a) natural (representative) profile (cross-section) of any waterway sections (e.g. Conrock Gully) that are proposed to be impacted and diverted including low flow channel, main channel and top of banks (b) existing and proposed profiles (cross-section) of the waterways where infrastructure is proposed including the bridge and temporary access over the Isaac River and access over Cherwell Creek."	Appendix D, Section 4
9.48	Describe watercourse diversion design, operation, monitoring and rehabilitation based on current engineering practice and relevant guidelines including 'Guideline Works that interfere with water in a watercourse for a resource activity—watercourse diversions (OSW/2019/4599) (DNRME 2019); Maintenance of geomorphic processes in Bowen Basin River Diversions' (Australian Coal Association Research Program ((ID&A Pty Ltd. 2000); 'Monitoring and Evaluation Program for Bowen Basin River Diversions' (Fisher Stewart, ID&A Pty Ltd., & Earth Technology 2001); and 'Criteria for functioning river landscape units in mining and post mining landscapes' (White, K., Moar, D., Hardie, R., Blackham, D., & Lucas, R. 2014). The diversion design must address function beyond mine life including hydrology, hydraulics, geomorphic stability, sediment transport regime, gradient continuity at diversion-waterway tie-ins at the upstream and downstream extents, floodplain corridor width, and riparian vegetation establishment in accordance with the relevant established Guidelines.	Appendix D, Section 4
9.49	Describe the various options for supplying water to the project and assess any potential consequential impacts in relation to the objectives and strategies of any water plan and associated planning documents that may apply. The construction of in-stream water storages to collect water supply for the project should not be the only option presented. Alternative water supply options must be fully detailed.	SWIA Section 4, Section 4.9 (HydroBalance, 2026)
9.50	Describe the proposed supply of potable water for the project, including temporary demands during the construction period. Also describe on-site storage and treatment requirements for wastewater from accommodation and/or offices and workshops.	SWIA Section 4.11 (HydroBalance, 2026)
9.51	Determine any additional town water supply demands to service worker camps or household water needs in Moranbah and surrounding towns that may experience growth (even if only	Refer to EIS report

Project specific matters	Requirement	Report Section
	temporary) from the project and how this will be met. Determine if the additional water needs for the project will have a water security impact on Isaac Regional Council towns, particularly Moranbah.	
Flooding		
9.55	Describe the history of flooding onsite and in proximity to the project site. Describe current flood risk considering the location of domains (operational and post-closure phase) for a range of annual exceedance probabilities up to the 0.1% annual exceedance probability (AEP) and probable maximum flood levels for the project site. Use flood modelling to assess how the project may potentially change flooding and run-off characteristics on-site and both upstream and downstream of the site. The assessment must consider all infrastructure associated with the project including levees, roads, and linear infrastructure, and all proposed measures to avoid or minimise impacts.	Appendix A, Section 5
9.56	Evidence must be provided to demonstrate that the securing of storage containers of hazardous contaminants during flood events meets the requirements of schedule 8 of the EP Regulation.	SWIA Section 4.12 (HydroBalance, 2026)
9.57	Describe, illustrate and assess where any proposed infrastructure, including tailing storage facilities, dams, voids and waste rock dumps, disturbed and rehabilitated areas, would lie in relation to modelled flood levels, including the 0.1% AEP and probable maximum flood levels. Describe management actions to minimise impacts of flooding to mine infrastructure and manage in mine pit water post-flooding.	Section 5
9.58	Identify and label the proposed dragline crossing point across the Isaac River on a map and provide indicative earthworks footprints required to facilitate the crossing. A specific model scenario should be undertaken as part of the flood study to assess the potential flood impacts and inform the crossing location.	Figure 4.2, Section4.4.4, Section 5
9.59	Assess the project's vulnerabilities to climate change as they relate to flooding (e.g. changing patterns of rainfall, hydrology, temperature and extreme weather events). Describe possible adaptation strategies (preferred and alternative) based on climate change projections for the project site.	Section 5.6
The Independent Expert Scientific Committee (IESC)		
9.60	The EIS must provide the information requirements contained in the IESC's Information guidelines (IESC 2024) including relevant information guidelines explanatory notes (e.g. uncertainty analysis, assessing groundwater-dependent ecosystems).	Refer to Table 1.2
9.115	Identify the quantity, quality and location of all potential discharges of water and contaminants by the project, including treated wastewater and sewage. Describe whether the discharges would be from point sources (whether uncontrolled and controlled discharges) or diffuse sources (such as irrigation to land of treated wastewater/sewage effluent) and describe the receiving environment (such as land or surface waters). Refer to the Water section of the TOR and Water—EIS information guideline (ESR/2020/5312) (DETSI 2024) for further guidance. For potential discharges to surface waters, provide detail to demonstrate consistency with the assessment approaches outlined in the guideline Wastewater release to Queensland waters (ESR/2015/1654) (DETSI 2025). For potential discharges to groundwaters, provide an assessment using the appropriate approaches and guidelines listed in the Water—EIS information guideline (ESR/2020/5312) (DETSI 2024). Note that the EP Act and EP regulation hold strict provisions in terms of waste discharges to groundwaters or sensitive areas.	SWIA Section 4.10, Section 6.9, Section 7.3.4, Section 7.3.5, Section 7.4.4, Section 7.4.5 (HydroBalance, 2026)
9.116	Provide a risk assessment of the potential impacts on waters, in the near-field and far-field, resulting from controlled or uncontrolled discharges from the site. Address the following	SWIA Section 6.9, Section 9.6, Section

Project specific matters	Requirement	Report Section
	matters with regard to every potential discharge of contaminated water, contaminants or wastes: (a) Describe the circumstances in which controlled and uncontrolled discharges might occur (b) Provide stream flow data and information on discharge water quality, including any potential variation in discharge water quality that will be used in combination with proposed discharge rates to estimate in-stream dilution and water quality. Chemical and physical properties of any wastewater, including concentrations of constituents, at the point of entering natural surface waters must be discussed along with toxicity of effluent constituents to human health, flora and fauna. (c) Provide an assessment of the available assimilative capacity of the receiving waters given existing water quality and other potential point source discharges in the catchment. Options for controlled discharge at times of natural stream flow must be investigated to ensure that adequate flushing of wastewater is achieved. (d) Provide water quality limits that are appropriate to maintain background water quality and protect other water uses (e) Describe the necessary streamflow conditions in receiving waters under which controlled discharges will be allowed.	9.9.4, Section 7.3.4, Section 7.3.5, Section 7.4.4, Section 7.4.5 (HydroBalance, 2026)
Regulated structures		
9.61	Conduct the impact assessments in accordance with the latest version of the department's guidelines on *Regulated structures—EIS information guideline* (ESR/2020/5307) (DETSI 2024), *Structures which are dams or levees constructed as part of environmentally relevant activities* (ESR/2016/1934) (DETSI 2025) and *Manual for assessing hazard consequence categories and hydraulic performance of structures* (ESR/2016/1933) (DETSI 2025).	Section 6 SWIA Section 5 (HydroBalance, 2026)
9.62	Describe the purpose of all dams or levees proposed on the project site. Show their locations on appropriately scaled maps, and provide plans and cross-sections, illustrating embankment lengths, heights and widths, spillways, discharge points, design storage allowances, and maximum volumes.	Section 4 SWIA Section 4 (HydroBalance, 2026)
9.63	Describe and illustrate how dams and levees would be: (a) sited to avoid or minimise risks from flooding using flood mapping showing the 0.1% AEP and probable maximum flood (b) located, constructed and operated to avoid, minimise and mitigate impacts on environmental values (c) located and designed to maximise progressive rehabilitation and closure.	Section 5 SWIA Section 4 (HydroBalance, 2026)
9.64	Undertake a consequence category assessment for each dam or levee, according to the criteria outlined in department's *Manual for assessing hazard consequence categories and hydraulic performance of structures* (ESR/2016/1933) (DETSI 2025). The assessment must be undertaken for the three different failure event scenarios described in the department's manual, i.e. for seepage, overtopping and dam break. Regulated structures must comply with the *Manual for assessing hazard consequence categories and hydraulic performance of structures* (ESR/2016/1933) (DETSI 2025) in accordance with schedule 8, division 2 of the EP Regulation.	Section 6 SWIA Section 6 (HydroBalance, 2026)
9.65	Following the consequence category assessment, determine the consequence category ('low, significant, or high') according to table 1 of department's *Manual for assessing hazard consequence categories and hydraulic performance of structures* (ESR/2016/1933) (DETSI	Section 6

Project specific matters	Requirement	Report Section
	2025) and provide certified copies of the consequence category determination for each of the proposed dams or levees assessed.	SWIA Section 5 (HydroBalance, 2026)
9.66	Describe how risks associated with dam or levee failure, seepage through the floor, or embankments, and/or with overtopping of the structures will be avoided, minimised or mitigated to protect people, property and the environment.	Section 6 SWIA Section 5 (HydroBalance, 2026)
Appendix 3: Terms of reference for matters of national environmental significance (MNES) under the Environment Protection and Biodiversity Conservation Act 1999 requirements		
Description of the environment		
A3.24	Describe the environment of the project site and surrounding areas (i.e. adjacent, upstream and downstream from project site) that may be affected by the project. At a minimum, this section needs to include details of:	
	g) Hydrology of water resources (surface water and groundwater), including flood extents, relevant hydrogeology, groundwater depth across the project area, and local water quality, including, but not limited to, the Isaac River and Cherwell Creek and relevant wetlands and aquifers in the region	Section 2 SWIA Section 2, Section 3 (HydroBalance, 2026)
	h) characteristics of potentially impacted water resources (surface water and groundwater) including, but not limited to, the Isaac River and Cherwell Creek and relevant wetlands in the region	Section 2 SWIA Section 2, Section 3 (HydroBalance, 2026)
	i) values of water resources, including but not limited to social and economic values (including third party uses of groundwater and surface water), and cultural values.	SWIA Section 2, Section 3 (HydroBalance, 2026)
Environmental information required within project area and surrounds		
A3.27	Provide information on topography and elevation across the project area and adjacent area to enable assessment of MNES and relevant impacts on MNES such as sediment run-off and erosion. Include a map with contour intervals.	Section 2
Matters of National Environmental Significance (MNES)		
A3.41	Provide information on the current baseline condition and characterisation of surface water hydrology and quality in the project area and surrounding area. Consider the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018), or updated revisions. Provide details of the potential impacts from creek diversions in relation to:	SWIA Section 3 (HydroBalance, 2026)
	a) surface water baseflows, flow and no-flow duration, seasonality, and other factors that could alter surface water regimes (such as high rainfall events)	Section 2, Appendix D SWIA Section 3.4 (HydroBalance, 2026)
A3.43	Provide a conceptualisation of water resources. Conceptualisation and understanding of surface water should:	

Project specific matters	Requirement	Report Section
	a) be informed by systematic water level and water quality monitoring with appropriate temporal coverage to best capture seasonality, inter-annual variability and trends, including:	Section 2, SWIA Section 3.4, Section 3.7 (HydroBalance, 2026)
	iii) regular water quality sampling of surface waters, and event-based sampling as needed	SWIA Section 3.7 (HydroBalance, 2026)
	b) follow relevant Commonwealth, State and/or best practice guidelines to conduct a baseline study and derive site-specific water quality guidelines where appropriate and/or adopt default guidelines as provided by the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) (and other relevant sources)	SWIA Section 2, Section 3.7 (HydroBalance, 2026)
	c) include measurement of physico-chemical parameters, nutrients, metals and metalloids, and any other relevant parameters, such as hydrocarbons, needed to understand potential impacts	SWIA Section 3.7 (HydroBalance, 2026)
	d) describe, if relevant, how baseline hydrological conditions may be influenced by activities associated with nearby mining operations	Section 3 and 7.5 SWIA Section 3.2, Section 3.7 (HydroBalance, 2026)
	e) provide a statement to evaluate the representativeness of water sampling and monitoring sites.	SWIA Section 3.7 (HydroBalance, 2026)
A3.44	Identify water quality and environmental flow guidelines and objectives within and at the outflow point of the Fitzroy Catchment.	SWIA Section 2.1 (HydroBalance, 2026)
Relevant impacts		
	The MNES chapter must include a description of all the relevant impacts of the project. Relevant impacts are impacts that the project will have or is likely to have on a matter protected by a controlling provision. The MNES chapter must include a description of all the relevant impacts of the project. 'Likely' is taken to mean a "real or not remote chance or possibility". Relevant impacts are impacts that the project will have or is likely to have on a matter protected by a controlling provision.	Section 5 and Section 7 SWIA Section 7, Section 8, Section 9 (HydroBalance, 2026)
A3.50	With consideration of all project phases, identify and describe which component/s and stage/s of the project and/or consequential actions are of relevance to each listed threatened species and/or ecological community. All relevant impacts of the project are to be assessed in accordance with the latest relevant Commonwealth policies and guidelines, and information provided in the SPRAT database, including but not limited to:	
	j) changes to hydrological regimes (including flow changes, groundwater levels and flooding)	Section 5, Section 7, Section 7.2 SWIA Section 9.5 (HydroBalance, 2026)

Project specific matters	Requirement	Report Section
	k) impacts on or changes to water quality (including direct and indirect), including but not limited to total suspended sediment and turbidity changes, waste and chemical pollution and land contamination	SWIA Section 9.6 (HydroBalance, 2026)
	n) sedimentation and erosion.	Section 5.5, Section 7.4
A3.51	Describe all relevant impacts of the project (direct, indirect, cumulative and facilitated), including the magnitude, duration and frequency of the impacts (including any temporary impacts). All stages and components of the project must be addressed, and the following information provided:	
	a) a detailed assessment of the nature and extent of the likely short-term and long-term relevant impacts, taking into consideration any indirect impacts (e.g. light and dust pollution, noise from operations, construction and explosives, increased risk of predation, edge effects, barrier effects, habitat fragmentation, drawdown, contamination)	Section 5, Section 7 SWIA Section 7, Section 8, Section 9 (HydroBalance, 2026)
	b) a statement, with supporting evidence, whether any relevant impacts are likely to be unknown, unpredictable or irreversible	Section 5, Section 7 SWIA Section 9 (HydroBalance, 2026)
	c) any technical data and other information used or needed to make a detailed assessment of the relevant impacts, including but not limited to baseline studies, site characterisation, relevant modelling, and surveys undertaken. This should include a discussion of what is included in studies and characterisation assessments and any relevant thresholds used	Section 5, Section 7 SWIA Section 4, Section 6, Section 7, Section 8, Section 9 (HydroBalance, 2026)
	d) the geographic extent of impacts and the length of the impact period(s).	Section 5, Section 7 SWIA Section 4, Section 6, Section 7, Section 8, Section 9 (HydroBalance, 2026)
	f) an analysis of the significance of the relevant impacts.	Section 5, Section 7 SWIA Section 7, Section 8, Section 9 (HydroBalance, 2026)
A3.52	Provide a detailed assessment of any likely impact that the project may have on the MNES above at the local, regional, state, and national scale. The assessment of impacts should include a discussion of the overall implication of all relevant impacts on population and sub-population size (including genetic diversity), species recovery, health and species range for each relevant MNES.	
	a) establish and describe clear spatial and temporal boundaries for the assessment of cumulative impacts	Section 3 and Section 7.5 SWIA Section 9.9, Section 9.9.4

Project specific matters	Requirement	Report Section
		(HydroBalance, 2026)
	c) a discussion of the potential for existing pressures and threats to be exacerbated by the proposed project	Section 3 and Section 7.5 SWIA Section 9.9, Section 9.9.4 (HydroBalance, 2026)
	d) a review and analysis of residual impacts of the proposed project, and of other known proposals, where there may be a spatial or temporal overlap.	Section 3 and Section 7.5 SWIA Section 9.9, Section 9.9.4 (HydroBalance, 2026)
A3.56	Where relevant, the MNES chapter should consider the anticipated/predicted future climatic conditions at the site in the assessment of impacts on MNES, and how changes in climate and the frequency and severity of weather events may interact with, exacerbate or reduce the impacts of the proposed project on MNES over time. This should include, but not be limited to, the:	
	c) overtopping of the sediment basin/Mine Affected Water (MAW) dam/s during extreme rain events and the downstream impacts on MNES	SWIA Section 7.3.5, Section 9.6, Section 9.7 (HydroBalance, 2026)
	d) inclusion of different climate scenarios in water modelling.	Section 5.6 SWIA Section 6.3, Section 7.4 (HydroBalance, 2026)
<u>Impacts to water resources</u>		
	The National Partnership Agreement on Coal Seam Gas and Large Coal Mining, to which Queensland is a signatory, specifies that all coal seam gas and large coal mining proposals that are likely to have a significant impact on water resources are to be referred to the Independent Expert Scientific Committee on Unconventional Gas Development and Large Coal Mining Development (IESC) for advice. The IESC provides scientific advice to decision makers on potential impacts from unconventional gas and large coal mining developments on Australia's water resources. The IESC's Information guidelines for proponents preparing coal seam gas and large coal mining development proposals (2024) outlines the information considered necessary to enable the IESC to provide robust scientific advice to relevant decision-makers on water-related impacts of unconventional gas and large coal mining projects. The proponent should ensure that all the information outlined in the IESC Information Guidelines is provided in the MNES chapter. Historic and contemporary data should be included.	Refer to Table 1.2
	The MNES chapter must describe and assess the impacts to water resources giving consideration to the EPBC Act Significant impact guidelines 1.3: Coal seam gas and large coal mining developments— impacts on water resources (2022).	This report and SWIA (HydroBalance, 2026)

Project specific matters	Requirement	Report Section
A3.67	With consideration of all project phases, identify and describe which component/s and stage/s of the project and/or consequential actions are of relevance to water resources. All relevant impacts of the project must be assessed in accordance with the latest relevant Commonwealth policies and guidelines, including but not limited to:	
	a) changes to hydrological regimes (including flow changes, groundwater levels, river-floodplain connectivity, inter-aquifer connectivity, groundwater recharge rates and flood regimes)	Section 5, Section 7 SWIA Section 9 (HydroBalance, 2026)
	b) impacts on or changes to water quality (including direct and indirect), including but not limited to total suspended sediment and turbidity changes, waste and chemical pollution and land contamination	SWIA Section 7, Section 9 (HydroBalance, 2026)
	e) changes to sedimentation and erosion.	Section 5.5, Section 7.4
A3.68	Identify and assess the cumulative impacts on water resources created by the project and the activities of other existing and proposed adjacent, upstream and downstream relevant developments, water users and land users. This must include at a minimum, cumulative impacts of other projects impacting on groundwater levels and other relevant parameters including, but not limited to, the Isaac Downs coal mine project (EPBC 2019/8413), the Bowen Gas Project (EPBC 2012/6377), the Moranbah South Project Coal Mine (EPBC 2012/6337) and any other mines which may might interact with the impacts for the proposed action. Details of these projects can be found on DCCEEW's EPBC Public Notices website.	Section 3 and Section 7.5, SWIA Section 9.9 (HydroBalance, 2026)
A3.69	Provide a conceptual model/s to describe impact pathways and linkages for pre- and post-mining activities, showing at least, but not limited to:	
	c) altered geomorphology of water courses through proposed infrastructure (e.g. diversion, bridge, levees).	Section 5.5, Section 7.4
Surface water		
A3.73	Provide a detailed impact assessment for surface water resources (and dependent flora and fauna) in the project area and downstream of the project area and in the surrounding area.	Section 5, Section 7 SWIA Section 7, Section 9 (HydroBalance, 2026)
A3.74	Provide information to identify and assess risks to all surface water resources (and dependent flora and fauna) in the project area.	Section 5, Section 7 SWIA Section 7, Section 9 (HydroBalance, 2026)
Independent Expert Scientific Committee on Unconventional Gas Development and Large Coal Mining Development (IESC) Explanatory notes		
	Deriving site-specific guideline values for physico-chemical parameters and toxicants (Huynh and Hobbs, 2019)	SWIA Section 3.7.2.4, Section 9.10 (HydroBalance, 2026)
Avoidance, mitigation and management measures		

Project specific matters	Requirement	Report Section
A3.84	Describe in detail measures proposed to avoid, mitigate and manage relevant impacts during all stages of the project on MNES. The proposed measures are to be based on best available practices, appropriate standards and supported by scientific evidence (e.g. outcomes of successful field trials, research papers, other projects, etc.). The MNES chapter is to include:	SWIA Section 4, Section 5, Section 8 (HydroBalance, 2026)
	a) proposed measures to be undertaken to avoid and mitigate the relevant impacts of the project on MNES, including those required by other Commonwealth, State and local government approvals. Measures must be specific to the ecology of each affected MNES	Section 7 SWIA Section 4, Section 5, Section 8, Section 9 (HydroBalance, 2026)
	b) an assessment and evaluation of the predicted effectiveness of the proposed measures supported by scientific evidence including details on how proposed measures meet best practice standards	Section 7 SWIA Section 7, Section 8, Section 9 (HydroBalance, 2026)
	e) details on measures, if any, proposed to be undertaken by State and local government, including the name of the agency responsible for approving each measure	SWIA Section 9 (HydroBalance, 2026)
	f) information on the timing, frequency and duration of the measures to be implemented	Section 7 SWIA Section 4, Section 5, Section 8, Section 9 (HydroBalance, 2026)
	g) the outcomes to be achieved for each relevant MNES through the implementation of individual or combined mitigation measures, including details of how these outcomes can be measured	Section 7 SWIA Section 9 (HydroBalance, 2026)
	h) name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.	SWIA Section 9 (HydroBalance, 2026)
A3.86	Describe how impacts to water resources will be avoided. Provide details on the expected water quality of the overflow water from sediment dams and whether the water will be treated prior to reuse. Clarify whether treatment of MAW will be undertaken and, if so, describe how.	SWIA Section 4 Section 7.3.4, Section 7.3.5, Section 9, Section 9.6.2, Section 9.6.3 (HydroBalance, 2026)

1.4 Commonwealth legislation

A referral under the EPBC Act was submitted to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) for the Project. DCCEEW determined that the Project was a controlled action under the EPBC Act subject to the following controlling provisions for matters of national environmental significance (MNES):

- listed threatened species and ecological communities

- water resources that relate to large coal mining development.

DCCEEW will assess the Project's relevant technical assessments, including review of assessments for water resources by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC).

Guidelines have been developed in order to assist the IESC in reviewing CSG or large coal mining development proposals that are likely to have significant impacts on water resources. Details on where aspects of IESC information requirements checklist relating to surface water impacts have been addressed and are documented within this report are outlined in Table 1.2.

Table 1.2 – Surface Water Resources related IESC Information Requirements Checklist Items

Item	Section in Report
Description of the proposed project	
Describe the watercourses, standing waters and springs across the site, including: • drainage patterns and key surface water and floodplain features • hydrological regimes (especially ecologically relevant components such as durations, timing and frequency of periods when no surface water is present) • current stressors, including impacts from any currently approved projects.	Section 2 SWIA Section 3 (HydroBalance, 2026)
Describe the existing water quality of surface waters potentially impacted by the proposed development. – Include comparison to relevant default guideline values (ANZG 2018) and regional and local (or site-specific) water quality objectives.	SWIA Section2, Section 3.7, Section 9.10 (HydroBalance, 2026)
Environmental impact assessment - Modelling of water storage and movement	
Provide a detailed description of all analytical, numerical and conceptual models used, and any methods and evidence (e.g., expert opinion, analogue sites) employed in addition to modelling.	Section 5, Appendix A, Appendix B SWIA Section 5, Section 6 (HydroBalance, 2026)
Explain the conceptualisation of the system(s), including multiple conceptual models if appropriate. Describe the data and information, including field data, on which the models are based; all key assumptions; and model limitations and their consequences.	Appendix A, Appendix B SWIA Section 4, Section 6, Section 8 (HydroBalance, 2026)
Calibrated models require adequate monitoring data from either the project area or sites representative of local conditions, ideally with calibration targets related to model predictions. Summarise the extent to which parameterisation is consistent with expectations based on literature values, outcomes of field or laboratory investigations, or with values obtained by calibration in similar nearby applications.	Appendix A, Appendix B SWIA Section 6 (HydroBalance, 2026)
Where possible, verify models by using past and/or existing site monitoring data that were not used for calibration.	Appendix A
Assess the quality of, and risks and uncertainty inherent in, the data used to establish baseline conditions and in modelling, particularly with respect to predicted potential impact scenarios. Identify key gaps in data and knowledge and describe how they can be addressed.	Appendix A, Appendix B SWIA Section 6, Section 7.5 (HydroBalance, 2026)

Item	Section in Report
Describe the various stages of the proposed project (construction, operation and rehabilitation) and their incorporation into the model. Provide predictions of changes and recovery in each water resource for the life of the project and beyond, including an assessment of the impacts of climate change where applicable, and cumulative impacts.	Section 4, Section 5.6, Section 7.5 SWIA Section 4.4, Section 6, Section 7.4, Section 8.4 (HydroBalance, 2026)
Provide a program for reviewing and updating models as more data and information become available, including reporting requirements.	SWIA Section 7.5 (HydroBalance, 2026)
For flood estimation, use methods in accordance with the most recent publication of *Australian rainfall and runoff* (Ball et al. 2019); for rainfall-runoff modelling, use methods as outlined by Vaze et al. (2012); and for the modelling of water and salt balances related to mine water management, refer to the water accounting framework (Minerals Council of Australia 2022). Consider the relevance of regional information (see Nathan and McMahon 2017). It is expected that flood risks are assessed for annual exceedance probabilities of at least 1% (i.e., 1 in 100); however, in many instances it may be necessary to estimate floods with rarer annual exceedance probabilities, such as 0.1% (i.e., 1 in 1,000), or events which have a negligible chance of being exceeded (the probable maximum flood).	Section 5, Appendix A
Describe all potential impacts of the proposed project on surface waters. Include a clear description of the impact on the resource and the likelihood and consequences of the impact. Consider: – impacts on streamflow under the full range of flow conditions, focusing on metrics that are most relevant to ecologically important flow components (e.g., the timing, frequency and variability of zero- and low-flow days, low flows exceeded 90% of the time, flow pulses related to ecological processes such as spawning and migration) as well as those relevant to water supply reliability • impacts associated with surface water diversions • impacts on water quality, including consideration of mixing zones (i.e., areas downstream of discharges where water quality objectives do not apply) if applicable • the quality, quantity and ecotoxicological effects of operational and emergency discharges of water (including saline water) at different flows, and the likely impacts on water resources and water-dependent assets • landscape modifications such as subsidence, voids, post-rehabilitation landform collapses and on-site earthworks (including disturbance of acid-forming or sodic soils, roadway and pipeline networks), and describe how these could affect surface water flow, surface water quality, erosion and sedimentation within and downstream of the project area.	Section 5, Section 7 SWIA Section 7, Section 8, Section 9 (HydroBalance, 2026)
Identify processes to determine surface water quality guidelines and quantity thresholds which incorporate seasonal variation but provide early indication of potential impacts on assets.	SWIA Section 2, Section 9.10 (HydroBalance, 2026)
Assess the risks of flooding (including channel form and stability, water level, depth, extent, velocity, shear stress and stream power) and the impacts of flooding on water-dependent assets, project infrastructure and the final project landform.	Section 5, Section 7

Item	Section in Report
Identify and evaluate the quality (including uncertainty) and other aspects of streamflow and other hydrological data, such as proximity to rainfall stations and stream gauges, duration of data records, and whether missing data have been patched.	Section 2, Section 5 SWIA Section 3.4, Section 3.7 (HydroBalance, 2026)
Develop and describe a plan for ongoing ecotoxicological monitoring, including direct toxicity assessment of discharges to surface waters where appropriate.	Aquatic Ecology and Stygofauna Assessment
Environmental impact assessment - Water and salt balances	
Describe the proposed development's water requirements and on-site water management infrastructure, including modelling to demonstrate the infrastructure's adequacy under a range of potential climatic conditions, including extremes associated with predicted climate change.	Section 4, Section 5 SWIA Section 4, Section 6, Section 7, Section 7.47.4 (HydroBalance, 2026)
Provide salt balance modelling that includes stores and the movement of salt between stores, and takes into account seasonal and long-term variation.	SWIA Section 7.3.10, Section 8, Section 9.6 (HydroBalance, 2026)
Indicate the vulnerability to contamination (e.g., from salt production and salinity) of, and the likely impacts of contamination on, the identified water-dependent ecological assets.	SWIA Section 9.6 (HydroBalance, 2026)
Identify how produced water, brine and waste from water treatment plants that are stored on site during operations will be managed and disposed of after operations cease, where applicable.	SWIA Section 4.11 (HydroBalance, 2026)
Provide a quantitative site-level water balance model describing the total water supply and demand under a range of rainfall conditions and allocations of water for mining activities (e.g., dust suppression, coal washing), including all sources and uses.	SWIA Section 6, Section 7 (HydroBalance, 2026)
Provide estimates of the quality and quantities of operational discharges under dry, median and wet conditions, potential emergency discharges due to unusual events, and the likely impacts on water-dependent ecological assets.	SWIA Section 7.3.4, Section 7.3.5, Section 9.6 (HydroBalance, 2026)
Baseline data	
For groundwaters, surface waters and ecological water-dependent assets that have been identified in the risk-based assessment, present data that are sufficient to establish pre-development (baseline) conditions and that have been collected at an appropriate sampling frequency and spatial coverage of monitoring sites, ideally over a period sufficiently long to characterise the impacts of climatic variability.	Section 2 SWIA Section 3.4, Section 3.7 (HydroBalance, 2026)
Provide data for the hydrological regime of all watercourses, standing waters and springs across the site, including: • spatial, temporal and seasonal trends in streamflow and/or standing water levels • spatial, temporal and seasonal trends in water quality data (such as turbidity, acidity, salinity, relevant organic chemicals, metals, metalloids and radionuclides).	Section 2 SWIA Section 3.4, Section 3.7 (HydroBalance, 2026)
Monitoring and management	

Item	Section in Report
Describe the rationale for selected monitoring parameters and their sampling duration, frequency and methods, including the use of satellite or aerial imagery to identify and monitor large-scale impacts. Target monitoring programs to address key areas of uncertainty, especially for valued assets and water resources that are at greater risk of impacts from the proposed development.	SWIA Section 9.10 (HydroBalance, 2026)
Ensure water quality monitoring complies with relevant National Water Quality Management Strategy guidelines (ANZG 2018) and relevant legislated state protocols (e.g., Queensland Government 2018). Identify and justify monitoring sites representative of the diversity of potentially affected water-dependent assets and the nature and scale of potential impacts. Match suitably replicated control and reference sites (BACI design, Downes et al. 2002) to enable detection and monitoring of potential impacts.	SWIA Section 9.10 (HydroBalance, 2026)
Describe the processes employed to determine impact thresholds for water-dependent assets (e.g., threshold at which a significant impact on an asset may occur).	SWIA Section 9.10 (HydroBalance, 2026)
Describe proposed mitigation and management actions, and their adequacy, for each significant impact identified, including any proposed mitigation or offset measures for long-term impacts post mining.	SWIA Section 4, Section 5, Section 9 (HydroBalance, 2026)
Identify modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts, and provide evidence of the likely success of these measures (e.g., case studies).	SWIA Section 9, Section 9.9 (HydroBalance, 2026)
Propose adaptive management measures and management responses, giving details of trigger action response plans (TARPs) for valued assets and water resources that are at greater risk of impacts from the proposed development.	SWIA Section 4.1 (HydroBalance, 2026)
Identify and justify dedicated sites to monitor hydrology, water quality, and channel and floodplain geomorphology before, during and for a suitable period after the proposed development.	SWIA Section 9.10 (HydroBalance, 2026)
Describe a surface water monitoring program that will collect sufficient data to detect and identify the cause of any changes from established baseline conditions, and assess the effectiveness of mitigation and management measures. The program should: – include baseline monitoring data for physico-chemical parameters, as well as contaminants (e.g., metals) • compare physico-chemical data to national/regional guidelines or to site-specific guidelines derived from reference condition monitoring if available • identify baseline contaminant concentrations and compare these to national guidelines, allowing for local background correction (e.g., bioavailability) if required.	SWIA Section 9.10 (HydroBalance, 2026)
Cumulative impacts	
Assess the condition and likely responses of all water-dependent assets and water resources likely to be cumulatively impacted by the proposed development combined with all developments (past, present and/or reasonably foreseeable) and other water-intensive activities.	Section 7.5 SWIA Section 9.9 (HydroBalance, 2026)
Assess the cumulative impacts on potentially affected water-dependent assets and water resources, considering: – the full extent of potential	Section 7.5

Item	Section in Report
impacts from the proposed project (including whether there are alternative options for infrastructure and mine configurations which could reduce impacts) • all stages of the development, including exploration, operations and post-closure/rehabilitation • the likely spatial magnitude and timeframe over which cumulative impacts will occur (ensuring that the analysis has sufficiently broad geographic and temporal boundaries to include all potentially significant impacts) • opportunities to work with other water users to avoid or mitigate potential cumulative impacts to meet specified environmental objectives.	SWIA Section 9.9 (HydroBalance, 2026)

1.5 State legislation

1.5.1 Water Act 2000

Under the *Water Act 2000 (QLD) (Water Act)*, a water licence is required for taking or interfering with surface water, overland flow water or underground water. Changes to several provisions in the Water Act (QLD) came into effect on 6 December 2016 through the *Water Reform and Other Legislation Amendment Act 2014 (*WROLA Act). These changes included a simplification of the water licensing process and several exemptions. Under Section 97 and 98 of the Water Act, diversions associated with an EA (Section 97), or resource activity (Section 98) are approved through the EA process. As such, the diversion of Conrock Gully associated with the Project will be authorised as part of the EA application process, and a separate water licence will not be required.

The defined watercourses in the vicinity of the Project are:

- Isaac River;
- Cherwell Creek; and
- the downstream reach of Conrock Gully (the upstream reach is a defined drainage feature).

The *Water Plan (Fitzroy Basin) 2011* and *Fitzroy Basin Resource Operations Plan* (DNRM, 2015) outline the use of water within the basin under the Water Act. The plan defines the availability of water and provides a framework for sustainable management such as targets for environmental flow objectives and regulating the taking of overland flow. The Project falls within the Isaac River sub-basin area of the Fitzroy Basin Resources Operations Plan.

1.5.2 Fisheries Act 1994

The *Fisheries Act 1994* (Fisheries Act) regulates waterway barrier works within declared watercourses, which may include certain watercourses and drainage features. Mapping for waterway barrier works classifies waterways based on their risk of impact to fish passage.

Conrock Gully (and its tributaries), Cherwell Creek and the Isaac River are mapped within the *Queensland waterways for waterway barrier works* layer, with classifications ranging between *Green* (low) and *Purple* (major). Conrock Gully within the Project disturbance boundary is classified as an *Amber* (moderate) waterway, and its tributaries classified as *Green* (low) waterways. Both the Isaac River and Cherwell Creek are classified as Purple (Major) waterways. Approval under the Fisheries Act for waterway barrier works within waterways is not required for the Project as mining activities on a ML are exempt from the Fisheries Act.

1.6 Report structure

This report is structured as follows:

- Section 2 describes the existing surface water environment including the regional and local drainage characteristics;
- Section 4 describes the proposed Project surface water infrastructure relevant to managing flows within watercourses or drainage features.
- Section 5 presents the outcomes from the flood modelling assessment and provides flood maps for the 1% and 0.1% annual exceedance probability (AEP) design flood events.
- Section 6 presents the preliminary Consequence Category Assessment for the assessable infrastructure.
- Section 7 describes the outcomes from the impact assessment for flooding, with proposed mitigation and management measures.
- Section 8 provides a list of references.
- Appendix A describes the setup and configuration of the hydrologic model.
- Appendix B describes the setup and configuration of the hydraulic model.
- Appendix C provides the flood maps for the 50%, 10%, 2% AEP and probable maximum flood (PMF) design flood events.
- Appendix D provides the Conrock Gully Diversion Functional Design report.

2 Existing surface water drainage network

2.1 Regional drainage network

The Project is located within the headwaters of the Isaac sub-catchment of the greater Fitzroy Basin. The Isaac River is the main watercourse in the vicinity of the Project area, and flows in the north-west to south-east direction to the east of the Project.

The catchment commences at the Denham Range located about 98 km to the north of the Project. The Isaac River flows in a southwesterly direction through the Carborough and Kerlong Ranges before turning in a southeasterly direction near the Goonyella Riverside Mine. The Connors River, which has a catchment area similar to the upstream Isaac River, flows into the Isaac River approximately 120 km downstream of the Project. The Isaac River finally converges with the Mackenzie River a further 53 km downstream.

Ultimately, the Mackenzie River joins the Fitzroy River, which flows initially north and then east towards the east coast of Queensland and discharges into the Coral Sea southeast of Rockhampton near Port Alma. Port Alma is located approximately 450 km downstream of the Project. Figure 2.1 presents the location of the Project and Isaac River catchment downstream of the Connors River confluence.

The greater Isaac-Connors sub-catchment area is approximately 22,364 km^2 (to the Mackenzie River confluence), out of a total Fitzroy River catchment of 142,665 km^2. That is, it represents around 15% of the overall Fitzroy River catchment.

The catchment area of the Isaac River to downstream of the Cherwell Creek confluence and including the Project area is around 3,528 km^2. This represents around 2.5% of the overall Fitzroy River catchment and 15.8% of the Isaac-Connors sub-catchment.

The Project MLA areas (of which approximately 25% will not be disturbed by mining) is approximately 27 km^2 and represents 0.02% and 0.12% of the overall Fitzroy River and Isaac-Connors catchment areas, respectively.

The Isaac River is a seasonally flowing watercourse, typically with surface flows in the wetter months from November to April, reducing to shallow subsurface flows from about May to October. All other waterways of the Project area are ephemeral and experience flow only after sustained or intense rainfall in the catchment. Stream flows are highly variable, with most channels drying out during winter to early spring when rainfall and runoff is historically low. Therefore, physical attributes, water quality, and the composition of aquatic flora and fauna communities are also expected to be highly variable over time.

The Isaac River catchment upstream of the Project comprises mainly scattered to medium dense bushland, grazing land and the township of Moranbah. There are several existing coal mines in the Isaac River catchment including Burton, North Goonyella, Grosvenor, Goonyella-Riverside, Broadmeadow, Broadlea, IPM, IDM, Carborough Downs, Caval Ridge, Poitrel, Daunia, Millennium and Moranbah North.

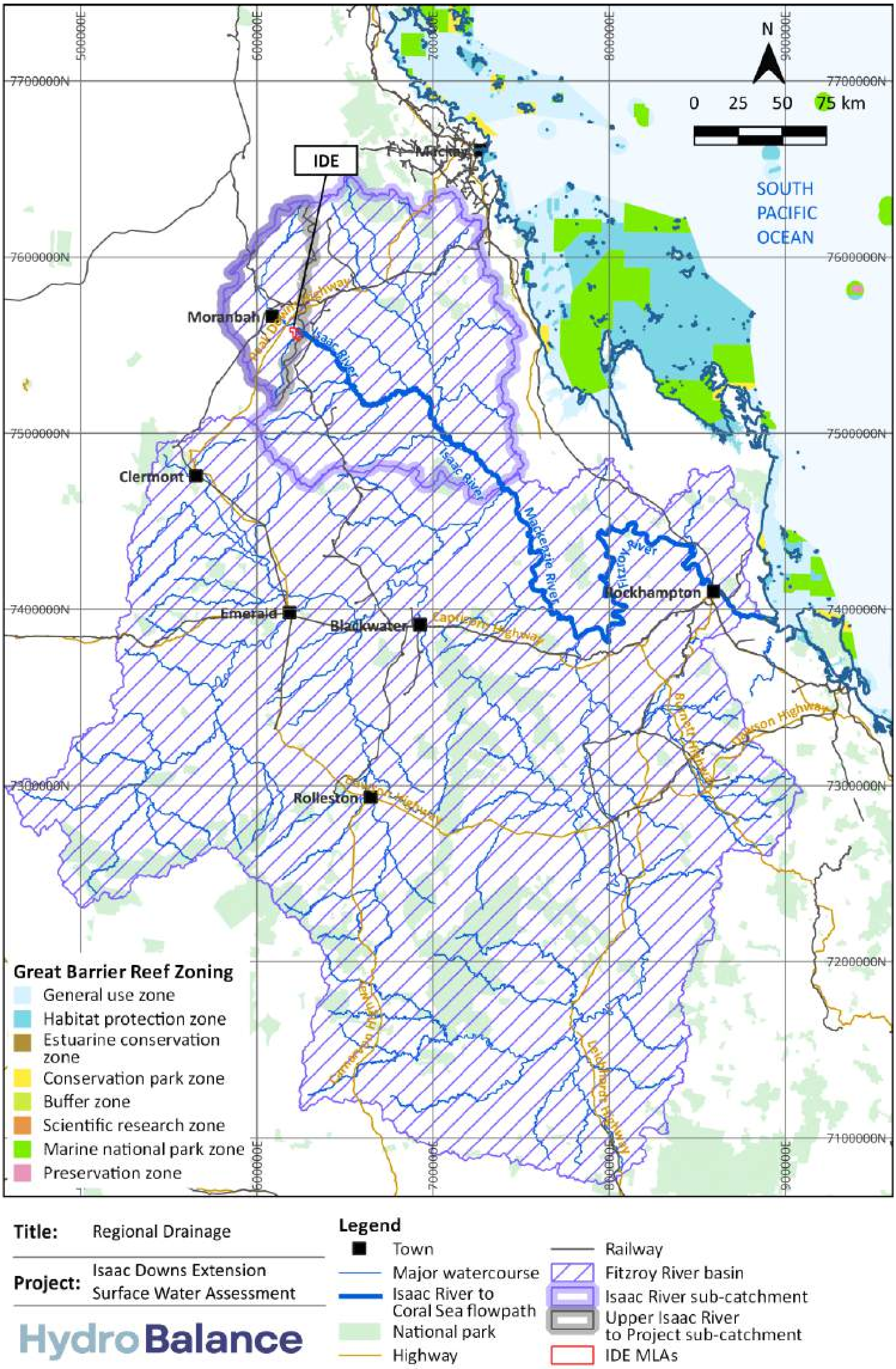


Figure 2.1 – Regional drainage characteristics

2.2 Local drainage network

The following ephemeral drainage systems (shown in Figure 2.5) are located in the vicinity of the Project:

- Isaac River – 2,759 km^2 catchment to the Project (upstream of the confluence with Conrock Gully).
- Cherwell Creek – 698 km^2 catchment to its confluence with the Isaac River.
- JB Gully - 26 km^2 catchment to its confluence with Cherwell Creek.
- Conrock Gully– 71 km^2 catchment to its confluence with the Isaac River.

2.2.1 Isaac River

The Isaac River channel in the vicinity of the Project has an average bed width of 45 m varying between 33 m and 60 m (90% confidence limits) and is approximately 10 m deep. The bed slope and hydraulic gradient from Moranbah township to the Cherwell Creek confluence is very uniform at 0.08%. Under the Strahler ordering system, the Isaac River is a fifth order stream upstream of the Grosvenor Creek confluence (which is located 7.3 km upstream of the Project) and a sixth order stream downstream of the Grosvenor Creek confluence (including the reach that drains past the Project).

The bed of the river channel is characterised by extensive sand sheet deposits indicating it is sediment choked. Sand point bars are evident on the inside of bends and vegetated benches are located on one or both sides of the river along the straight sections. A number of well vegetated sand islands are located in the river channel indicating that some of the old benches have eroded forming channels either side of the old river bank. SedNet modelling of the catchment undertaken by Dougall et al (2006) indicated hillslope erosion to be a dominant input over gully and river bank erosion. Total predicted sediment inputs range from 0.31 to 1.25 t/ha/annum.

The banks of the river consist of a sandy loam and have eroded to near vertical for a depth of 1 m to 2 m along much of its length and 1V:4H to 1V:5H batters above this depth. The bank batters are well vegetated with established and mature trees, mostly eucalypts and casuarinas, and buffel grass understorey. The active benches consist of scattered trees and buffel grass with the overbank areas cleared for grazing.

As part of the Project works, a bridge will be constructed across the Isaac River, connecting the Project with the neighbouring IDM. A temporary dragline crossing will also be constructed across the Isaac River. No diversion of the Isaac River is proposed.

2.2.1.1 Review of other geomorphic investigations of the Isaac River

As part of the Pembroke Olive Downs Coking Coal Project (ODCCP) EIS study, Fluvial Systems (FS, 2018) undertook a geomorphological study of a reach of the Isaac River and its tributaries approximately 15 – 50 km downstream of the Project area. Given the close proximity of the FS study to the IDE Project, the findings from the FS study are considered relevant for the IDE Project.

Key outcomes from this study are as follows:

- The surface geology of the ODCCP Study Area comprised extensive undifferentiated sandy sediments and soils and Quaternary alluvium within river corridors. This suggests that sand bed rivers and streams would be naturally occurring in this region, and not necessarily the result of accelerated sediment delivery caused by land use change, although this process could have increased the rate of sand delivery to channels above background levels.
- The majority of the wider ODCCP Study Area has moderately stable surface soils. Erodible non-cohesive soils and dispersive soils occur in fragmented patches, with more concentrated areas of erodible soils occurring in Ripstone Creek catchment just upstream of the core ODCCP Study Area, and in the corridor of the Isaac River just upstream of the core ODCCP Study Area.
- Most of the stream reaches were in a stable, close to natural geomorphic condition. Some streams were potentially impacted by factors that reduced their condition, in particular high loads of sand in the bed, but without historical data concerning condition prior to the land cover and drainage being modified for agricultural and mining use, this remains uncertain.

- No knickpoints or zones of major geomorphic instability were observed.
- The risk of erosion of the Isaac River channel and floodplain was assessed using the method of maximum permissible bed shear stress and velocity assessment, with the hydraulic variables modelled as part of the flood study. This assessment of the most critical areas found that while there could be isolated areas subject to somewhat higher risk of scour compared to the existing situation, the overall risk of rapid and significant geomorphic change in the Isaac River due to the proposed mining activity was low.

Photographs of the Isaac River channel upstream and downstream of, and adjacent to the Project MLA from taken in 2024 as part of the aquatic ecology study are shown in Figure 2.2.

2.2.2 Cherwell Creek and JB Gully

Cherwell Creek, a tributary of the Isaac River, runs west to east to the south of the Project area. The Cherwell Creek catchment begins in the Cherwell Range and Denham Ranges at an elevation of 380 m (west of the Project area) and flows downstream to join the Isaac River at an elevation of 200 m (east of the Project area). Cherwell Creek is approximately 65 km long to the Isaac River junction with a catchment area of approximately 698 km^2. Cherwell Creek and its tributaries have clearly defined channels.

The dominant land use within the Cherwell Creek catchment is beef cattle grazing, with substantial clearing of vegetation having occurred over time to improve pastures. The Peak Downs Mine is located in the middle reaches of Cherwell Creek, about 13 km upstream of the Project, and has approval for controlled releases to Cherwell Creek. The catchment is not in pristine condition and is susceptible to the impacts of these land use activities, such as increase runoff, scouring, erosion and unstable creek banks.

Cherwell Creek has previously been diverted (in 1991 and 1995) as part of the Peak Downs Mine progression. Both diversions replaced meandering sections of creek floodplain, terraces, benches, low flow channel, active channel, and high flow channel features with relatively straight alignment and trapezoidal channel. The designs were developed in accordance with best practice at the time, which preceded current best practice design guidelines (DNRM, 2019). Erosion of the Cherwell Creek diversions (channel widening and deepening) and reduced functioning of stream stabilisation structures has been observed in previous years.

Within and adjacent the Project area, the natural low flow channel width varies between 15 m to 25 m wide and the high flow channel top width varies between approximately 100 m to 200 m. The channels are generally deeply incised to a depth of 6 m to 10 m. The channel banks slopes are typically 1(V) in 2(H) and vegetated with native long grass and scattered trees. A number of minor anabranches form along the length of Cherwell Creek, particularly within the Isaac River floodplain. The river bed consists mainly of silty sands.

Cherwell Creek also includes a second order tributary (JB Gully), that runs west to east to the south of the Project area. JB Gully is significantly smaller than Cherwell Creek, with a typical main channel bed width of 1 m to 2 m and a depth of 2 m. The high flow channel near the confluence with Cherwell Creek is relatively wide, around 200 m to 300 m, likely due to natural headcut from Cherwell Creek backwater flows.

The proposed secondary access route to the Project will cross Cherwell Creek (via a bridge) and JB Gully (low level crossing).

AQ1 (downstream Cherwell Creek confluence) **Isaac River** **10/11/2024**	**<u>Co-ordinates (UTM 55K)</u>** **E 627664** **S 7556522**
 **Upstream**	 **Downstream**
AQ10 (upstream of IDM) **Isaac River** **9/11/2024**	**<u>Co-ordinates (UTM 55K)</u>** **E 619807** **S 7562136**
 **Upstream**	 **Downstream**
AQ9 (adjacent to Project MLA, upstream Conrock Gully) **Isaac River** **9/11/2024**	**<u>Co-ordinates (UTM 55K)</u>** **E 622711** **S 7558630**
 **Upstream**	 **Downstream**

Figure 2.2 – Photos of the Isaac River – taken in 2024, adjacent to the Project MLA

2.2.3 Conrock Gully

Conrock Gully has a catchment area of approximately 38 km^2 upstream of the proposed stream diversion, and approximately 71 km^2 to the confluence with the Isaac River.

The catchment extends west approximately 10 km from the western MLA boundary and east to the Isaac River confluence approximately 1.5 km upstream of the eastern MLA boundary.

The Conrock Gully channel banks appear well vegetated and relatively stable. Digital elevation models acquired in 2012 to 2018 shows no evidence of significant channel movement when compared to photographs taken in 2011.

A long-section of the Conrock Gully channel bed in the vicinity of the Project area (approximately 6 km upstream from the confluence with the Isaac River, including the section that intersects the Project area) is shown in Figure 2.3. The channel bed slope in this area is a uniform 0.14% (1 in 690), aside from a steeper downstream section at 0.48% (1 in 210) as Conrock Gully joins the Isaac River.

The Conrock Gully channel cross-section geometry can be typified by the generalised cross-section in Figure 2.4, which was created from a statistical analysis of cross-section data collected from the topography within and surrounding the Project area. The median channel can be described as having:

- A base width of approximately 4 m;
- A side slope of 1V in 6H for the channel;
- A side slope of 1V in 30H on the channel overbank;

The channel is typically approximately 1.5 m to 3.5 m deep. At a depth of 2 m, the channel top width is typically approximately 50 m.

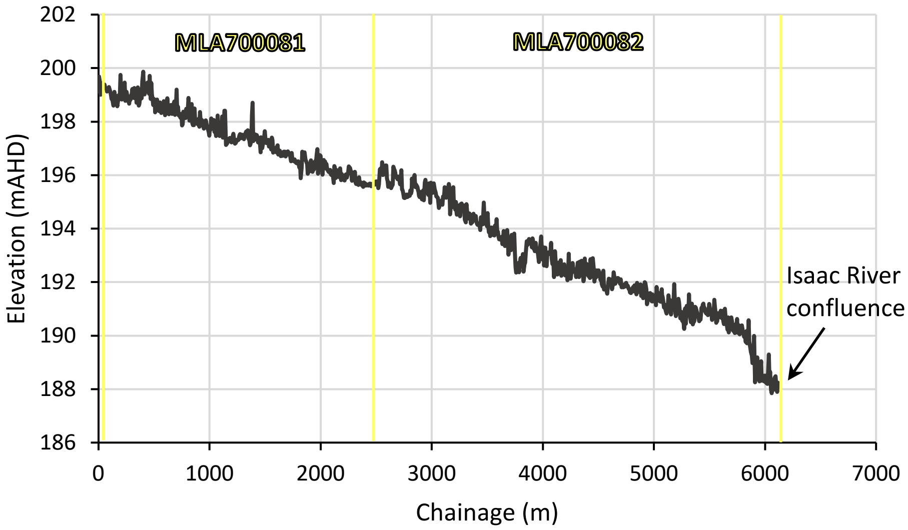


Figure 2.3 – Long-section of the Conrock Gully reach to be diverted

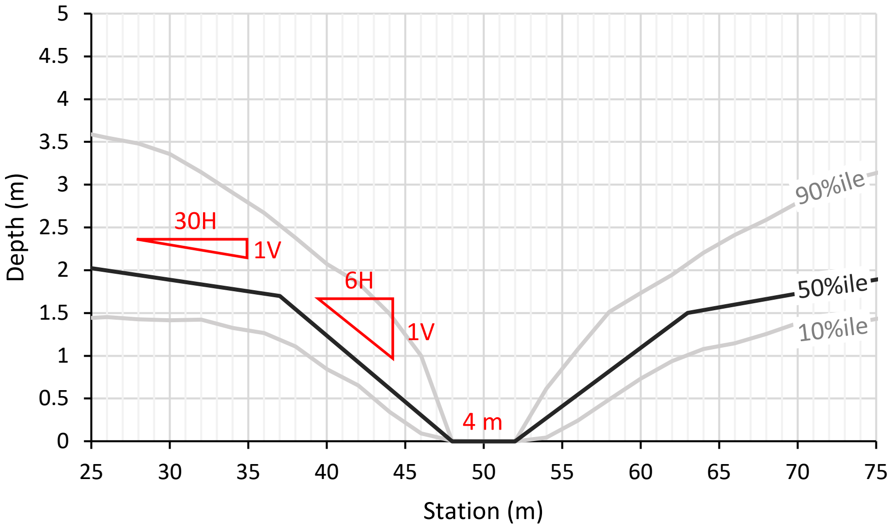


Figure 2.4 – Generalised Conrock Gully cross-section in the vicinity of the reach to be diverted

2.3 Project area watercourse identification

Figure 2.6 shows the watercourse identification mapping within the Project area under the Water Act per the DoR (2017) mapping. Isaac River, Cherwell Creek and JB Gully are designated watercourses in the vicinity of the Project. The majority of Conrock Gully upstream and including the beginning of the proposed diversion is defined as a drainage feature. The 3.2 km downstream reach of Conrock Gully to its confluence with Isaac River is defined as a watercourse. The several minor drainage lines in the vicinity of the Project (highlighted in Figure 2.6), are designated as either “drainage features” or “unmapped”.

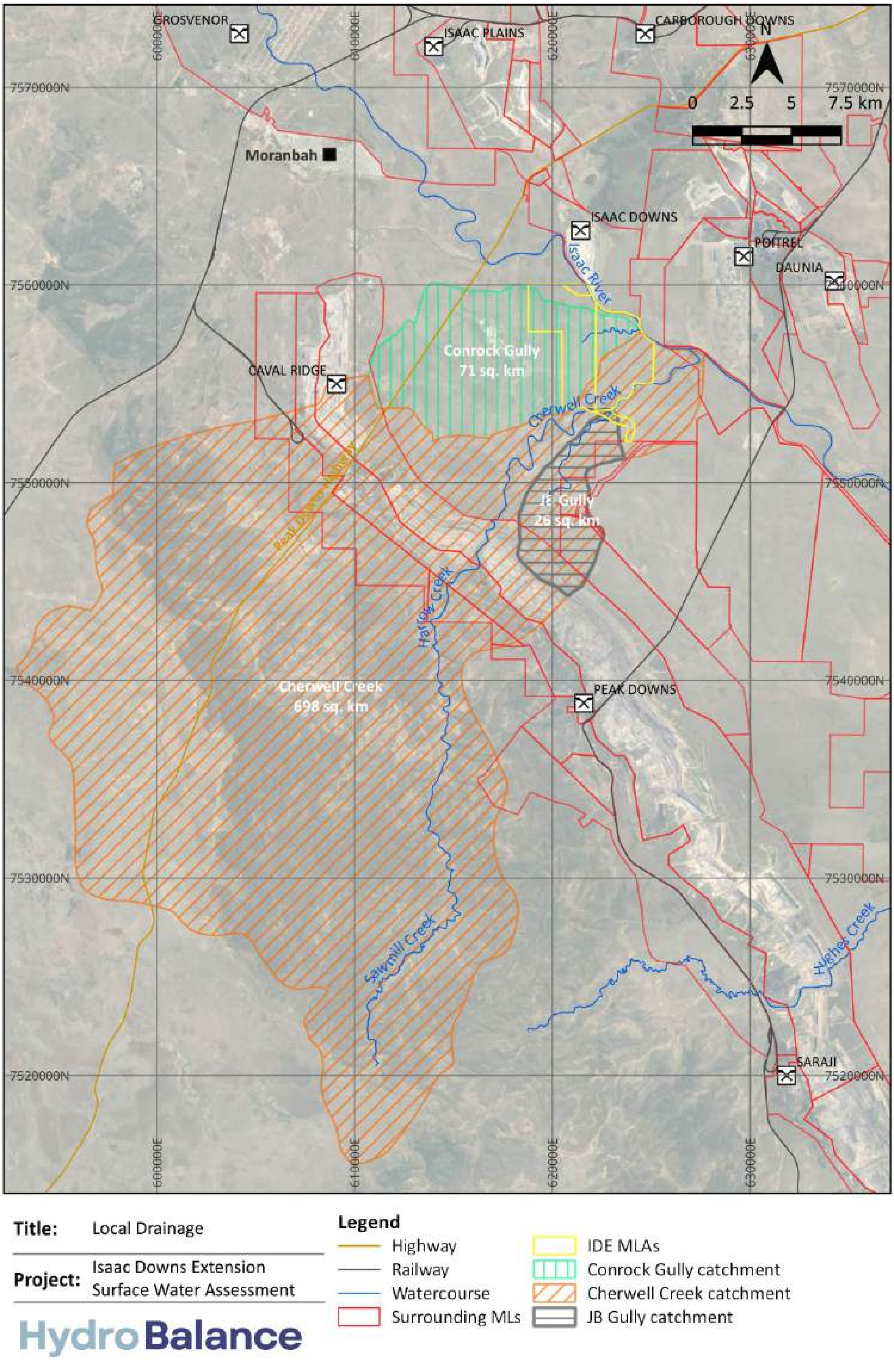


Figure 2.5 – Local drainage characteristics

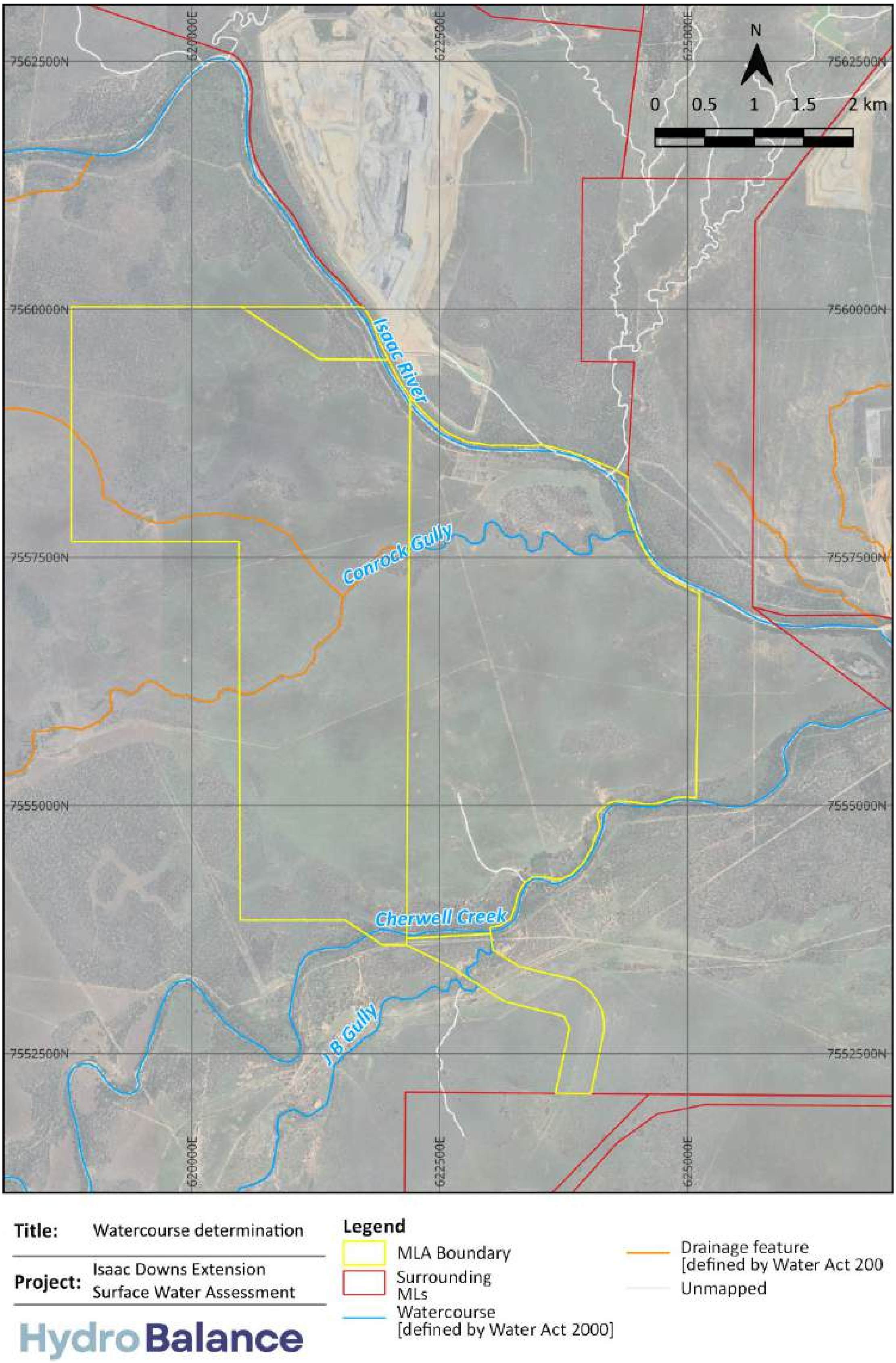


Figure 2.6 – Project area watercourse determination

2.4 Streamflow

2.4.1 Isaac River at Deverill (DNRMMRRD gauge)

The Isaac River at Deverill stream flow gauge is located 25 km downstream of Conrock Gully, which is operated by the Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development (DNRMMRRD).

Figure 2.7 shows a ranked plot of the daily stream flows in the Isaac River recorded at the Deverill stream gauge. The following is of note with respect to the recorded stream flows:

- The Isaac River is ephemeral with flows recorded only on 27% of days at Deverill. Flows above 100 ML/d occur for less than 10% of days at Deverill. A flow of 100 ML/d would not fully inundate the bed of the Isaac River at Deverill.
- The mean daily flow (all days) is 430 ML/d at Deverill.
- The highest recorded flow (2,638 m^3/s) at the Deverill gauge occurred in March 1988 where the river reached a gauge height of 11.4 m.

The downstream reach of Conrock Gully, including the proposed diversion, will be impacted by Isaac River flood flows. Hydraulic modelling (presented in Section 5) indicates Isaac River flood flows will back up into Conrock Gully during a 50% AEP (1 in 2 year) regional flood event, which is equivalent to a 375 m^3/s (32 ML/d) peak discharge at the Isaac River at Deverill. Isaac River floodwaters are expected to back up into Conrock Gully for approximately 15% of total days or around 55% of Isaac River flow days.

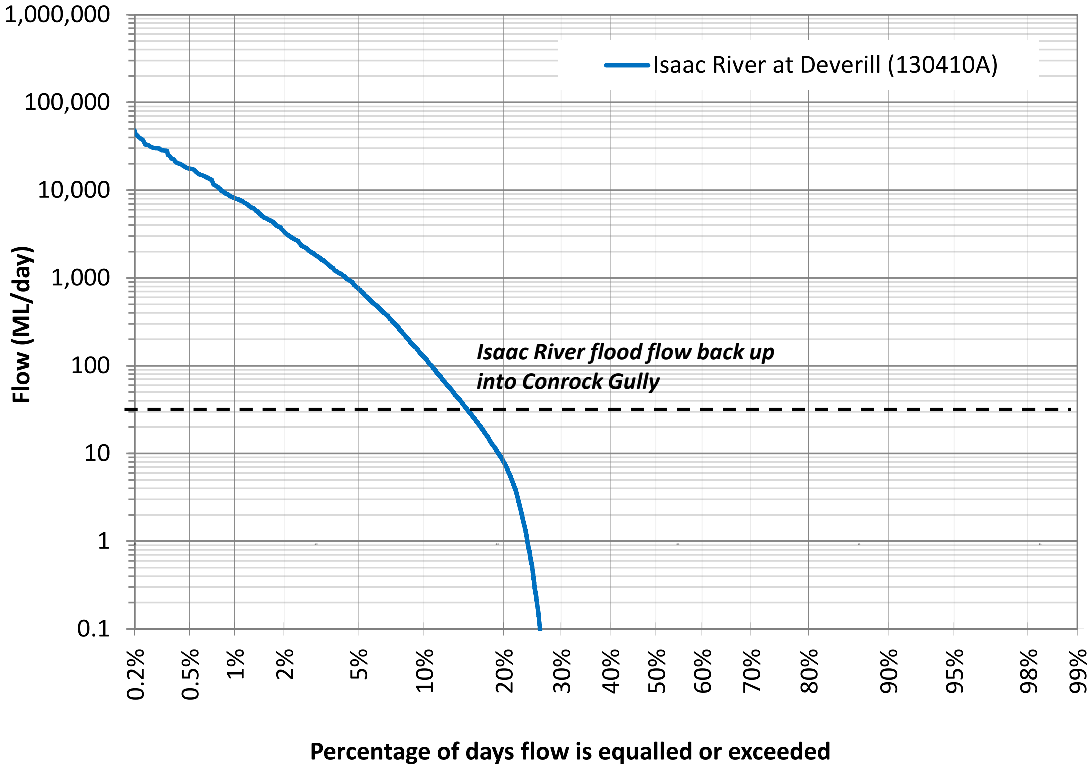


Figure 2.7 - Stream flow duration curves, Isaac River at Deverill gauge

2.4.2 Isaac River at Isaac Downs (Stanmore gauge)

Stanmore has operated a stream gauge on the Isaac River (Isaac River at Isaac Downs) since August 2021, with the gauge located approximately 4.5 km upstream of the Conrock Gully confluence.

The recorded stream flows in the Isaac River are shown in Figure 2.8. At Isaac River at Isaac Downs streamflow gauge, flows were recorded on approximately 6.6% of days over the four-year period. Flows of greater than 100 ML/d occurred for less than 1.2% of days at this location over the four-year period.

The maximum water level recorded at Isaac River at Isaac Downs was 16.292 mGH in April 2025 (flow depth of around 6.292 m at the gauge), which corresponded to a flow of 1,028 m^3/s.

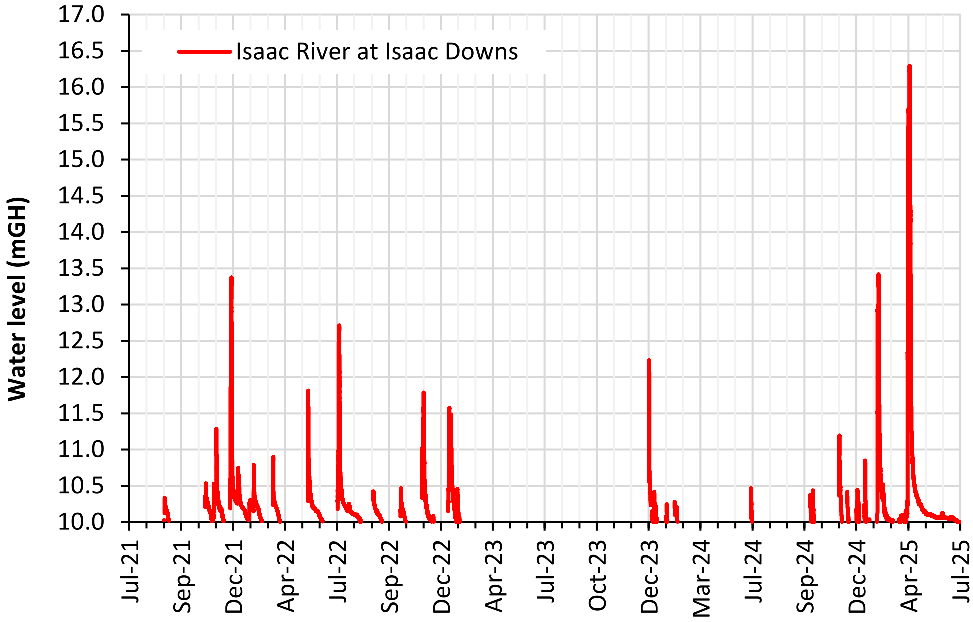


Figure 2.8 - Recorded water level at Isaac River at Isaac Downs (Gauge No. 333925)

2.4.3 Conrock Gully

There are no streamflow gauges on Conrock Gully, hence there is no current or historical streamflow data for Conrock Gully.

Stanmore had operated a stream gauge on Billy's Gully at the nearby IPM since 2013. Billy's Gully has a similar catchment area (68 km^2) and general characteristics to Conrock Gully. An analysis of the Billy's Gully streamflows has been undertaken to represent the potential flows in Conrock Gully.

The recorded streamflows in Billy's Gully, along with recorded rainfall, is shown in Figure 2.9. At Billy's Gully streamflow gauge, flows were recorded on approximately 0.1% of days. The maximum water level recorded at Billy's Gully was 12.6 mGH in February 2016 (flow depth of around 2.6 m at the gauge).

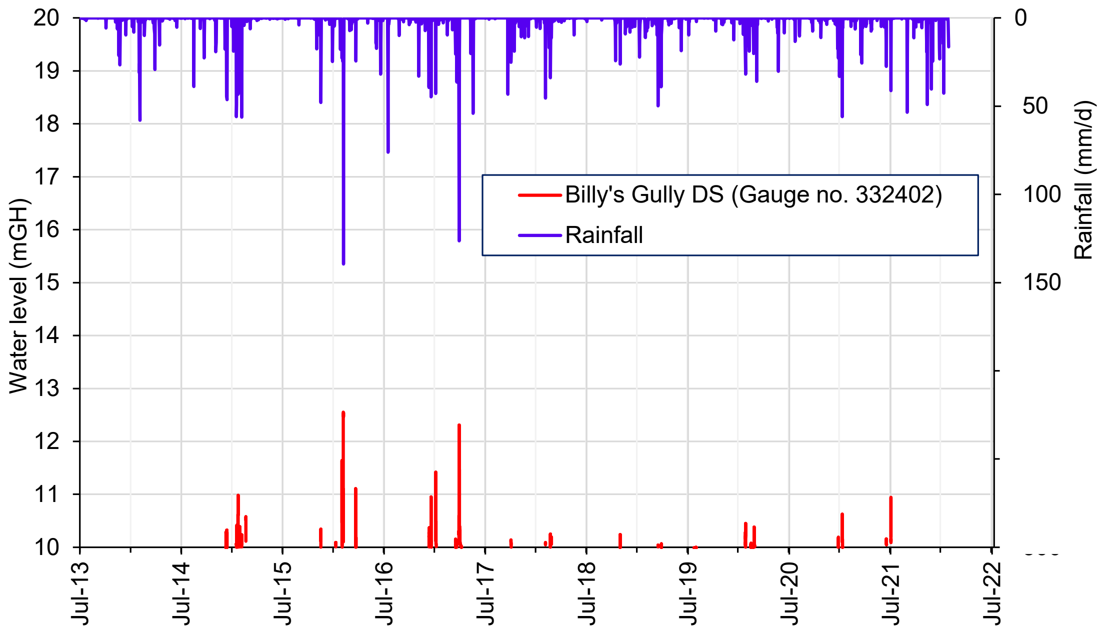


Figure 2.9 - Recorded water level at Billy's Gully DS (gauge no. 332402)

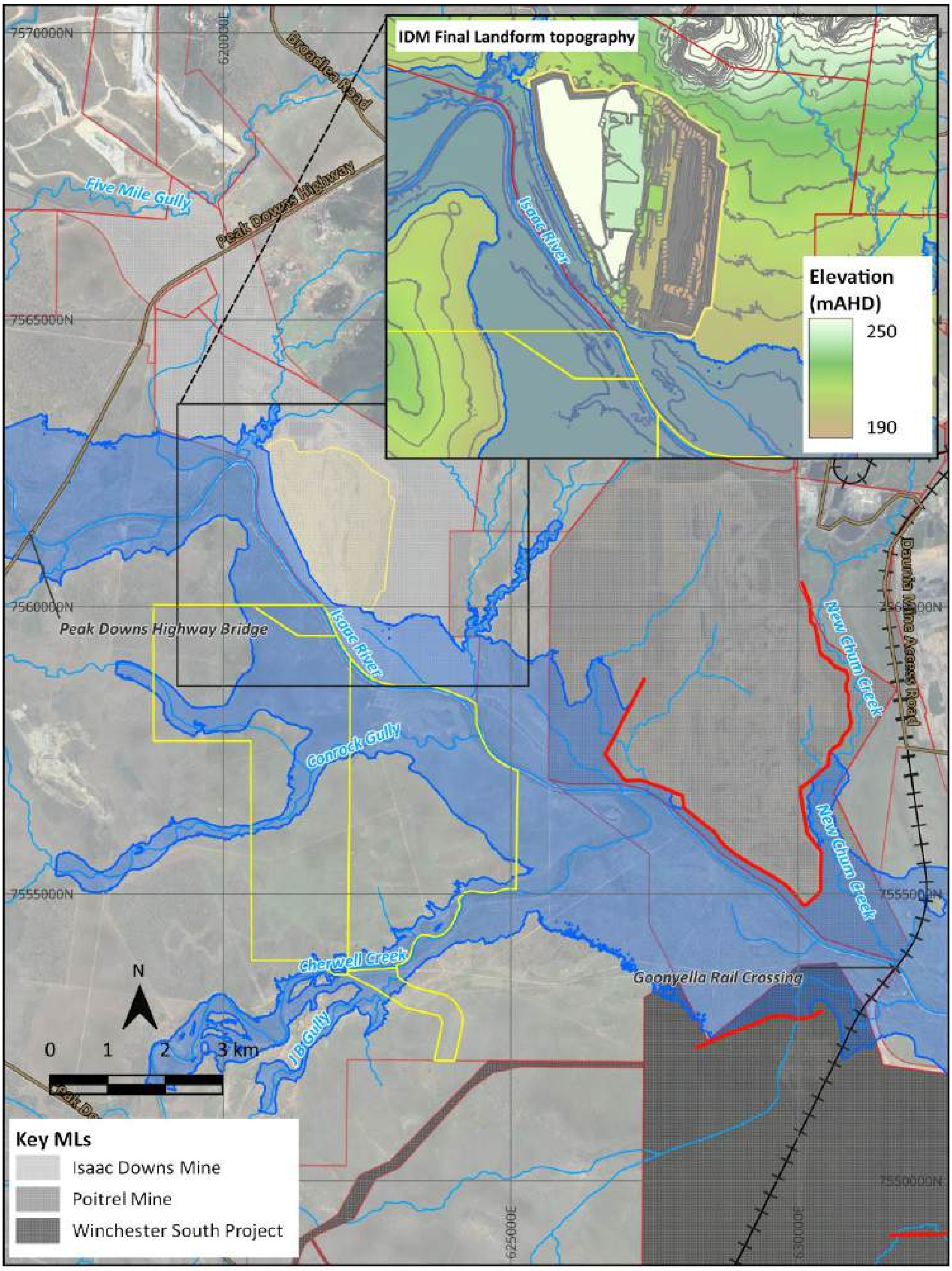
3 Existing surface water infrastructure

3.1 Overview

The reach of the Isaac River in the vicinity of the Project contains a number of existing and approved mining and transport infrastructure projects. Many of the major infrastructure projects in this reach of the Isaac River maintain surface water infrastructure to manage flows from Isaac River, as well as the local creeks. Key major infrastructure projects in the vicinity of the IDE Project, and relevant to the existing or approved surface water drainage network include the following:

- IDM;
- Poitrel Mine;
- Winchester South Project; and
- Road and rail bridges.

Details of the surface water infrastructure associated with the above projects is summarised in the following sections. The locality of the relevant surface water infrastructure features is shown in Figure 3.1.



Title:	Existing surface water infrastructure layout
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- Surrounding MLs
- 0.1% AEP flood extent (existing conditions)
- Highway/road
- Rail line
- Existing/approved levees

Figure 3.1 – Layout of existing and approved surface water infrastructure

3.2 Isaac Downs Mine

IDM MLs adjoin the Project MLAs, with mining operations predominantly north of proposed Project mining activities. The Project, once approved, will result in an extension of mining operations at IDM (part of IPC).

The IDM flood levee protects the IDM mining pit from Isaac River floodwaters. IDM flood levee is located between the Isaac River and the IDM pit on the southwestern side of the IDM ML and spans a distance of about 5 km. The existing levee has a height of up to 8 m from natural surface. The engineered structure designed is situated above the 0.1% AEP flood event plus 0.7 m of freeboard. The existing levee is planned to be decommissioned following the end of mining at IDM, which is expected to occur prior to the commencement of operations at the Project. Hence, the IDM flood levee is not included in the 'existing conditions' relative to the operations and post-closure phases of the Project.

The approved IDM final landform will be completed prior to the decommissioning of the IDM flood levee. The proposed IDM final landform configuration is shown in Figure 3.1. The final landform consists of a single void and a rehabilitated dump structure bounding the southern and western edges of the void. The dump structure spans about 3.8 km adjacent to the Isaac River and will prevent Isaac River flood waters from entering the IDM final void for at least a 0.1% AEP event. The IDM final landform will be in place, with the operational flood levee decommissioned, during operations and the post-closure period at the Project.

3.3 Poitrel Mine

Poitrel mine is an open-cut coal mine owned and operated by Stanmore, located approximately 2 km downstream of the Project.

A 3.5 km diversion of New Chum Creek has been constructed in the vicinity of the eastern ex-pit waste rock dump. A levee bank has been constructed along the south-western and southern boundaries of the mine to protect mining operations from flooding up to the 0.1% AEP flood event, plus freeboard. An portion of the levee will run parallel to the New Chum Creek diversion to the east and the remaining portion of the diversion will run parallel to the Isaac River to the south.

The location of the Poitrel Mine levees is shown in Figure 3.1. The Poitrel Mine levees will remain in place during the IDE Project operations and the post-closure period and hence are included in flood modelling assessment.

3.4 Winchester South Project

The Winchester South project is located approximately 8 km downstream of the Project, adjacent to the Isaac River. The Winchester South project involves the development of an open cut metallurgical coal mine.

Flood levees are proposed for the Winchester South project to prevent floodwater from Isaac River from entering the mine water management system (specifically, the open cut pits). The location of the approved levees are shown in Figure 3.1.

The temporary levees on Isaac River would be regulated structures designed with a crest level above the 0.1% AEP design event plus freeboard. The levees are assumed to be constructed by the start of operations at the IDE Project. The mine life of the Winchester South Project is longer than the IDE Project mine life, hence the levees are also expected to be operational during IDE operations and in the early stages of the IDE Project post-closure period.

A flood model for the Winchester South project was developed as part of the project's surface water and flooding assessment (WRM, 2022). The changes to the flood regime (i.e. levels) due to the Winchester South project are largely limited within that project's ML application area, with a minor excursion (360 m) to the north of the northern levee (shown in Figure 3.1). As there would be no changes to flood levels or velocity at any key infrastructure (e.g. residences, roads, rail), the Winchester South project would not result in any flooding impacts to key infrastructure.

The Winchester South project levees will remain in place during the IDE Project operations and the post-closure period and hence are included in flood modelling assessment.

3.5 Road and rail bridges

There are two major existing Isaac River crossings in the vicinity of the Project:

- Peak Downs Highway Bridge (located 7.3 km upstream of the Project MLA boundary); and
- Goonyella Railway crossing (located 7.8 km downstream of the Project MLA boundary).

The locations of the existing crossings are shown in Figure 3.1. Details of the existing crossing configurations and layouts are provided in Section B.6 of Appendix B.

4 Proposed surface water infrastructure

4.1 Overview

The proposed Project infrastructure that would interact with flows in watercourses and drainage features includes a diversion of Conrock Gully with associated levee plug, levee along the Isaac River, levee plug along a section of backwater flow from Cherwell Creek, bridge crossing of the Isaac River from the primary access road, bridge crossing of Cherwell Creek for the secondary access road, temporary dragline crossing of the Isaac River, low level crossing of JB Gully along the secondary access road. The proposed infrastructure has been designed to allow operations, while minimising potential impacts on the receiving environment and sensitive ecological receptors.

The layout of the key surface water infrastructure elements is presented in Figure 4.2. Details of the proposed infrastructure is provided in the following section.

4.2 Diversions

A diversion of Conrock Gully is proposed to facilitate access to mine the coal resource extending under Conrock Gully.

Table 4.1 shows a comparison of the geomorphic characteristics for the existing gully and proposed diversion. The proposed diversion and the diverted reach are approximately 5.2 km long and 5.8 km long, respectively. The channel slope of the proposed diversion and the diverted reach is approximately 0.147% to 0.140% in the upstream reaches of the channel. The proposed diversion is marginally steeper than the diverted reach in the downstream section where the channel rejoins the Isaac River (0.341% compared to 0.330%) due to the topography at the proposed diversion outlet location.

The proposed diversion channel geometry is shown in Figure 4.1. The diversion cross-section includes the following key components:

- 1.7 m deep main channel, which will convey 50% AEP local creek flows.
- 0.5 m deep overbank channel, which will convey 2% AEP local creek flows.
- Variable batter back to natural topography, which may contain local creek events rarer than the 50% AEP local creek flows. The diversion, particularly in its lower reaches, would not contain regional Isaac River flood flows for the majority of design events, which is typical of local creeks joining the Isaac River in the area. The Isaac River levee will protect flood flows from mining operations.

The proposed diversion design balances matching the typical cross-section of the existing channel (which has relatively gradual overbank slopes) against minimising the diversion footprint.

A geomorphic assessment of the Conrock Gully diversion is provided in Appendix D.

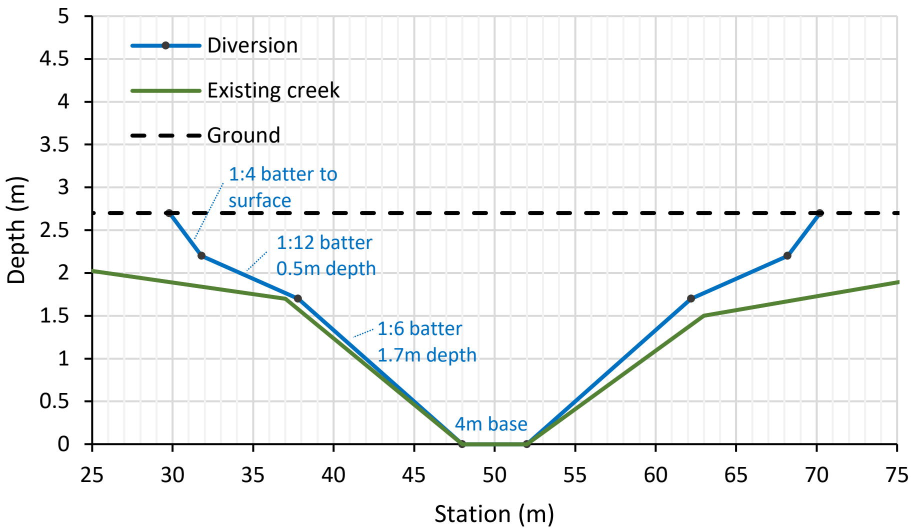


Figure 4.1 – Typical Conrock Gully diversion cross-section

Table 4.1 – Changes to typical channel geomorphic characteristics

Parameter		Existing gully	Proposed diversion
Length (km)		5.8	5.2
Bed Grade (%) – floodplain reach		0.140	0.147
Bed Grade (%) – downstream reach		0.330	0.341
Bed Width (m)		4	4
Top Width (m)		26	28
Depth to floodplain (m)		7	5
Meander Radius (m)		240 (median)	240 (median)
Meander Sinuosity Index		1.2-1.7	1.1
Meander Wavelength (m)		250-1,200	140-350
Meander Amplitude (m)		150-330	75-170
50% AEP	Mean Velocity (m/s)	0.95	0.93
	Mean Bed Shear Stress (N/m^2)	30.1	23.66
	Mean Stream Power (N/m s)	42.7	29.3
	Hydraulic Gradient (%)	0.17	0.14
2% AEP	Mean Velocity (m/s)	1.28	1.33
	Mean Bed Shear Stress (N/m^2)	33.5	30.9
	Mean Stream Power (N/m s)	55.7	49.6
	Hydraulic Gradient (%)	0.16	0.15

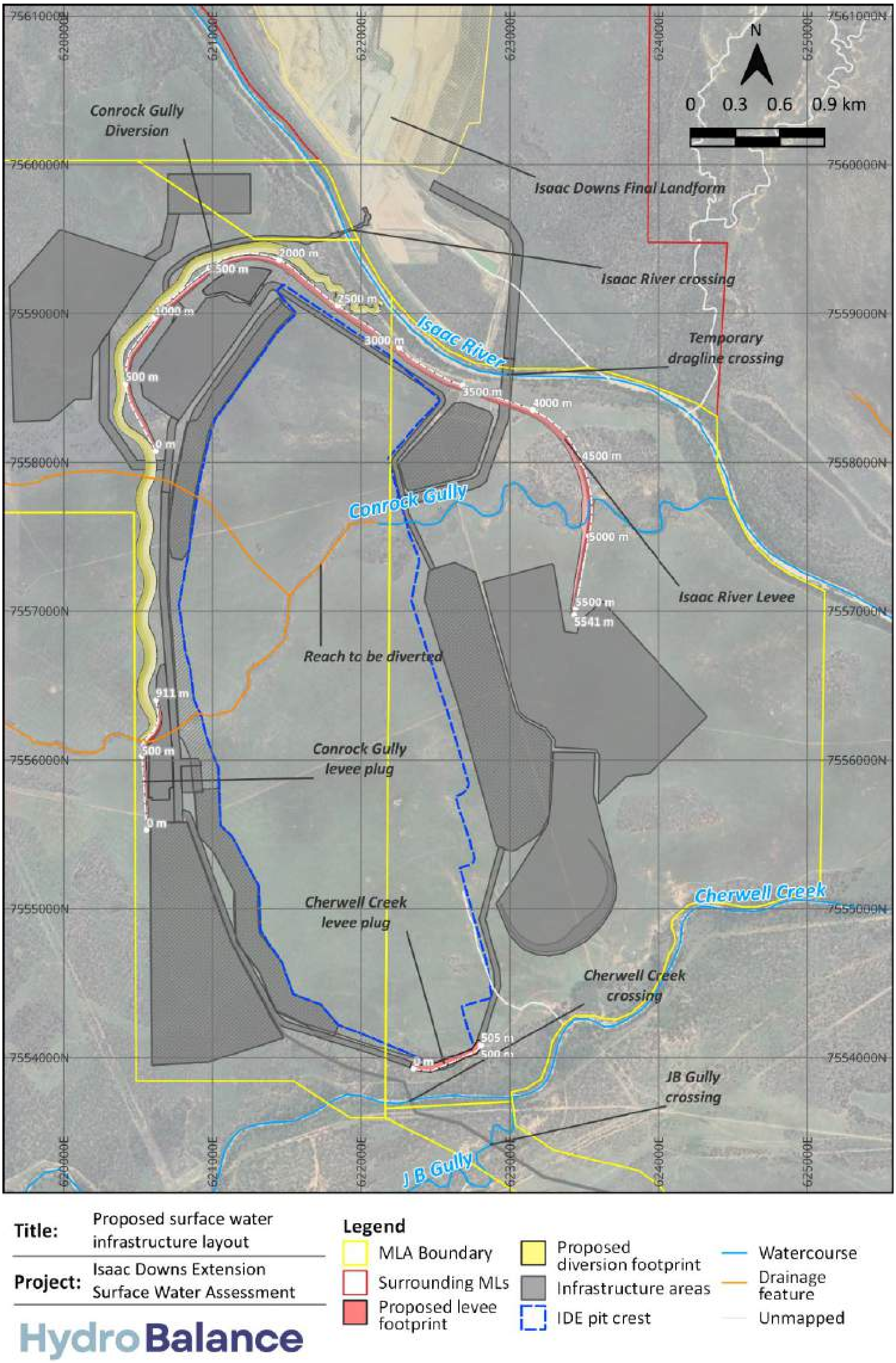


Figure 4.2 – Layout of proposed operational surface water infrastructure

4.3 Levees

The following levees are proposed, to protect mine working from local and regional flooding:

- **Isaac River levee:** The proposed 5.9 km long levee would provide immunity from the regional Isaac River flood and has been located at the edge of the proposed mine disturbance area.
- **Cherwell Creek levee plug**: A 0.5 km levee will be required along Cherwell Creek, to prevent ingress of floodwaters into the mine pit during operations.
- **Conrock Gully levee plug**: A 0.9 km levee will be required at the upstream end of the diversion to prevent flows continuing to traverse the old Conrock Gully channel.

All levees have been designed with sufficient height to provide immunity from the 0.1% (1 in 1,000) AEP local and regional design flood events. The proposed levees are described in the following sub-sections.

4.3.1 Isaac River Levee

A levee, approximately 5.9 km in length, will be constructed adjacent to the Isaac River to protect mine pits from the 0.1% AEP (1:1000 year) flood event (see Figure 4.3). The Isaac River levee will be located outside the high bank of the Isaac River to minimise impacts on the zone of riparian vegetation. A buffer distance is proposed between the levee and high bank of the Isaac River, which will reduce impacts to the riparian zone. The high bank was determined using LiDAR surfaces as the level at which bank slope changes from steep (i.e. 21-32%) to shallow (i.e. 1-4%). Along the length of the levee the buffer zone is:

- > 50 m in all locations
- 50 – 100 m wide for 15% (870 m) of its length
- 100 – 200 m wide for 6% (340 m) of its length
- > 200 m wide for 79% (4,680 m) of its length.

An allowance has been made for a 15 m construction width area adjacent the levee toe, which is contained within the proposed disturbance area shown in Figure 4.4.

Figure 4.3 and Figure 4.4 show two cross sections of the Isaac River levee in locations within 50 – 100m of the high bank of the Isaac River. These demonstrate that the levee, inclusive of construction working areas remains outside of riparian vegetation.

Levee construction will occur prior to mining in the 0.1% AEP flood zone.

The levee will be designed in accordance with The Manual for assessing consequence categories and hydraulic performance of structures (Queensland Government, 2016) (the Manual) with a flood immunity level for the 0.1% AEP flood event. Levees will be regulated structures and will be designed and certified by a suitably qualified person (i.e. registered professional engineer Queensland (RPEQ)).

Typical cross section designs for the Isaac River levee, looking south (i.e. the 'upstream' side is adjacent the River), are provided in Figure 4.5 and Figure 4.6. Levees will be constructed from adjacent borrow material within the disturbance area and / or from suitable overburden material, conditioned with water, placed and compacted. The conceptual Isaac River levee design has:

- height ranging between less than 1 m and 10 m
- embankment crest width of 5 m
- upstream 1:4 batter slopes
- downstream 1:3 batter slopes.

The northern and southern sections of the levee are unlikely to require rock protection due to lower velocities of flood water. However, rock protection is proposed on approximately 2.5 km of the central section of the levee between chainages 1700 m and 4200 m to prevent scour during the 0.1% AEP flood conditions.

Detailed levee design will be undertaken and could include cut-off trenches beneath the levee, erosion protection such as rock armouring, clay cut-off and capping of the levee crest.

Datum:	GDA2020 Zone 55
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Source:	Minserve
File:	20251027 High Bank Analysis.aprx

DISCLAIMER: Third party data sources are used in this map compilation. Minserve makes no warranty regarding this data's accuracy or currency.

stanmore

ISAAC DOWNS EXTENSION

Isaac River Levee Cross Sections

Figure | 4-27

Figure 4.3 – Isaac River Levee cross section location

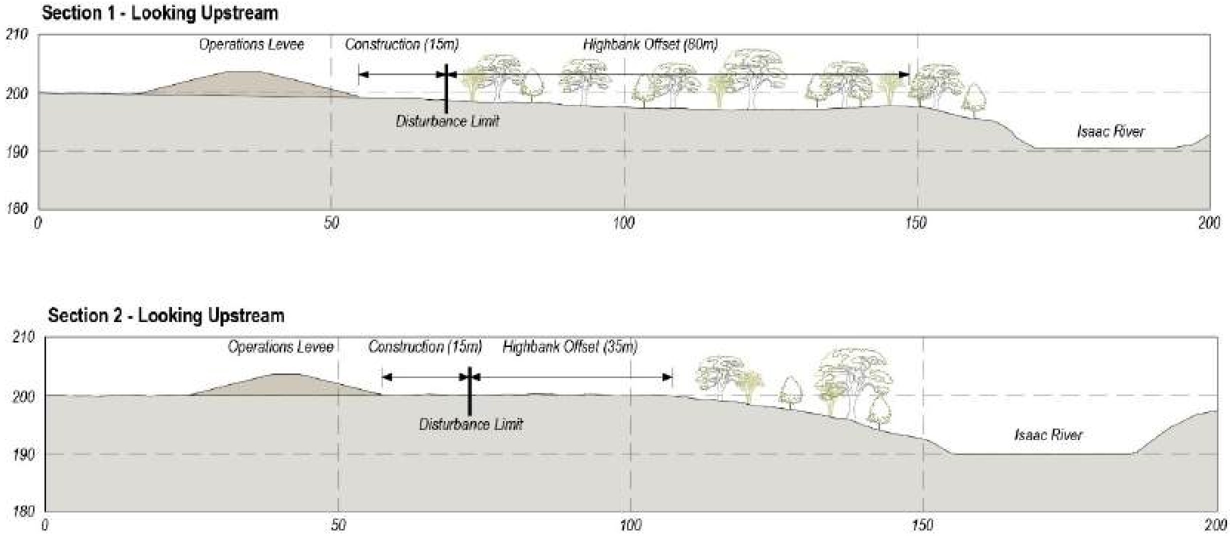


Figure 4.4 – Isaac River Levee cross section diagrams

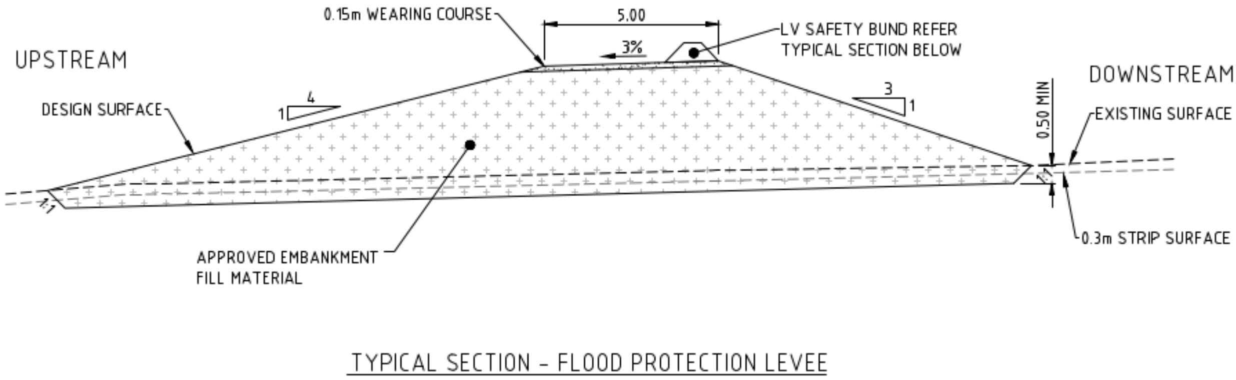


Figure 4.5 – Typical section of Isaac River Levee

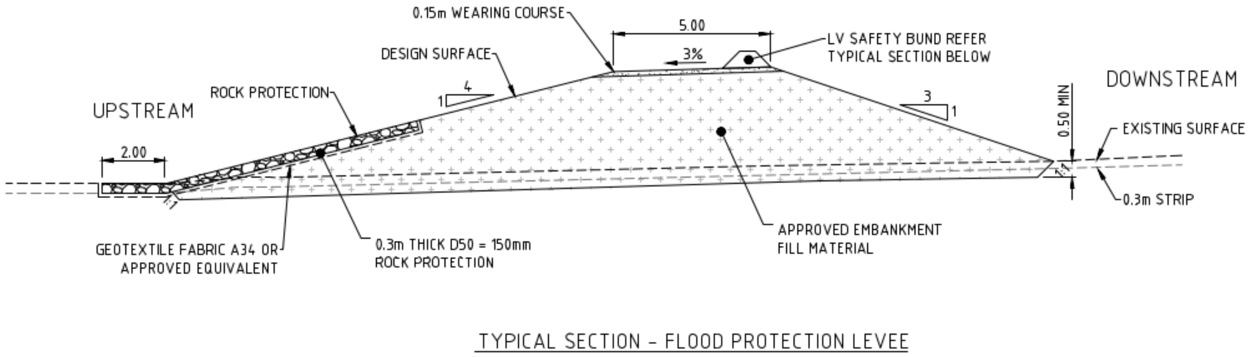


Figure 4.6 – Typical section of Isaac River Levee with rock protection

The northern and southern sections of the levee are unlikely to require rock protection due to lower velocities of flood water. However, rock protection is proposed on approximately 2.5 km of the central section of the levee between chainages 1700 m and 4200 m to prevent scour during the 0.1% AEP flood conditions. This is by definition, highly infrequent and scour is not expected to occur for a vegetated levee for flood events more frequent than the 0.1% AEP.

Detailed levee design will be undertaken and could include cut-off trenches beneath the levee, erosion protection such as rock armouring, clay cut-off and capping of the levee crest.

4.3.2 Cherwell Creek levee plug

A levee plug, approximately 500 m in length (see Figure 4.2), will be constructed adjacent to Cherwell Creek to protect the southern pit area during a short duration (i.e. 1 – 2 years) window of operations when backwaters along a landform gully, during a 0.1% AEP flood event, approach the pit end wall. This levee plug will be rehabilitated and vegetated following construction. Modelled velocities are consistently low for all flood events up to the 0.1% AEP, and hence are unlikely to cause scour along the vegetated levee plug.

This levee plug will not be required once in-pit backfill with overburden occurs following coal extraction in this pit area. The levee plug may be integrated into the haul road around the south of the pit area.

A preliminary Consequence Category Assessment has been undertaken for the levee plug in accordance with the Manual, in Section 6 of this report.

4.3.3 Conrock Gully levee plug

A levee plug, as shown in Figure 4.2, will be required at the upstream end of the diversion to prevent flows continuing to traverse the old Conrock Gully channel. This will be designed in accordance with The Manual (Queensland Government, 2016) with a flood immunity level for the 0.1% AEP flood event. This levee plug will be rehabilitated and vegetated following construction. Modelled velocities are low, with the exception of a small section (around 20 m) at chainage 590 m for the 0.1% AEP event, where velocities may reach up to 2.1 m/s. Rock protection will be applied in this section. Velocities along the remainder of the levee are unlikely to cause scour along the vegetated levee plug.

A preliminary Consequence Category Assessment has been undertaken for the levee plug in accordance with the Manual, in Section 6 of this report.

4.4 Waterway crossings

The Project will have a network of internal haul roads for haulage of ROM coal from the pit to the ROM coal pad and for haulage of overburden.

A haul road will be constructed between the ROM coal pad and existing haul roads at IDM, including a bridge crossing of the Isaac River. The haul road will be used for transport of ROM coal by off-road trains (e.g. C triples), or similar. ROM coal haulage on IDM and IPM MLs will be in areas authorised for disturbance, other than small sections on the north side of the Isaac River. ROM coal haul roads on IDM and IPM MLs will utilise existing haul roads, including the Peak Downs Highway underpass.

Access to the Project will be via IDM, utilising the existing access road intersection with the Peak Downs Highway. The extension of the access route to reach the Project is likely to follow the haul road to the Project, including Isaac River bridge crossing.

A secondary access route is proposed via the Eagle Downs project MLs and will be utilised intermittently, for example when access via IDM is constrained. The secondary access route will be approximately 20 m wide with a bridge crossing of Cherwell Creek. The secondary access route also crosses JB Gully.

New sections of the haul roads will be constructed as a cut and fill, with any additional road base sourced from overburden material, and a capping material sourced from a local quarry, if quarry materials are unavailable onsite. The road material will be sourced, crushed and screened, conditioned with water prior to placement and compaction. New sections of access road, if different to new haul road sections, will also be constructed using the cut and fill method; however the specifications of this road would be lower than that of the haul road due to the differences in axle loads and will require less material. Mine equipment will primarily be used for road construction, including dozers and excavators.

The dragline currently operating at IDM will be walked to the Project. The proposed walk route (see Figure 4.2) is different to the haul road and access road, but will be short duration (e.g. days to a few weeks), with a temporary crossing of the Isaac River. The walk route may also be utilised by other heavy vehicles to cross the Isaac River prior to bridge construction, in which case the walk route may remain open for 6 – 12 months.

The waterway crossings proposed across the Project area are summarised below:

- **Isaac River bridge:** crossing on the proposed Isaac Downs Mine access road, spanning the Isaac River channel.
- **Cherwell Creek bridge:** crossing on the secondary access road, spanning the Cherwell Creek channel.
- **Conrock Gully diversion crossing:** crossing on the proposed ROM coal haul road / site access road, spanning the proposed Conrock Gully diversion channel.
- **JB Gully low-level crossing:** bed level crossing on the proposed secondary access road, spanning the JB Gully channel.
- **Temporary dragline crossing:** The dragline currently operating at IDM will be walked to the Project. The proposed walk route requires a temporary crossing of the Isaac River.

The proposed waterway crossings are described in further detail in the following sub-sections.

4.4.1 Isaac River and Cherwell Creek bridges

The Isaac River and Cherwell Creek bridges will be approximately 110 m and 70 m long, respectively. The conceptual design of the bridges includes:

- approximate 15 m bridge width;
- dual lanes;
- between 2 and 4 concrete and / or steel spans supported by concrete piers, piled into the banks and beds, nominally to a depth a 10 m;
- less than 1:10 year flood event immunity;
- rip rap rock scour protection for bank abutments to minimise risk of scour, which will be inspected following major flood events and, if required, reinstated to reduce the risk of future scour; and
- waterway crossings perpendicular to the waterway direction.

Bridge designs are subject to detailed design which may result in changes to the conceptual design. A draft of the Isaac River bridge design is shown in Figure 4.7. This bridge is expected to be similar to the existing Peak Downs Highway Isaac River bridge (as shown in Figure 4.8) approximately 8 km upstream of the proposed Project Isaac River bridge. The Cherwell Creek bridge will have a similar design to that shown in Figure 4.7, but approximately half the length. A draft of the Cherwell Creek bridge design is shown in Figure 4.9, with cross section diagrams for both bridges presented in Figure 4.10.

Construction of bridges will involve methodologies similar to the following:

- preferentially constructed in the dry season
- geotechnical investigations to determine the stable depth
- temporary (i.e. less than 180 days) sheet piles around each pier location to create a dry work area
- installation of pier piles driven done to a suitable depth
- installation of a reinforced concrete pile cap to tie piles together construction of piers
- construction of abutments adjacent the river banks, with riprap rock protection placed adjacent abutments
- lifting of the of the girders (bridge superstructure) span by span between the abutments and piers

- casting of the bridge deck slab.
- bed scour protection, if required, with any bed scour protection to be at, or below the natural bed level of the waterway, such that it does not alter the profile of the low-flow channel, and no more than 20 m upstream or downstream.

A nominal 200 m width has been allowed for the construction of the Isaac River bridge and Cherwell Creek bridge to allow some flexibility in precise location during detailed design. However it is expected that the construction width will be less than this, allowing for buffers of vegetation within the nominated disturbance area. The construction and operation of the bridge will not create a barrier for fish passage.

At the end of the closure period, when the bridges are no longer required, the bridges will be decommissioned, with affected lands rehabilitated in accordance with the PRCP schedule requirements to restore riparian habitat. Bridges would be retained if there is an agreement with a third party for their retention.

4.4.2 Conrock Gully diversion crossing

The crossing of Conrock Gully diversion will be constructed as a culvert crossing based on the principles described in the Waterway Barrier Works Guideline. Following operations this crossing will be decommissioned and rehabilitated, with the diversion continuing to function as a geomorphically stable waterway.

The Conrock Gully diversion crossing will have sufficient capacity to convey the 10% AEP local Conrock Gully flows, with the conceptual design comprising:

- 199.5 mAHD road deck height.
- Eight (8) concrete culverts, square edge entrance with headwall.
- 2.7 m diameter culverts.

Hydraulic assessment of the of the Conrock Gully diversion crossing is provided in Appendix D.

As the crossing of Conrock Gully diversion will be constructed based on the principles in the Waterway Barrier Works Guideline, it will allow for lows flows and will not act as waterway barriers to fish passage.

4.4.3 JB Gully low-level crossing

The secondary access route crossing of JB Gully will be constructed as a bed level crossing based on the principles described in the Department of Primary Industry's (DPI's) '*Accepted development requirements for operational work that is constructing or raising waterway barrier works: September 2025'* (DPI, 2025) (the Waterway Barrier Works Guideline). At the end of the closure period, when the crossing is no longer required, the crossing will be decommissioned, with affected lands rehabilitated in accordance with the PRCP schedule requirements to restore the pre-mining land use (i.e. grazing).

As the crossing of JB Gully will be constructed based on the principles in the Waterway Barrier Works Guideline, it will allow for lows flows and will not act as waterway barriers to fish passage.

4.4.4 Temporary dragline crossing

The dragline currently operating at IDM will be walked to the Project. The proposed walk route (see Figure 4.11) is different to the haul road and access road, but will be short duration (e.g. a few weeks to a few months), with a temporary crossing of the Isaac River. The walk route may also be utilised by other heavy vehicles to cross the Isaac River prior to bridge construction, in which case the walk route construction, use and removal of material on the bed of the river would occur for less than 180 days (6 months). The dragline walk route will be preferentially constructed and utilised in the dry season when flows in the Isaac River are unlikely.

At the conclusion of mining operations, and once the dragline is no longer required for use in rehabilitation (i.e. approximately 20 years after operations commenced), the temporary crossing will be reestablished for a short duration (e.g. a few weeks). The temporary crossing will not be required for the movement of other equipment at closure as the Isaac River bridge will be available. All walk route crossing construction, use and removal of material on the bed of the river would occur within weeks to a few months (i.e. less than 180 days).

The proposed location for the dragline walk route crossing of the Isaac River has been selected based on relatively shallow and low river banks and minimising areas of remnant vegetation clearing. The dragline crossing construction will involve:

- gravel, road base or similar overlain on the bed of the river to a height of around 100 – 250 mm above the bed (noting that there will be flexibility in the height of the base as part of detailed design)
- bank cuttings on either side of the river to create a suitable gradient to facilitate the dragline's movements
- stabilisation of the banks of the river with rock protection.

Following utilisation of the crossing, and within 180 days of construction commencement, the temporary gravel base will be removed, and any sand that has been removed will be replaced to restore the natural bed of the Isaac River. Bank cuttings and the walk route itself will be stabilised and rehabilitated through topsoiling, seeding and vegetation establishment. Rock protection installed during construction will remain in place. This will create a stable landform during the operational period and prior to the dragline being walked from the Project back to IDM at closure.

At closure those parts of the walk route required for the movement of the dragline will be re-opened during the dry season, with gravel, road base or similar overlain on the bed of the river. Once the dragline has returned to IDM, the crossing will be fully rehabilitated with the gravel base removed, sandy bed reestablished, bank cuttings filled to resemble pre-mining topography and landforms rehabilitated through topsoiling, seeding and revegetation in accordance with the PRCP schedule requirements to restore riparian habitat.

A conceptual design of the dragline walk route crossing of the Isaac River is provided in Figure 4.11, showing that bank cuttings will be approximately 150 m long, with rock armouring on the channel bank slopes. Long sections and cross sections of the walk route (as per locations on Figure 4.11) are shown in Figure 4.12 for the period after the initial crossing with bank cutting stabilisation, and the period after closure when the bank cuttings have been filled and rehabilitated.

As the dragline crossing will be temporary for the pre and post operational crossings, it will not result in a permanent waterway barrier that will impede fish passage.

High voltage power lines will be installed prior to the walk, to allow for the connection of the dragline substation and dragline trailing cable to support the walk, with a required separation distance between the power line and the walk route for safety purposes. The powerline would be strung across the river from poles on either side of the bank. A nominal 250 m width has been allowed for the dragline walk route and power line crossing activities. However it is expected that the construction width will be less than this, allowing for buffers of vegetation within the nominated disturbance area.

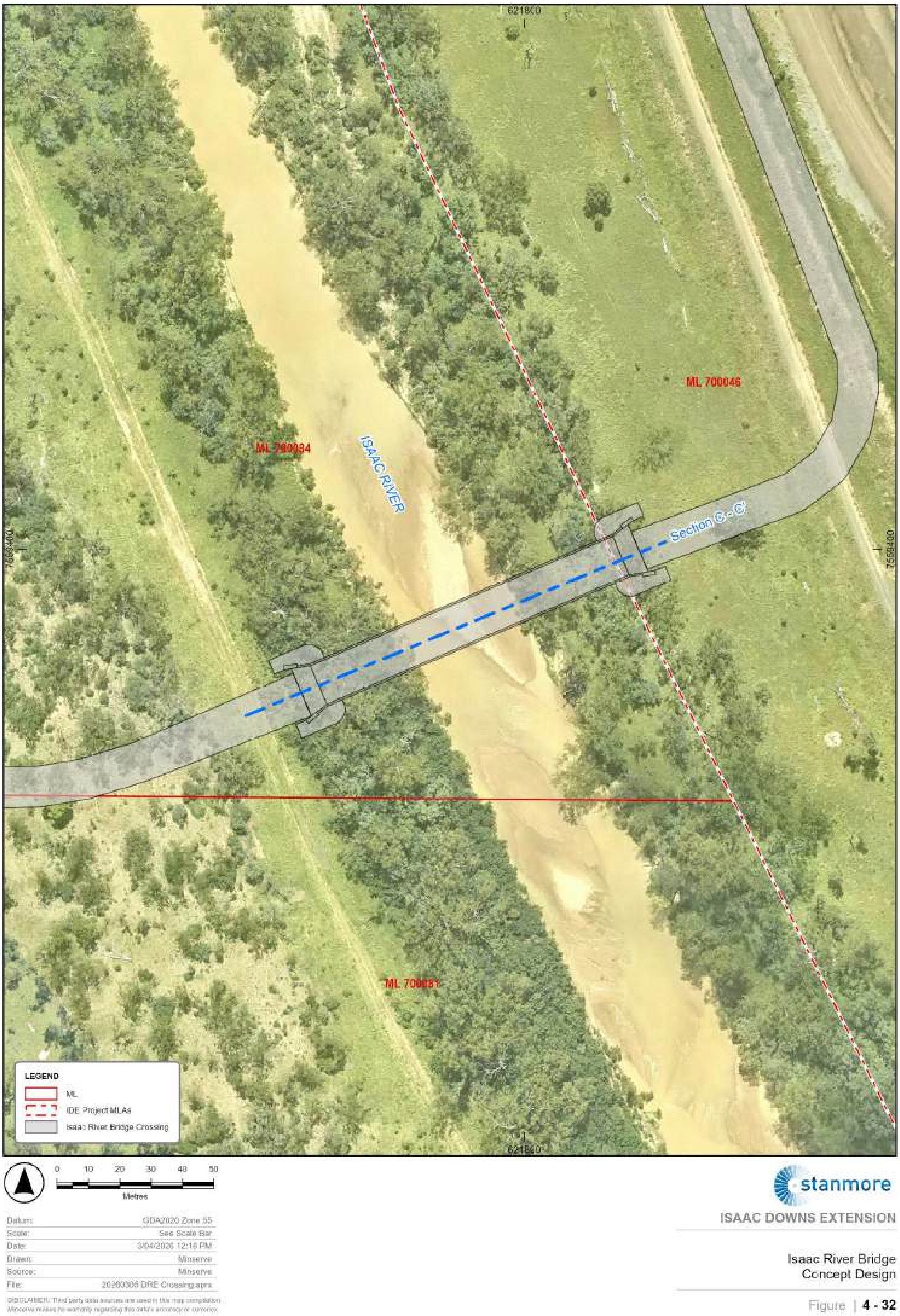


Figure 4.7 – Isaac River bridge concept design

Figure 4.8 – Existing Peaks Downs Highway Bridge over the Isaac River

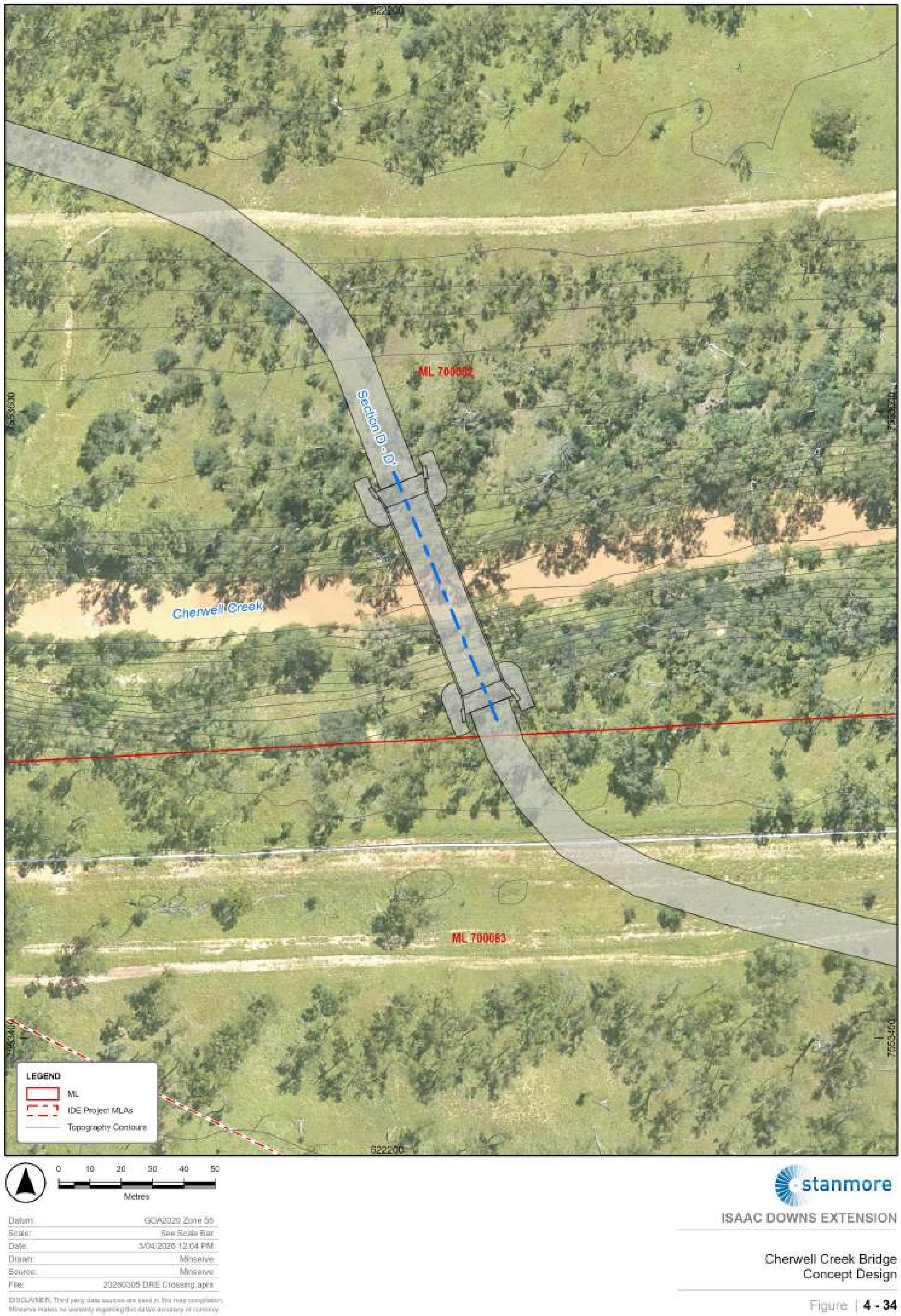


Figure 4.9 – Cherwell Creek bridge concept design

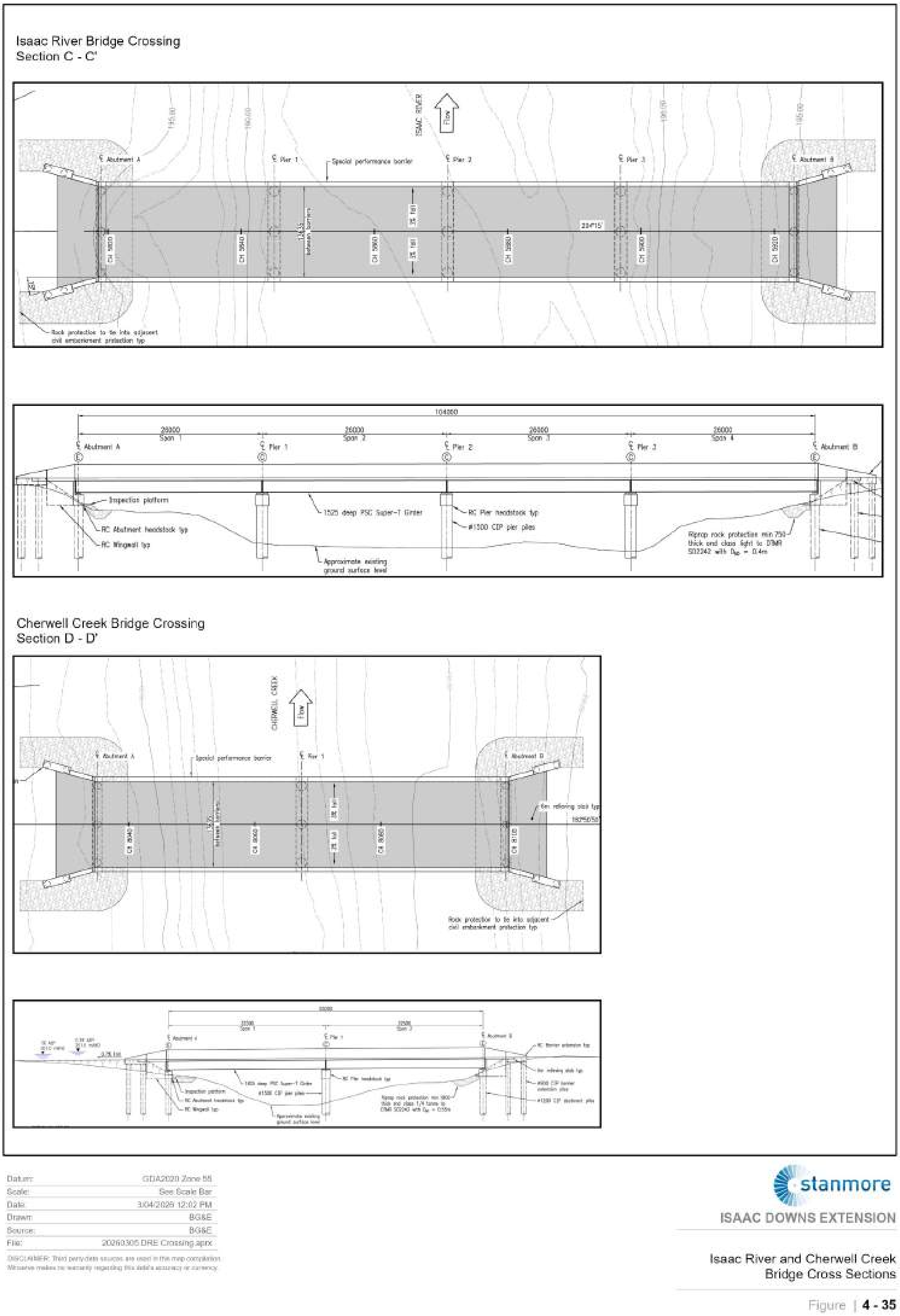


Figure 4.10 – Isaac River and Cherwell Creek bridge cross sections

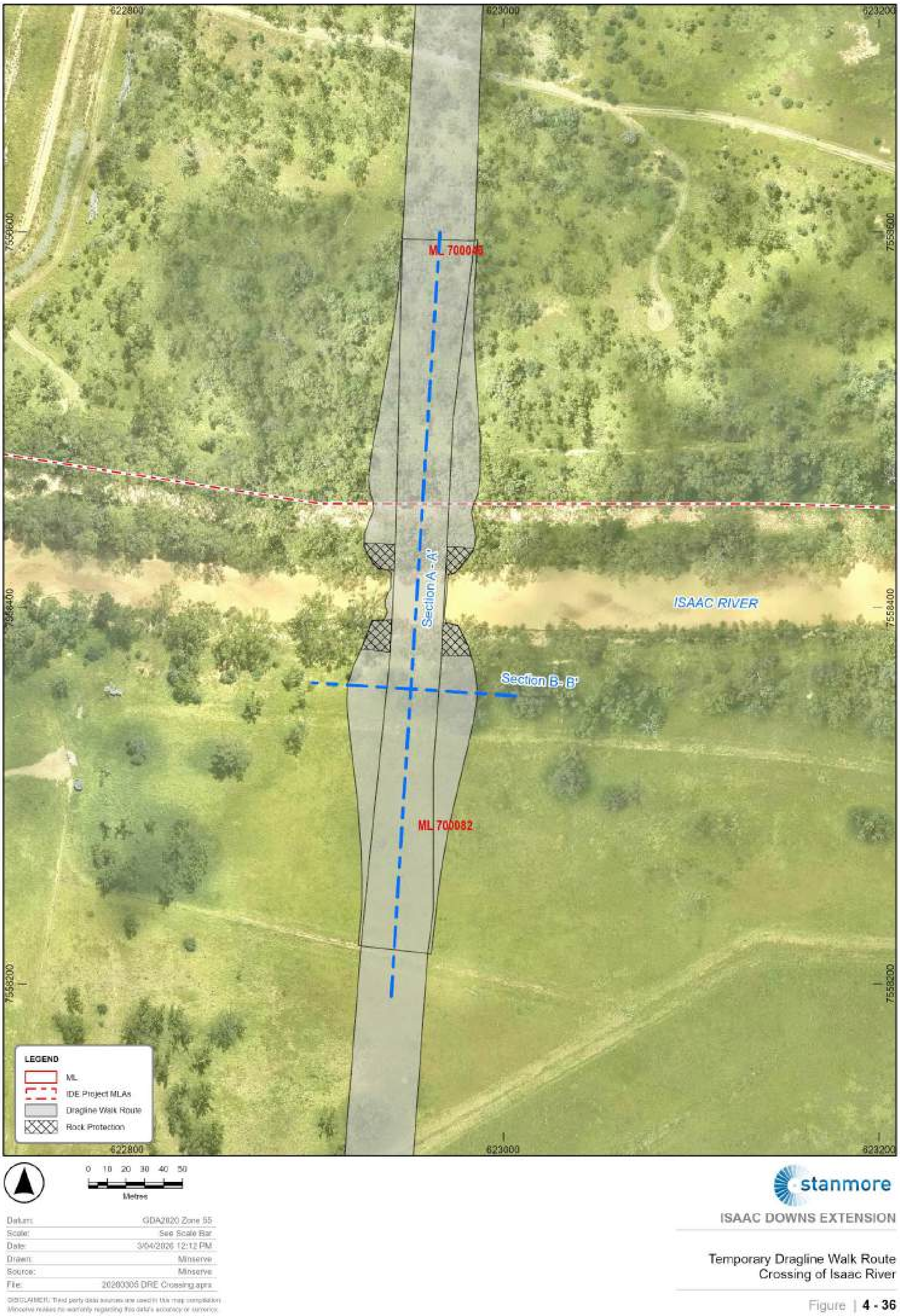


Figure 4.11 – Temporary dragline walk route crossing of Isaac River

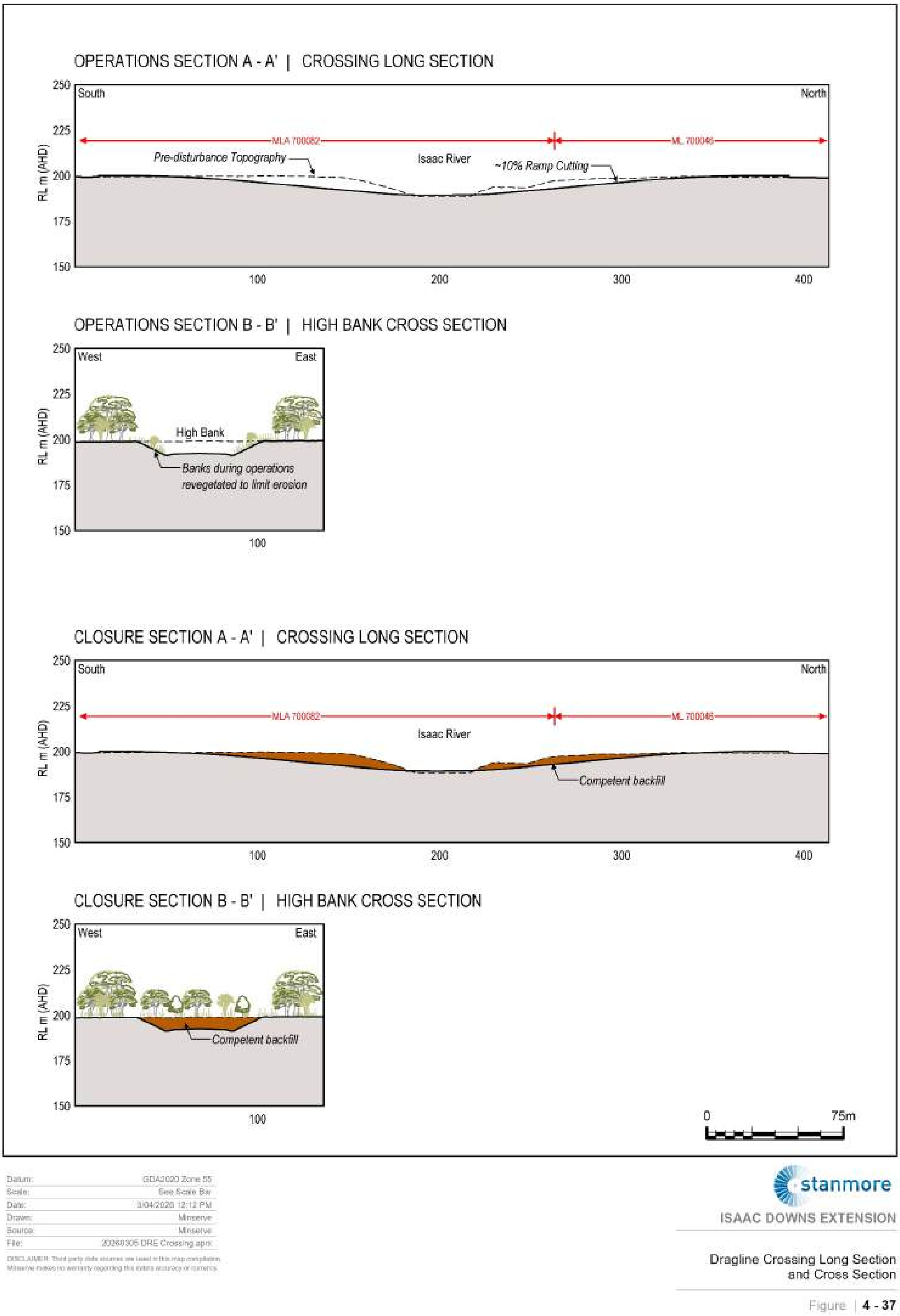


Figure 4.12 –Dragline crossing long section and cross section

5 Flood modelling assessment

5.1 Overview

A TUFLOW hydraulic model was used to assess the impacts of the Project on Isaac River, Cherwell Creek and Conrock Gully flooding for a range of design flood events. The development of the hydrological and hydraulic models is documented in Appendix A and Appendix B, respectively. The following development scenario/event combinations were modelled:

- Existing (approved) conditions:
  - 50%, 10%, 2%, 1% and 0.1% AEP
- Developed (operational) conditions:
  - 50%, 10%, 2%, 1% and 0.1% AEP
- Post-closure (final landform) conditions:
  - 1% AEP, 0.1% AEP and PMF

The existing conditions represent the approved conditions prior to the commencement of construction and operation at the Project. This includes the following key assumptions:

- Mining would be completed at IDM, with the final landform established at IDM. The IDM levee would be decommissioned and rehabilitated in the southern extent shown in Figure B.1 (Appendix B) as part of the post-closure works.
- The Poitrel Mine levee would be operational, following the alignment shown in Figure B.1 (Appendix B).
- The Winchester South project levees would be fully constructed, following the alignments shown in Figure B.1 (Appendix B).

The developed conditions represent the operational disturbance area for the proposed works. The following drainage infrastructure is proposed as part of the Project, to manage surface water flows:

- Conrock Gully diversion and levee plug;
- Isaac River levee; and
- Cherwell Creek levee plug.

The layout of the proposed drainage infrastructure is shown in Figure 4.2. A geomorphic assessment of the Conrock Gully diversion is provided in Appendix D.

The layout of the post-closure landform is shown in Figure 5.1. The Conrock Gully diversion will remain post-closure, however the levees would be decommissioned and rehabilitated as they are not required for final void protection (as the void is not located within a 0.1% AEP floodplain). The raised haul road located at the upstream end of the Conrock Gully diversion would be rehabilitated, stabilised and incorporated into the final landform dump structure, effectively replacing the functionality of the Conrock Gully levee plug. The final landform includes backfilling of the northern section of the pit to natural topographical levels, as well as rehabilitated overburden dumps.

For impact assessment, the modelled existing conditions flood levels and velocities were subtracted from the flood levels and velocities modelled under the developed and post-closure scenarios. A positive value of impact therefore represents an increase in peak flood levels and velocities and conversely a negative value of impact represents a reduction in peak flood level or velocity.

The results of modelling of existing conditions and the impacts of the development and post-closure scenarios are described in detail in the following sections. The location of the key reporting locations for the flood modelling assessment are presented in Figure 5.2.

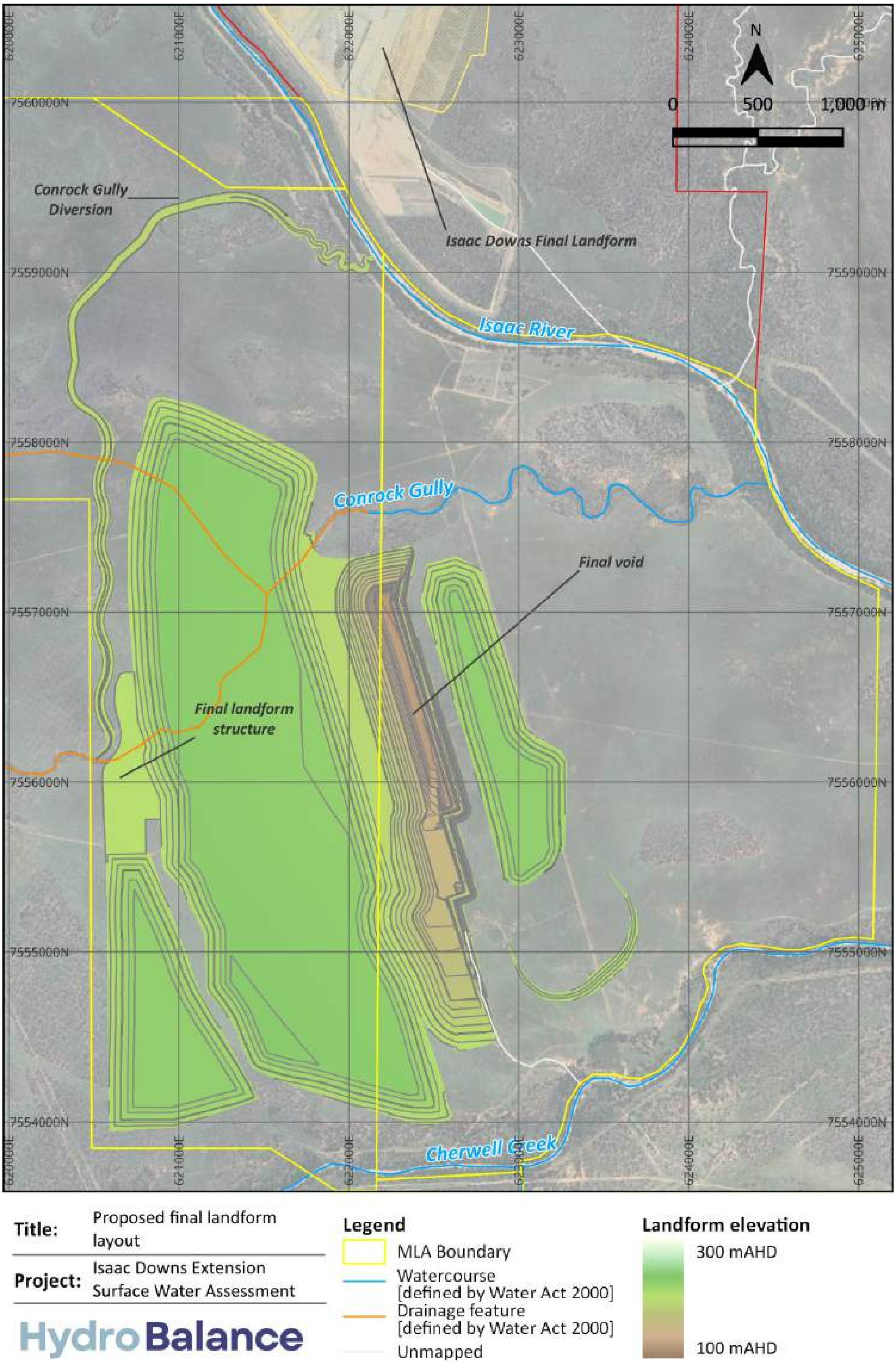


Figure 5.1 – Layout of proposed final landform

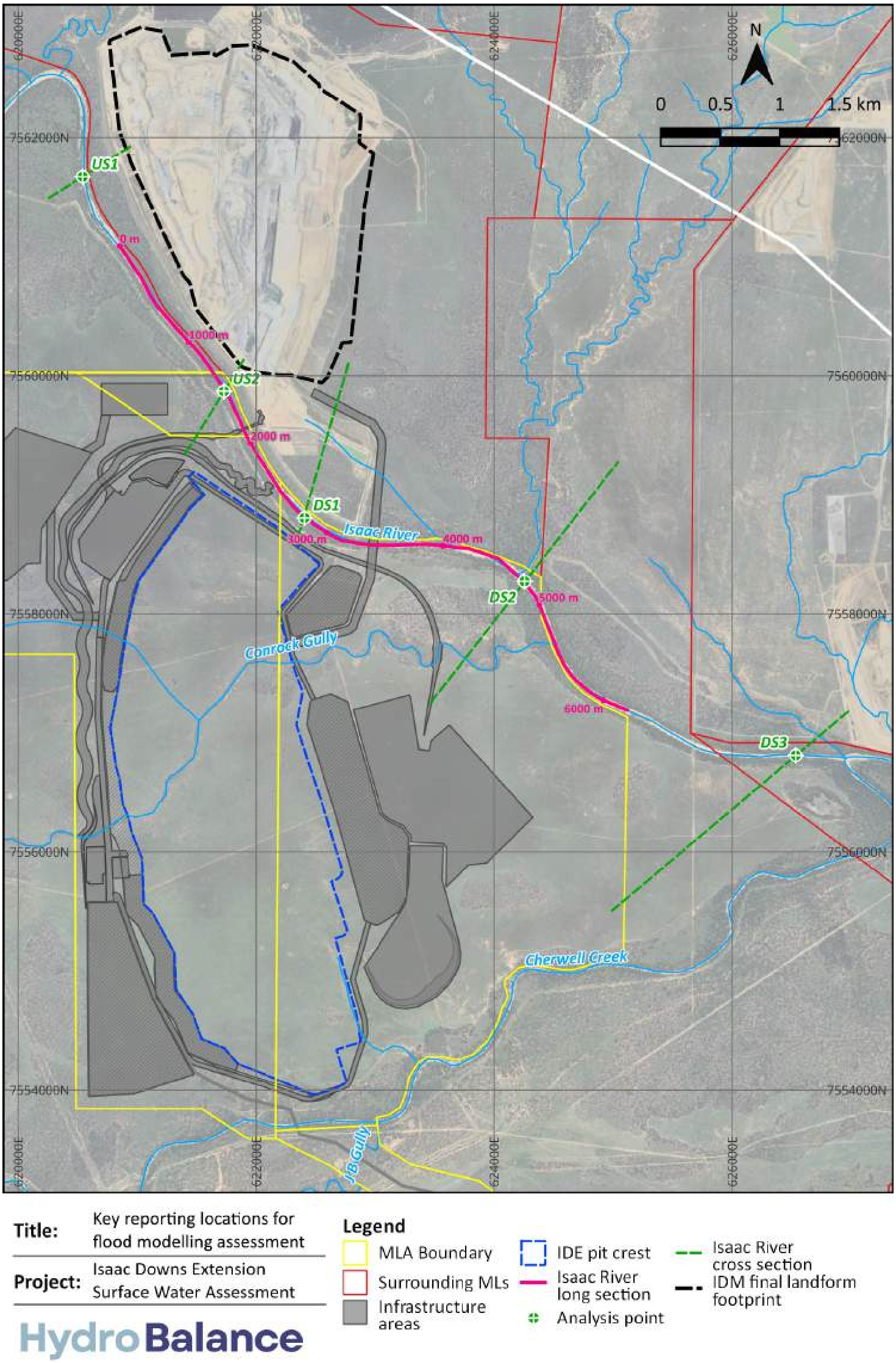


Figure 5.2 – Key reporting location for the flood modelling assessment

5.2 Existing conditions

Modelled 1% AEP and 0.1% AEP flood depths and extents for the existing conditions scenario are shown in Figure 5.3 and Figure 5.4 respectively. Modelled flood velocities for the existing conditions for the 1% AEP and 0.1% AEP events are shown in Figure 5.5 and Figure 5.6 respectively.

The modelled existing Isaac River flood depths and velocities show the following:

- A perched overbank channel runs along the west bank of the Isaac River from upstream of US1 to immediately upstream of DS1.
- The width of the Isaac River floodplain ranges been 700 m at US1 upstream of the Project to 2,500 m at DS2 downstream of the Project.
- 1% AEP depths and velocities:
  - The maximum flood depths in the Isaac River channel adjacent to the Project typically ranges between 11 m to 12 m.
  - The western floodplain depths vary in the vicinity of the Project, with the perched overbank channel experiencing depths up to 4 m to 5 m and the depths in the flatter regions of the floodplain ranging from 1.0 m to 1.5 m.
  - The depths in the eastern floodplain adjacent to the Project range between 1.8 m to 2.2 m.
  - The maximum flood velocities in the Isaac River main channel in the vicinity of Project range between 2 m/s to 2.5 m/s. The floodplain velocities generally remain below 1 m/s, aside from the western perched overbank channel, where velocities may reach up to 2 m/s.
- 0.1% AEP depths and velocities:
  - The maximum flood depths in Isaac River channel adjacent to the Project typically ranges between 13 m to 14 m.
  - The western floodplain depths vary in the vicinity of the Project, with the perched overbank channel experiencing depths up to 5 m to 6 m and the depths in the flatter regions of the floodplain ranging from 1.5 m to 2.5 m.
  - The depths in the eastern floodplain adjacent to the Project range between 3 m to 4 m.
  - The maximum flood velocities in the Isaac River main channel in the vicinity of Project range between 2.5 m/s to 3.0 m/s. The floodplain velocities generally remain below 1.5 m/s, aside from the western perched overbank channel, where velocities may reach up to 2.4 m/s.
  - The IDM final void would not be encroached by the 0.1% AEP Isaac River flood.

The modelled existing Cherwell Creek flood depths and velocities show the following:

- A number of minor breakout channels occur along Cherwell Creek, particularly along the southern bank and in the reach downstream of the JB Gully confluence. The number of breakout channels increases during the 0.1% AEP event and rarer, suggesting that the Cherwell Creek main channel generally has a conveyance capacity of equivalent to the 1% AEP event.
- Cherwell Creek is generally well confined during the 1% AEP event. The Cherwell Creek floodplain width during the 0.1% AEP event ranges between 600 m to 1,000 m.
- Cherwell Creek is impacted by the Isaac River flood, with river backwater flowing 3.0 km into Cherwell Creek during major (1% AEP and 0.1% AEP) flood events.
- The JB Gully channel is poorly defined in comparison to Cherwell Creek. JB Gully is impacted by Cherwell Creek backwater.
- 1% AEP depths and velocities:
  - The non-backwater affected reaches of Cherwell Creek in the vicinity of the Project generally range between 6 m to 8 m.

    - The non-backwater affected reaches of Cherwell Creek in the vicinity of the Project generally range between 2.0 m/s and 3.0 m/s.

- 0.1% AEP depths and velocities:
    - The non-backwater affected reaches of Cherwell Creek in the vicinity of the Project generally range between 8 m to 12 m deep.
    - The non-backwater affected reaches of Cherwell Creek in the vicinity of the Project generally range between 2.5 m/s and 4.0 m/s.

The modelled existing Conrock Gully flood depths and velocities show the following:

- The Conrock Gully floodplain width ranges between 150 m and 300 m in the vicinity of the Project.
- Conrock Gully is impacted by the Isaac River flood, with river backwater flowing 2.5 km to 3.5 km into Conrock Gully during major (1% AEP and 0.1% AEP) flood events.
- The flood behaviour in Conrock Gully does not change significantly between the 1% AEP and 0.1% AEP design events.
- The depth in non-backwater affected reaches of Conrock Gully in the vicinity of the Project generally range between 1.0 m to 2.0 m in the upstream reach and 2.0 m to 3.5 m in the downstream reach.
- The velocity in non-backwater affected reaches of Conrock Gully in the vicinity of the Project generally ranges between 1.0 m/s and 3.0 m/s.

Mapping of 50% AEP, 10% AEP, 2% AEP and PMF results of the flood modelling for existing conditions are presented in Appendix C.

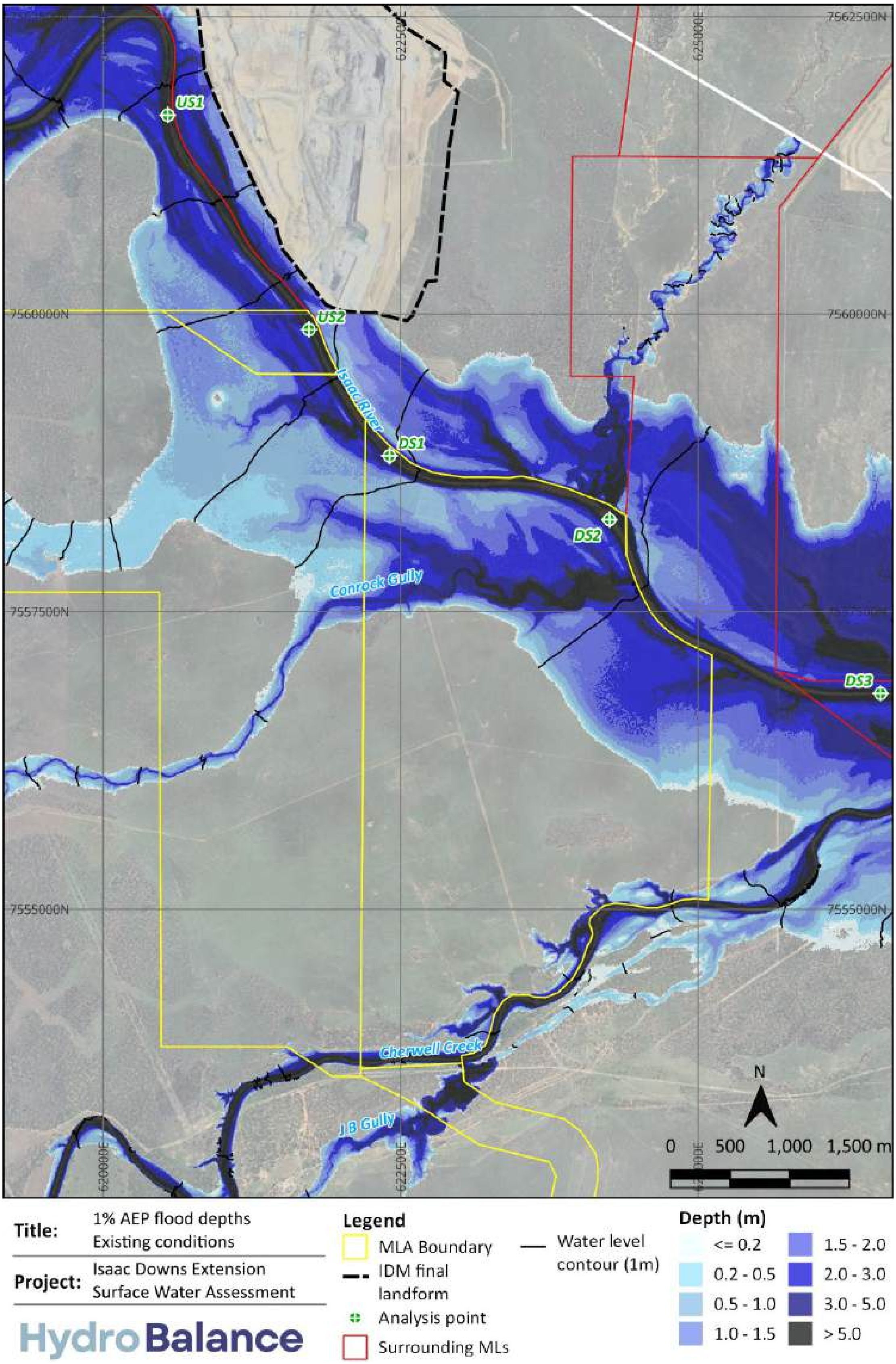


Figure 5.3 – Existing conditions 1% AEP flood depths and heights

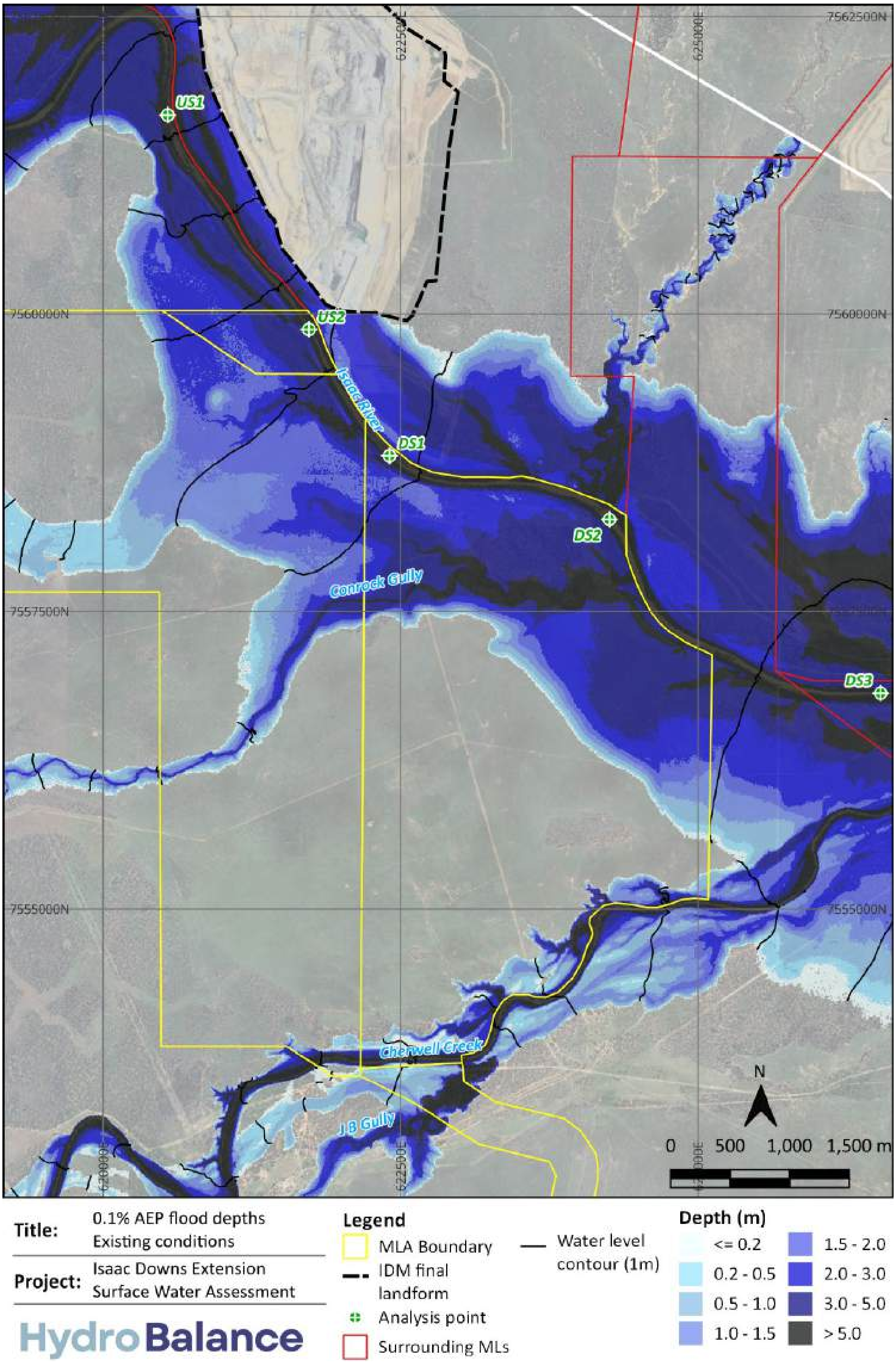


Figure 5.4 – Existing conditions 0.1% AEP flood depths and heights

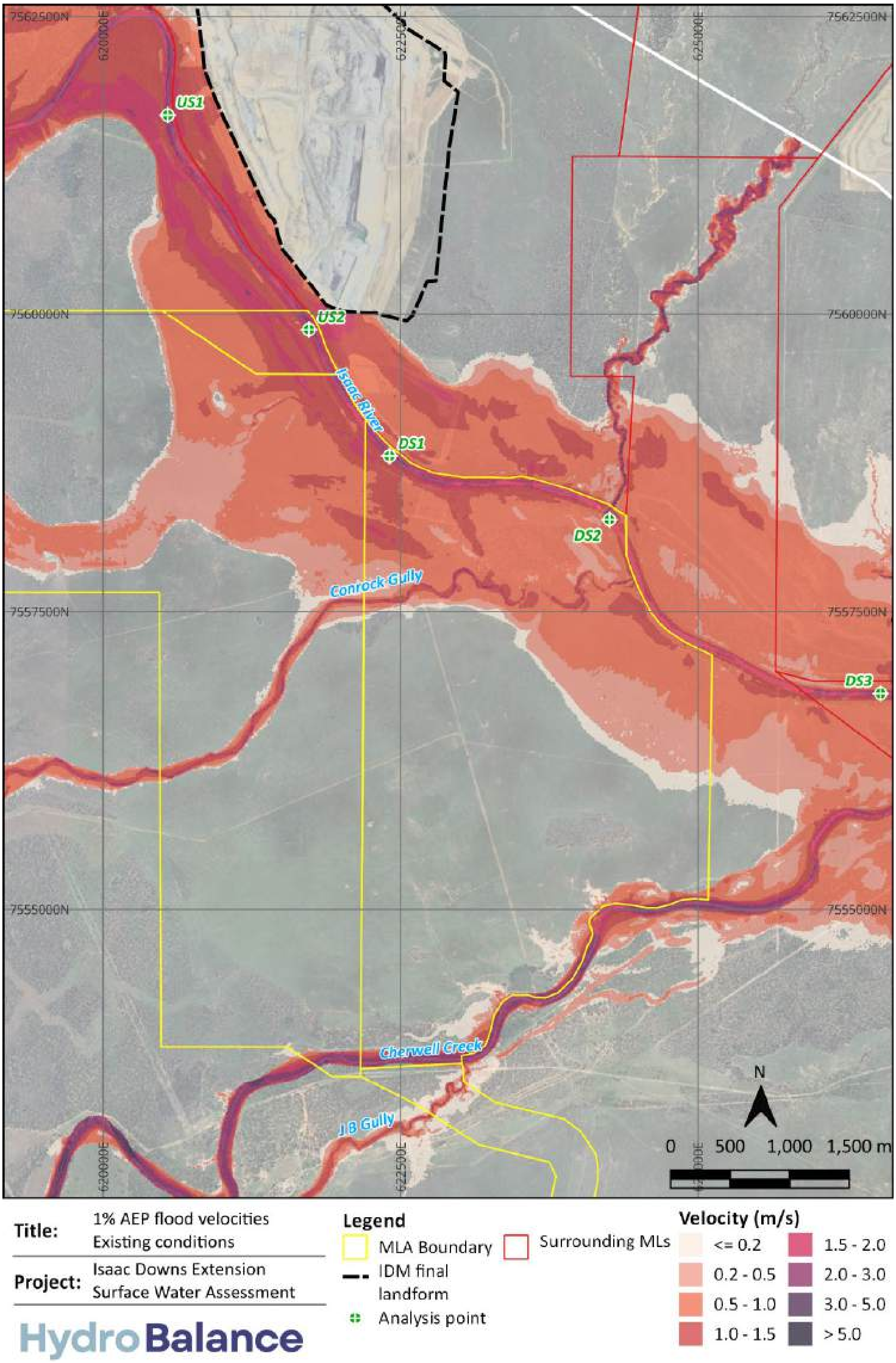


Figure 5.5 – Existing conditions 1% AEP flood velocity

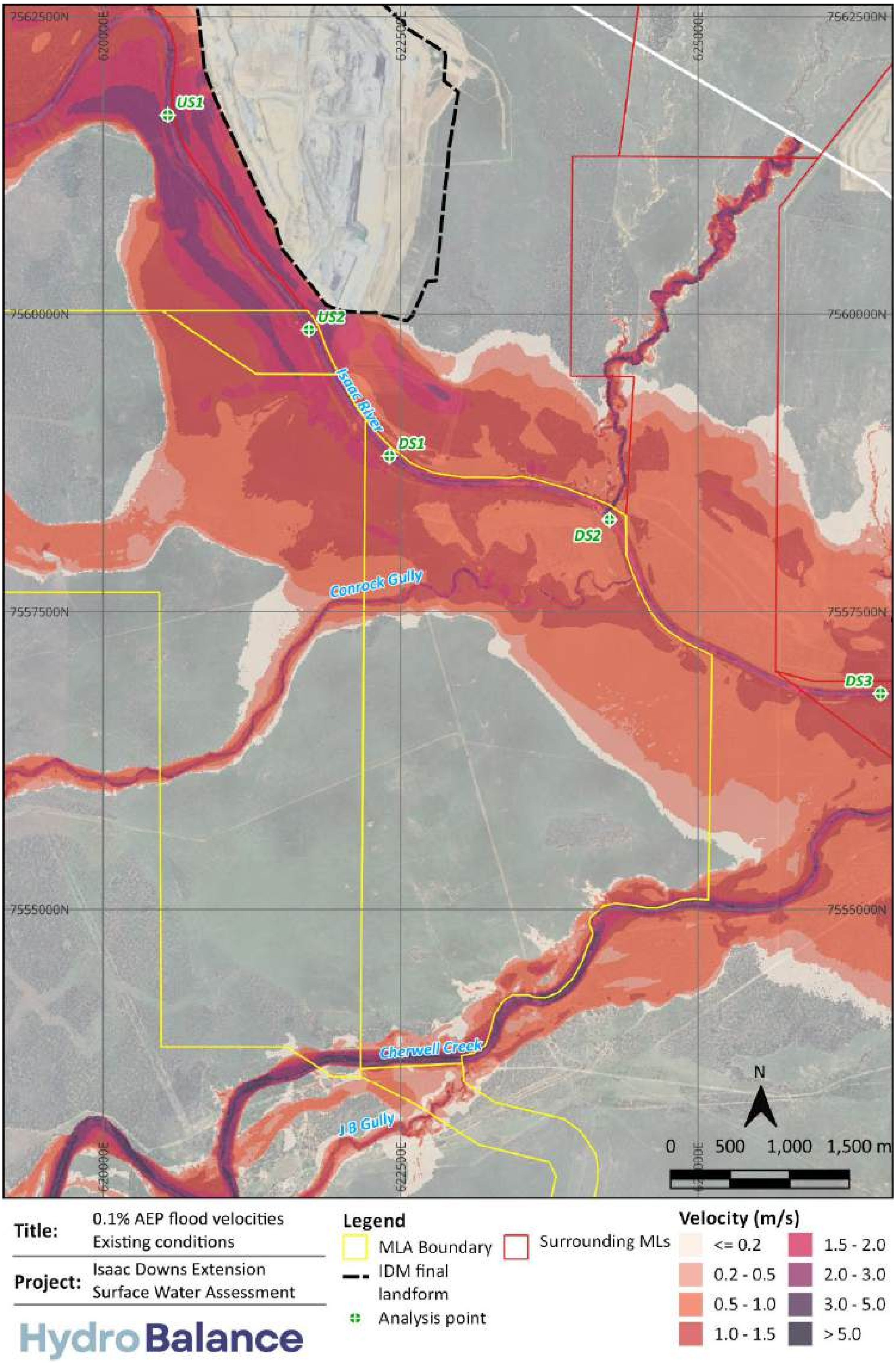


Figure 5.6 – Existing conditions 0.1% AEP flood velocity

5.3 Developed conditions

Modelled 1% AEP and 0.1% AEP flood depths and extents for the developed conditions scenario are shown in Figure 5.7 and Figure 5.8, respectively. Modelled flood velocities for the developed conditions for the 1% AEP and 0.1% AEP events are shown in Figure 5.9 and Figure 5.10 respectively.

The modelled developed Isaac River flood depths and velocities show the following:

- The Isaac River floodplain is partially reduced around US2, between the proposed Project Isaac River levee and the IDM final landform. The width of the Isaac River floodplain in this location is less than 900 m. The proposed levee, along the western bank of the Isaac River interacts with Isaac River floodwaters to around DS2.
- The proposed Isaac River levee has sufficient height to provide flood immunity to the Project's operational pit area and other mine infrastructure from the 0.1% AEP flood event.
- Infrastructure associated with the haul road bridge crossing of the Isaac River will interact with flood waters. The topsoil stockpiles have been located so that they are almost entirely outside the 1% AEP event, with flexibility to modify the locations of these stockpiles during operations and as topsoil is recycled for use in rehabilitation.
- 1% AEP depths and velocities:
    - The maximum flood depths in the channel Isaac River adjacent to the Project are typically greater than 12 m.
    - The depths in the western perched overbank channel range between 4 m to 5 m and the depths in the flatter regions of the western floodplain upstream of the proposed levee range between 1 m to 2 m.
    - The eastern floodplain depths range between 2.0 m to 2.6 m.
    - The maximum flood velocities in the Isaac River main channel in the vicinity of Project range between 1.8 m/s to 2.4 m/s. The western floodplain velocities upstream of the proposed levee generally remain below 1.0 m/s, aside from the perched overbank channel, where velocities may reach up to 1.8 m/s. The velocities in the eastern floodplain generally remain below 1.0 m/s.
- 0.1% AEP depths and velocities:
    - The maximum flood depths in Isaac River adjacent to the Project are typically greater than 13 m.
    - The depths in western perched overbank channel range between 5 m to 7 m and the depths in the flatter regions of the western floodplain upstream of the proposed levee range between 2.5 m to 3.5 m.
    - The eastern floodplain depths range between 3 m to 4 m.
    - The maximum flood velocities in the Isaac River main channel in the vicinity of Project range between 2.2 m/s to 3.0 m/s. The western floodplain velocities upstream of the proposed levee generally remain below 1.3 m/s, aside from the perched overbank channel, where velocities may reach up to 2 m/s. The velocities in the eastern floodplain generally remain below 1.8 m/s.

The modelled developed Cherwell Creek flood depths and velocities show the following:

- There is no interaction between the Project operations and infrastructure, other than the secondary access road and bridge crossing, for the 1% AEP event, and only minor interaction between the northern floodplain and the proposed Cherwell Creek levee plug during a 0.1% AEP event.
- The Cherwell Creek flood depths and velocities for the developed conditions are generally similar to the existing conditions levels.

The modelled developed Conrock Gully flood depths and velocities show the following:

- The proposed drainage infrastructure, including the Conrock Gully diversion and levee plug, and Isaac River levee, have sufficient capacity to convey the 0.1% AEP flood event.
- 1% AEP depths and velocities:
    - The depths in the Conrock Gully upstream of the diversion generally range between 1 m in the upper reaches to 4 m as it meets the diversion.
    - The depths in the Conrock Gully diversion generally range between 4 m and 6 m.
    - The velocities in the Conrock Gully upstream of the diversion generally range between 0.6 m/s and 2.2 m/s.
    - The velocities in the Conrock Gully diversion generally range between 1.0 m/s and 2.0 m/s.
- 0.1% AEP depths and velocities:
    - The depths in the Conrock Gully upstream of the diversion generally range between 1 m in the upper reaches to 5 m as it meets the diversion.
    - The depths in the Conrock Gully diversion generally range between 4 m and 8 m.
    - The velocities in the Conrock Gully upstream of the diversion generally range between 1.0 m/s and 2.5 m/s.
    - The velocities in the Conrock Gully diversion generally range between 1.3 m/s and 2.5 m/s.

Mapping of 50% AEP, 10% AEP, 2% AEP and PMF results of the flood modelling for developed conditions are presented in Appendix C.

5.3.1 Proposed levee water levels and velocities

The locations and chainages along the following proposed levees are presented in Figure 4.2:

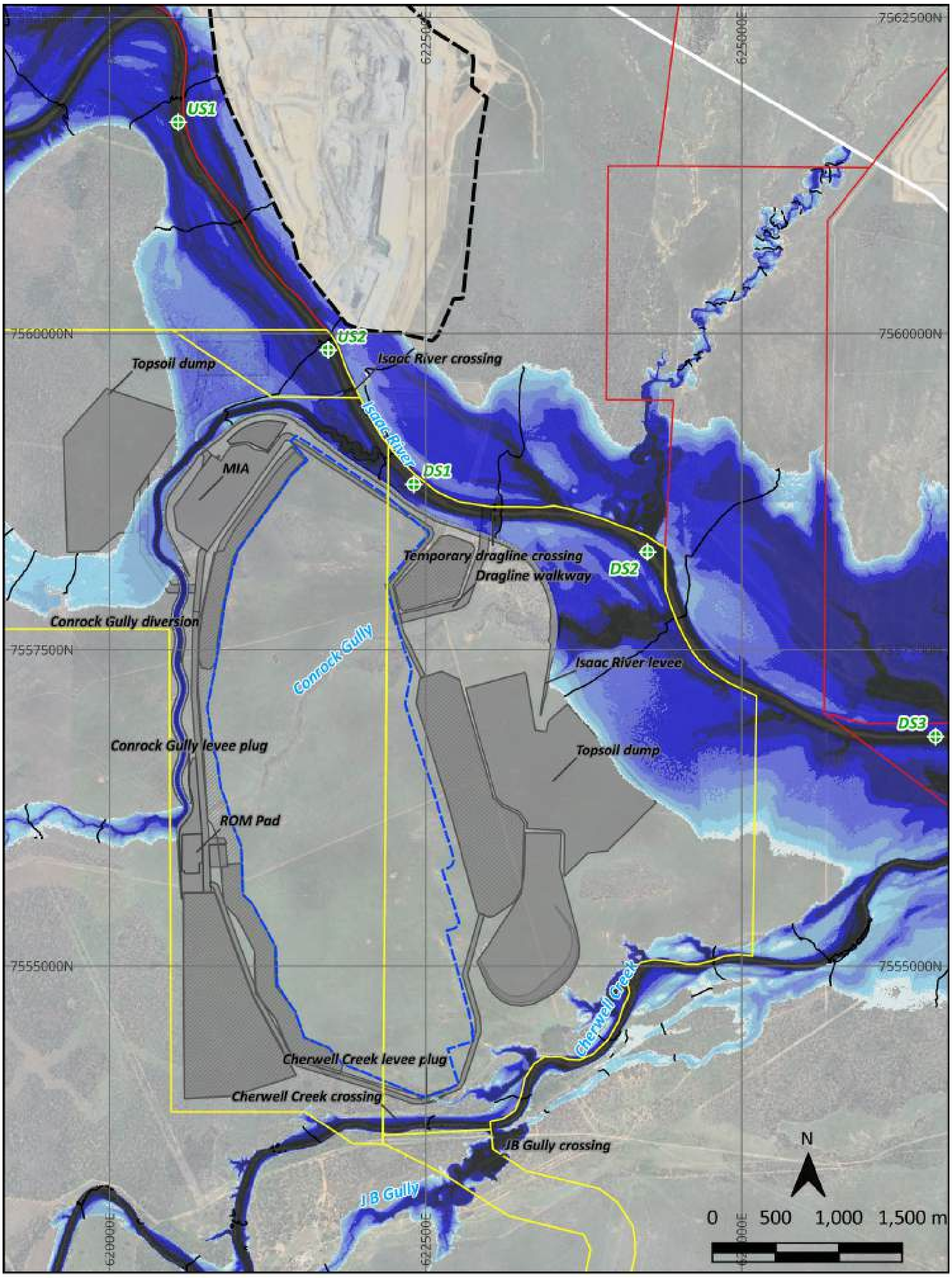
- Isaac River levee;
- Cherwell Creek levee plug; and
- Conrock Gully levee plug.

Figure 5.11, Figure 5.12 and Figure 5.13 show proposed levee heights and 0.1% AEP water levels for the Isaac River levee, Cherwell Creek levee plug and the Conrock Gully levee plug, respectively. These figures shows that the 0.1% AEP water levels along the proposed levees do not overtop the levee crests and will maintain a freeboard of at least 300 mm along the length of all levees / plugs.

Figure 5.11, Figure 5.12 and Figure 5.13 also show the modelled 0.1% AEP, 1% AEP and 10% AEP velocities for the respective levees / plugs. The following is of note:

- Isaac River levee:
    - The 1% AEP and 10% AEP velocities are consistently less than 1.7 m/s, and hence are unlikely to cause scour if the levee is fully vegetated.
    - The highest risk of scour occurs in the centre of the levee (which is closest to the Isaac River) for the 0.1% AEP. Rock protection could be implemented between chainage 1,700 m and 4,200 m, if required, equating to a 2.5 km rock protected section. However, the occurrence of the 0.1% AEP event, by definition, highly infrequent and scour is not expected to occur for a vegetated levee for events more frequent than the 0.1% AEP. The remaining sections of the levee would experience velocities less than 1.7 m/s during the 0.1% AEP, and hence are unlikely to cause scour if these sections are fully vegetated.
- Cherwell Creek levee plug:
    - The 0.1% AEP, 1% AEP and 10% AEP velocities are consistently less than 1.7 m/s, and hence are unlikely to cause scour if the levee is fully vegetated.

- Conrock Gully levee plug
  - The 0.1% AEP, 1% AEP and 10% AEP velocities are consistently less than 1.7 m/s, with the exception of a small section at chainage 590 m for the 0.1% AEP event, where velocities may reach up to 2.1 m/s. Rock protection may be applied in this section if required. Velocities along the remainder of the levee are unlikely to cause scour if the levee plug is fully vegetated.



Title:	1% AEP flood depths Developed conditions
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

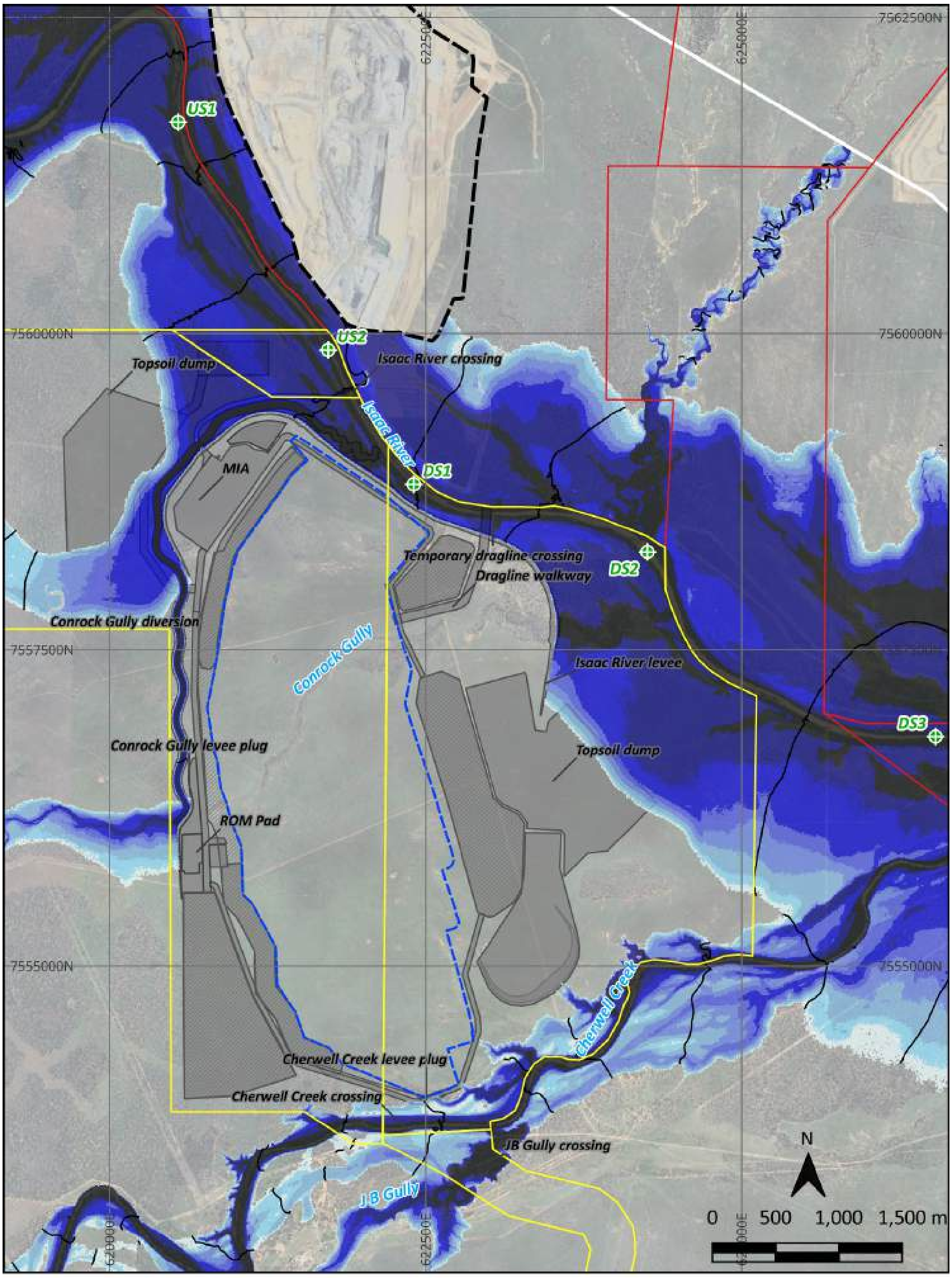
Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Water level contour (1m)
- Pit crest
- Infrastructure area

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- > 5.0

Figure 5.7 – Developed conditions 1% AEP flood depths and heights



Title:	0.1% AEP flood depths Developed conditions
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Water level contour (1m)
- Pit crest
- Infrastructure area

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- > 5.0

Figure 5.8 – Developed conditions 0.1% AEP flood depths and heights

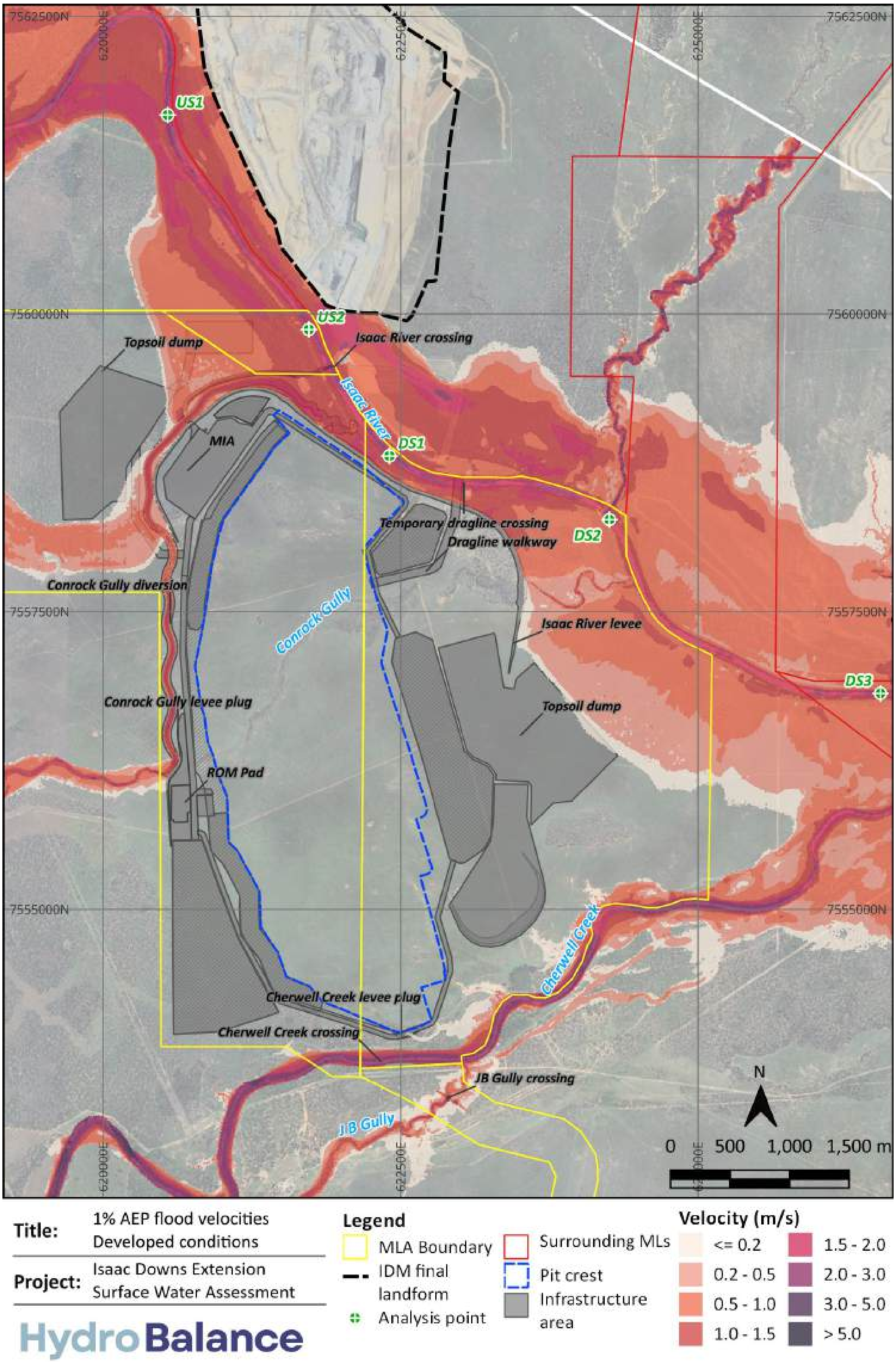


Figure 5.9 – Developed conditions 1% AEP flood velocity

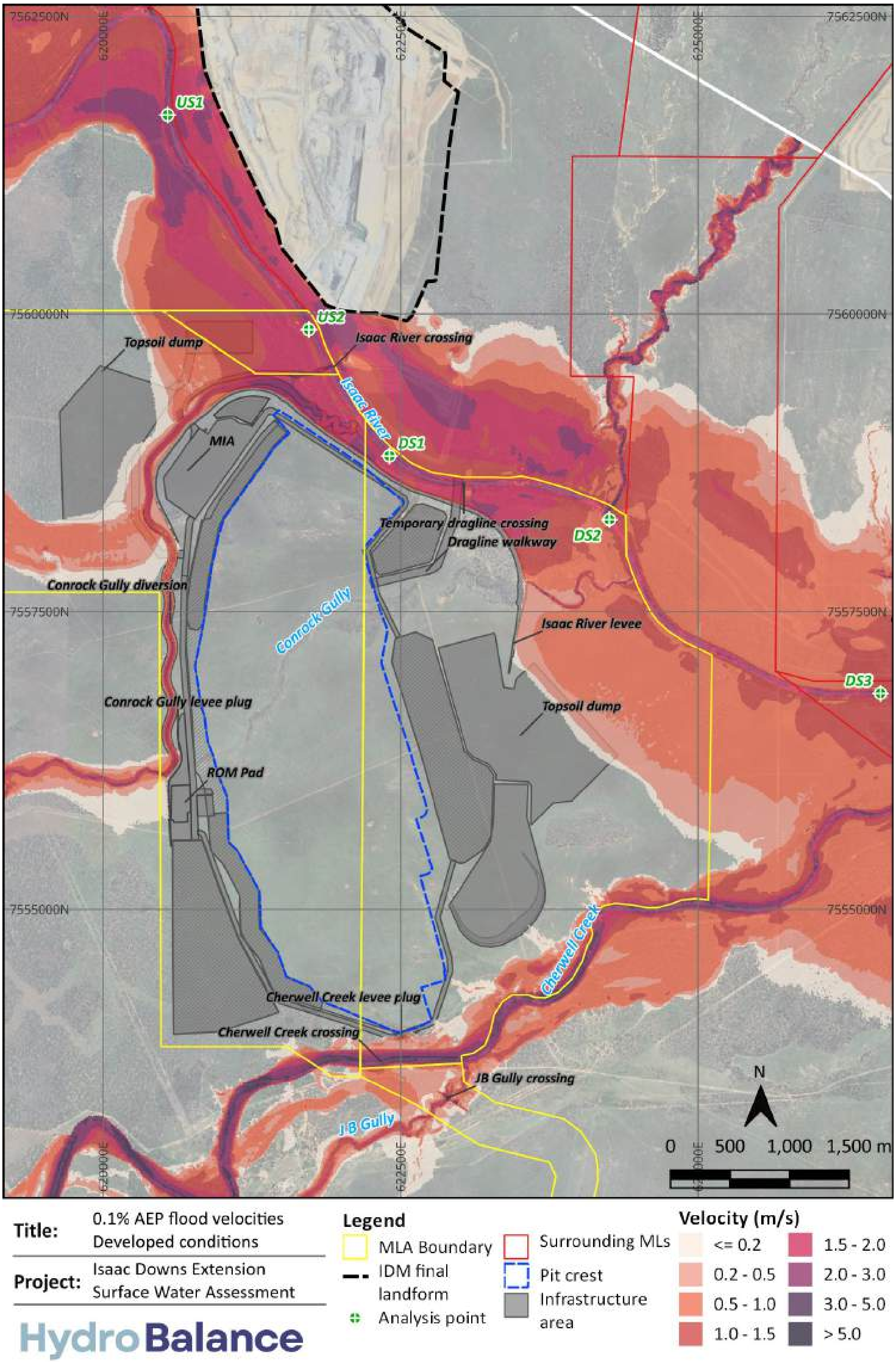


Figure 5.10 – Developed conditions 0.1% AEP flood velocity

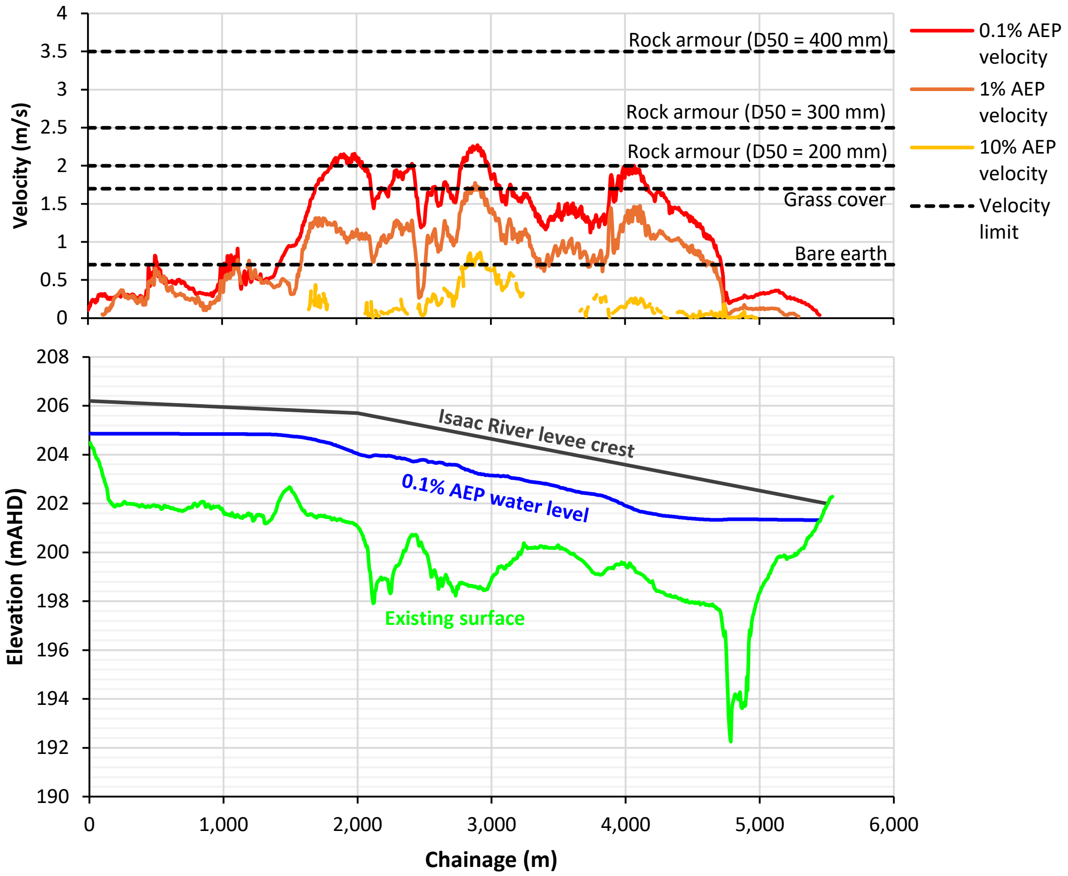


Figure 5.11 – Isaac River levee 0.1% AEP water levels and velocities – long section

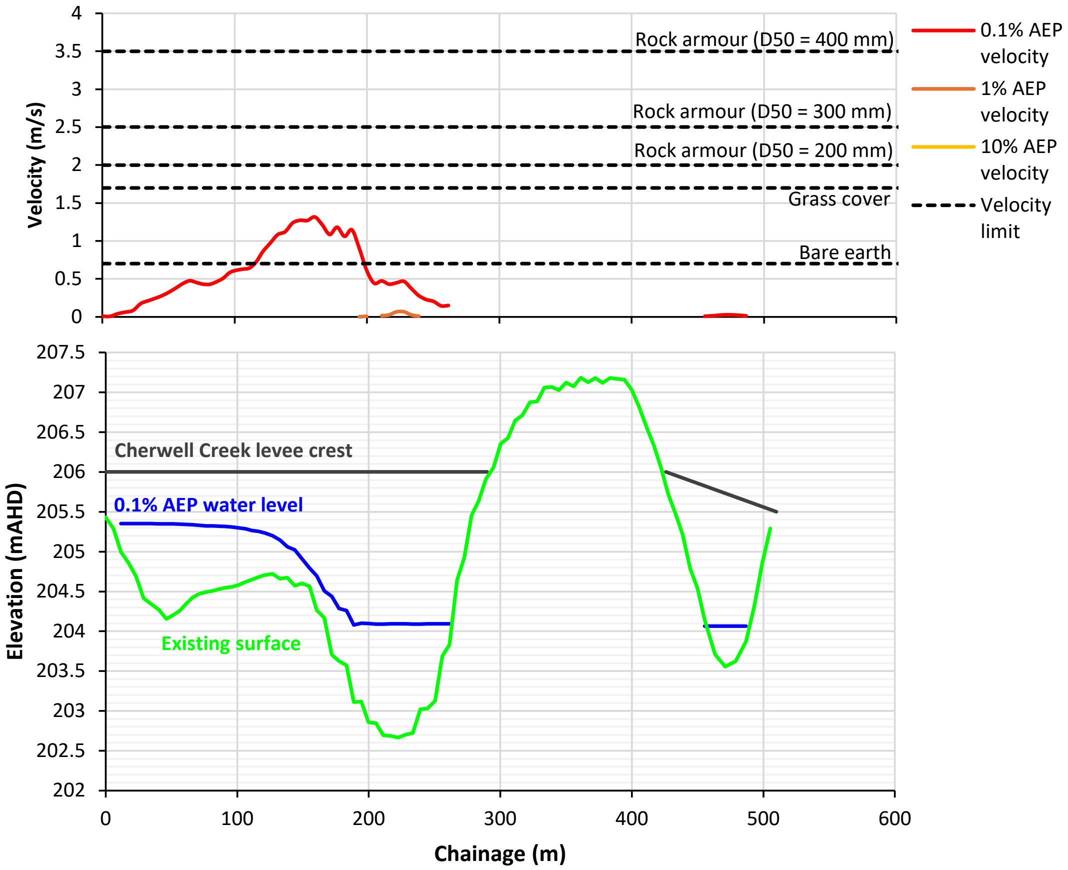


Figure 5.12 – Cherwell Creek levee plug 0.1% AEP water levels – long section

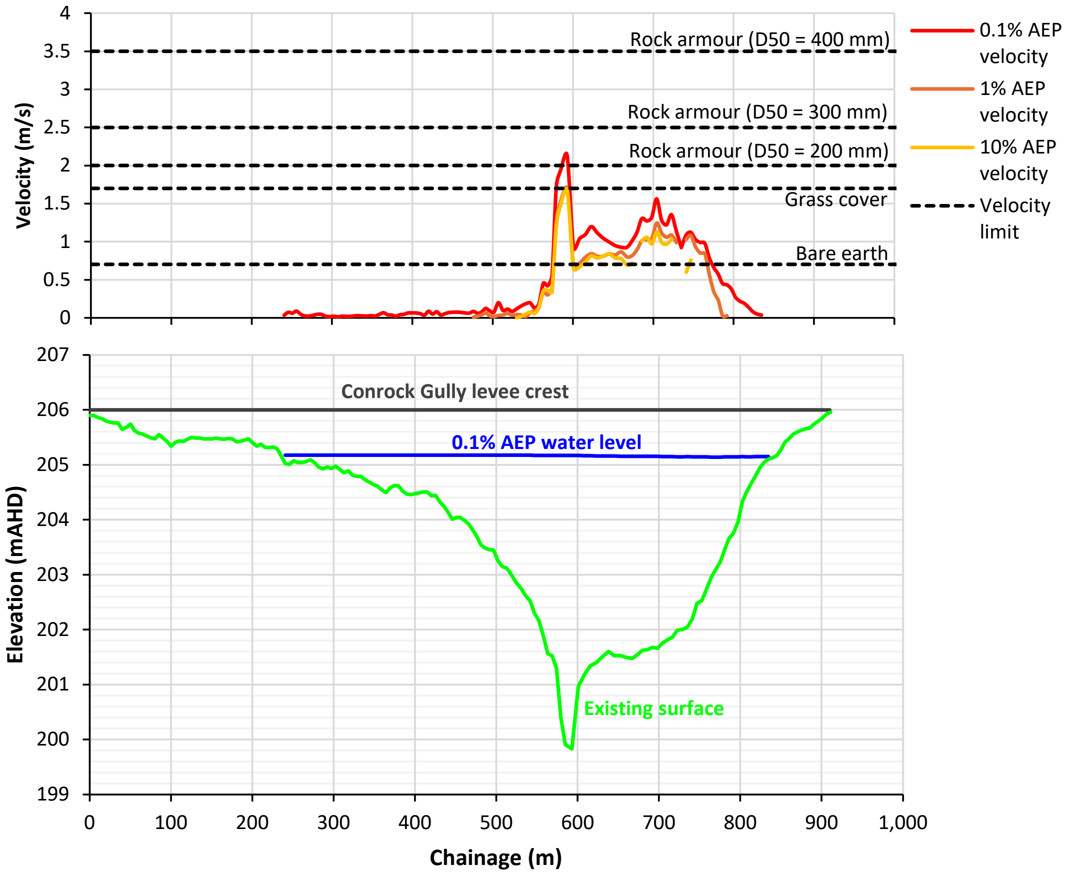


Figure 5.13 – Conrock Gully levee plug 0.1% AEP water levels – long section

5.3.2 Flood level impacts

The modelled Isaac River and local creek flood level changes (afflux) for developed conditions for the 1% AEP and 0.1% AEP events are shown in Figure 5.19 and Figure 5.20 respectively. This section summarises the impacts across all modelled events. Flood level impact mapping of the 50% AEP, 10% AEP, and 2% AEP events is presented in Appendix C.

The following is of note regarding the modelled Isaac River flood level changes for developed conditions:

- The flood levels in Isaac River channel and floodplain increase up to:
  - 1 m (generally less than 0.5 m) along a 4 km reach for the 1% AEP event.
  - 1.2 m (generally less than 1 m) along a 5.4 km reach for the 0.1% AEP event.
- Changes in flood level adjacent the IDM final landform are generally around 0.5 m The flood level impacts do not extend downstream beyond the Project footprint. Changes in flood levels are considered to be minor.
- The greatest increase in the Isaac River flood levels occur near US2, where the floodplain width is reduced by both the approved Isaac Downs levee and the proposed Isaac River levee. The flood levels may be increased by up to 0.5 m for the 1% AEP event and 1.2 m for the 0.1% AEP event.
- There are minor decreases in flood levels on the downstream face of the Isaac River levee for the 0.1% AEP event, due to reduced conveyance past this location.
- The magnitude of changes in flood levels reduces for more frequent flood events.

- Reducing the extent of the floodplain behind the Isaac River levee has negligible to minor impact on the expansion of the floodplain into areas that were previously not flooded.
- The proposed Isaac River bridge and the temporary dragline crossing have negligible impacts on the 1% and 0.1% AEP flood events, as the structures are inundated by these flood flows. Minor water level changes of up to 0.5 m at the Isaac River bridge and 0.25 m at the temporary dragline crossing can be observed for smaller events (e.g. the 10% AEP). The minor water level increases at the temporary dragline crossing are primarily a result of the bed level crossing. The bed level crossing would be removed and stabilised once the dragline walk is completed, hence the water level impacts in this area are highly unlikely to occur. .
- The IDM final void would not be encroached by the 0.1% AEP flood during the Project's developed conditions. That is, the IDM final landform is sufficient to hold back 0.1% AEP Isaac River flood water, even with the Project's Isaac River levee in place.
- There are no material water level impacts to the Peak Downs Highway bridge or the Goonyella rail bridge for any of the modelled events.

The following is of note regarding the modelled Conrock Gully flood level changes for developed conditions:

- The flood levels immediately upstream of the diversion would be increased by up to 1.2 m for the 1% AEP event and 2.2 m for the 0.1% AEP event. Water level increases up to 0.1 m (10 cm) would propagate 800 m upstream for the 1% AEP event and 1,200 m upstream for the 0.1% AEP event. The magnitude of changes in flood levels reduces for more frequent flood events. Changes in flood levels are considered to be minor and localised.
- The remainder of the existing Conrock Gully channel will be excised by the Project. However, downstream of the Project area, in the remnant Conrock Gully channel, there is no change in flood levels for the 1% AEP and 0.1% AEP events, up to the 10% AEP event (refer to Appendix C), as these areas continue to be flooded by backwater flow from the Isaac River.

The following is of note regarding the modelled Cherwell Creek flood level changes for developed conditions:

- The proposed Cherwell Creek bridge may increase water levels upstream of the bridge by up to 0.1 m for the 1% AEP event and 0.2 m for the 0.1% AEP event.
- During the 0.1% AEP event, flows are pushed towards the proposed Cherwell Creek levee plug by the bridge, causing a localised increase of up to 0.6 m at the proposed levee plug. The 0.1% AEP flows do not overtop the Cherwell Creek levee plug. Flows do not interact with the Cherwell Creek levee plug for any events more frequent than the 0.1% AEP.
- The JB Gully bed-level crossing has a negligible impact on all modelled flood events, as the structure is inundated by flood flows.

5.3.3 Flood duration impact assessment

Table 5.1 presents an assessment of the potential impact on the duration of floodplain inundation along the Isaac River. The developed conditions were compared to the existing conditions to represent the potential impact on floodplain residence times, as the developed conditions represent the greatest potential change to the Isaac River floodplain. The locations of the assessment points are shown in the flood maps (see Figure 5.2, and Figure 5.3 to Figure 5.22). The following rationale was applied to select the assessment points:

- **US1:** upstream location in the vicinity of mapped regional ecosystems (REs) and groundwater dependent ecosystems (GDEs).
- **US2:** upstream of the proposed Isaac River bridge crossing and mapped REs located upstream of the proposed Conrock Gully diversion.
- **DS1:** downstream of proposed Conrock Gully diversion and located in the vicinity of mapped GDEs.

- **DS2:** downstream of old Conrock Gully channel and in the vicinity of mapped GDEs and Poplar Box threatened ecological communities (TECs).
- **DS3:** located at the wetland near the confluence of Isaac River and Cherwell Creek.

Cross sections of the Isaac River floodplain and main channel at each of the assessment points are shown in Figure 5.14 to Figure 5.18. These figures also show the modelled flood water levels at each of the assessment points. The locations of the Isaac River floodplain cross sections are shown on Figure 5.2. These cross sections show that the impact to water level is greatest at the US2 and DS1 locations, with water level differences of up to 1 m for the 0.1% AEP event. For more frequent flood events at US2 and DS1 (e.g. 10% AEP) flood level changes are negligible. However at other locations upstream and downstream (US1, DS2, DS3) water level changes are negligible for all modelled flood events.

The duration of floodplain inundation was derived from the TUFLOW hydraulic model. The Isaac River floodplain is considered inundated when the water level increases above the Isaac River main channel top of bank. The following is of note regarding the floodplain inundation:

- Under existing conditions, the Isaac River floodplain may be inundated by between 5 to 22 hours for the 10% AEP event, and between 40 and 50 hours (i.e. less than 2 days) for the 0.1% AEP event.
- The floodplain inundation duration is generally the greatest at US2 and DS1, both of which are adjacent to the existing IDM. The Isaac River main channel capacity appears to be slightly reduced in this section - the western bank in this reach is lower than other sections of the river, causing flows to enter the floodplain earlier.
- The Project results in negligible change to the duration of floodplain inundation, with less than 1 hour change in duration for all AEP events, and generally less than 0.5 hours (30 minutes).

Overall, the Project does not materially impact the Isaac River floodplain residence times.

Table 5.1 – Floodplain inundation time impact assessment

Design event AEP	Condition	Duration of floodplain inundation (hrs)				
		US1	US2	DS1	DS2	DS3
10% AEP	Existing	5.0	15.1	21.2	8.4	5.0
	Developed	5.6	15.4	21.4	8.5	5.2
	Difference	***0.6 (13%)***	***0.3 (2%)***	***0.2 (1%)***	***0.1 (1%)***	***0.2 (2%)***
1% AEP	Existing	28.9	35.8	40.4	31.1	28.8
	Developed	29.2	36.1	40.8	31.2	28.7
	Difference	***0.3 (1%)***	***0.3 (1%)***	***0.4 (1%)***	***0.1 (<1%)***	***-0.1 (<1%)***
0.1% AEP	Existing	39.6	45.3	49.1	41.6	39.6
	Developed	39.9	45.6	49.4	41.7	39.5
	Difference	***0.3 (1%)***	***0.3 (1%)***	***0.3 (<1%)***	***0.1 (<1%)***	***-0.1 (<1%)***

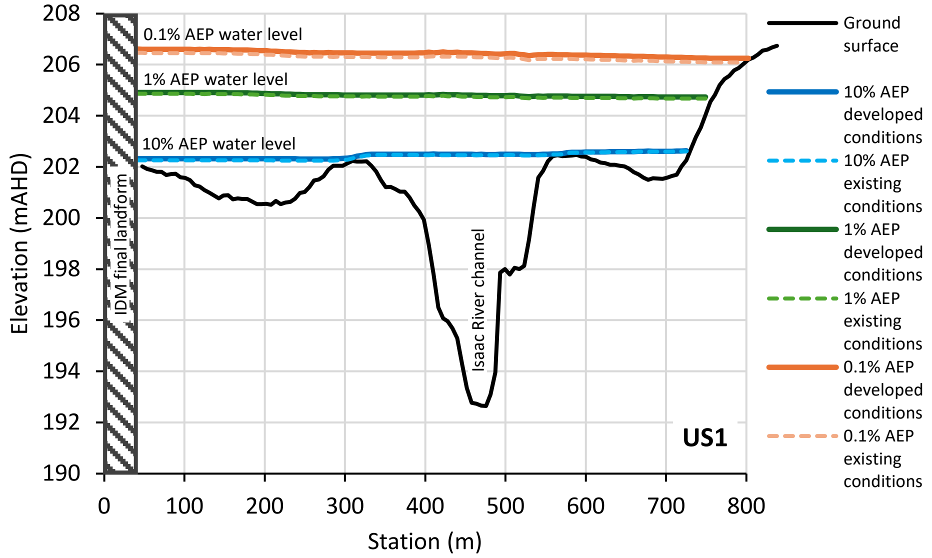


Figure 5.14 – Assessment point cross sections in the Isaac River, US1

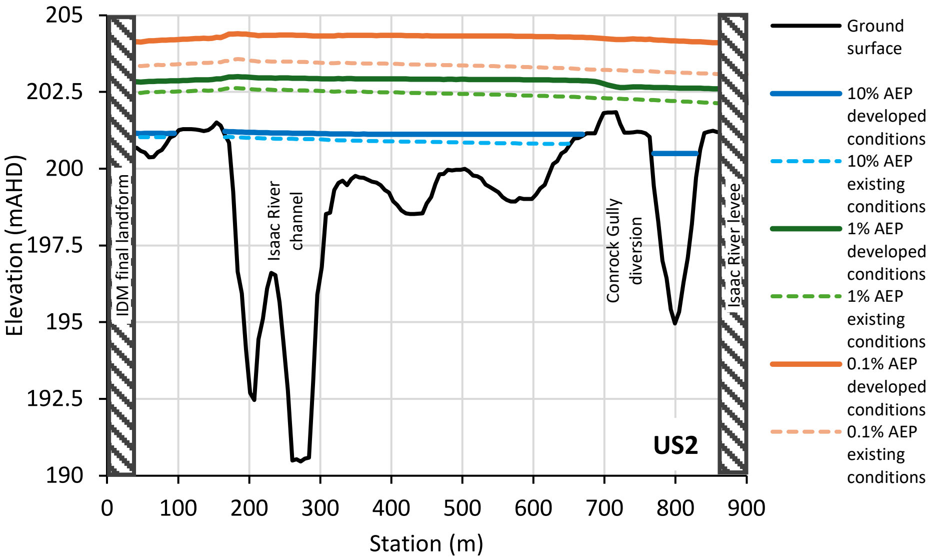


Figure 5.15 – Assessment point cross sections in the Isaac River, US2

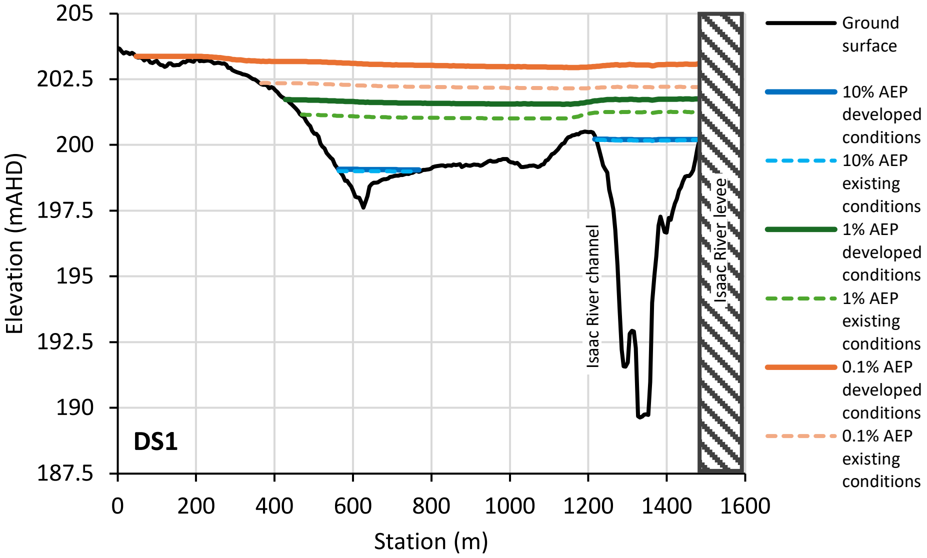


Figure 5.16 – Assessment point cross sections in the Isaac River, DS1

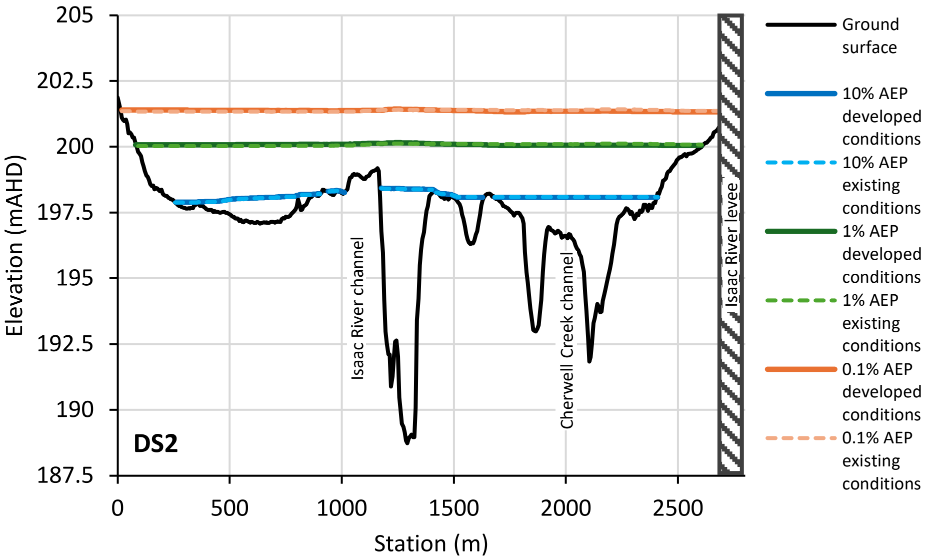


Figure 5.17 – Assessment point cross sections in the Isaac River, DS2

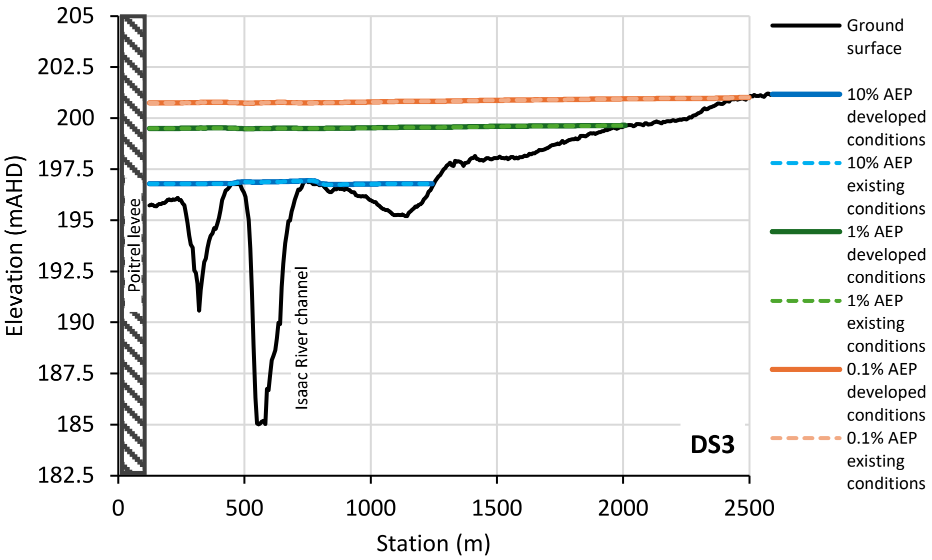


Figure 5.18 – Assessment point cross sections in the Isaac River, DS3

5.3.4 Velocity impacts

The modelled Isaac River and local creek flood velocity changes for developed conditions for the 1% AEP and 0.1% AEP events are shown in Figure 5.21 and Figure 5.22 respectively. This section summarises the changes across all modelled events. Flood velocity change mapping of the 50% AEP, 10% AEP, and 2% AEP events is presented in Appendix C.

The following is of note regarding the modelled Isaac River flood velocity changes for developed conditions:

- The flood velocities are generally decreased upstream of the Project, including adjacent the IDM final landform. The greatest decreases are located around the proposed Isaac River crossing, with modelled decreases reaching up to 0.9 m/s for the 1% AEP event and 1.1 m/s for the 0.1% AEP event. Velocity decreases also occur in the Isaac River floodplain adjacent to the Conrock Gully diversion, due to reduced conveyance in this location.
- The flood velocities in the eastern floodplain adjacent to the Project and the floodplain downstream of IDM (between DS1 and DS2) would be increased. This increase occurs due to the increased conveyance through this section, due to the upstream reduction of the floodplain width due to the proposed Isaac River levee. The velocity increases in these sections may reach up to 0.7 m/s for the 1% AEP event and 1.0 m/s for the 0.1% AEP event. The potential geomorphic impact of the velocity increases on the Isaac River floodplain is discussed in Section 5.5.4.
- There are decreases in flood velocities on the downstream face of the Isaac River levee, due to reduced conveyance past this location. The velocity reduction in this location is up to 1.0 m/s for the 1% AEP event and 1.2 m/s for the 0.1% AEP event.
- The flood velocity changes do not extend downstream beyond the proposed levee.
- There are no material velocity impacts to the Peak Downs Highway bridge or the Goonyella rail bridge for any of the modelled events.
- The magnitude of change in velocity reduces for more frequent flood events.

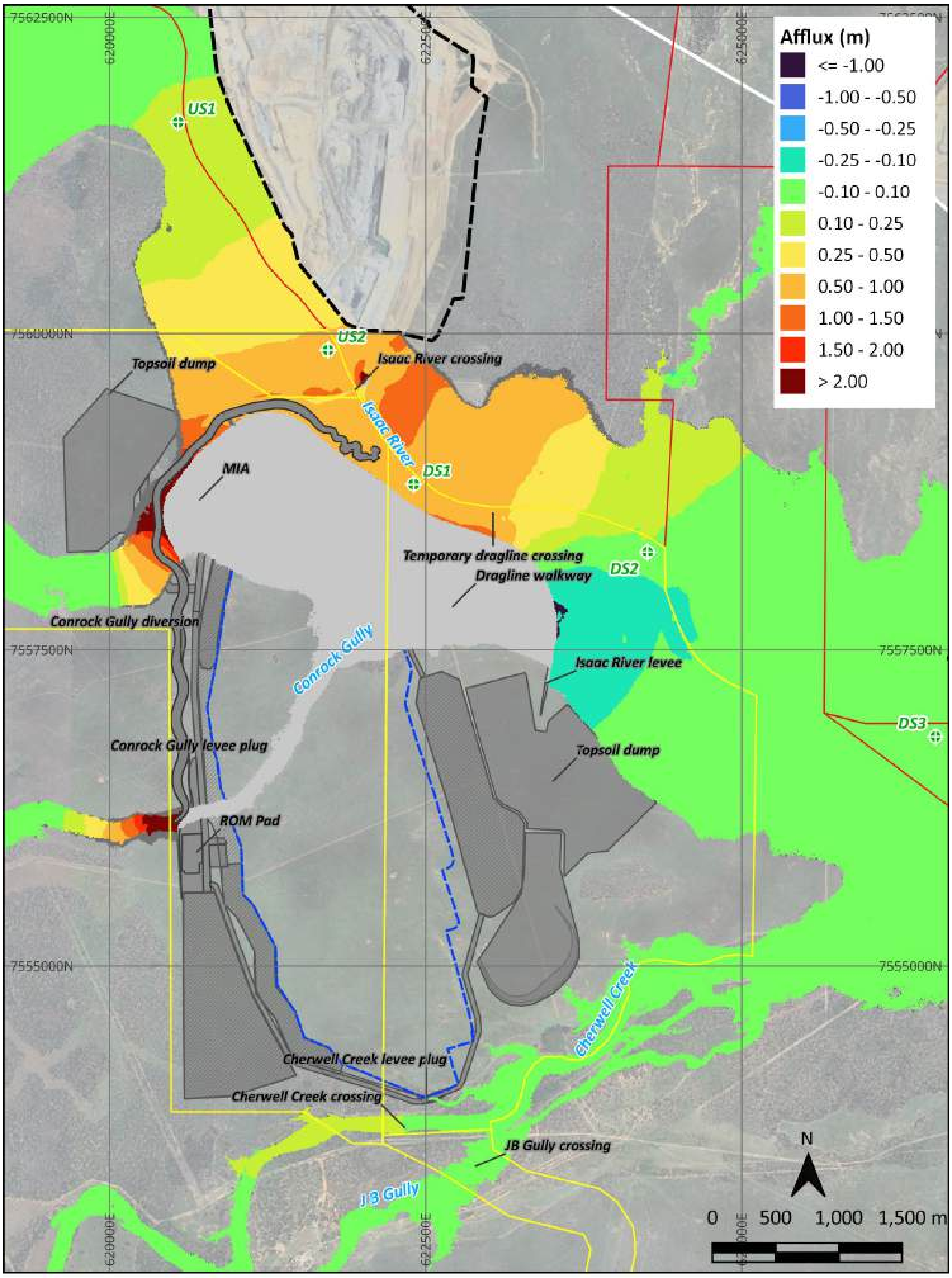
The following is of note regarding the modelled Conrock Gully flood velocity changes for developed conditions:

- The flood velocities upstream of the diversion would be decreased by up to 0.4 m/s for the 1% AEP event and 0.5 m/s for the 0.1% AEP event. The velocity reduction would propagate 700 m upstream for the 1% AEP event and 900 m upstream for the 0.1% AEP event. The magnitude of change would reduce for more frequent flood events.

- The remainder of the existing Conrock Gully channel will be excised by the Project; however as noted above, the remnant Conrock Gully channel will continue to be flooded by the Isaac River backwaters; with lower velocities than pre-mining.

The following is of note regarding the modelled Cherwell Creek flood velocity changes for developed conditions:

- There are minor localised changes in velocities for the 1% AEP and 0.1% AEP events downstream of the proposed Cherwell Creek bridge and JB Gully bed-level crossing. The velocity impacts do not propagate downstream.
- Velocity impacts in Cherwell Creek in the vicinity of the Project are more apparent for flood events more frequent than the 1% AEP event. For example, for the 10% AEP event, velocities may be impacted for up to 660 m downstream of the Cherwell Creek bridge and 400 mm downstream of the JB Gully bed-level crossing. The velocities downstream of the Cherwell Creek bridge are generally increased and the velocities downstream of the JB Gully low level crossing are generally decreased. The velocities for the developed conditions are within the range of the expected existing condition velocities for this reach of Cherwell Creek.

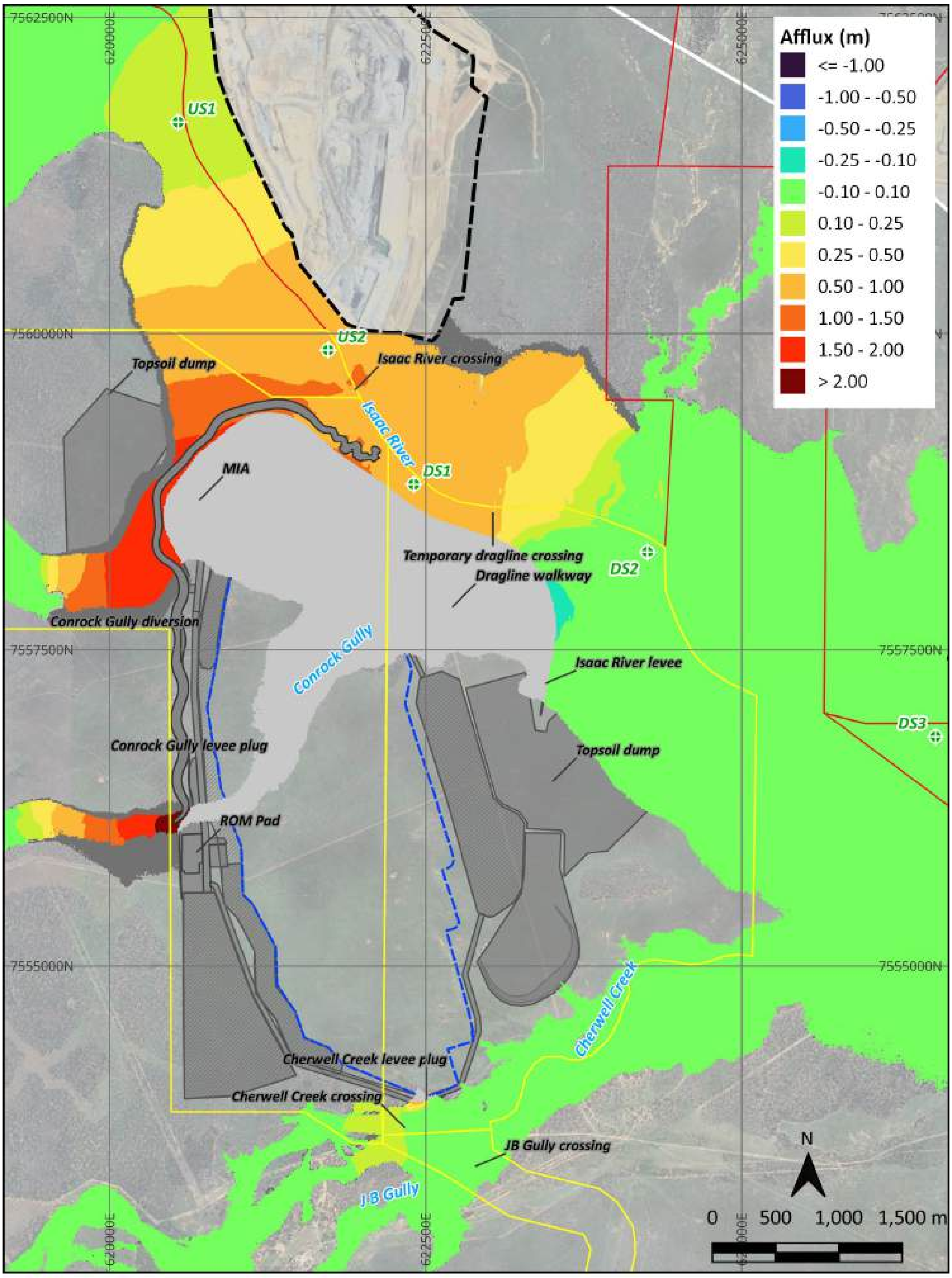


Title:	1% AEP flood level impact
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend
- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Pit crest
- Infrastructure area
- Was wet, now dry
- Was dry, now wet

Figure 5.19 –1% AEP flood level impact



Title:	0.1% AEP flood level impact
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Pit crest
- Infrastructure area
- Was wet, now dry
- Was dry, now wet

Figure 5.20 – 0.1% AEP flood level impact

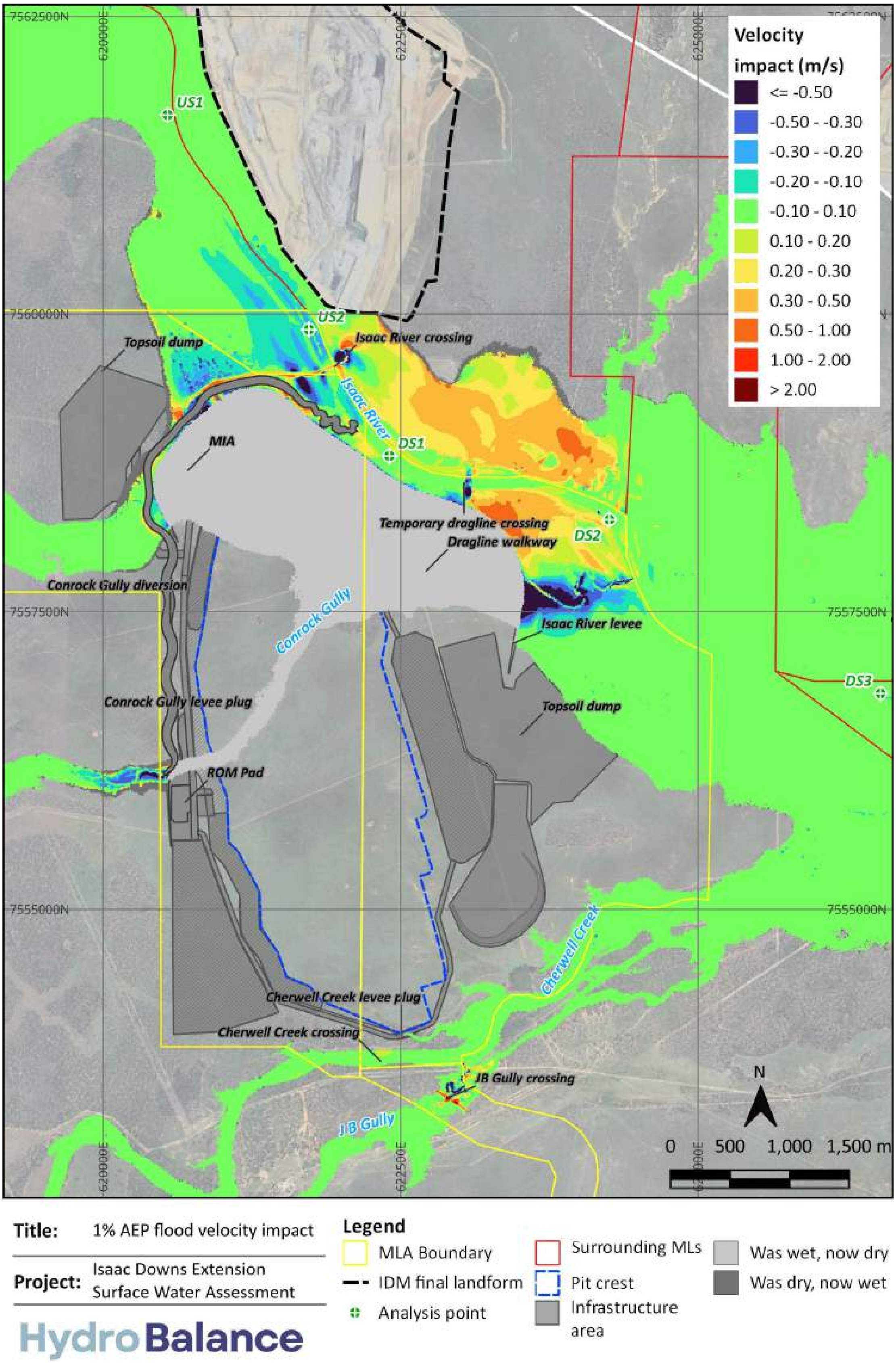


Figure 5.21 –1% AEP flood velocity impact

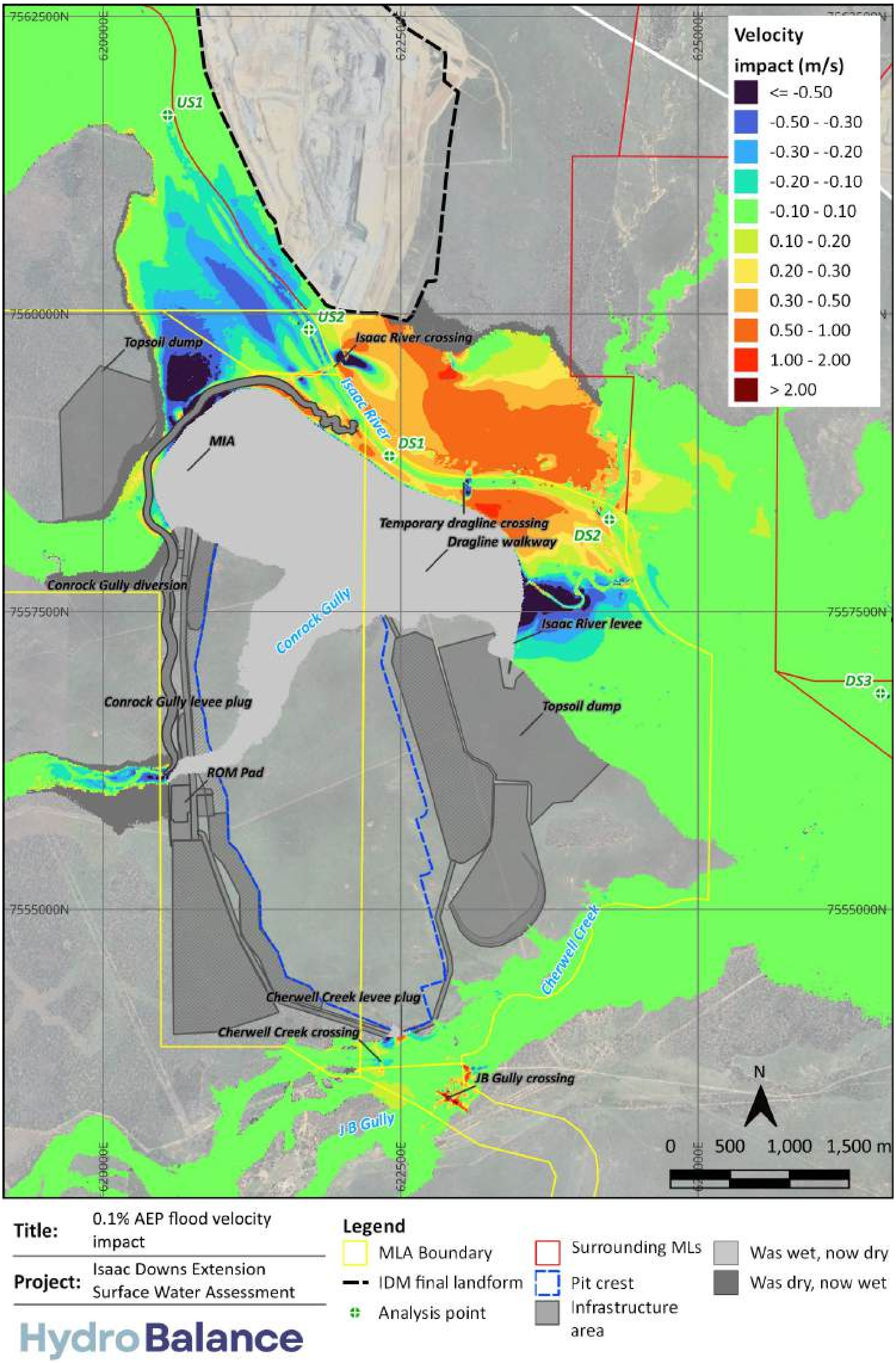


Figure 5.22 – 0.1% AEP flood velocity impact

5.4 Post-closure (final landform) conditions

Modelled 0.1% AEP flood depths and velocities for the final landform scenario are shown in Figure 5.23 and Figure 5.24, respectively. There would be insignificant interactions between floodwaters and the final landform for an event more frequent than the 2% AEP.

The modelled 0.1% AEP final landform flood depths and velocities show the following:

- The flood does not interact with the proposed final void. The final void crest has a freeboard of at least 1,100 mm above the flood level.
- The Isaac River floodwaters interact with the main spoil dump. The flood does not interact with either the eastern or south western out of pit dumps. Conrock Gully floodwaters will be directed to the diversion by a stabilised final landform design, incorporating the rehabilitated raised haul road and adjacent spoil dump.
- The Isaac River floodwaters may reach up to 3.3 m against the main spoil dump. Conrock Gully may reach up to 3.6 m against the final landform.
- Velocities range between 0.5 and 2.0 m/s may occur along the northern face of the main spoil dump within the Isaac River floodplain. Velocities do not exceed 0.8 m/s for the 1% AEP along this face (see Appendix C) and there is minimal interaction for the 2% AEP event (and more frequent). Hence, potentially erosive flows will be very infrequent and occur for short durations. For the vast majority of Isaac River flood events, interaction between floodwaters and the final landform will be either minimal or non-existent.
- Velocities up to 1.1 m/s may occur in an approximate 25 m wide section of the stabilised final landform where the existing Conrock Gully channel is redirected to the diversion. The velocities within the remainder of the Conrock Gully where is interacts with the stabilised final landform are typically 0.1 m/s (i.e. minor) or lower. The vegetation cover on the final landform is expected provide sufficient scour protection in this section for the flood events up to and including the 0.1% AEP.

Modelled 1% AEP and PMF flood depths and velocities for the final landform scenario are shown in Appendix C. The PMF event is a hypothetical extreme event that is larger than the 0.1% AEP event, with the Isaac River floodwaters being 3 m to 5 m higher during the PMF. The larger event may cause floodwater to encroach on the northern end of the void. If required, the final landform elevation can be adjusted with a bund to provide immunity the PMF flood event, with a bund shown in figures with PMF in Appendix C. This bund is not required for protection of the final void from the 0.1% AEP flood event.

5.4.1 Flood level and velocity impacts

The modelled Isaac River and local creek 0.1% AEP flood level changes (afflux) and flood velocity changes for the final landform are shown in Figure 5.25 and Figure 5.26, respectively.

The following is of note regarding the modelled 0.1% AEP flood level changes for the final landform:

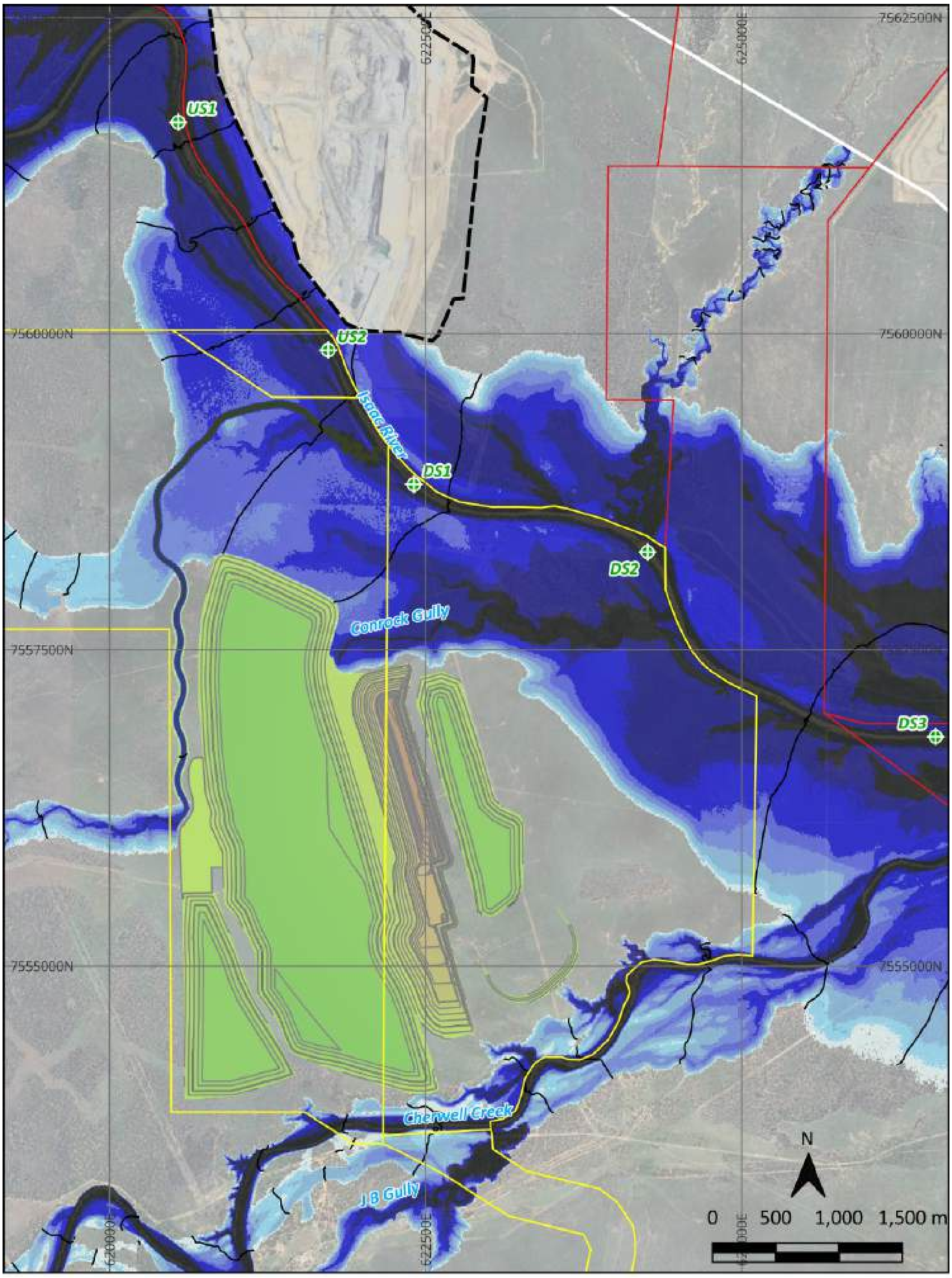
- The final landform results in negligible change to flood levels in the Isaac River. There are minor increases in water levels (up to 0.2 m) in the reach where the Conrock Gully diversion meets the floodplain.
- The flood levels upstream of the diversion would be increased by up to 1.9 m, with changes up to 0.1 m (i.e. 10 cm) localised and propagating up to 1,100 m upstream.
- There are no water level changes in Cherwell Creek in the vicinity of the final landform.
- Reducing the extent of the floodplain has negligible impact on the expansion of the floodplain into areas that were previously not flooded.
- The magnitude of change in flood level reduced compared to the developed conditions scenario, as the final landform allows for the expansion of the floodplain into areas previously protected by the Isaac River levee.

- There are no changes in flood levels in the downstream remnant section of Conrock Gully as this area is subject to backwater flooding from the Isaac River.

The following is of note regarding the modelled 0.1% AEP flood velocity changes for the final landform:

- The final landform results in negligible change to velocity in the Isaac River channel.
- Velocities within the Conrock Gully diversion are ‘increased’ as they are compared to the pre-mining (‘existing’) scenario without a diversion. See Section 7 and Appendix D for an assessment of diversion hydrology and geomorphology which demonstrates that design meets accepted standards
- There are decreased velocities in the existing Conrock Gully channel downstream of the mine, noting that these areas will continue to receive flood flows from Isaac River backwater flooding, but at reduced velocities.
- The flood velocities upstream of the diversion would be decreased by up to 0.8 m/s, propagating up to 1,100 m upstream.
- There are no flood velocity changes in Cherwell Creek in the vicinity of the final landform.
- The magnitude of velocity change is generally reduced compared to the developed conditions scenario.

The magnitude of flood level and velocity change reduces for more frequent flood events.



Title: 0.1% AEP flood depths Final landform

Project: Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Water level contour (1m)

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- >5.0

Figure 5.23 – 0.1% AEP flood depths and heights, final landform

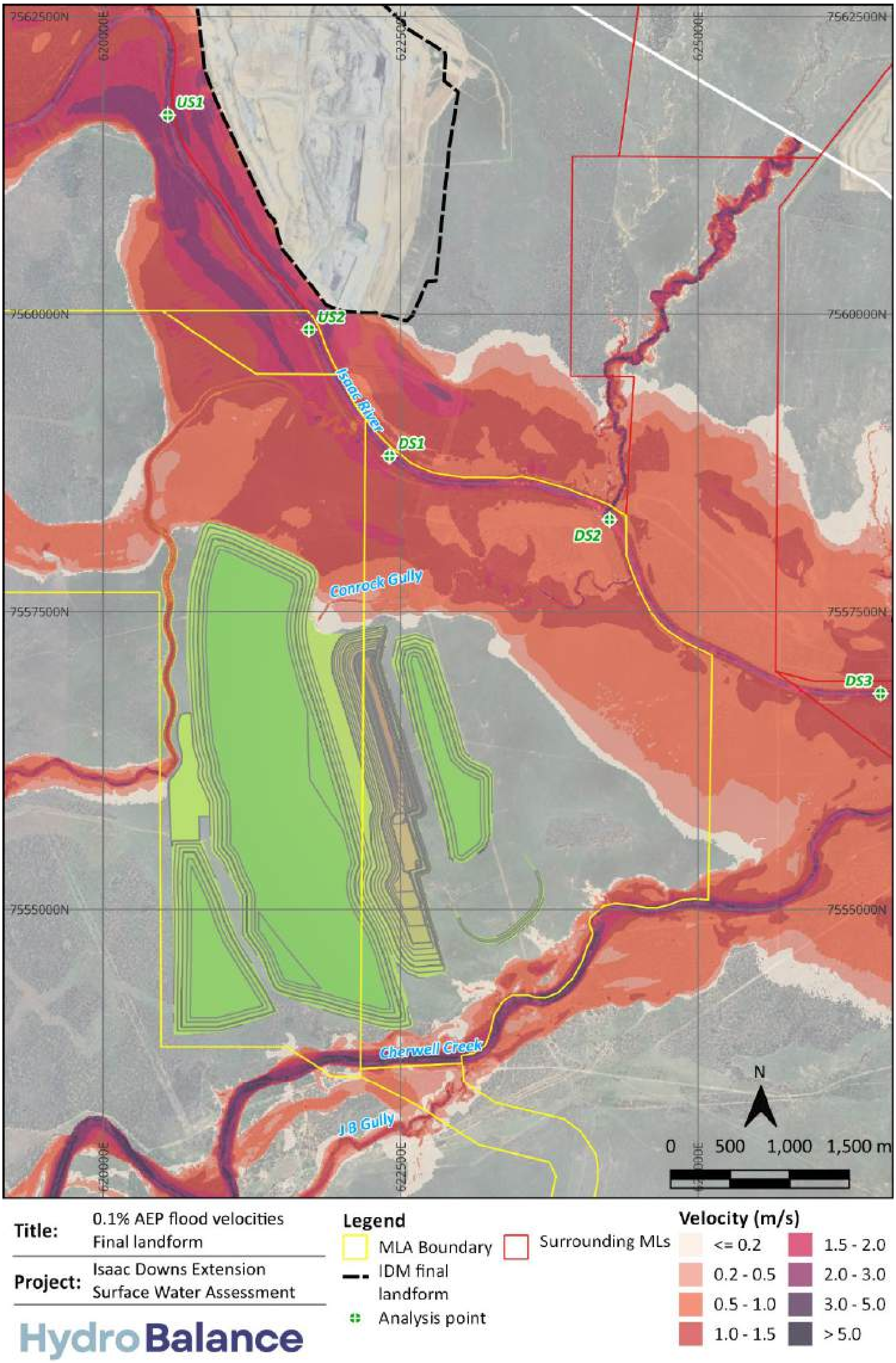
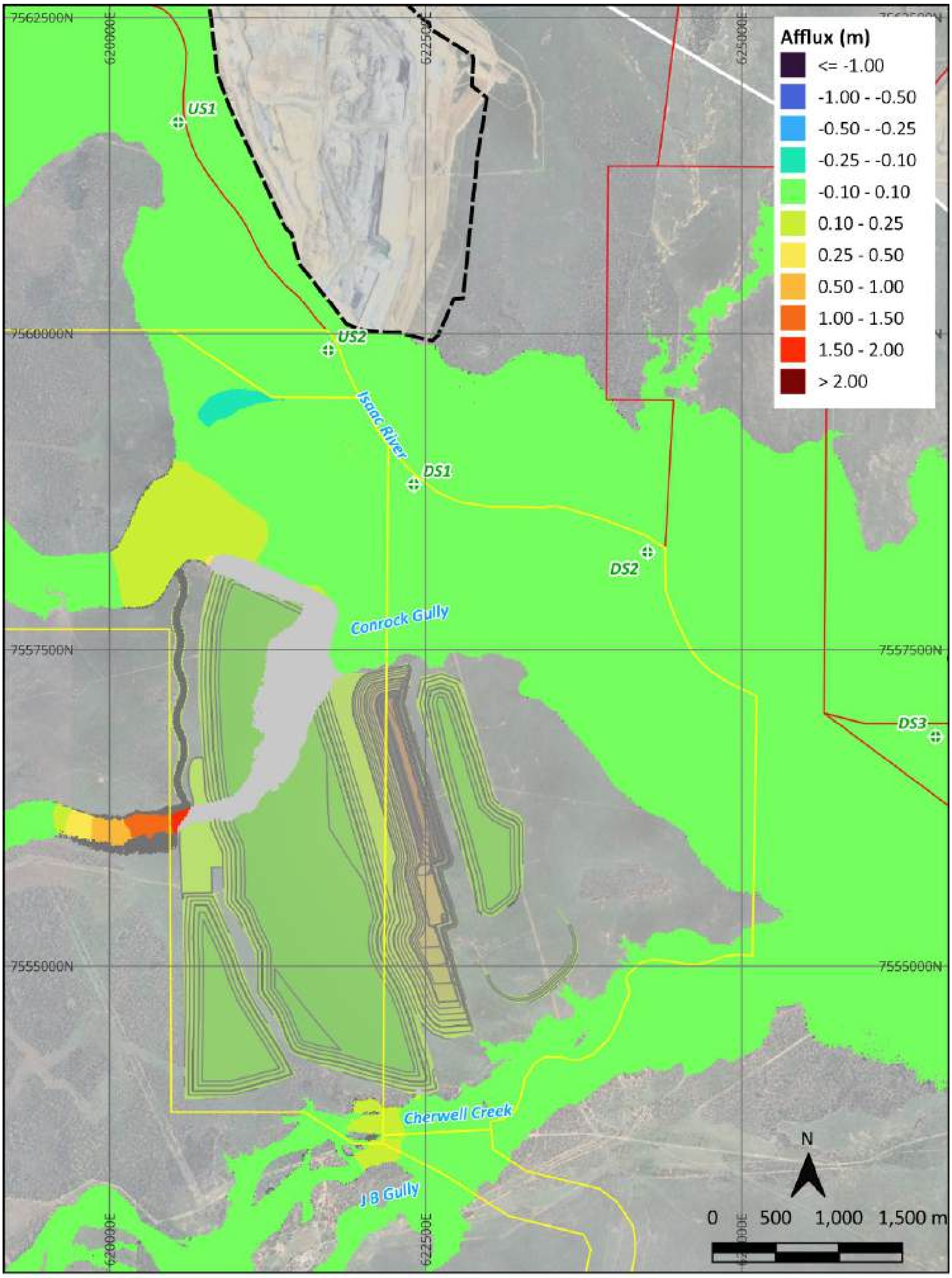


Figure 5.24 – 0.1% AEP flood velocities, final landform

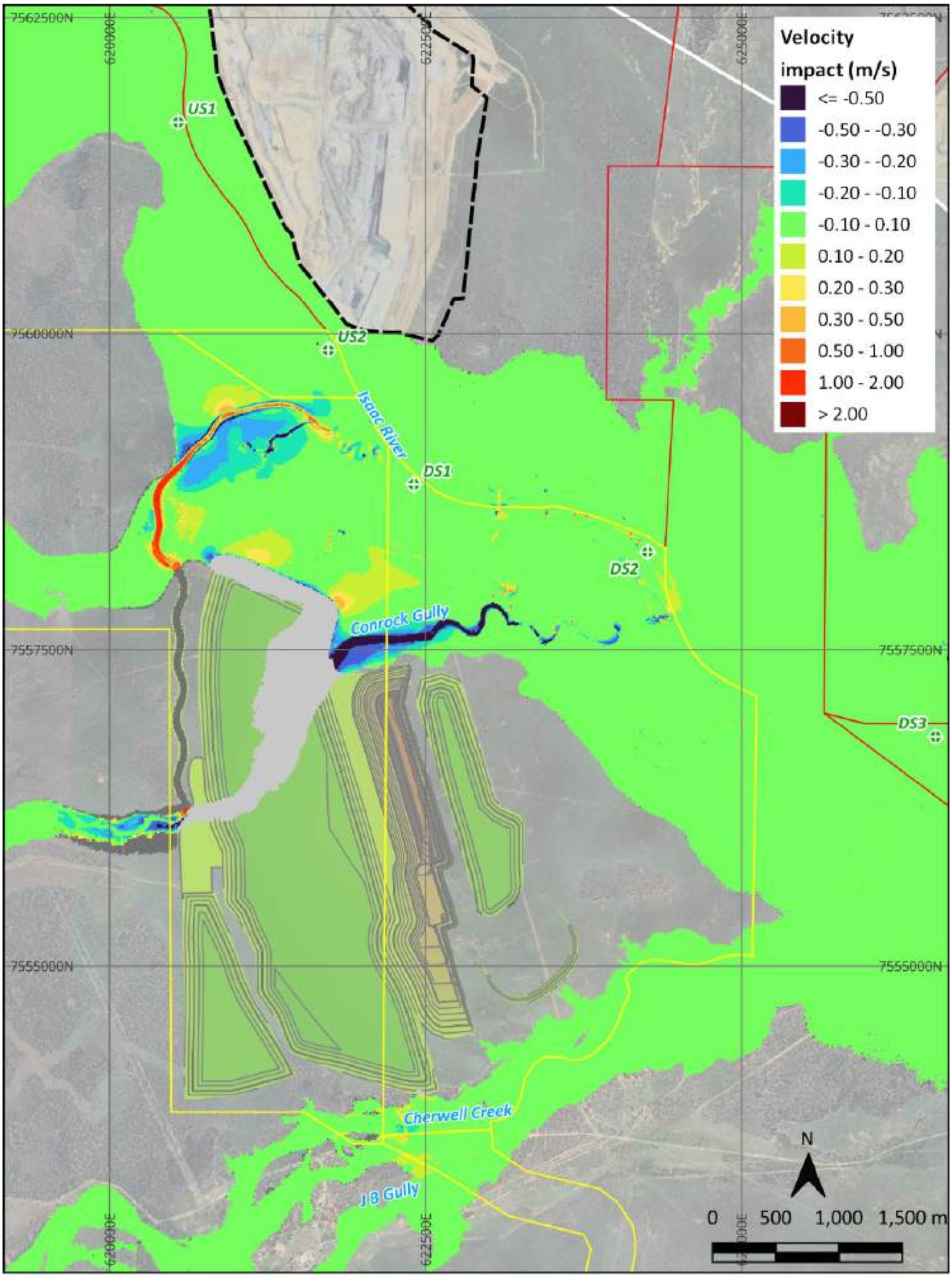


Title:	0.1% AEP flood level impact, final landform
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend
- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Was wet, now dry
- Was dry, now wet

Figure 5.25 – 0.1% AEP flood level impact, final landform



Title:	0.1% AEP flood velocity impact, final landform
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend
- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Was wet, now dry
- Was dry, now wet

Figure 5.26 – 0.1% AEP flood velocity impact, final landform

5.5 Isaac River geomorphic impact assessment

5.5.1 Overview

The hydraulic model results have been used to assess the potential impacts of the Project (including the operational and post-closure conditions) on the geomorphic behaviour of the Isaac River, including the potential to increase erosion and/or sedimentation and the impact on the morphology of the adjacent floodplains. The geomorphic impacts have been assessed through comparative analysis of the peak velocity, bed shear stress and stream power for existing conditions, developed conditions, and the post-mining final landform configuration.

The hydraulic criteria to assess the impacts on geomorphology were adopted from ACARP 9068 guideline values for Bowen Basin River Diversions Design and Rehabilitation Criteria. The guideline is further discussed in Section 5.5.2. While changes in channel geomorphology are generally controlled by regular flows, not extreme low-probability events (hence the ACARP Guideline refers to these type of AEP events), results and discussion on channel morphology for the 0.1% AEP are also provided.

An assessment of floodplain geomorphology was undertaken for out-of-channel events (2% and 0.1% AEP events), with the 50% AEP event being excluded as Isaac River flows are generally within the channel for this event.

The geomorphological impacts on the Cherwell Creek and JB Gully main channels and floodplains due to the Project are negligible, aside from highly localised changes near the proposed crossings, based on Figure 5.33 to Figure 5.40. Due to the negligible geomorphic impacts, no further discussion of Project's impacts on geomorphology of these watercourses is provided in this report.

A geomorphic assessment of Conrock Gully and the proposed Conrock Gully diversion is provided in Appendix D.

5.5.2 Hydraulic criteria

Shear stress provides a measure of the tractive force acting on sediment particles at the boundary of the stream and is used to determine the threshold of motion for bed material. It provides an indication of the potential for erosion of cohesive sediments or movement of non-cohesive sediments at the channel boundary.

The Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development (DNRMMRRD) (formerly Department of Natural Resources and Mines [DNRM]) has developed a guideline *Works that interfere with water in a watercourse—watercourse diversions* (DNRM, 2019) that provides documentation on design parameters for watercourse diversions. The guideline is also applicable to constrictions of watercourses due to levee banks. The guideline states that the hydraulic criteria of the existing watercourse should be used as first preference to develop design parameters for the watercourse diversion. Additionally, these guidelines provide some nominal hydraulic threshold values to compare against for floodplain geomorphology.

Values from the ACARP guideline (ACARP 9068: Bowen Basin River Diversions Design and Rehabilitation Centre) shown in Table 5.2 summarise watercourse diversion design within the Bowen Basin for velocity, stream power and shear stress levels. The minimum requirement when undertaking a hydraulic analysis is to review the watercourse and diversion energy conditions for the 2% and 50% AEP flood events.

The ACARP guideline does not include relevant guideline values for events rarer than the 2% AEP event with respect to assessing floodplain morphology. For the purpose of the geomorphic assessment undertaken in this report for the 2% and 0.1% AEP event, conclusions for the 0.1% AEP event were drawn from the impacts caused to the hydraulic criteria on the Isaac River floodplain as a result of the proposed infrastructure compared to Existing Conditions.

Table 5.2 – ACARP Design Criteria for Bowen Basin Stream Diversions

Scenario	Stream Power (W/m^2)	Velocity (m/s)	Bed Shear (N/m^2)
50% AEP (no vegetation)	<35	<1.0	<40
50% AEP (vegetated)	<60	<1.5	<40
2% AEP	<150	<2.5	<50

5.5.3 Impact on channel morphology

The reach of Isaac River channel assessed in this section is presented Figure 5.2.

5.5.3.1 Hydraulic characteristics – existing conditions

The Existing Conditions model results show that:

- For the 50% AEP event (see Figure 5.27):
  - velocities are highest within the main channel banks and are generally under 2.0 m/s, with peak velocities occurring along the centre of the Isaac River channel up to 2.4 m/s;
  - the bed shear stress levels along the centre of the Isaac River channel are generally less than 30 N/m^2, with some localised areas exceeding 40 N/m^2;
  - the stream power levels along the centre of the Isaac River channel are generally less than 50 W/m^2, with some localised areas exceeding 60 W/m^2;
  - the highest hydraulic parameters occur at around chainage 4,000 m where the Isaac River main channel is constricted to a base width of about 20 m, due to an instream island. The main channel width in the vicinity of the Project is generally around 45 m. Bed shear stress reaches up to 57 N/m^2 in this location, and stream power reaches up to 120 W/m^2.
  - compared to the ACARP guideline values, the Isaac River channel velocities are higher than the guideline value of 1.5 m/s. Whilst this guideline value is for frequent flood events (i.e. 50% AEP), it indicates that stream velocities generally exceed the guideline value for existing conditions; and
  - bed shear stress and stream power levels are generally within the ACARP guideline values except for localised areas.
- For the 2% AEP event (see Figure 5.28):
  - velocities are highest within the main channel banks and are consistently less than 2.5 m/s;
  - the bed shear stress levels along the centre of the Isaac River channel are generally less than 40 N/m^2, with some localised areas exceeding 50 N/m^2;
  - the stream power levels along the centre of the Isaac River channel are generally less than 100 W/m^2, with some localised areas reaching up to 150 W/m^2;
  - compared to the ACARP hydraulic criteria, under existing conditions, Isaac River channel velocities are lower than the guideline value of 2.5 m/s; and
  - velocity and stream power levels are below the ACARP guideline values.
  - bed shear stress levels are generally within the ACARP guideline values except for localised areas.
- For the 0.1% AEP event (see Figure 5.29):
  - velocities are highest within the main channel banks and are generally under 2.5 m/s, however, where there are major bends in the Isaac River channel, velocities can reach up to 3.3 m/s;

- the bed shear stress levels along the centre of the Isaac River channel are generally less than 60 N/m^2; and
- the stream power levels along the centre of the Isaac River channel are generally less than 150 W/m^2, with some localised areas reaching up to 240 W/m^2.

5.5.3.2 Impact assessment - developed conditions

A longitudinal section along the centre of the Isaac River channel was taken to compare the velocities, bed shear stress and stream power under developed conditions to those under existing conditions. The results are provided in Figure 5.27 to Figure 5.29, with chainage starting from approximately 1.3 km upstream of the levee and finishing 1.7 km downstream of the levee.

The impact assessment for developed conditions is summarised below:

- For the 50% AEP event (see Figure 5.27):
    - overall there is negligible to minor change in velocities, bed shear stress and stream power;
    - velocities are increased by up to 0.2 m/s at the downstream end of the levee, however, the velocities in this area are lower than the peak velocities along the channel under existing conditions;
    - bed shear stress levels increase by up to 5 N/m^2 at the downstream end of the levee, however, levels are still generally within ACARP guideline values to a similar degree as the existing conditions; and
    - stream power levels increase by up to 20 W/m^2 at the downstream end of the levee, however, levels remain below the ACARP guideline values to a similar degree as the existing conditions.
- For the 2% AEP event (see Figure 5.28):
    - overall there is negligible to minor change in velocities, bed shear stress and stream power;
    - velocities are increased by up to 0.4 m/s at the downstream end of the levee, however, levels are still below ACARP guideline values.
    - bed shear stress levels increase by up to 5 N/m^2 at the downstream end of the levee, however, levels are still generally within ACARP guideline values to a similar degree as the existing conditions; and
    - stream power levels increase by up to 21 W/m^2 at the downstream end of the levee, however, levels remain below the ACARP guideline values to a similar degree as the existing conditions.
- For the 0.1% AEP event (see Figure 5.29):
    - overall there are minor change in velocities, bed shear stress and stream power;
    - velocities are increased by up to 0.2 m/s at the downstream end of the levee, with velocities peaking at 3.3 m/s;
    - bed shear stress levels increase by up to 4 N/m^2 at the downstream end of the levee, however, bed shear stresses in this area are lower than peak bed shear stresses in the channel under existing conditions; and
    - stream power levels increase by up to 15 W/m^2 at the downstream end of the levee, peaking at to 210 W/m^2, however, stream power levels in this area are lower than peak stream power levels in the channel under existing conditions.

Under developed conditions, the proposed levee causes negligible to minor impacts to flood velocities, bed shear stress and stream power along the centre of the Isaac River channel compared to existing conditions and are appropriate compared to guideline values for the 50% and 2% AEP events.

Under developed conditions, during the 0.1% AEP event, the proposed levee causes minor impacts to peak velocities at the downstream end of the levee, however, these velocities are well within the range of velocities experienced in the Isaac River main channel in this reach.

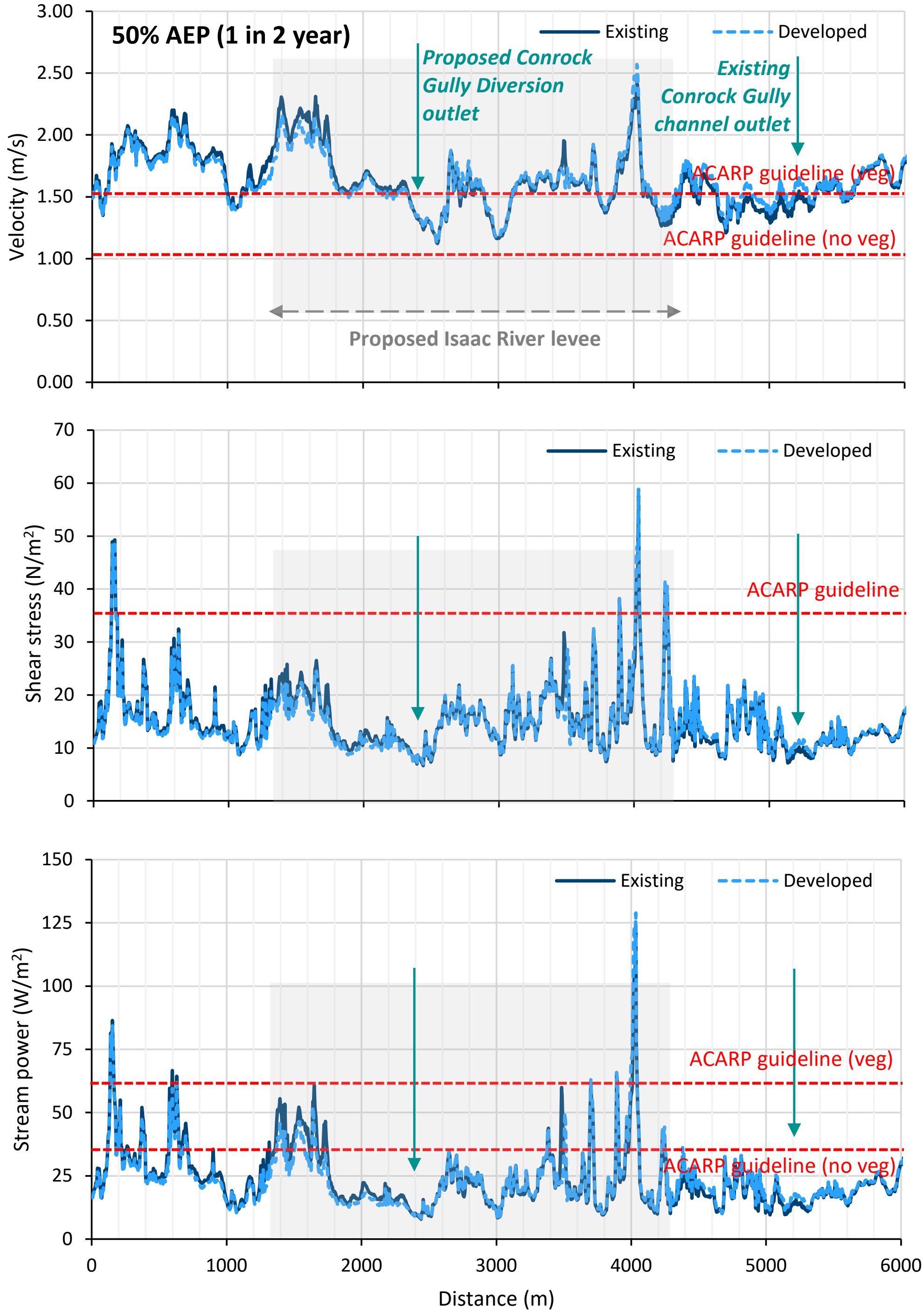


Figure 5.27 – Developed Conditions vs Existing Conditions peak velocities, stream power and bed shear stress along centre of the Isaac River channel, 50% AEP event

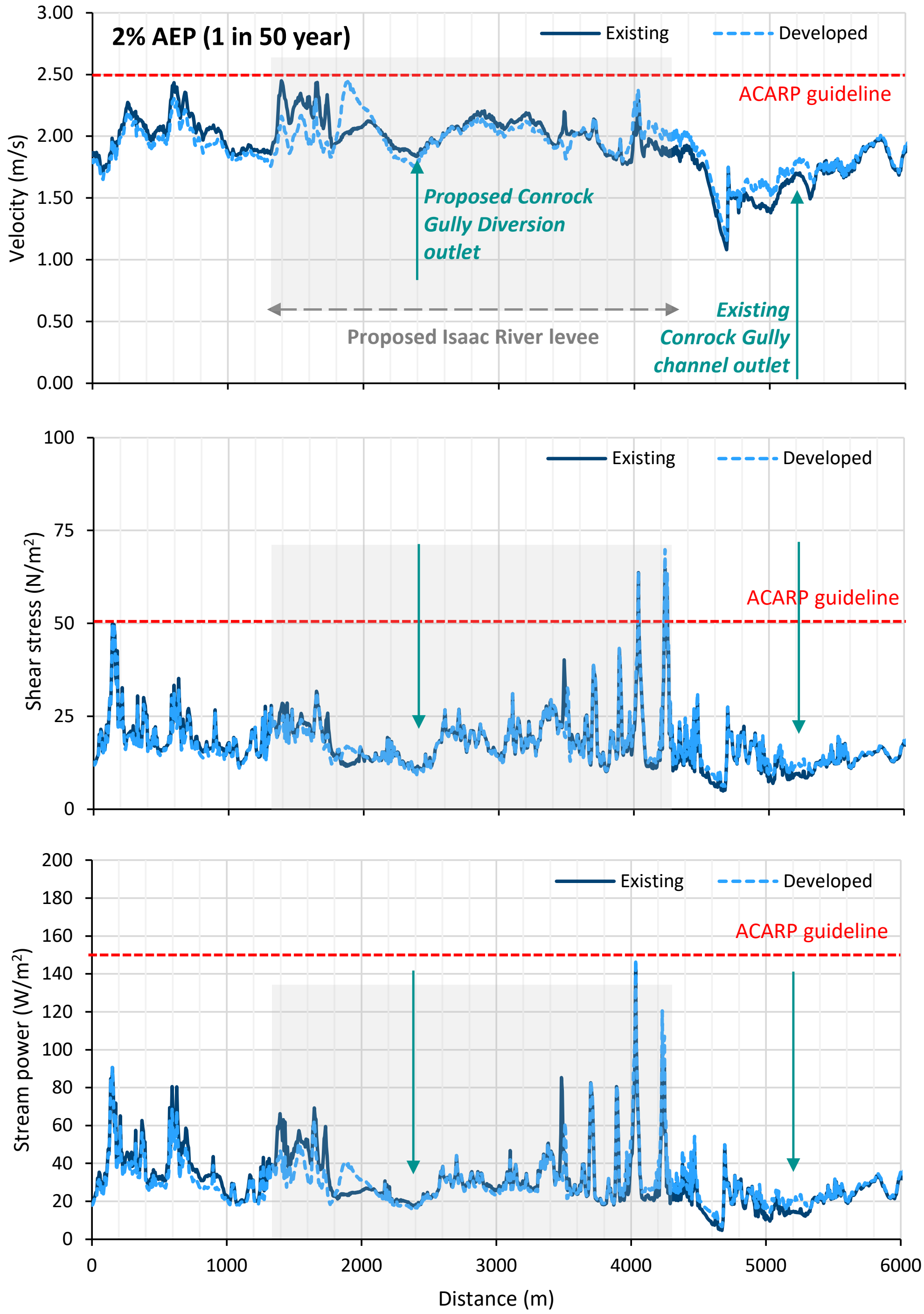


Figure 5.28 – Developed Conditions vs Existing Conditions peak velocities, stream power and bed shear stress along centre of the Isaac River channel, 2% AEP event

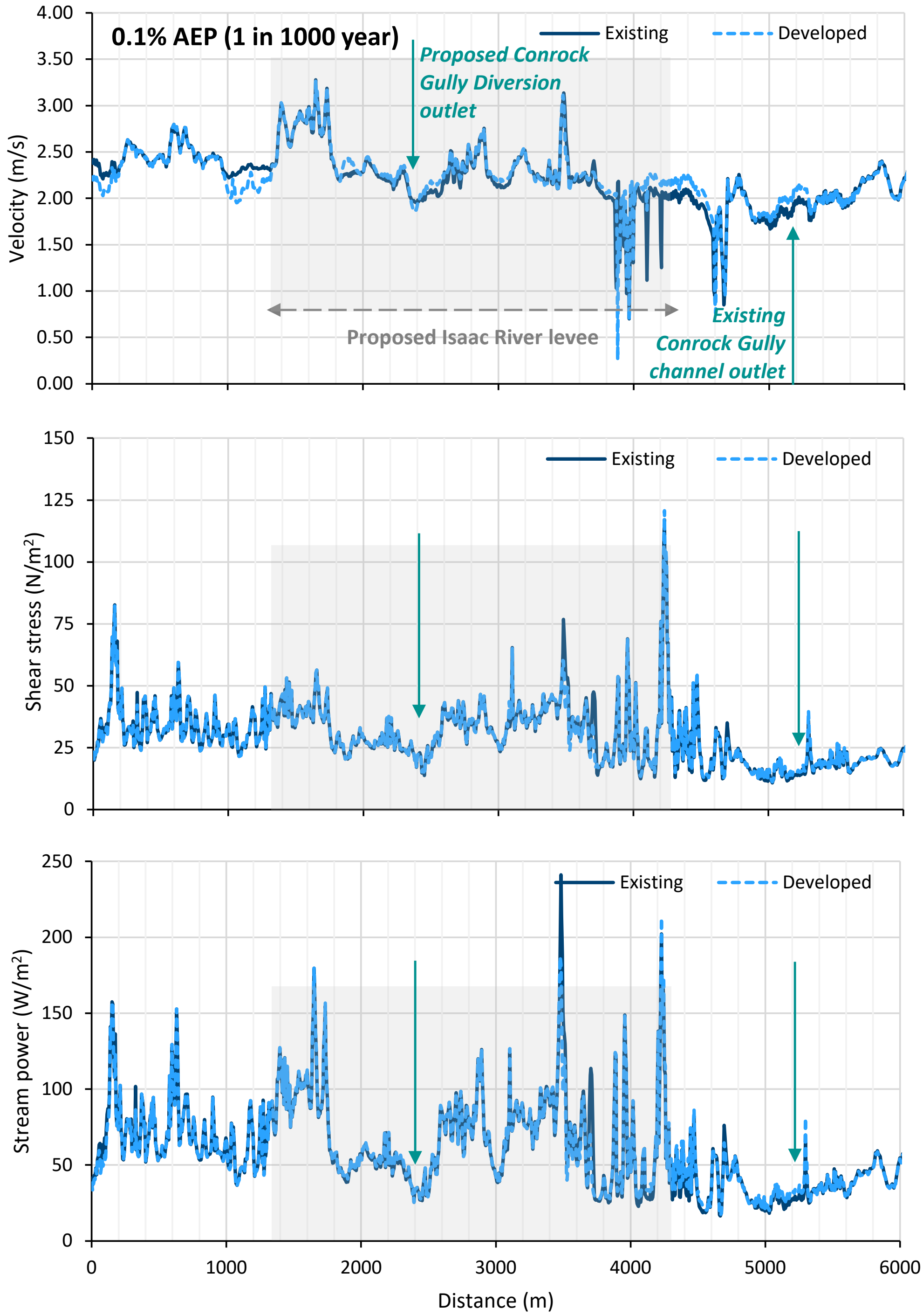


Figure 5.29 – Developed Conditions vs Existing Conditions peak velocities, stream power and bed shear stress along centre of the Isaac River channel, 0.1% AEP event

5.5.3.3 Impact assessment – Post-mining conditions

A longitudinal section along the centre of the Isaac River channel was taken to compare the velocities, bed shear stress and stream power under post-closure conditions to those under existing conditions. The results are provided in Figure 5.30 to Figure 5.32.

The impact assessment for post-closure conditions is summarised below:

- For the 50% AEP event (see Figure 5.30):
  - overall there is negligible change in velocities, bed shear stress and stream power;
  - velocities are increased by up to 0.1 m/s downstream of the final landform, however, the velocities in this area are lower than the peak velocities along the channel under existing conditions;
  - bed shear stress levels increase by up to 1 N/m^2 downstream of the final landform, however, levels are still generally within ACARP guideline values to a similar degree as the existing conditions; and
  - stream power levels increase by up to 3 W/m^2 downstream of the final landform, however, levels remain below the ACARP guideline values to a similar degree as the existing conditions.
- For the 2% AEP event (see Figure 5.31):
  - overall there is negligible change in velocities, bed shear stress and stream power;
  - velocities are increased by up to 0.2 m/s downstream of the final landform, however, the velocities consistently remain below the ACARP guidelines;
  - bed shear stress levels increase by up to 3 N/m^2 downstream of the final landform, however, levels are still generally within ACARP guideline values to a similar degree as the existing conditions; and
  - stream power levels increase by up to 7 W/m^2 downstream of the final landform, however, levels consistently remain below the ACARP guidelines.
- For the 0.1% AEP event (see Figure 5.32):
  - overall there is negligible change in velocities, bed shear stress and stream power;
  - velocities are increased by up to 0.15 m/s downstream of the final landform;
  - there are negligible impacts on bed shear stress or stream power levels under post-mining conditions.

Post closure conditions would have even less impact on velocities, bed shear stress and stream power than developed conditions as the Isac River levee is decommissioned and rehabilitated. Under post-closure conditions, the proposed final landform causes negligible impacts to flood velocities, bed shear stress and stream power along the centre of the Isaac River channel compared to existing conditions and are appropriate compared to guideline values for the 50% and 2% AEP events. The impacts of the proposed final landform during the 0.1% AEP event are negligible.

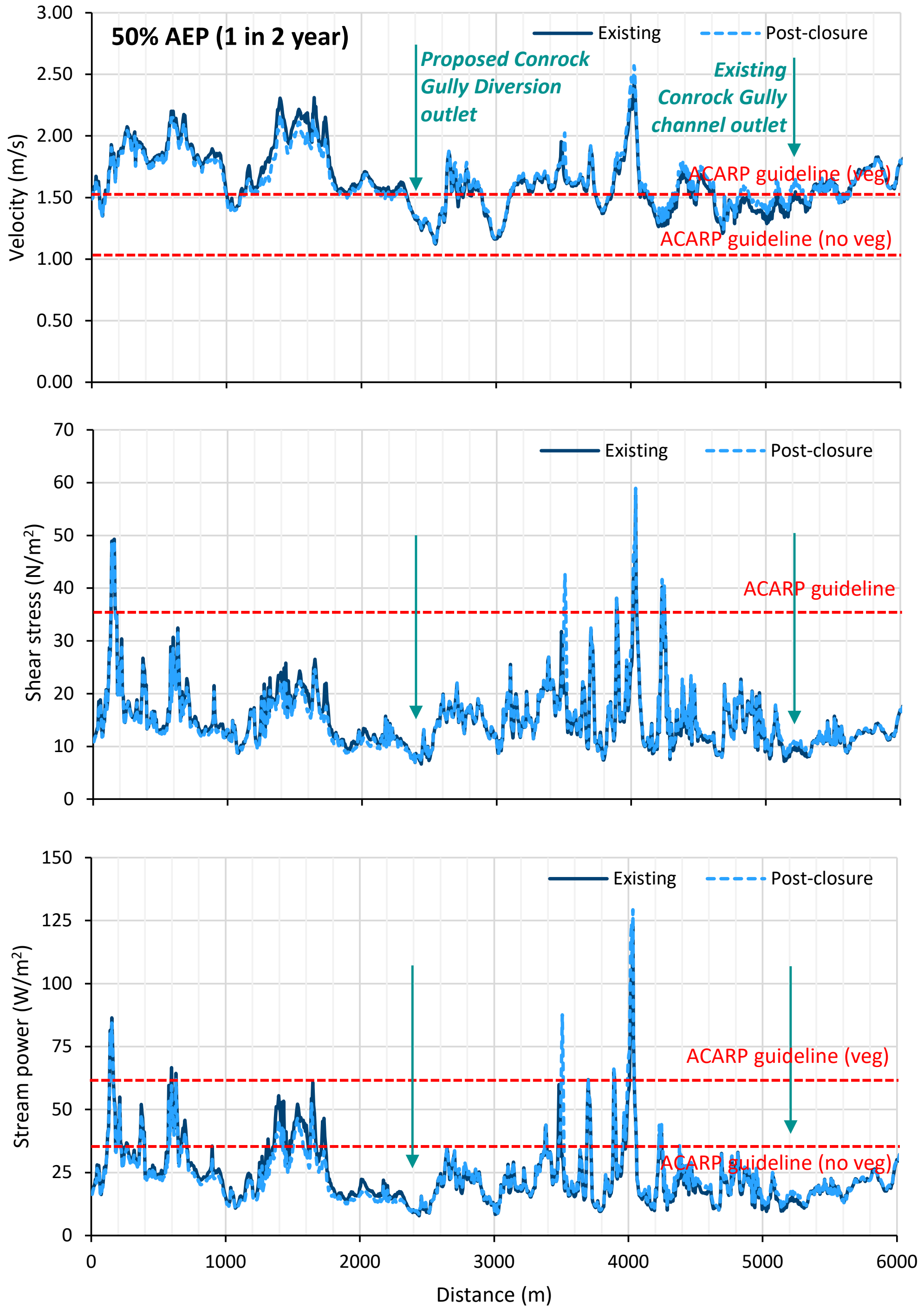


Figure 5.30 – Post-Closure Conditions vs Existing Conditions peak velocities, stream power and bed shear stress along centre of the Isaac River channel, 50% AEP event

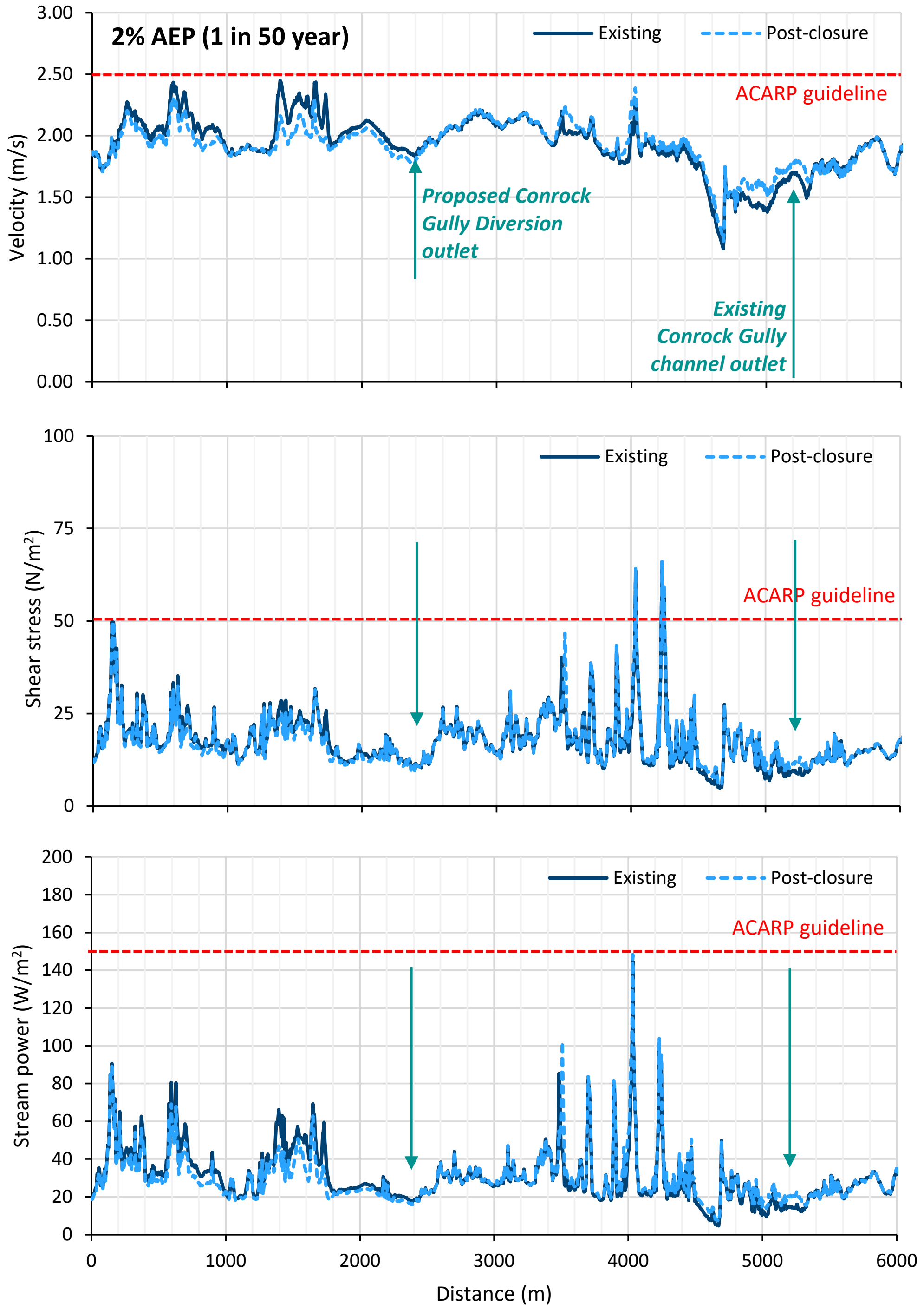


Figure 5.31 – Post-Closure Conditions vs Existing Conditions peak velocities, stream power and bed shear stress along centre of the Isaac River channel, 50% AEP event

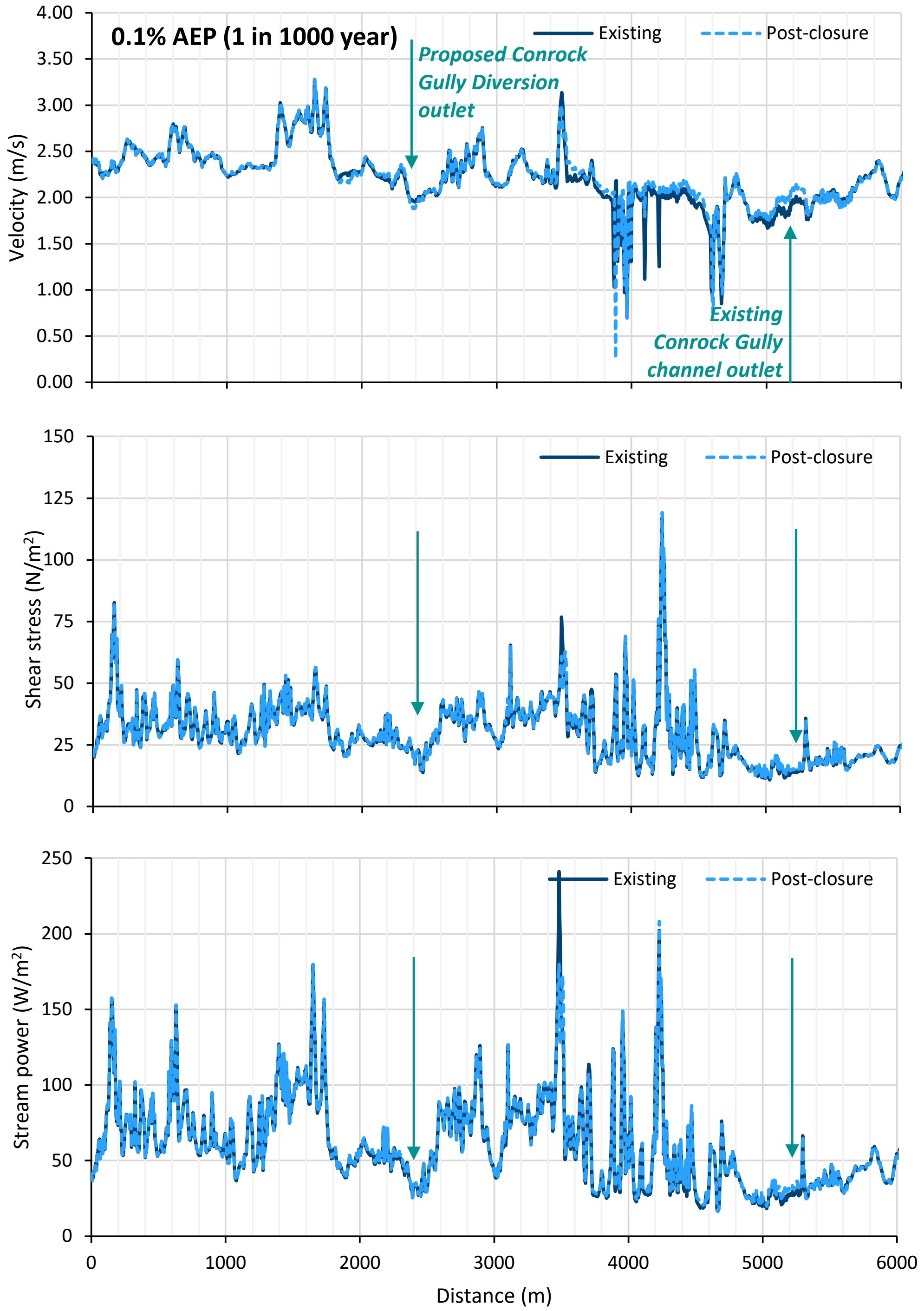


Figure 5.32 – Post-Closure Conditions vs Existing Conditions peak velocities, stream power and bed shear stress along centre of the Isaac River channel, 50% AEP event

5.5.4 Impact on floodplain morphology

The hydraulic characteristics (velocity, shear stress and stream power) for the Isaac River floodplain for the existing, developed and post-mining conditions are provided in the following sections for the 2% AEP and

0.1% AEP design events. The 50% AEP design event has been excluded as the Isaac River flow is generally contained within the river channel for this event and hence does not interact with the floodplain.

5.5.4.1 Hydraulic characteristics – existing conditions

The Existing Conditions model results show that:

- For the 2% AEP event (see Appendix C maps):
    - floodplain velocities generally less than 2 m/s and peak along floodplains adjacent to the major bends in the Isaac River channel;
    - floodplain bed shear stresses are generally less than 35 N/m^2, with some localised areas adjacent to the channel reaching 60 N/m^2;
    - floodplain stream power levels are generally less than 60 W/m^2, with some localised areas peaking to values greater than 100 W/m^2; and
    - velocities, bed shear stresses and stream power levels are generally below the ACARP guideline values, with the exception of small localised areas along the floodplain directly adjacent to the Isaac River channel where previous scour is evident and levels can exceed guideline values.
- For the 0.1% AEP event (see Appendix C maps):
    - floodplain velocities are generally less than 2.6 m/s and peak along floodplains adjacent to the major bends in the Isaac River channel;
    - floodplain bed shear stresses are generally less than 60 N/m^2, with some localised areas reaching 80 N/m^2; and
    - floodplain stream power levels are generally less than 150 W/m^2, with some localised areas exceeding 200 W/m^2.

5.5.4.2 Impact assessment - -developed conditions

The impact assessment for Operational Conditions is summarised below:

- For the 2% AEP event (see Figure 5.33, Figure 5.35 and Appendix C maps):
    - velocities are increased by up to 0.5 m/s along the floodplain to the south of IDM and by up to 0.8 m/s along the downstream reach of the levee. However, the floodplain velocities in these areas are generally lower than 2 m/s and below the guideline values;
    - overall bed shear stress and stream power experience negligible change across the majority of the floodplain, with some minor localised changes;
    - bed shear stresses are increased by up to 15 N/m^2 along the floodplain to the south of IDM and by up to 30 N/m^2 along the downstream reach of the levee. However, levels are generally similar to existing conditions along the floodplain adjacent to the proposed levee; and
    - stream power levels are increased by up to 35 W/m^2 along the floodplain to the south of IDM and by up to 50 W/m^2 along the downstream reach of the levee. Levels are generally unchanged from existing conditions along the floodplain adjacent to the proposed levee and below the guideline values.
- For the 0.1% AEP event (see Figure 5.34, Figure 5.36 and Appendix C maps):
    - velocities are generally increased by around 0.7 m/s in the floodplain adjacent to the Project, with some areas increasing by up to 1.1 m/s downstream of IDM and adjacent to the downstream reach of the proposed levee. However, the velocities in this area are lower than the peak velocities along the floodplain under existing conditions;

- bed shear stresses increase by up to 25 N/m^2 along the floodplain adjacent to the Project. However, increases in shear stress of up to 35 W/m^2 are observed in the floodplain downstream of IDM and adjacent to the downstream reach of the proposed levee; and
- stream power levels are generally increased by less than 60 W/m^2 in the floodplain adjacent to the Project. However, increases in stream power of up to 100 W/m^2 are observed in the floodplain downstream of IDM and adjacent to the downstream reach of the proposed levee.
- The bed shear stress and stream power levels in the Isaac River floodplain are higher than the levels typically experienced during the 0.1% AEP event for existing conditions with potential localised floodplain changes downstream of IDM and adjacent to the downstream reach of the proposed levee (which will have rock protection to prevent scour).

Under developed conditions, the peak velocities, bed shear stresses and stream power levels along the floodplain adjacent to Isaac River are generally similar to the peak levels under existing conditions and are appropriate compared to guideline values during the 2% AEP event. For extremely rare events (0.1% AEP) it is possible that some impacts to the Isaac River floodplain geomorphology may occur in localised areas (the sections downstream of IDM and in the downstream section of the proposed levee). Geomorphological changes are most likely to occur due to frequent and repeated flood flows (i.e. not a 0.1% AEP flood event). Hence it is considered unlikely that changes would occur within the 15-year mine life when the levee is in place. The proposed Isaac River levee will be decommissioned and rehabilitated following operations. The potential Isaac River floodplain geomorphic impacts during the post-closure period are discussed in Section 5.5.4.3.

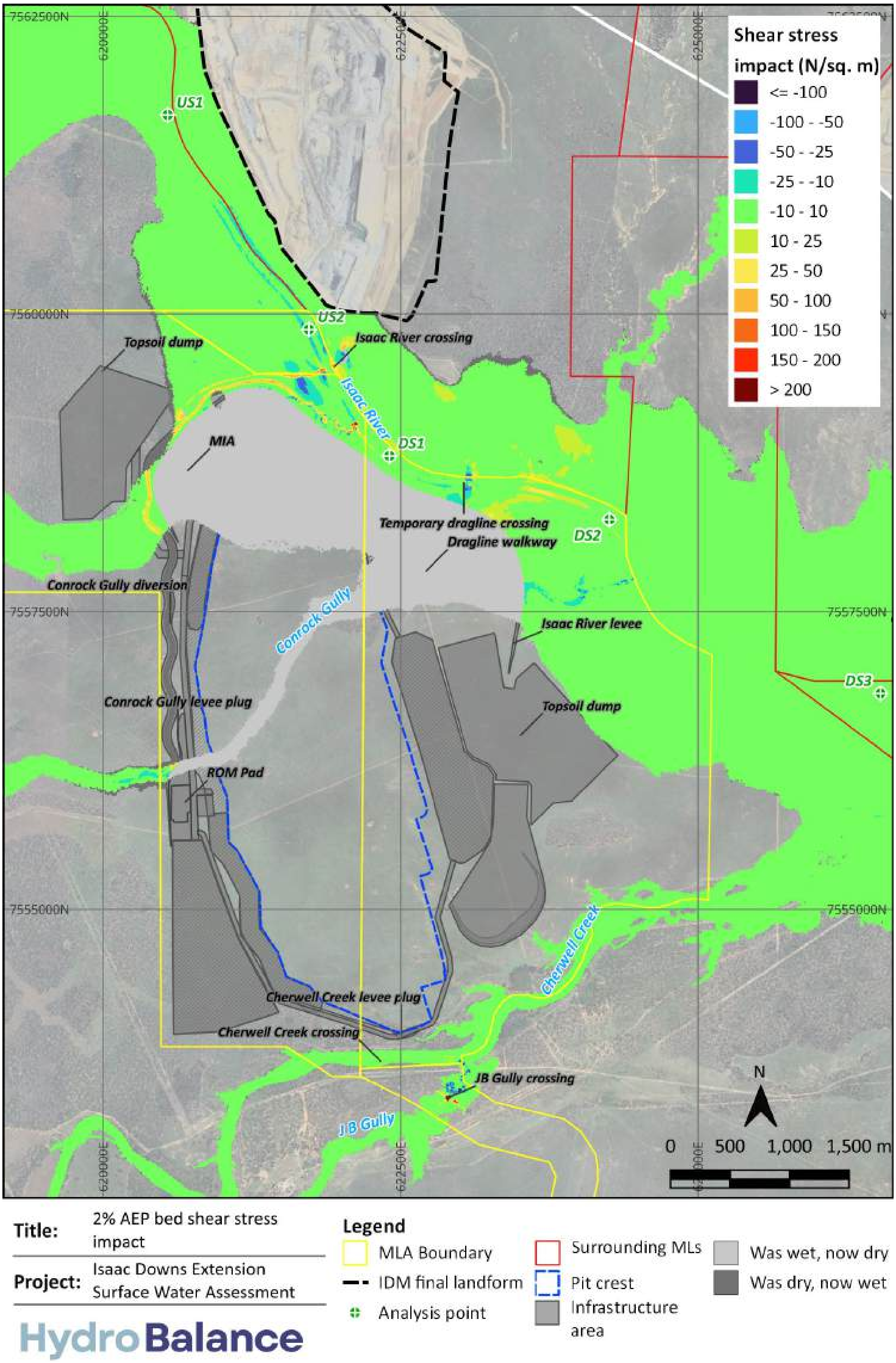
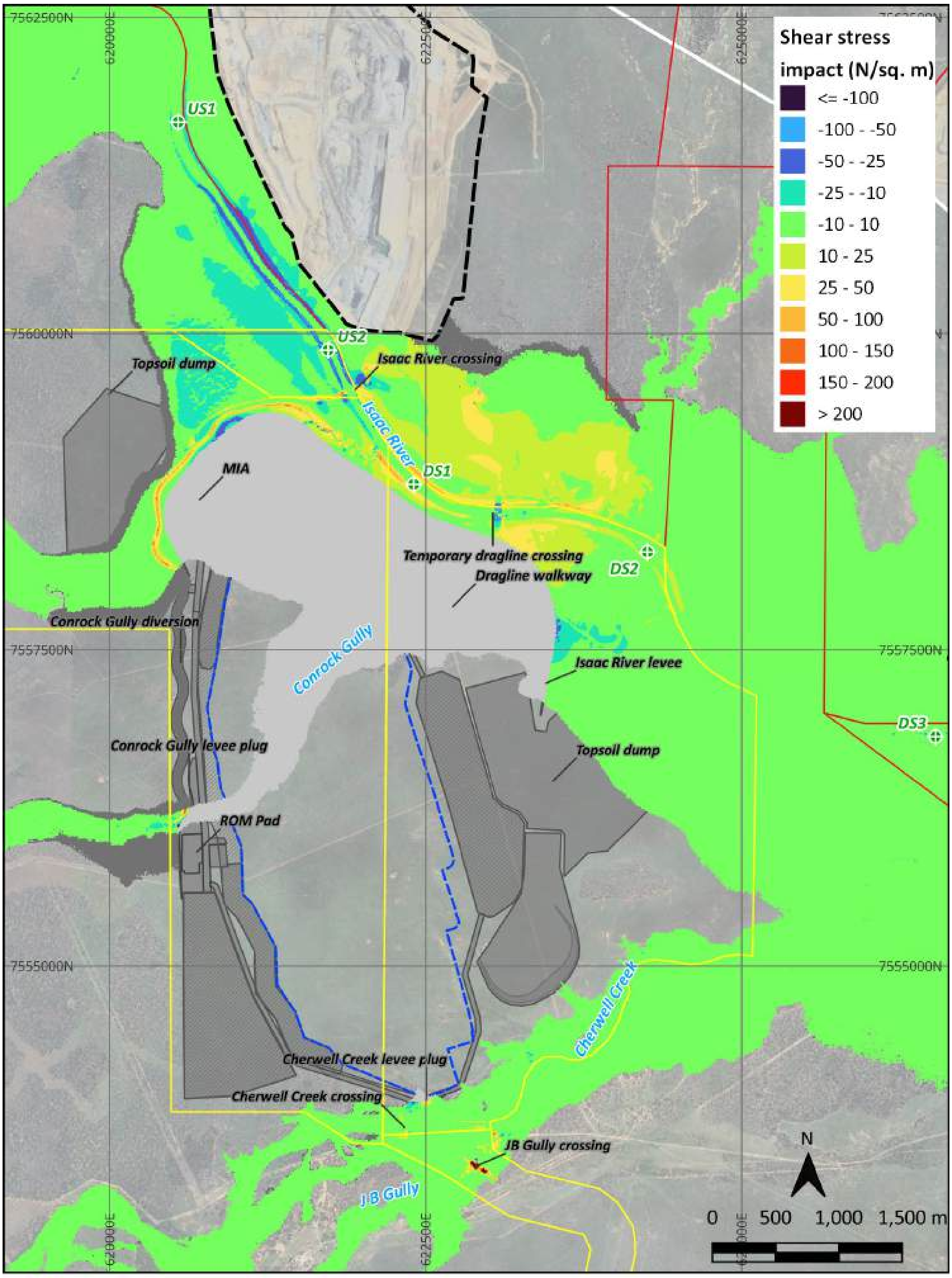


Figure 5.33 – Bed shear stress impact 2% AEP (developed minus existing conditions)



Title:	0.1% AEP bed shear stress impact
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Pit crest
- Infrastructure area
- Was wet, now dry
- Was dry, now wet

Figure 5.34 – Bed shear stress impact 0.1% AEP (developed minus existing conditions)

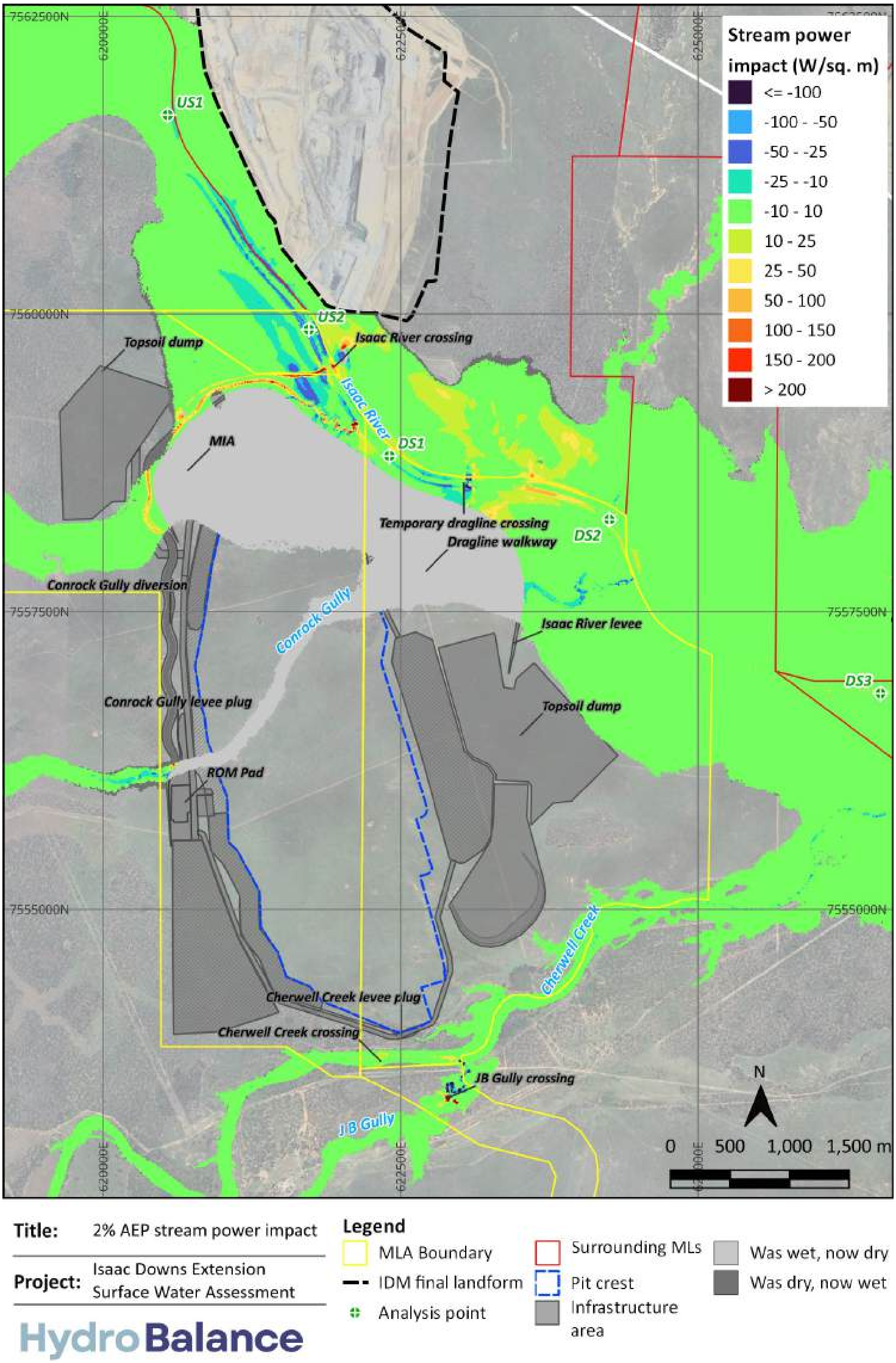


Figure 5.35 – Stream power impact 2% AEP (developed minus existing conditions)

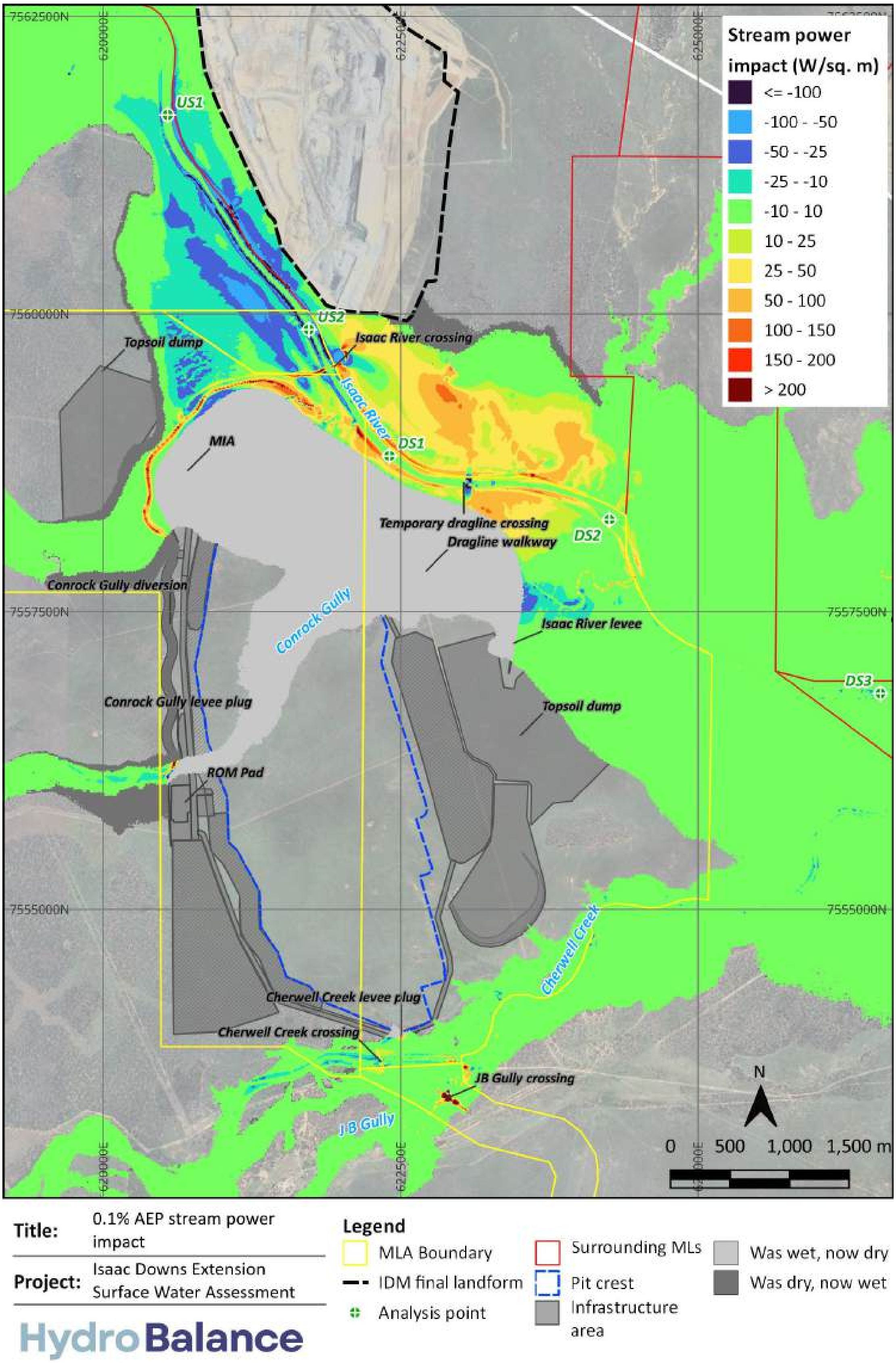


Figure 5.36 – Stream power impact 0.1% AEP (developed minus existing conditions)

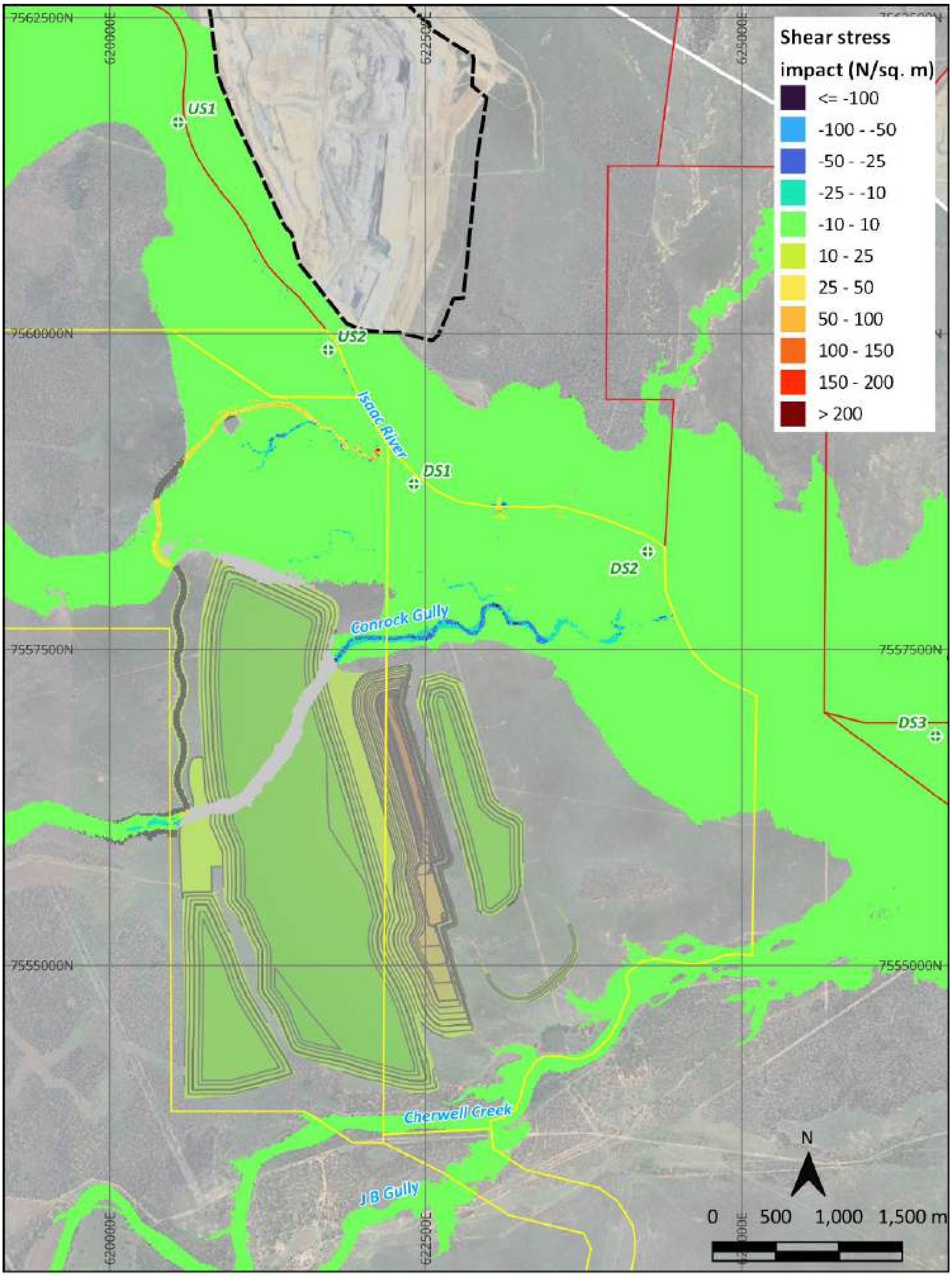
5.5.4.3 Impact assessment – post-mining conditions

The proposed Isaac River levee will be decommissioned and rehabilitated following operations, and hence an y impacts on floodplain morphology would be even less than during operations. An assessment of the floodplain morphology for Post-mining Conditions under rare and extreme flood events has been undertaken for the 2% and 0.1% AEP events. The impact assessment is summarised below:

- For the 2% AEP event (see Figure 5.37, Figure 5.39 and Appendix C maps):
  - there are negligible impacts to velocity, bed shear stress and stream power levels in the Isaac River floodplain due to the proposed final landform.
- For the 0.1% AEP event (see Figure 5.38, Figure 5.40 and Appendix C maps):
  - velocities may increase by up to 0.4 m/s along the floodplain adjacent to the out-of-pit emplacement, however, the velocities in this area are generally consistent with peak velocities along the floodplain under existing conditions;
  - overall there are negligible changes in bed shear stress and stream power across the entire floodplain;
  - bed shear stress impacts along the western floodplain are generally less than 10 N/m^2. There are no material impacts along the eastern floodplain; and
  - stream power level impacts along the western floodplain are generally less than 20 W/m^2. There are no material impacts along the eastern floodplain.

Overall, there are negligible to minor increases in velocity, and negligible changes in shear stress and stream power within floodplain of the Isaac River, as a result of the proposed final landform. Hence, the geomorphic impact on the Isaac River floodplain due to the proposed final landform is expected to be negligible.

As part of the final landform preparation, floodplain surfaces will be stabilised and rehabilitated to achieve a self sustaining vegetation cover. This vegetation cover will minimise the risk of scour. The hydraulic characteristics of flow within the backfilled pit area is similar to (or lower than) under existing conditions, and is expected to remain a stable landform with revegetation of the floodplain surface.

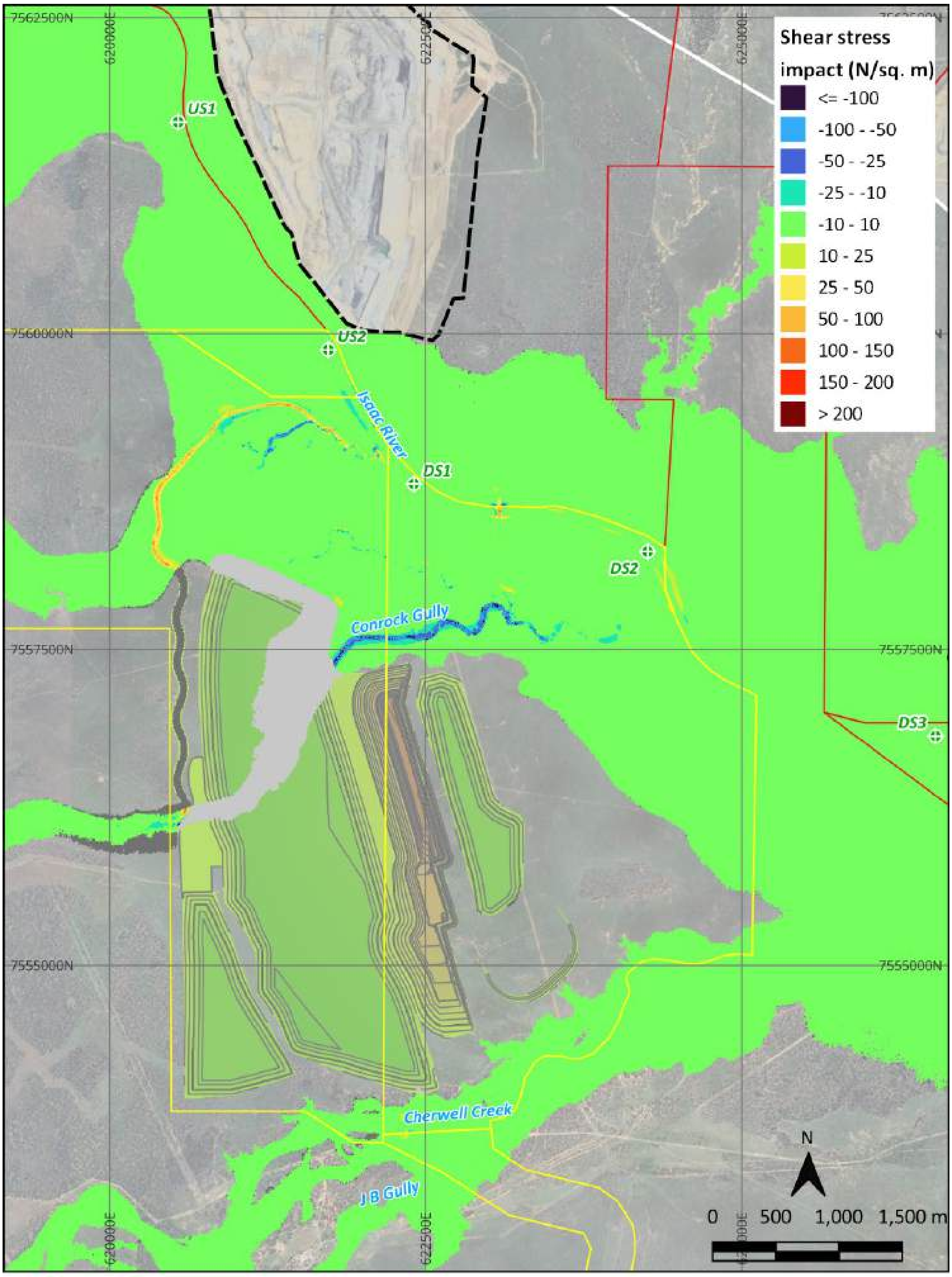


Title:	2% AEP bed shear stress impact, final landform
Project:	Isaac Downs Extension Surface Water Assessment

Legend
- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Was wet, now dry
- Was dry, now wet

HydroBalance

Figure 5.37 – Post-closure bed shear stress impact 2% AEP (final landform minus existing conditions)



Title:	0.1% AEP bed shear stress impact, final landform
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Was wet, now dry
- Was dry, now wet

Figure 5.38 – Post-closure bed shear stress impact 0.1% AEP (final landform minus existing conditions)

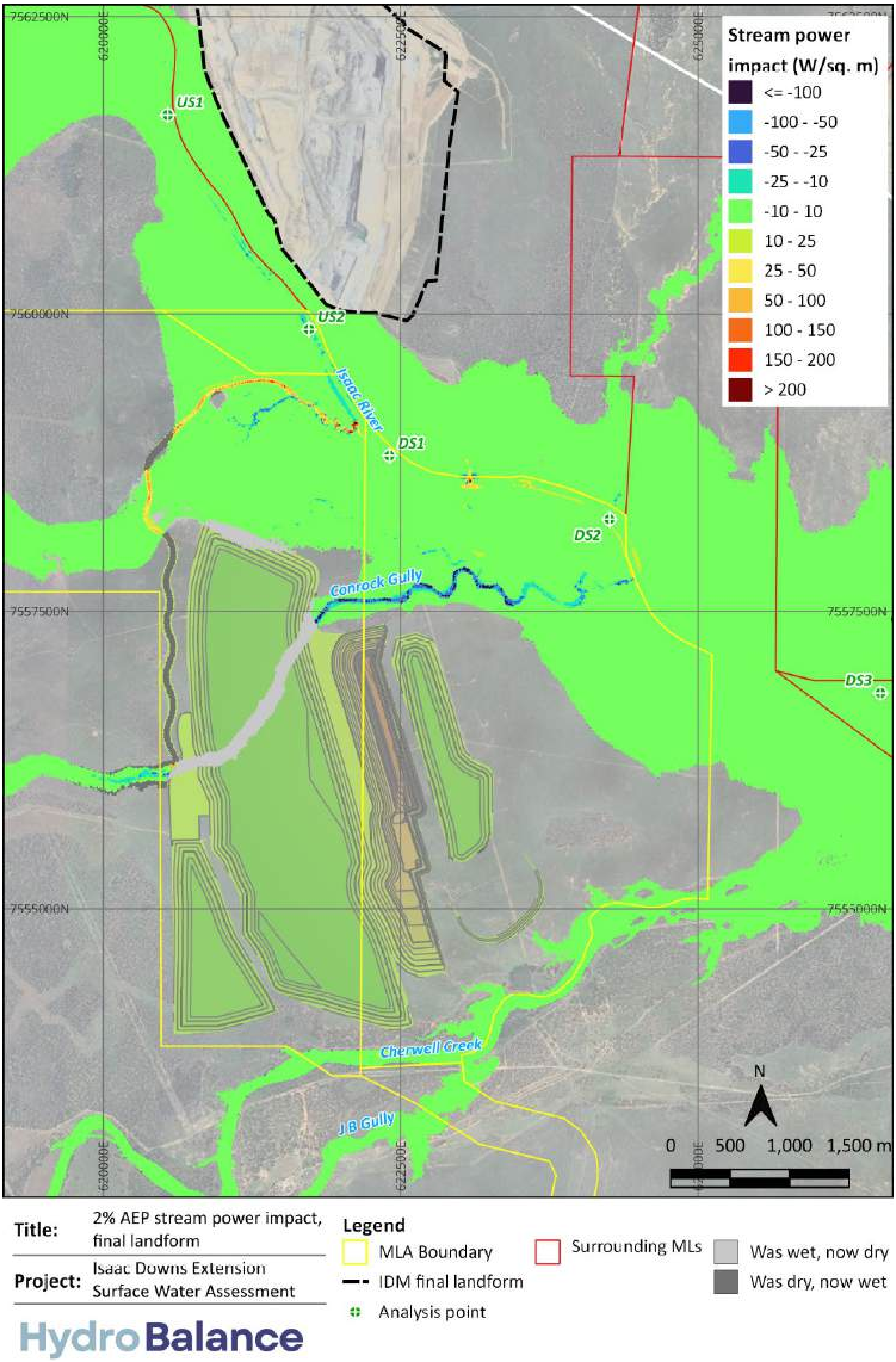


Figure 5.39 – Post-closure stream power impact 2% AEP (final landform minus existing conditions)

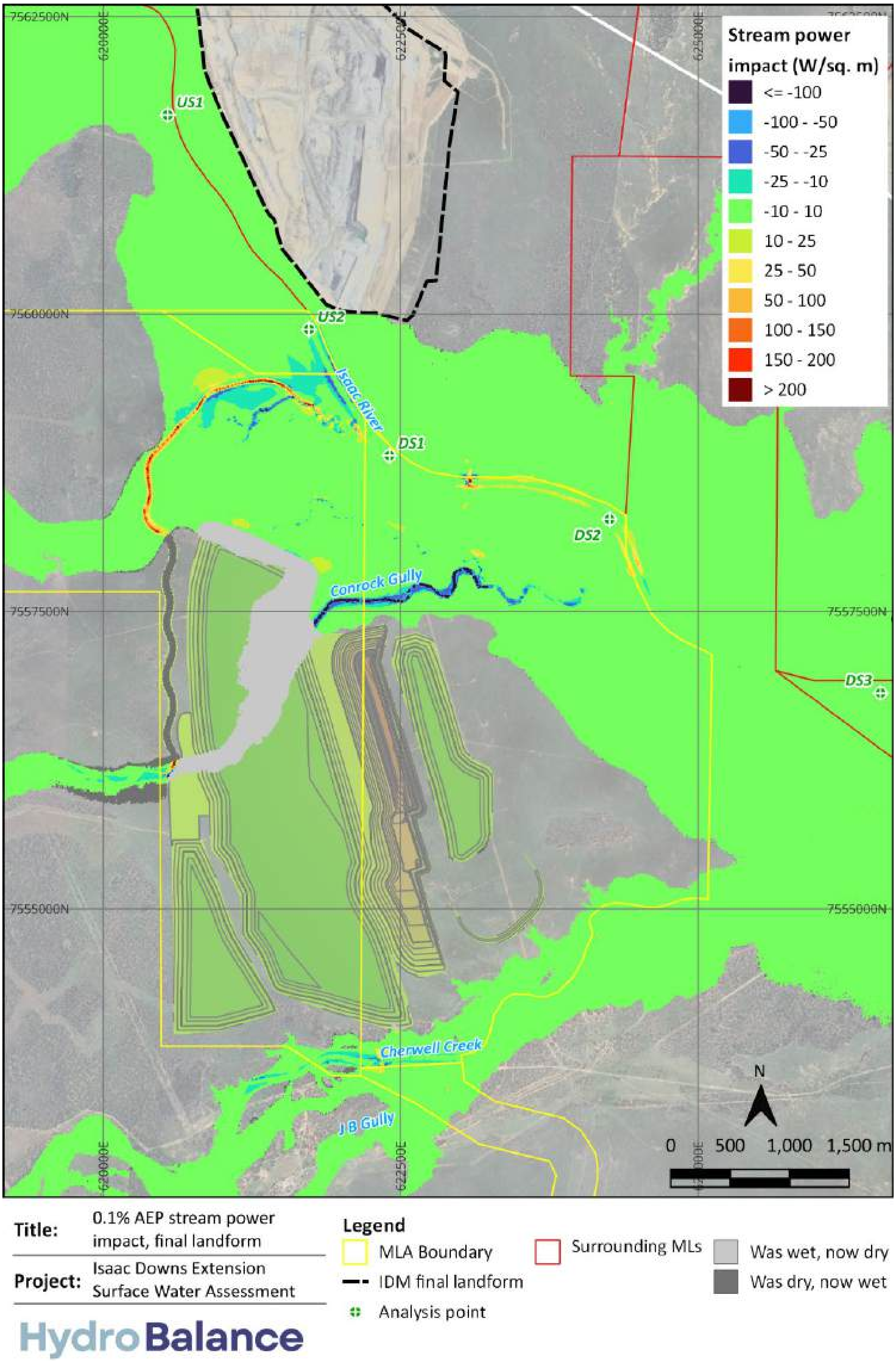


Figure 5.40 – Post-closure stream power impact 0.1% AEP (final landform minus existing conditions)

5.5.5 Summary of geomorphic impact assessment

The geomorphic impact assessment with respect to channel morphology is provided below:

- Under existing conditions:
  - Velocities within the main channel are generally higher than the ACARP guideline values for the 50% AEP event. The 2% AEP velocities are consistently less than the ACARP guideline values.
  - Bed shear stress and stream power are generally within the ACARP guideline values, except for small localised areas.
- Under developed conditions:
  - The proposed levee causes negligible to minor impacts to flood velocities, bed shear stress and stream power along the Isaac River channel.
  - The outcomes from the impact assessment indicate that the proposed Project infrastructure is unlikely to materiallyimpact on the geomorphology of the Isaac River channel in the vicinity of the Project.
- Under post-mining conditions:
  - With the decommissioning and rehabilitation of the Isaac River levee, the proposed final landform causes negligible impacts to flood velocities, bed shear stress and stream power along the Isaac River channel.
  - The outcomes from the impact assessment indicate that the proposed final landform is unlikely to impact on the geomorphology of the Isaac River channel in the vicinity of the Project.

The geomorphic impact assessment with respect to floodplain morphology is provided below:

- Under existing conditions:
  - Velocities along the Isaac River floodplain are generally within the ACARP guideline values for the 2% AEP event.
  - Shear stress and stream power are generally within the ACARP guideline values, except for small localised areas.
- Under developed conditions:
  - the peak velocities, bed shear stresses and stream power levels along the floodplain adjacent to Isaac River are generally similar to the peak levels under existing conditions and are appropriate compared to guideline values during the 2% AEP event.
  - For extremely rare events (0.1% AEP) it is possible that some localised impacts the Isaac River floodplain geomorphology may occur in the sections downstream of IDM and in the downstream section of the proposed levee. However, it is considered unlikely that these changes would occur within the relatively short 15-year mine life. The proposed Isaac River levee will be decommissioned and rehabilitated prior to closure.
- Under post-mining conditions:
  - There are negligible to minor changes in the hydraulic characteristics within the floodplain of the Isaac River as a result of the proposed final landform.

As part of the final landform preparation, floodplain surfaces will be stabilised and rehabilitated to achieve a self sustaining vegetation cover. This vegetation cover will increase erosion resistance and stability.

5.6 Climate change assessment

5.6.1 Overview

To assess the potential impacts of climate change on the flood behaviour, the 0.1% AEP design rainfall intensities were increased by a climate change factor (presented in Table A.14 of Appendix A).

Year 2050 climatic conditions have been used to assess the impact of climate change on developed conditions The year 2050 was selected as the representative year, being the period at the within 5 – 10 years of the end of mining operations. This is a conservative approach as it represents changes in climate greater than what is likely to be experienced during operations when the levee or levee plugs are operational.

Year 2100 climatic conditions have been used to assess post-closure conditions flooding. The year 2100 was selected as it is the furthest time horizon for which AR&R 2019 climate change factors are available.

5.6.2 Developed conditions climate change flood assessment

Figure 5.41 to Figure 5.43 show the impact the year 2050 climate conditions have on the predicted peak flood levels along the proposed levee and levee plugs. Under climate change conditions, the predicted peak flood levels along the Isaac River levee and Conrock Gully levee plug increase by up to 0.5 m. The predicted peak flood levels along the Cherwell Creek levee plug increase by up to 0.8 m.

Figure 5.44 shows the peak flood depths, levels and extents in the vicinity of the Project for the 0.1% AEP climate change event for developed conditions and Figure 5.45 shows the peak 0.1% AEP climate change flood velocities.

The results show that the proposed flood protection levee and levee plugs for the developed conditions configuration adequately protects the mining operations from flooding during the 0.1% AEP climate change event, even under conservative assumptions about changes in climate during the operational life of the Project..

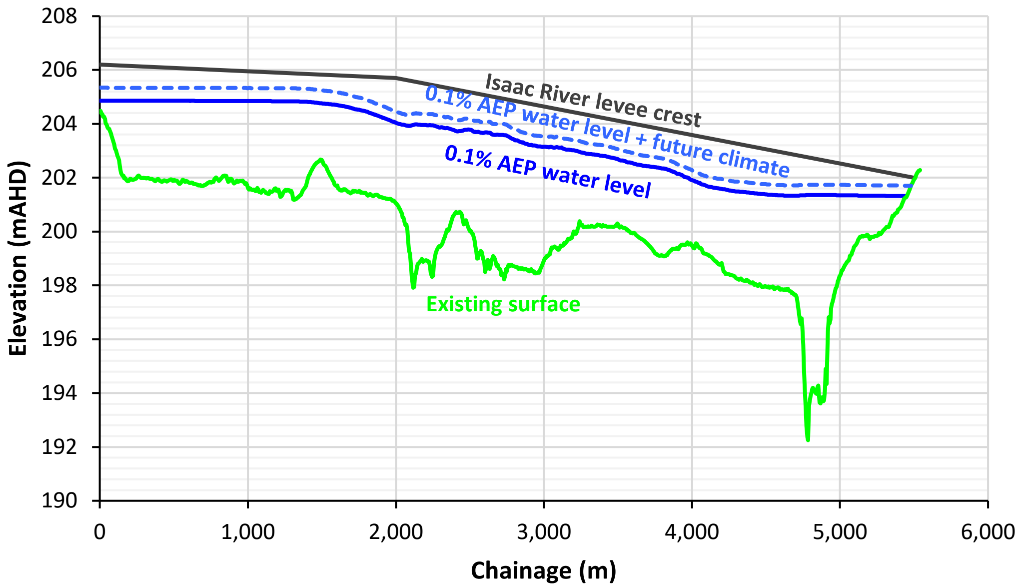


Figure 5.41 – Isaac River levee 0.1% AEP water levels plus Year 2050 climatic conditions – long section

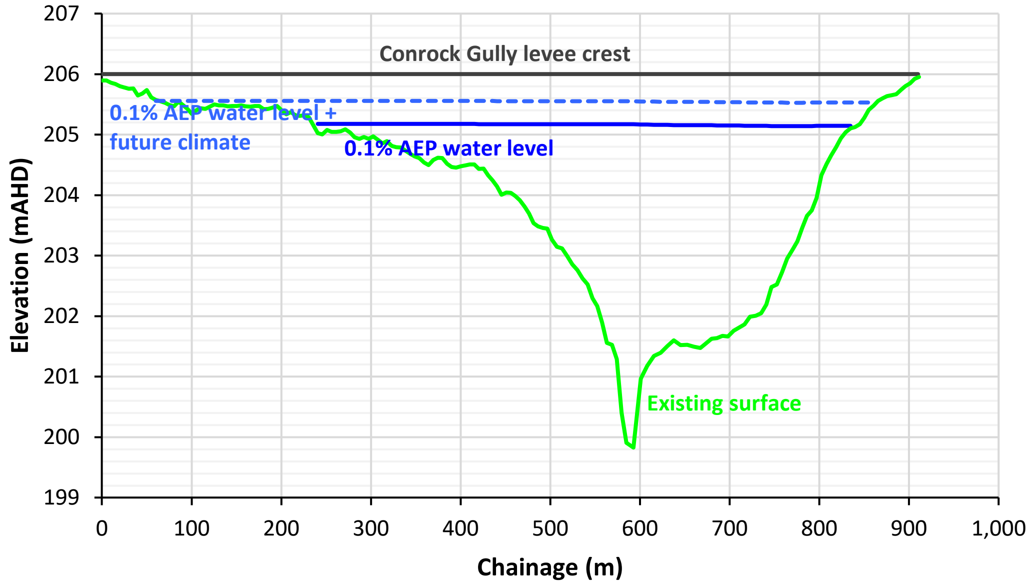


Figure 5.42 – Cherwell Creek levee plug 0.1% AEP water levels plus Year 2050 climatic conditions – long section

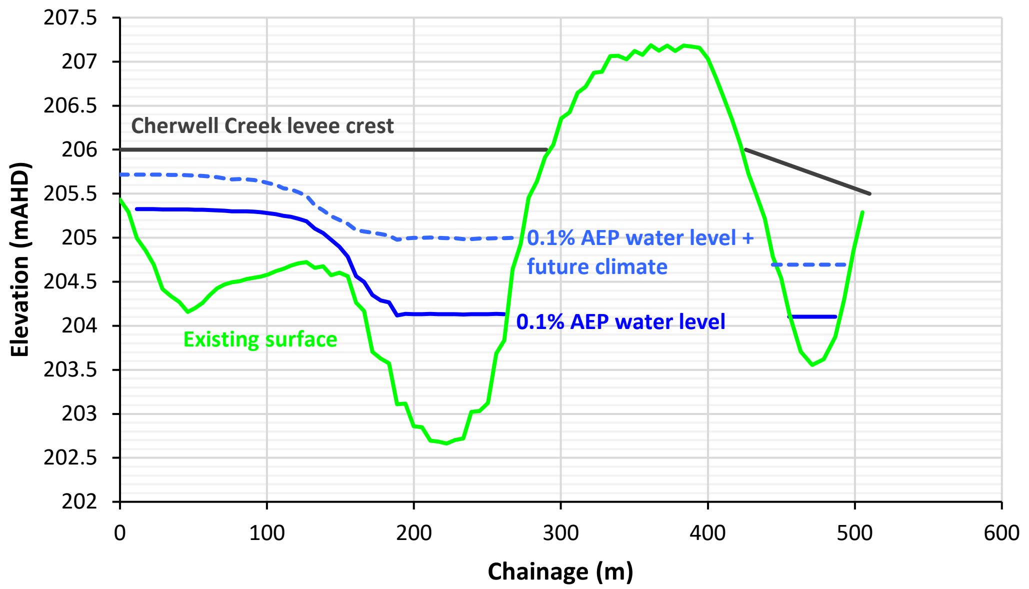
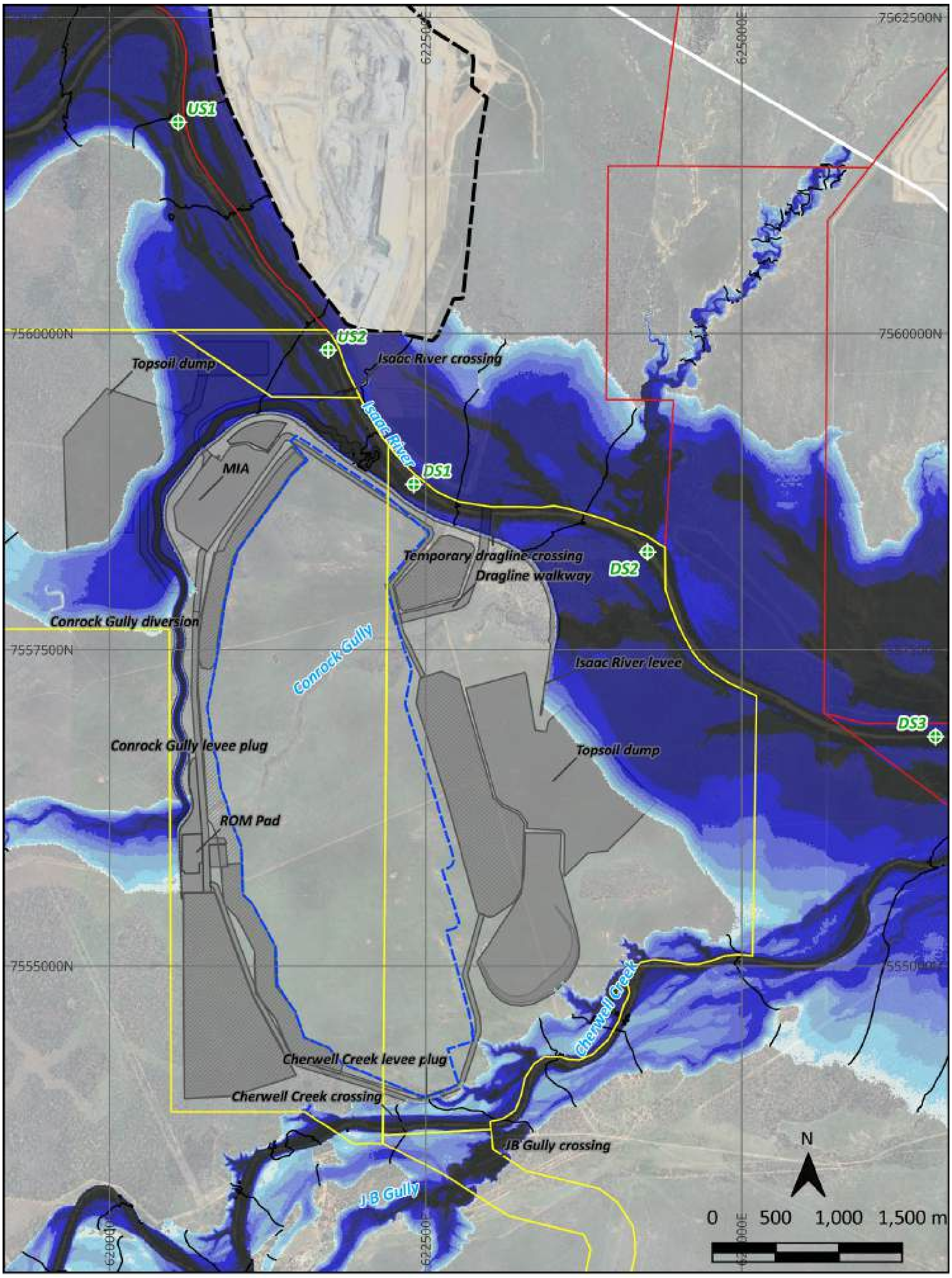


Figure 5.43 – Conrock Gully levee plug 0.1% AEP water levels plus Year 2050 climatic conditions – long section

5.6.3 Post-mining conditions climate change flooding assessment

Figure 5.46 shows the extent of the 0.1% AEP climate change (year 2100) flood event and Figure 5.47 shows the peak 0.1% AEP climate change velocities, for the final landform configuration. The modelled final landform configuration would include at least a 0.5 m high bund adjacent to the final void, which is a part of normal void safety features in the closure landform and would be sufficient to hold back the 0.1% AEP climate change flood.

The modelling results indicate that the final void would not be inundated in the post-mining phase in the 0.1% AEP climate change flood event. The velocities under the future climatic conditions are similar to the predicted velocities under climatic conditions described in Section 5.4.



Title:	0.1% AEP flood depths Developed conditions, 2050
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Water level contour (1m)
- Pit crest
- Infrastructure area

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- > 5.0

Figure 5.44 – Developed conditions flood depths, 0.1% AEP design event - climate change scenario

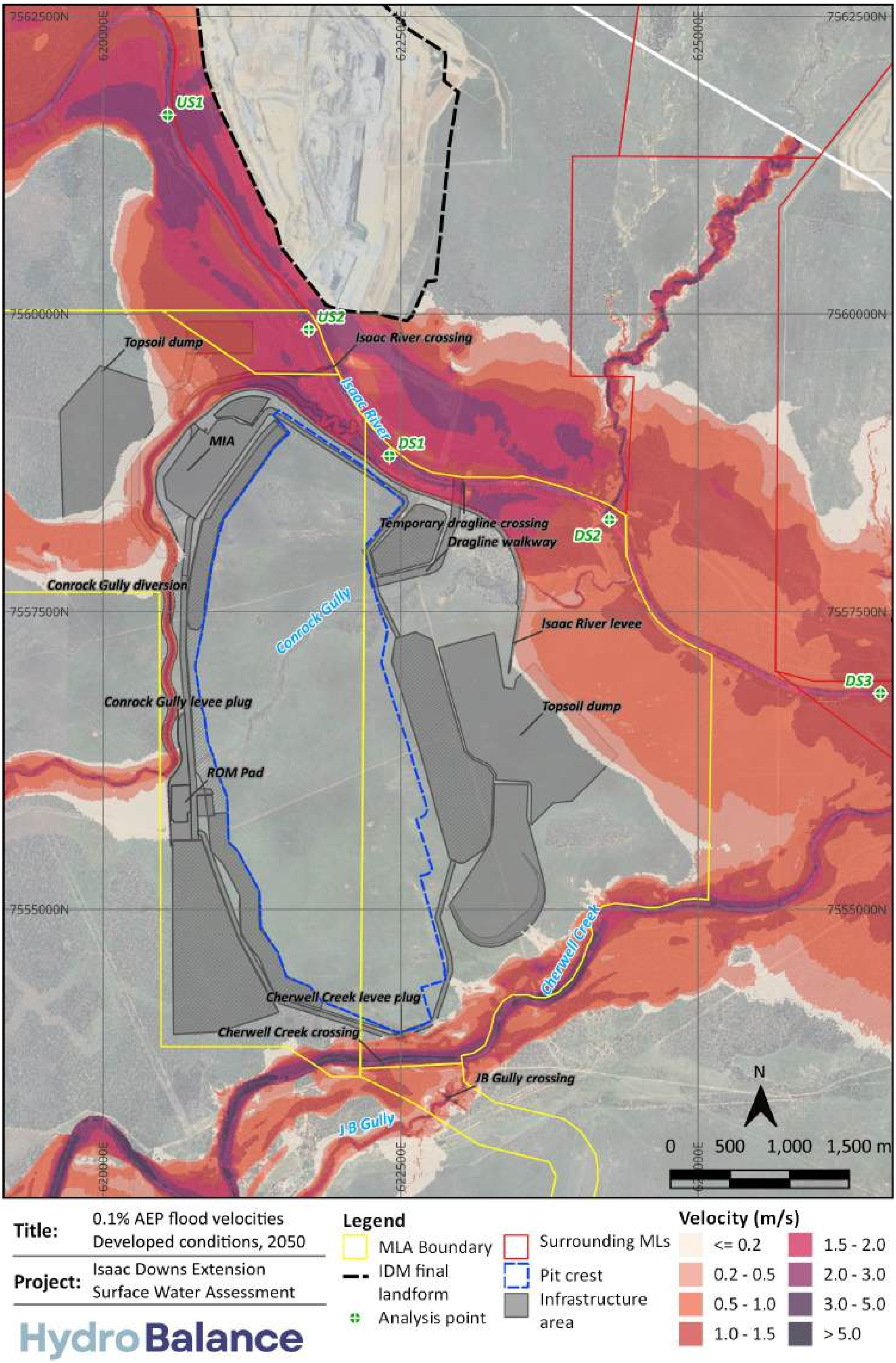


Figure 5.45 – Developed conditions flood velocities, 0.1% AEP design event - climate change scenario

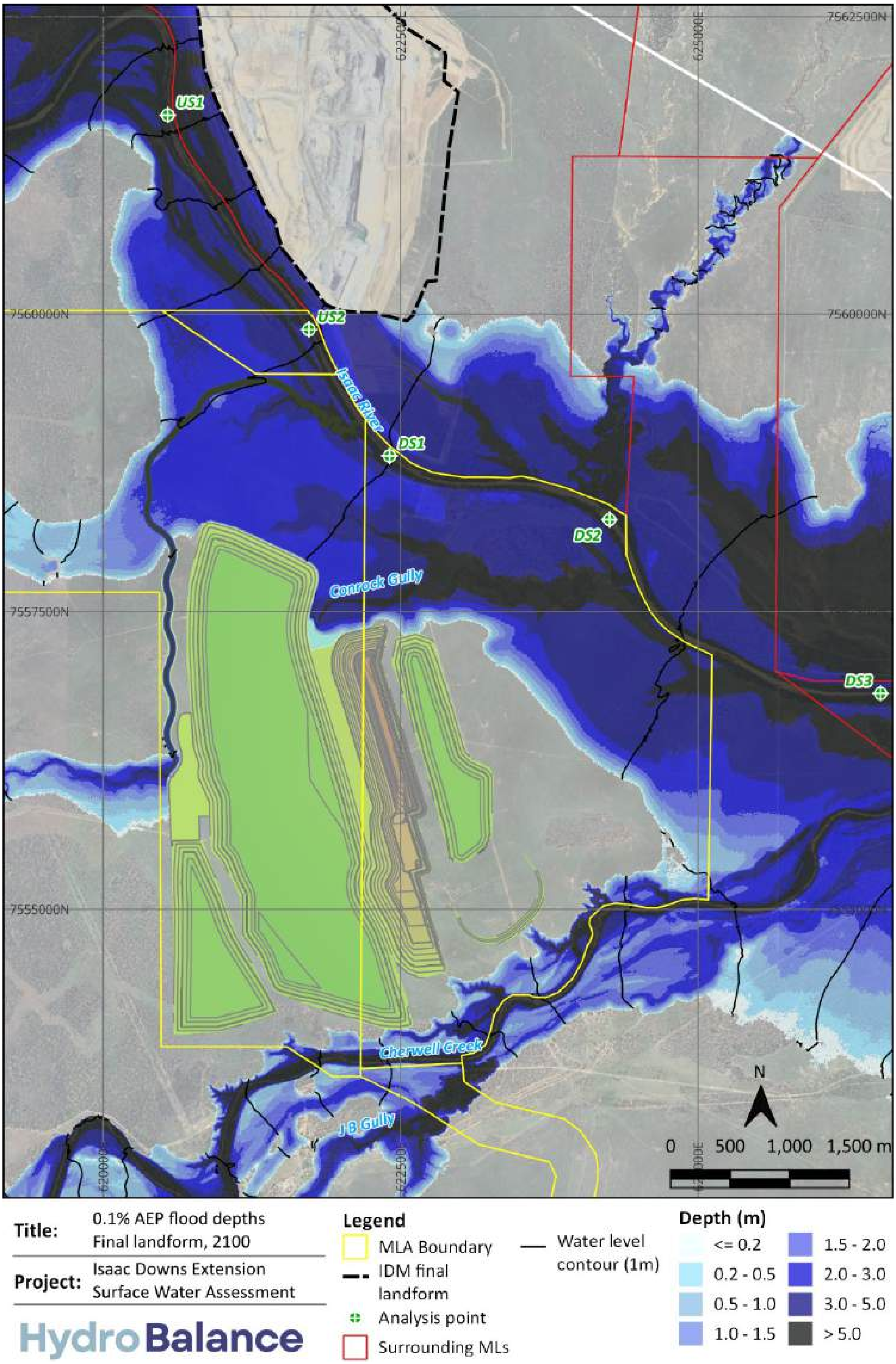


Figure 5.46 – Post-mining conditions flood depths, 0.1% AEP design event - climate change scenario

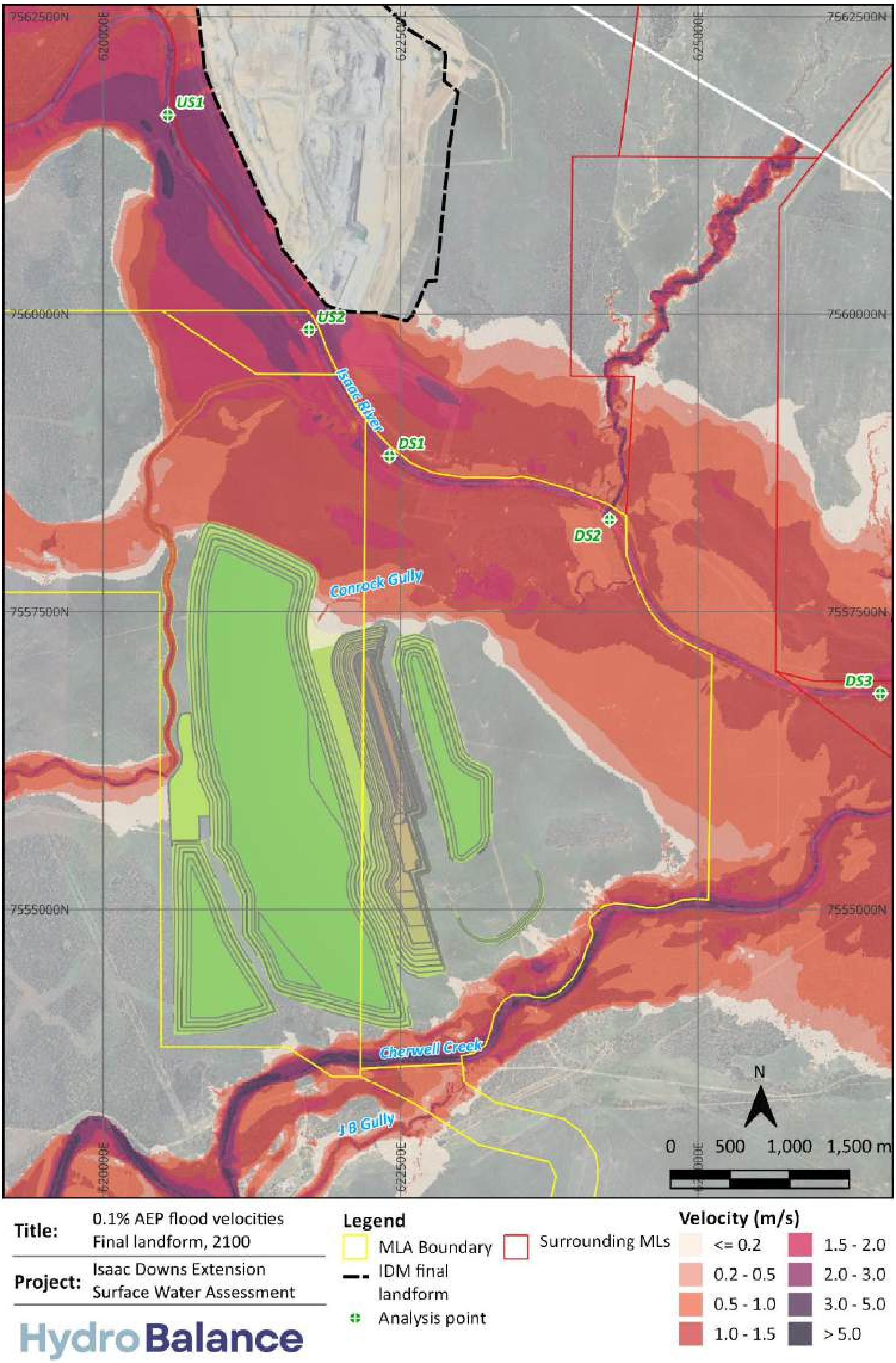


Figure 5.47 – Post-mining conditions flood velocities, 0.1% AEP design event - climate change scenario

6 Preliminary consequence category assessment

6.1 Overview

A preliminary consequence category assessment (CCA) for the Project's levees and levee plugs has been undertaken in accordance with the DES Manual for assessing consequence categories and hydraulic performance of structures ESR/2016/1933 (Dams Manual). The outcomes from this assessment are provided in the sections below.

Note that this assessment is based on preliminary design information only and therefore relies on a number of assumptions. This assessment will be updated during detailed design, once more information becomes available on the design of the proposed levee and levee plugs.

6.2 Assessable infrastructure

6.2.1 Water storages

A preliminary consequence category assessment for the Project water storages is provided in the SWIA report (HydroBalance, 2026).

6.2.2 Levee and Levee Plugs

The Dams Manual specifies the following with respect to levees:

> *Where a levee is designed to prevent ingress of non-mine affected floodwater into an operational area, or catchment of a containment system, the suitably qualified and experienced person conducting and certifying the assessment and construction would declare that the levee is a regulated structure where the flood modelling shows that the pit would be encroached by a flood event with a probability more likely than or equal to 1:1000 AEP.*

The Isaac River, Cherwell Creek and the downstream 3.2 km reach of Conrock Gully are the only defined watercourses that flow immediately past the Project mining activities, and have been assessed as part of this preliminary CCA.

The CCA rating for the Isaac River levee, Conrock Gully levee plug and Cherwell Creek levee plug has been described in the following section.

6.3 Assessment outcomes

The Isaac River flows past the eastern side of the Project, from northwest to southeast. Cherwell Creek flows past the southern boundary of the Project, from west to east. The alignment of these watercourses have not been modified as part of mining activities. Conrock Gully currently flows through the proposed Project area towards Isaac River. A diversion of Conrock Gully is proposed to divert the local creek flows and around the Project and into the Isaac River.

The flood modelling assessment (see Section 5) shows that, under pre-mining conditions, the Isaac River, Conrock Gully and Cherwell Creek 0.1% AEP design flood extents (AEP 1:1000) would interact with the proposed operational mining pit. Based on this outcome, the proposed Isaac River flood protection levee, the Conrock Gully levee plug and the Cherwell Creek levee plug are therefore classified as a regulated structures in accordance with the Dams Manual.

The operational flood modelling results (with the levee / plug in place) demonstrate that the proposed levee / plug designs protect the mining operations from the 0.1% AEP design flood event (with freeboard), and therefore are compliant with the hydraulic performance requirements for regulated levees outlined in the Dams Manual.

7 Assessment of potential impacts, and mitigation and management measures

7.1 Potential impacts

The potential impacts of the Project on surface water resources include:

- Alterations to the flooding regime of the Isaac River and local creeks (Cherwell Creek, JB Gully and Conrock Gully) due to Project infrastructure and the final landform;
- Impact on stream flows due to ingress of floodwater into the final void (not modelled to occur);
- Changes to creek and floodplain geomorphology, due to the construction of Conrock Gully diversion and the Project levees; and
- Cumulative impacts of all projects in the region on the environmental values of the receiving waters.

The assessment of surface water impacts has been undertaken based on commonly applied methodologies for the simulation of hydrologic and hydraulic processes using currently available data. The adopted approach is considered suitable for quantifying impacts to a level of accuracy consistent with current industry practice. Certain aspects of the Project, such as changes to landforms due to construction of overburden emplacements, will create permanent changes, however these will be designed and managed to protect environmental values of receiving waters.

7.2 Flooding impacts

Potential impacts of the Project on flood levels and velocities of Isaac River, Cherwell Creek, JB Gully and Conrock Gully have been assessed using a two-dimensional TUFLOW hydraulic model. The modelling included a range of design flood events (from 50% AEP to the PMF) and considered both existing (approved), developed and final landform conditions. Potential impacts of the Project on flood levels and velocities described in Section 5 of this report, with a summary of those findings provided below.

7.2.1 Operational flood regime

The modelled impacts to the operational flood regime in Isaac River, Cherwell Creek, JB Gully and Conrock Gully are presented in Table 7.1.

Table 7.1 – Summary of modelled flood impacts due to the Project, operational conditions

Location	Water level impact	Velocity impact
Isaac River	The flood levels in Isaac River channel and floodplain increase up to 1.2 m (generally less than 1 m) along a 5.4 km reach for the 0.1% AEP event. The magnitude of changes in flood levels reduces for more frequent flood events. The flood level impacts do not extend downstream beyond the Project footprint. The magnitude of changes in flood levels reduces for more frequent flood events. The Isaac River bridge and the temporary dragline crossing have negligible impacts on the rare flood events, as the structures are inundated by flood flows. A floodplain residence time impact assessment was also undertaken considering the developed conditions. Overall, this assessment found that the Project results in	The flood velocities are generally decreased upstream of the Project, including adjacent the IDM final landform. The greatest decreases are located around the proposed Isaac River crossing. Velocity decreases also occur in the Isaac River floodplain adjacent to the Conrock Gully diversion and downstream of the Isaac River levee. The flood velocities in the floodplain adjacent to the Project and the floodplain downstream of IDM would be increased by up to 1.0 m/s for the 0.1% AEP event. Rock protection is recommended along a 2.5 km section of the Isaac River levee, to mitigate potential scour risk. The flood velocity changes do not extend downstream beyond the proposed levee.

Location	Water level impact	Velocity impact
	negligible change to the duration of Isaac River events (i.e. negligible change to floodplain residence times)	The magnitude of change in velocity reduces for more frequent flood events.
Cherwell Creek and JB Gully	The proposed Cherwell Creek bridge may increase water levels upstream of the bridge by up 0.2 m. The Cherwell Creek levee plug would hold back flows from the operational area for the 0.1% AEP event, causing a localised increase of up to 0.6 m. Flows do not interact with the Cherwell Creek levee plug for any events more frequent than the 0.1% AEP. The JB Gully bed-level crossing has a negligible impact on all modelled flood events, as the structure are drowned out by flood flows.	There are minor localised changes in velocities downstream of the proposed Cherwell Creek bridge and JB Gully bed-level crossing. The relative impacts are typically higher for more frequent events, although the absolute velocities are lower. The velocity impacts do not propagate downstream.
Conrock Gully	The flood levels immediately upstream of the Conrock Gully diversion would be increased by up to 2.2 m and minor impacts would propagate up to 1,200 m upstream for the 0.1% AEP event. The magnitude of changes in flood levels reduces for more frequent flood events. The remainder of the existing Conrock Gully channel will be excised by the Project. However, downstream of the Project area, in the remnant Conrock Gully channel, there is no change in flood levels as these areas continue to be flooded by backwater flow from the Isaac River.	The flood velocities upstream of the Conrock Gully diversion would be decreased by up to 0.5 m/s and minor impacts would propagate up to 900 m upstream for the 0.1.% AEP event. The magnitude of change would reduce for more frequent flood events. The remainder of the existing Conrock Gully channel will be excised by the Project.; however as noted above, the remnant Conrock Gully channel will continue to be flooded by the Isaac River backwaters; with lower velocities than pre-mining.

7.2.2 Post-closure flood regime

The modelled impacts to the post-closure flood regime in Isaac River, Cherwell Creek, JB Gully and Conrock Gully are summarised as follows:

- Water level:
  - The final landform results in negligible change to flood levels in the Isaac River. There are minor increases in water levels (up to 0.2 m) in the reach where the Conrock Gully diversion meets the floodplain.
  - The flood levels upstream of the Conrock Gully diversion are impacted to a similar level as the operational conditions scenario (see Table 7.1).
  - There are no water level changes in Cherwell Creek in the vicinity of the final landform.
- Velocities:
  - The final landform results in negligible change to velocity in the Isaac River channel.
  - There are decreased velocities in the existing Conrock Gully channel downstream of the mine, noting that these areas will continue to receive flood flows from Isaac River backwater flooding, but at reduced velocities.
  - The flood velocities upstream of the Conrock Gully diversion are impacted to a similar level as the operational conditions scenario (see Table 7.1).
  - There are no flood velocity changes in Cherwell Creek in the vicinity of the final landform.

7.3 Ingress of floodwater into the final void

The flood modelling assessment in Section 5.4 shows that the final void lies outside of the 0.1% AEP flood extent for the Isaac River. As such, the Project will have no impact on Isaac River flows resulting from ingress of water to the final void up to the 0.1% AEP event.

7.4 Geomorphic impact assessment

7.4.1 Isaac River channel geomorphology

The geomorphic impact assessment indicated that the proposed Project infrastructure and the proposed final landform is likely to have negligible to minor impact on velocity, bed shear stress and stream power and hence unlikely to have a material impact on the geomorphology of the Isaac River channel in the vicinity of the Project.

7.4.2 Isaac River floodplain geomorphology

The geomorphic impact assessment indicated that the proposed Project infrastructure and the proposed final landform is likely to have negligible to minor impact on velocity, bed shear stress and stream power and hence is unlikely to have a material impact on the geomorphology of the Isaac River floodplain in the vicinity of the Project.

During operations and for extremely rare events (0.1% AEP) it is possible that some localised impacts the Isaac River floodplain geomorphology may occur in the sections downstream of IDM and in the downstream section of the proposed levee. However, it is considered unlikely that these changes would occur within the relatively short 15-year mine life. The proposed Isaac River levee will be decommissioned and rehabilitated prior to closure.

As part of the final landform preparation, floodplain surfaces will be stabilised and rehabilitated to achieve a self sustaining vegetation cover. This vegetation cover will increase erosion resistance and stability. The hydraulic characteristics of flow within the backfilled pit area is similar to (or lower than) under existing conditions, and is expected to remain a stable landform with revegetation of the floodplain surface..

7.4.3 Diversion geomorphology

The Functional Design Report for the Conrock Gully diversion is provided in Appendix D, and outlines the geomorphological assessment of the diversion. The assessment and findings are summarised in the following section.

The existing Conrock Gully main channel flows into the Isaac River from the west. To provide access to the underlying coal resource, the gully channel will be relocated to the northwest. The Isaac River levee will be constructed along the southern edge of the diversion to protect the mine workings from Isaac River flood events which results in Isaac River backwater entering the diversion (similarly the Isaac River backwaters enter the existing Conrock Gully channel).

A functional design has been prepared addressing the Guideline objectives and design criteria:

- **Outcome 1** - The design incorporates natural features present in the local watercourses, and it replicates the channel length, slope and cross-sectional shape. It incorporates meanders with radii, amplitude and magnitude similar to existing meanders in the adjacent reaches and the reach to be diverted. A revegetation plan will be established which will incorporate local vegetation to achieve bank stability.
- **Outcome 2** - As the diversion is located on the edge of the floodplain, and it incorporates the above features, it maintains the existing hydrologic characteristics of surface water systems.
- **Outcome 3** - The hydraulic characteristics of the design are comparable with those in the existing watercourse, and it is therefore suitable for the region in which the diversion is located.
- **Outcome 4** - As the hydraulic characteristics are largely unchanged, the sediment transport will allow the watercourse diversion to be self-sustaining and is unlikely to result in material or serious environmental harm on upstream and downstream reaches.
- **Outcome 5** - The watercourse diversion and associated structures maintain stability and functionality and are appropriate for all substrate conditions they encounter. This will be confirmed in later design phases.

Specifically, the following criteria have been considered when developing the proposed diversion design:

1 The diversion ties in with the existing watercourse within the Project's MLA boundaries. The proposed diversion alignment has been selected to minimise interference with mining infrastructure, whilst being within the MLA boundaries.

2 The stability and performance of the diversion will be assisted by vegetation within the watercourse diversion and adjoining floodplain and will not include artificial structures for grade control.

3 The proposed diversion channel has similar dimensions to the existing channel and thus has similar design capacity (see Table 7.2).

4 The existing channel includes a large meander which contributes significantly to the length of channel being diverted. A number of meanders are to be reintroduced at the upstream end of the diversion which results in a length of channel and bed slope similar to the existing channel. The meanders have similar amplitude, wavelength, sinuosity, and bend radius to bends found in the existing creek channel (see Table 7.2).

5 The main channel has a similar geometry to the existing channel, but with slightly steeper side slopes to reduce the extent of disturbance required. The hydraulic conditions within the existing Conrock Gully channel and proposed diversion channel have been compared for conditions before and after the proposed development, and to Guideline conditions (see Table 7.3).

Table 7.2 compares the average geomorphic characteristics of the existing and proposed channels. Overall, the diversion design reasonably matches the existing Conrock Gully geometry.

Table 7.2 – Changes to typical channel geomorphic characteristics

Parameter		Existing gully	Proposed diversion
Length (km)		5.8	5.2
Bed Grade (%) – floodplain reach		0.140	0.147
Bed Grade (%) – downstream reach		0.330	0.341
Bed Width (m)		4	4
Top Width (m)		26	28
Depth to floodplain (m)		7	5
Meander Radius (m)		240 (median)	240 (median)
Meander Sinuosity Index		1.2-1.7	1.1
Meander Wavelength (m)		250-1,200	140-350
Meander Amplitude (m)		150-330	75-170
50% AEP	Mean Velocity (m/s)	0.95	0.93
	Mean Bed Shear Stress (N/m^2)	30.1	23.66
	Mean Stream Power (N/m s)	42.7	29.3
	Hydraulic Gradient (%)	0.17	0.14
2% AEP	Mean Velocity (m/s)	1.28	1.33
	Mean Bed Shear Stress (N/m^2)	33.5	30.9
	Mean Stream Power (N/m s)	55.7	49.6
	Hydraulic Gradient (%)	0.16	0.15

Within the diversion, the design hydraulic conditions are similar, and generally improved, to those in the existing Conrock Gully channel, and are consistent with the ACARP design criteria guidelines (see Section 5.5.2) for channel-averaged shear stress, stream power and velocity. The results are summarised in more detail in Table 7.3.

Table 7.3 – Comparison of modelled Guideline hydraulic conditions before and after diversion construction

Shear stress	Stream power	Velocity
50% (1 in 2) AEP		
Upstream Decreased, due to ponding upstream.	Decreased, due to ponding upstream.	Decreased, due to ponding upstream.
Diversion Reach Generally similar to existing. Isolated locations above Guideline in both existing and proposed, although improved for proposed diversion.	Slight decrease in mid diversion. Isolated locations above Guideline in both existing and proposed although improved for proposed diversion.	Slight decrease in mid diversion. Isolated locations above Guideline in both existing and proposed although improved for proposed diversion.
Downstream Overall decrease and within range of existing values.	Overall decrease and within range of existing values.	Overall decrease and within range of existing values.
2% (1 in 50) AEP		
Upstream Decreased, due to ponding upstream.	Decreased, due to ponding upstream.	Decreased, due to ponding upstream.
Diversion Reach Generally similar to existing. Isolated locations above Guideline in both existing and proposed although improved for proposed diversion.	Slight decrease in mid diversion. Isolated locations above Guideline in both existing and proposed although improved for proposed diversion.	Generally similar to existing reach. Isolated locations above Guideline in both existing and proposed although improved for proposed diversion.
Downstream Overall decrease and within range of existing values.	Overall decrease and within range of existing values.	Overall decrease and within range of existing values.

Under close to bank-full conditions, there are small reductions in shear stress, stream power and velocity predicted for the diversion channel itself compared to the existing channel. In the downstream diversion reaches shear stress, stream power and velocity will increase, compared to the rest of the diversion, as flows enter Isaac River, but they will be similar to or lower than those occurring in the existing Conrock Gully.

Revegetation of the diversion will occur to achieve Guideline criteria. Rehabilitation of the diversion will be scheduled to align with operational requirements for the diversion and to achieve a long term stable landform.

7.5 Cumulative impact assessment

The flood assessment includes flood infrastructure from existing and proposed neighbouring mines, including IDM, Poitrel Mine and the Winchester South Project, where there is potential for cumulative hydrological impacts. The flood model assesses the Isaac River flood regime with the existing and proposed flood infrastructure (including levees and final landforms) with and without the proposed Project infrastructure in place. The flood model considers the impact of the existing and proposed infrastructure on the flooding in the vicinity on the Project and determines the potential flood impact to the neighbouring mines. The potential flood impacts to the neighbouring mines due to the Project, as determined through the flood modelling, is summarised as follows:

- **IDM:**
  - Isaac River flood water levels adjacent to IDM increase by up to 0.6 m to 0.9 m for the 1% AEP and 0.1% AEP event due to the Project. The IDM final landform would not be overtopped by the 0.1% AEP Isaac River flood, with the proposed Project infrastructure in place.
  - Isaac River flood velocities decrease adjacent to the western face of IDM final landform by 0.1 m/s to 0.2 m/s for the 1% AEP and 0.1% AEP event due to the Project.
  - Isaac River flood velocities increase immediately downstream of the southern face of IDM final landform by 0.1 m/s to 0.3 m/s for the 1% AEP and 0.1% AEP event due to the Project. However, velocities were low in this location during existing conditions (i.e. generally less than 1.5 m/s during the 0.1% AEP event), as the southern face of the IDM landform is located in a low-conveyance area of the Isaac River floodplain, and therefore the change in velocity would not alter the proposed final landform design.
- **Poitrel Mine:** no material water level or velocity impact to the Poitrel levee due to the proposed Project infrastructure.
- **Winchester South Project:** no material water level or velocity impact to the approved Winchester South Project levee due to the proposed Project infrastructure.

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Appendix A. Hydrological model configuration

A.1 Overview

A hydrological model was developed of the study area using the RORBwin (RORB) runoff-routing model (HARC, 2008). This section of the report describes the model development, configuration and calibration of the hydrological model.

The RORB model was calibrated to hydrographs recorded at the Deverill and Goonyella stream flow stations for the three flood events (2008, 2010 and 2017).

The calibrated RORB model was used to estimate 50%, 2% and 1% AEP peak design discharges at the Deverill gauging station based on design rainfall data (rainfall depths, areal reduction factors and temporal patterns) applied in accordance with ensemble event procedures in AR&R (Ball et al., 2019), These peak design discharges were validated against the peak discharges estimated using Flood Frequency Analysis (FFA) methodology.

The validated RORB model was then used to estimate design discharges at the Peak Downs Highway for input into the hydraulic model. Design flood discharge hydrographs were estimated for the 50%, 10%, 2%, 1% and 0.1% AEP design discharges as well as the probable maximum flood (PMF) discharge. Design flood discharge hydrographs for future climate conditions (i.e. climate change impacted conditions by year 2050) for the 0.1% AEP design discharges were also estimated.

The configuration of the Isaac River RORB model is detailed in the following sections.

A.2 Flood frequency analysis

Methodology

A Log Pearson III (LP3) distribution was fitted to an annual series of recorded peak flood discharges at the Deverill gauge using the Bayesian inference methodology recommended in the AR&R (Ball et al., 2019). FLIKE software (BMT, 2017) was used to generate the FFA, giving the option to censor lows flows to improve the LP3 fit for the larger events. For the purposed of the FFA, an October to September water year was adopted.

Annual maximums series

The 56 annual maximums for the October 1968 – September 1969 water year through to the October 2023 - September 2024 water year are shown in Table A.1. These values were determined using the revised Deverill gauge rating curve developed for the Deverill gauge (WRM, 2022).

Table A.1 – Annual maximum discharges at Isaac River at Deverill stream gauge

Year (Sep-Oct)	Peak flow (m^3/s)	Year (Sep-Oct)	Peak flow (m^3/s)	Year (Sep-Oct)	Peak flow (m^3/s)
1968/69	3	1987/88	3,701	2006/07	401
1969/70	511	1988/89	1,971	2007/08	1,975
1970/71	102	1989/90	235	2008/09	466
1971/72	188	1990/91	3,037	2009/10	501
1972/73	233	1991/92	110	2010/11	1,783
1973/74	1,261	1992/93	1	2011/12	1,121
1974/75	424	1993/94	753	2012/13	263
1975/76	533	1994/95	30	2013/14	1
1976/77	156	1995/96	236	2014/15	205

Year (Sep-Oct)	Peak flow (m^3/s)	Year (Sep-Oct)	Peak flow (m^3/s)	Year (Sep-Oct)	Peak flow (m^3/s)
1977/78	1,703	1996/97	1,198	2015/16	1,761
1978/79	2,113	1997/98	1,687	2016/17	1,625
1979/80	179	1998/99	581	2017/18	25
1980/81	608	1999/00	144	2018/19	30
1981/82	83	2000/01	638	2019/20	56
1982/83	1,124	2001/02	68	2020/21	610
1983/84	307	2002/03	195	2021/22	214
1984/85	137	2003/04	350	2022/23	353
1985/86	142	2004/05	20	2023/24	105
1986/87	184	2005/06	308		

Log Pearson III fitting

Figure A.1 shows the LP3 distribution fitted to the annual series of peak flows in the Isaac River at Deverill gauge within the 90% confidence interval of the LP3 distribution. To improve the fit of the LP3 curve at higher discharges the lowest 3 annual maximums (flows less than 10 m^3/s) were censored from the main dataset.

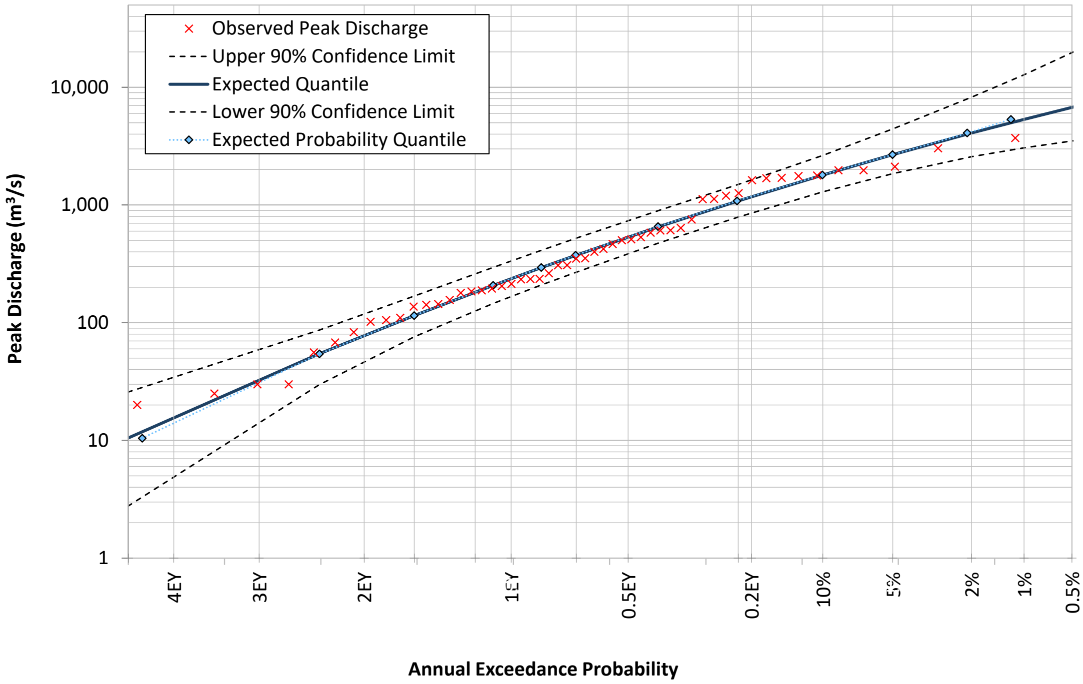


Figure A.1 – LP3 distribution fitted to Isaac River at Deverill annual series, 1968 to 2024

Summary of results

Table A.2 provides a summary of the FFA peak discharges from the annual series of historical flows. The following is of note:

- The estimated 1% AEP design discharge at Deverill is 5,337 m^3/s and the 90% confidence interval ranges from 3,058 m^3/s to 12,761 m^3/s.

- The estimated 2% AEP design discharge at Deverill is 4,086 m^3/s and the 90% confidence interval ranges from 2,570 m^3/s to 8,257 m^3/s.
- The estimated 10% AEP design discharge at Deverill is 1,802 m^3/s and the 90% confidence interval ranges from 1,294 m^3/s to 2,641 m^3/s.
- The estimated 50% AEP design discharge at Deverill is 375 m^3/s and the 90% confidence interval ranges from 268 m^3/s to 522 m^3/s.

Table A.2 – FFA design discharges at Deverill

Design storm event (AEP)	Peak discharge (m^3/s)	Lower confidence limit (m^3/s)	Upper confidence limit (m^3/s)
1%	5,337	3,058	12,761
2%	4,086	2,570	8,257
10%	1,802	1,294	2,641
50%	375	268	522

A.3 RORB model configuration

Spatial configuration

Figure A.2 shows the RORB model configuration used for determining catchment hydrology in the vicinity of the project area. The hydrologic model consists of 91 sub-catchments representing the total extents of the Isaac River catchment upstream of the Deverill stream gauge.

Sub-catchment parameters

The RORB model uses a single sub-catchment approach to determine runoff hydrographs, based on the overall sub-catchment parameters (fraction impervious and area). Sub-catchment fraction impervious and lag parameters were weighted based on the various land use types in each sub-catchment based on available topographic data and aerial photographs.

Model parameters for each sub-catchment were determined as follows:

- A percentage impervious of zero was adopted for all sub-catchments;
- A ‘kc’ factor of 72.24;
- A ‘m’ factor of 0.8; and
- The selection of initial and continuing losses for design events is described in Section A.5.

The catchment areas of the 91 sub-catchments are shown in Table A.3.

Table A.3 – Isaac River RORB subcatchment areas

Catchment ID	Area (km^2)	Catchment ID	Area (km^2)	Catchment ID	Area (km^2)	Catchment ID	Area (km^2)
CC1	49.4	CC22b	7.1	GC9	22.1	IR23	7.1
CC2	63	CC23	23.7	IR1	82.7	IR24	36.4
CC3	45.3	CG1	8.8	IR2	122.7	IR25	25.1
CC4	13.3	CG1a	4.2	IR3	24.3	IR26	10.7
CC5	43.2	CG1b	1.9	IR4	54.2	IR27	18.2
CC6	21.5	CG2	17.1	IR5	30.9	IR28	24

Catchment ID	Area (km^2)	Catchment ID	Area (km^2)	Catchment ID	Area (km^2)	Catchment ID	Area (km^2)
CC7	78.2	CG3	12.6	IR6	48	IR29	15.1
CC8	55.3	CG4	7.9	IR7	41.1	IR30	44.3
CC9	13.2	CG4a	2.5	IR8	102.9	IR31	21.2
CC10	14.1	CG4b	6.3	IR9	110.8	IR32	24.7
CC11	50.9	CG5	9.7	IR10	57.8	IR33	53.6
CC12	56.9	GC1	78.5	IR11	110.1	IR34	50
CC13	9.1	GC10	6.7	IR12	114.4	IR35	128.6
CC14	29	GC11	3	IR13	184	NC1	15.2
CC15	39.5	GC12	21.5	IR14	56.7	NC2	20.9
CC16	9.1	GC13	25.6	IR15	166.8	NC3	37.6
CC17	14.8	GC2	109.5	IR16	204.3	NC4	57.8
CC18	7.4	GC3	104.4	IR17	126.5	NC5	93.3
CC19	5.4	GC4	112.9	IR18	19.4	NC6	52.3
CC20	14	GC5	77.8	IR19	7.8	NC7	29.4
CC21	11.1	GC6	72	IR20	34.1	NC8	24.9
CC22	8.3	GC7	80	IR21	23	TEV	40.5
CC22a	15.5	GC8	37.5	IR22	17.3		

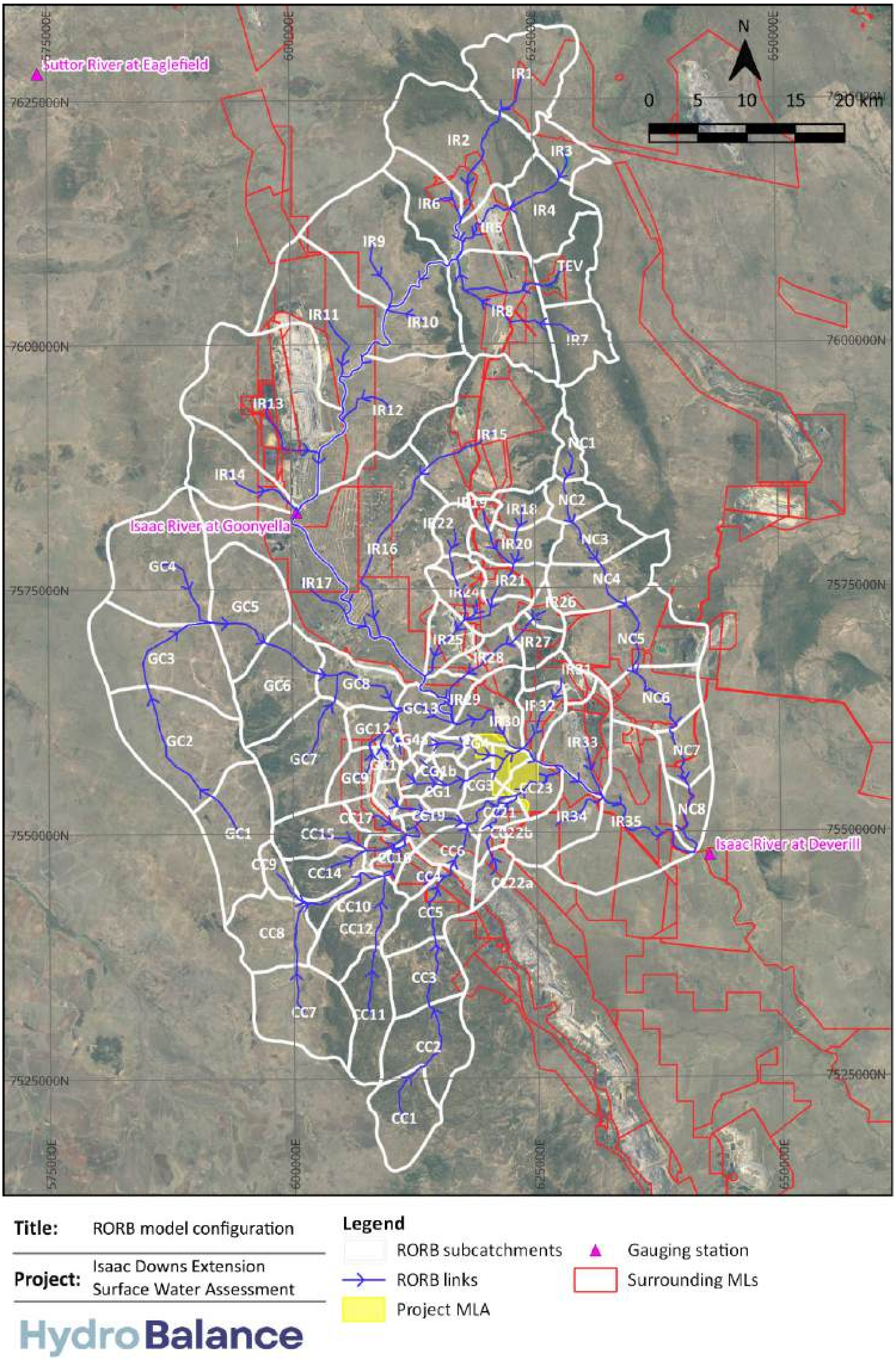


Figure A.2 – RORB hydrological model configuration

A.4 Hydrological model calibration

Methodology

The RORB model was calibrated to hydrographs recorded at the Deverill and Goonyella stream flow stations for the three flood events (2008, 2010 and 2017). The routing parameters and losses were adjusted to match the timing and magnitude of peak discharge in the recorded hydrograph. Note, the priority was to create the best fit at Deverill.

Each sub-catchment of the model was assigned the rainfall from the nearest rainfall station. A constant loss model (initial loss/continuing loss) was adopted uniformly for all sub-catchments.

Available data

The available data for the three calibration events is summarised in Table A.2. The model was calibrated using sub-daily rainfall data as well as streamflow data recorded at the Deverill and Goonyella stream flow stations on the Isaac River. Table A.3 shows recorded rainfall and peak discharges for each of the calibration events.

Table A.4 – Available rainfall and streamflow data

Station ID	Station name	Data type	Data frequency	Source	Calibration event		
					Feb-08	Dec-10	Mar-17
130410A	Isaac River at Deverill	Rainfall	Sub-daily	DNRMMRRD	✓	✓	✓
		Discharge	Sub-daily		✓	✓	✓
130414A	Isaac River at Goonyella	Discharge	Sub-daily	DNRMMRRD	✓	✓	✓
534026	Isaac River Bridge	Rainfall	Sub-daily	BOM	✓	✓	-
34038	Moranbah WTP	Rainfall	Sub-daily	BOM	✓	✓	-
34035	Moranbah Airport	Rainfall	Sub-daily	BOM	-	-	✓

DNRMMRRD – Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development
BOM – Bureau of Meteorology

Table A.5 – Adopted calibration events, Isaac River catchment

Calibration event	Start date	Event duration (days)	Recorded peak discharge (m^3/s)	
			Goonyella	Deverill
February 2008	09/02/2008	9	1,070	2,142
December 2010	18/01/2010	15	91	1,827
March 2017	27/03/2017	7	199	1,614

Calibration results

The calibration of the RORB model was achieved by adjusting the catchment and routing parameters and adjusting initial and continuing rainfall losses to obtain the best fit between recorded and predicted discharge hydrographs. The adopted initial and continuing losses for the three events are shown in Table A.6.

Table A.7 compares recorded and predicted peak discharges at the Goonyella and Deverill gauging stations.

Table A.6 – Adopted initial and continuing loss rates, calibration events

Calibration event	Initial loss (mm)	Continuing loss (mm)
February 2008	20	3.7
December 2010	20	3.7
March 2017	45	3.0

Table A.7 – Comparison of recorded and modelled peak flood discharges, Isaac River at Goonyella and Deverill gauging stations

Calibration event	Peak discharge at Goonyella (m^3/s)		Difference (%)	Peak discharge at Deverill (m^3/s)		Difference (%)
	Recorded	Modelled		Recorded	Modelled	
February 2008	1,070	1,233	15.2	2,142	1,803	-15.8
December 2010	910	712	-21.8	1,827	1,952	6.9
March 2017	199	119	-40.2	1,625	1,673	3.0

February 2008 calibration

Figure A.3 and Figure A.4 show comparisons of recorded and predicted discharge hydrographs at the Goonyella and Deverill gauging stations for the February 2008 event. The model reproduced the timing and shapes of the hydrographs relatively well. However, the model overestimates the peak discharge at Goonyella and underestimates the peak discharge at Deverill. This is likely due to spatial variation in rainfall that was not covered by the recorded rainfall data.

December 2010 calibration

Figure A.5 and Figure A.6 show comparisons of recorded and predicted discharge hydrographs at the Goonyella and Deverill gauging stations for the December 2010 event. A good calibration was achieved for both gauges, with the XP-RAFTS model satisfactorily reproducing the flood peaks, timing and shapes of the hydrographs.

March 2017 calibration

Figure A.7 and Figure A.8 show comparisons of recorded and predicted discharge hydrographs at the Goonyella and Deverill gauging stations for the March 2017 event. A good calibration was achieved at the Deverill station, with the XP-RAFTS model satisfactorily reproducing the flood peaks, and the timing and shapes of the hydrographs. However, the model moderately overestimates the peak flows at Goonyella.

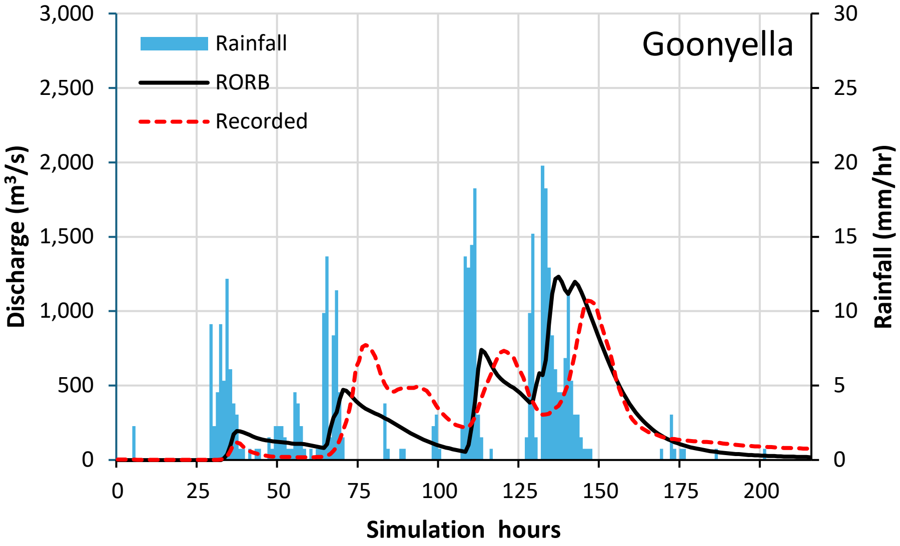


Figure A.3 – Comparison of recorded and modelled discharge hydrographs, February 2008, Isaac River at Goonyella

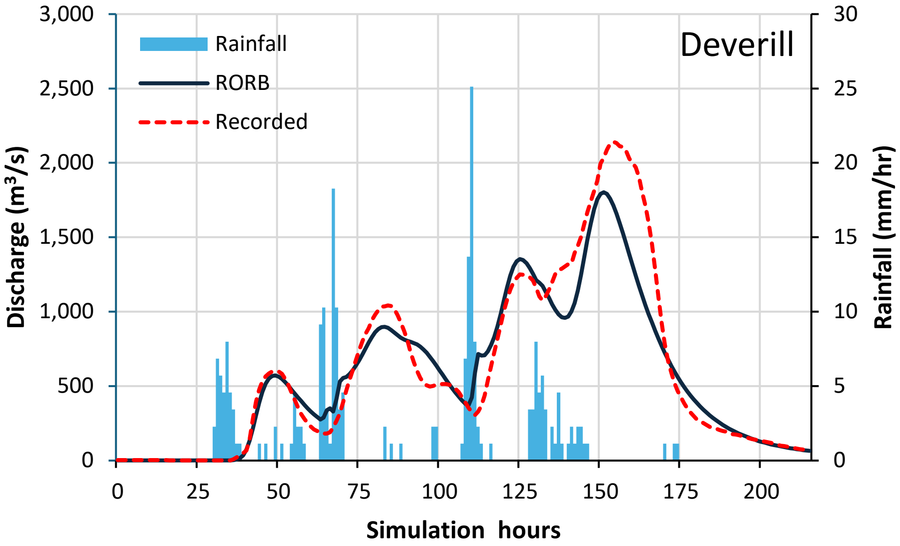


Figure A.4 – Comparison of recorded and modelled discharge hydrographs, February 2008, Isaac River at Deverill

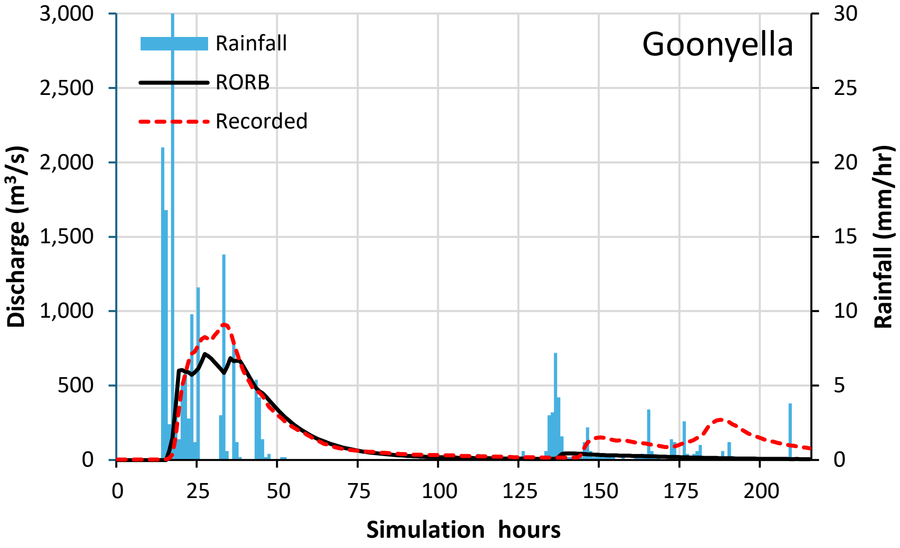


Figure A.5 – Comparison of recorded and modelled discharge hydrographs, December 2010, Isaac River at Goonyella

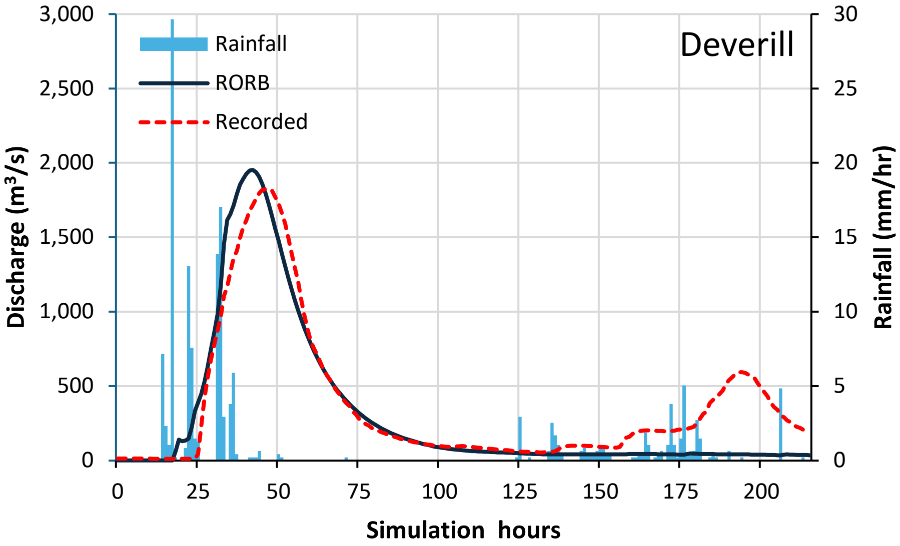


Figure A.6 – Comparison of recorded and modelled discharge hydrographs, December 2010, Isaac River at Deverill

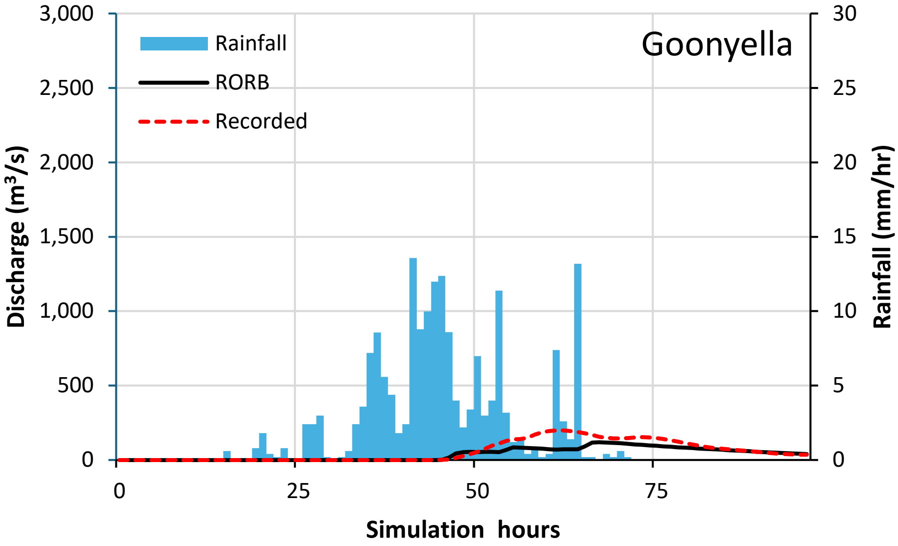


Figure A.7 – Comparison of recorded and modelled discharge hydrographs, March 2017, Isaac River at Goonyella

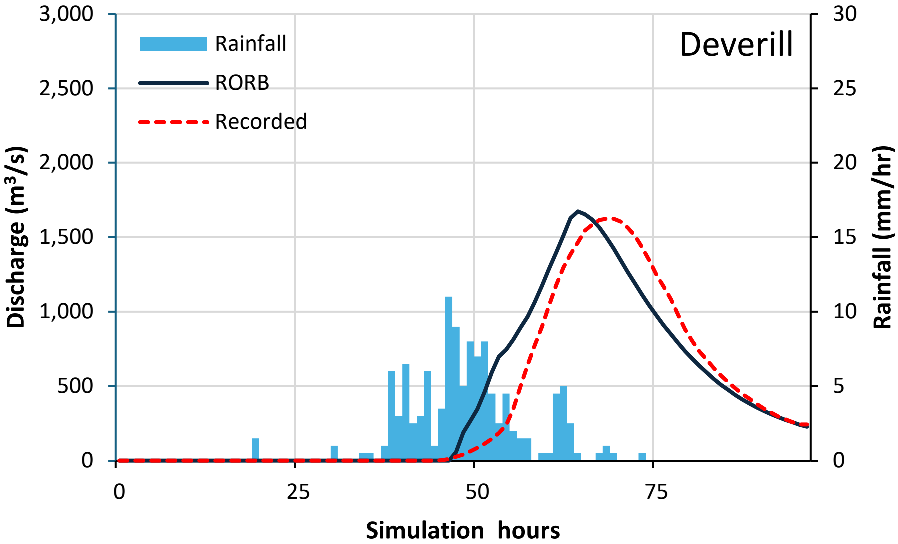


Figure A.8 – Comparison of recorded and modelled discharge hydrographs, March 2017, Isaac River at Deverill

A.5 Design hydrology

Overview

The flowing sections describe the derivation of the design rainfall and discharge estimates for the 50%, 10%, 2%, 1% and 0.1% AEP events, as well as the probable maximum precipitation (PMP) design event, for a range of storm durations.

Design rainfall

Design rainfall depths and intensities for design event up to 0.1% AEP were derived using intensity-frequency duration (IFD) data obtained from the BOM's 2016 Rainfall IFD Data System.

The rainfall depths for the Probable Maximum Precipitation (PMP) design events for durations of 24 hours and longer were estimated using the standard methodology given in the Guidebook to the Estimation of Probable Maximum Precipitation: Generalised Tropical Storm Method (GTSMR) (BOM, 2005) based on the Isaac River catchment to the Deverill gauging station. As the Isaac River catchment to Deverill is larger than 1,000 km^2, PMP rainfalls could only be derived for storm durations of 24 hours or longer.

Table A.8 – Adopted design rainfall depths for Isaac River catchment

Storm duration (hours)	Rainfall depth (mm)					
	50% AEP	10% AEP	2% AEP	1% AEP	0.1% AEP	PMP
18	74.3	127	182	209	333	890
24	79.8	138	200	231	369	1,030
30	84.7	147	216	250	396	1,170
36	89	155	229	267	422	1,410
48	96.4	170	253	295	465	1,610
72	108	192	288	336	528	1,700
96	116	208	312	364	566	NA
120	122	220	329	382	587	NA
144	126	229	340	394	598	NA
168	129	236	348	400	600	NA

NA – not available

Spatial and areal variability

A comparison of the Isaac River IFDs at the southern, eastern and western catchment boundaries, and at the centroid, revealed on average less than 5% variance in rainfall for 1% AEP event across all durations. The IFDs at the northern catchment boundary were on average within 15% of the IFDs at the centroid of the catchment.

Due to the small variation in design rainfall estimates over majority of the catchment, a uniform spatial rainfall distribution was adopted across the catchment. A uniform spatial distribution was also adopted for the PMP rainfall estimates to maintain consistency.

Areal reduction factors (ARFs) appropriate to the Isaac River catchment to Deverill (Semi-Arid Inland Queensland ARF region) was applied for design events up to 0.1% AEP rainfalls per the recommendation in AR&R (Ball et al., 2019).

No ARF was adopted for PMP rainfalls due to catchment area already being incorporated into the PMP rainfall estimation.

Temporal patterns

The East Coast North temporal patterns from AR&R Data Hub (Geoscience Australia, 2019) were used for design events up to 1% AEP event. For the 0.1% AEP and PMP events, ARR recommends using the GTSMR (BOM, 2005) temporal patterns for storm durations of 24 hours and longer.

Design rainfall losses

The initial (IL) and continuing loss (CL) method of accounting for rainfall losses was adopted for this assessment.

The recommended regional loss values for the Isaac River catchment to Deverill from the AR&R Data Hub (Geoscience Australia, 2019) were an initial loss of 45.0 mm (prior to adjustment for preburst rainfall) and a continuing loss of 2.2 mm/h.

The adopted design rainfall losses were selected to achieve the best match between the RORB design discharges with the design discharges estimated by the FFA at the Deverill gauging station (see Section A.2). The following is of note:

- The initial loss was set to 30 mm for the 50% AEP event and scaled down to 15 mm for the 1% AEP to match the FFA.
- The continuing losses adopted for the calibration of the RORB model (3.0 to 3.7 mm/h) were higher than the recommended 2.2 mm/h. A continuing loss of 2.5 mm/hr was adopted for the design events up to 1% AEP in order to reconcile the RORB model design discharges with the losses used in the calibration and validated with the FFA results.
- For the 0.1% AEP design event, a conservative 0 mm initial loss was adopted.
- For the PMF design event, an initial loss of 0 mm was adopted as per the recommendations from AR&R for arid and semi-arid regions (Ball et al., 2019). The continuing loss for PMP design rainfalls was set to 0 mm/h.

Table A.9 summarises the initial and continuing rainfall losses adopted in the RORB model.

Table A.9 – Adopted Initial and continuing losses

Source/scenario	Initial loss (mm)	Continuing loss (mm/hr)
AR&R Data hub	45	2.2
50% AEP	30	2.5
10% AEP	30	2.5
2% AEP	30	2.5
1% AEP	15	2.5
0.1% AEP	0	2.5
PMP	0	0

Storages

The three waterbodies upstream of the Project (Lake Elphinstone, Teviot Dam and Burton Gorge Dam) were represented as a reservoir in the RORB model. For the estimation of design discharges, it was assumed that these storages are at full supply level at the start of each simulation.

Current climate change factors

Traditionally, design flood estimation has assumed that historical observations are representative of current and future conditions. This is no longer the case. Records on historical flooding or flood drivers (such as extreme rainfall or sea level) can no longer be assumed to provide a direct analogue of current or future flood risk. To account for significant observed and projected changes to the drivers of flooding, it is necessary to account for the non-stationarity of flooding in the assessment of current and future flood risks.

ARR 2019 advises methodology to adjust the following climate-related factors to reflect the changing climate for all current climate design flood events:

- A design storm of a given AEP and duration, usually derived from published IFD data.
- Temporal patterns to distribute the design rainfall over the duration of the event.
- Spatial patterns to represent rainfall variation over a catchment.
- Loss parameters that represent soil moisture conditions in the catchment antecedent to the event and the capacity of the soil to absorb rainfall during the event.

The above climate considerations will be applied to all design flood events.

Rainfall

The latest Intergovernmental Panel on Climate Change (IPCC) developed temperature projections based on Shared Socioeconomic Pathways (SSPs) to cover a broad range of potential future development options often referred to as very low (SSP1-1.9), low (SSP1-2.6), medium (SSP2-4.5), high (SSP3-7.0) and very high (SSP5-8.5) emissions pathways. As global temperatures have risen since this period, design rainfall estimates require factoring to account for this temperature increase.

The design rainfalls have been adjusted based on the “Current and near-term (2021-2040)” timeframe for the SSP3-7.0 climate scenario. The SSP3-7.0 climate scenario is the high potential development pathway, and is expected to give a conservatively high estimate of the climate change impacts. The mean SSP3-7.0 factors for a range of event durations are shown in Table A.10 and will be applied to each of the design rainfall depths. Table A.11 shows the resultant rainfall depths.

Table A.10 – Design rainfall climate change factors

Design event duration (hr)	Mean (average) rainfall climate change factor (SSP3-7.0)
1	1.18
1.5	1.17
2	1.16
3	1.14
4.5	1.13
6	1.12
9	1.12
12	1.11
≥24	1.10

Table A.11 – Adopted design rainfall depths for Isaac River catchment, factored for current climate change

Storm duration (hours)	Rainfall depth (mm)				
	50% AEP	10% AEP	2% AEP	1% AEP	0.1% AEP
18	81.9	140	200	230	367
24	87.5	151	219	253	405
30	92.9	161	237	274	434
36	97.6	170	251	293	463
48	106	186	277	324	510
72	118	211	316	369	579
96	127	228	342	399	621
120	134	241	361	419	644
144	138	251	373	432	656
168	141	259	382	439	658

Temporal patterns

Temporal patterns may become slightly more front-loaded with a greater proportion of the storm volume falling towards the start of the storm. While the shift towards more front-loaded storms based on the analysis of historical data is statistically significant, the magnitude of these changes is small and the impact of temporal pattern changes on design flood estimates may be of little practical significance, particularly for those systems where flood levels are largely dependent on flood volume.

Currently there is no published methodology for quantifying the effect of changing temporal patterns on design flood estimates, nor published literature on the implications on their impacts on design flood estimates.

Spatial patterns

Although there is some evidence that climate change will influence spatial patterns of extreme rainfall, there are considerable uncertainties around such changes for localised regions. As such, there is insufficient justification for amending spatial patterns or areal reduction factors.

Losses

The rates of change for initial loss (IL) and continuing loss (CL) are due to climate change are generally positive (losses will generally increase with higher temperatures), which reduces the impact of increased rainfall intensities, particularly for frequent floods or for systems whose performance is dependent on the volume of a flood as well as its peak.

ARR recommends adjusting the IL and CL using a rate (%/°C) based on the spatial location and predicted temperature changes for the selected climate future.

Based on the recommended mean rates for the East Coast North, and East Coast South" Natural Resource Management Cluster and the SSP3-7.0 climate future, the following adjustment factors have been adopted:

- Initial loss: +2%.
- Continuing loss: +5%

Design discharges

Design discharges were determined using an 'ensemble' of 10 temporal patterns, which produces 10 design hydrographs (and peak discharges) for each duration for each AEP. The temporal pattern which results in a peak discharge closest to, but higher than, the ensemble mean is selected as the representative temporal pattern for that storm duration. For the PMP storm, the storm producing the maximum peak discharge was selected. The peak design discharges in Isaac River at the Deverill gauge are summarised in Table A.12. For each AEP event a single representative critical duration and temporal pattern was selected.

Flows for a range of durations in Isaac River at Deverill for each AEP are presented as boxplots in Figure A.9 to Figure A.14.

Table A.12 – RORB design discharges, Isaac River at Deverill

Design storm event (AEP)	RORB peak discharge (m^3/s)	Critical storm duration (hours)	Temporal pattern
PMP	53,666	36	4
0.1%	11,216	24	4
1%	5,595	24	6
2%	4,295	24	6
10%	1,794	18	5

Design storm event (AEP)	RORB peak discharge (m^3/s)	Critical storm duration (hours)	Temporal pattern
50%	377	18	6

Comparison to FFA design discharges

Table A.13 shows the estimated RORB model design discharges at the Deverill gauging station and compares to the adjusted FFA discharge estimates. The following is of note:

- The 50% AEP peak discharge is 1% higher than the FFA, but within the 90th percentile confidence limits;
- The 10% AEP peak discharge is 0.4% lower than the FFA, but within the 90th percentile confidence limits; and
- The 1% AEP and 2% AEP peak discharge are 5% higher than the FFA, but within the 90th percentile confidence limits.

The RORB model design peak discharges are between -0.4% to 5% higher than the FFA peak discharges. However, the RORB design peak discharges are within the 90th percentile confidence limits for all events. The RORB model design discharge estimates are considered reasonable and will be adopted for this study.

Table A.13 – Comparison of FFA and RORB design discharges, Isaac River at Deverill

Design storm event (AEP)	RORB peak discharge (m^3/s)	FFA Peak discharge (m^3/s)	Difference
1%	5,595	5,337	+5%
2%	4,295	4,086	+5%
10%	1,794	1,802	-0.4%
50%	377	375	+1%

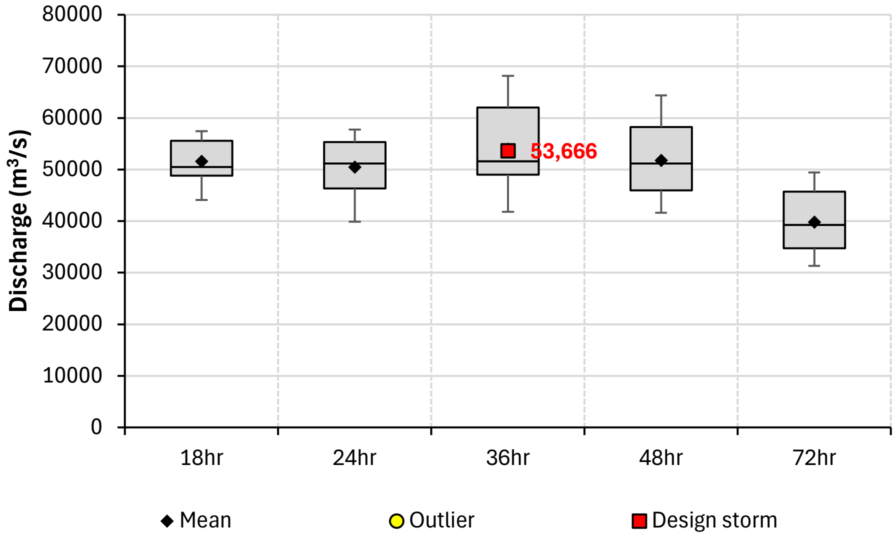


Figure A.9 – PMF in Isaac River at Deverill

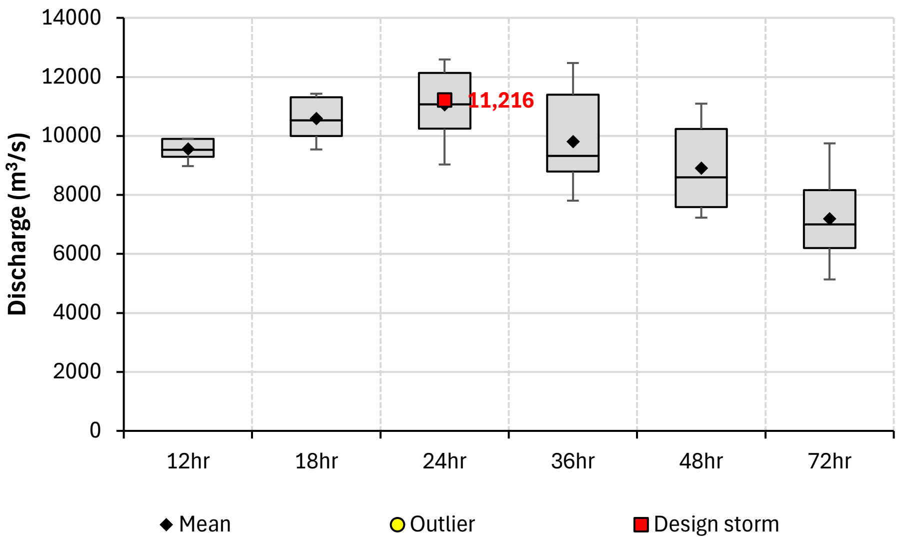


Figure A.10 – 0.1% AEP in Isaac River at Deverill

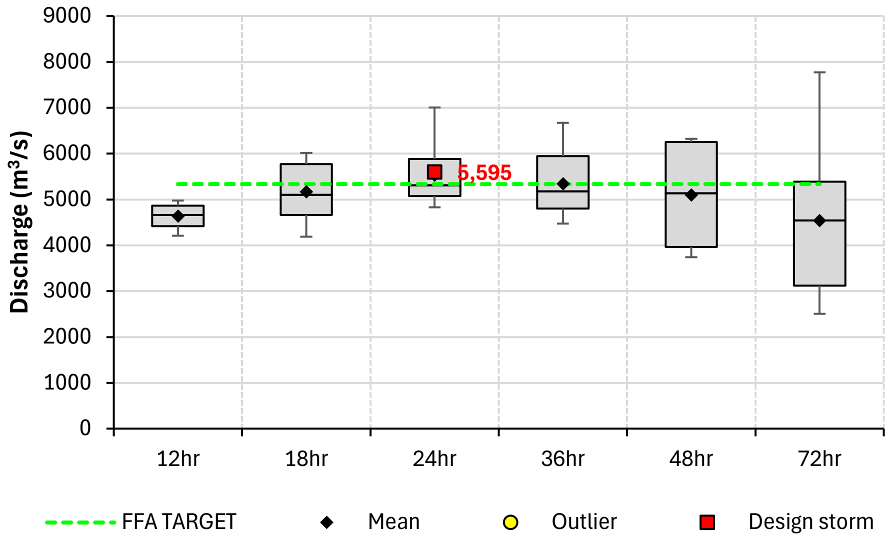


Figure A.11 – 1% AEP in Isaac River at Deverill

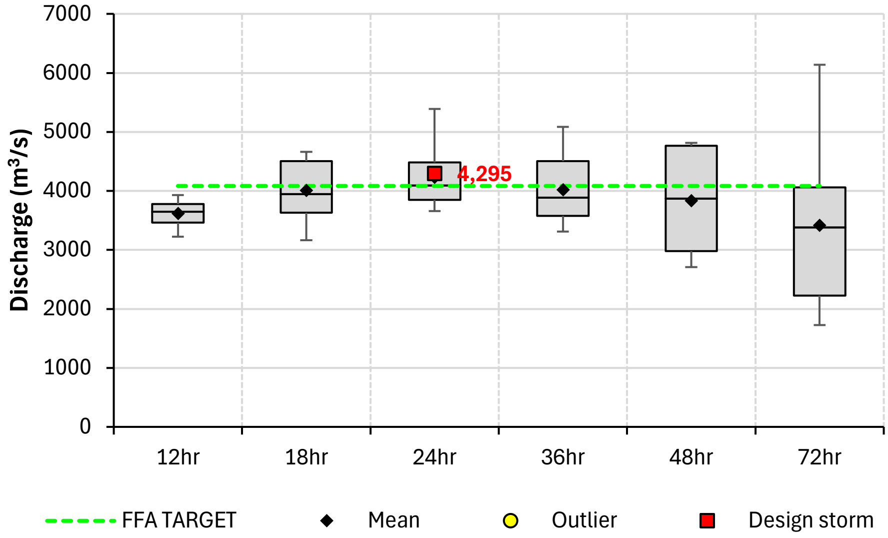


Figure A.12 – 2% AEP in Isaac River at Deverill

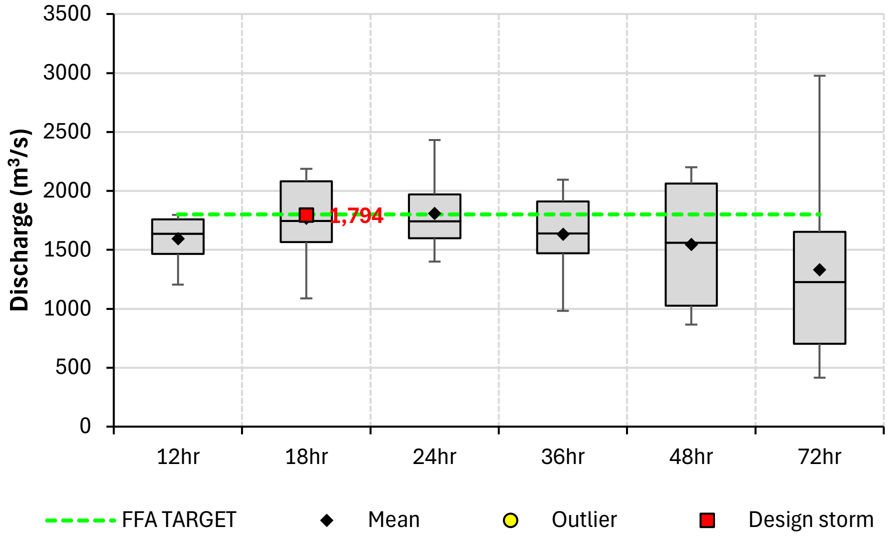


Figure A.13 – 10% AEP in Isaac River at Deverill

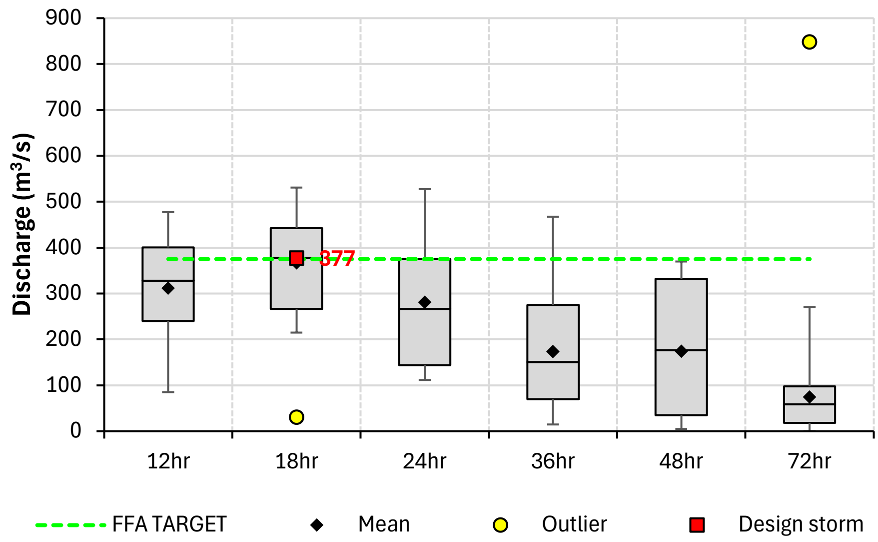


Figure A.14 – 50% AEP in Isaac River at Deverill

Future climate scenarios

Design rainfall depths for the 0.1% AEP design event were also assessed under future climate conditions by year 2050 and year 2100 (i.e. year 2050 climate change conditions and year 2100 climate change conditions) by estimated by multiplying current 0.1% AEP IFD values by a climate change factor. The year 2050 was selected as the representative year for the developed conditions scenario, being the period shortly after the end of mining operations and year 2100 is the furthest time horizon for which AR&R 2019 climate change factors are available.

AR&R Data Hub (Geoscience Australia, 2019) provide guidance on the climate change factors. Table A.14 shows the climate change factors for the East Coast North region to year 2100.

Table A.14 – Climate change factors for Isaac River catchment

Year	SSP3-7.0‡	SSP5-8.5‡
2030	1.1	1.11
2040	1.12	1.14
2050	1.15	1.18
2060	1.18	1.21
2070	1.21	1.26
2080	1.25	1.31
2090	1.29	1.37
2100	1.32	1.41

‡ for design rainfall durations of 24 hours or greater

For this assessment, the Shared Socioeconomic Pathway 3-7.0 (SSP3-7.0) emissions scenario has been adopted for year 2050 and year 2100. Table A.15 shows the adopted year 2050 and 2100 climate change IFD values for the 0.1% AEP design event for the Isaac River catchment to Peak Downs Highway. The future climate flood behaviour is assessed in Section 5.5 of the report.

Table A.15 – Adopted year 2050 and 2100 climate change IFD depths (mm) for Isaac River catchment to Peak Downs Highway

Storm duration(hours)	0.1% AEP design rainfall (mm)		
	Current‡	Year 2050	Year 2100
18	333	383	440
24	369	424	487
30	396	455	523
36	422	485	557
48	465	535	614
72	528	607	697
96	566	651	747
120	587	675	775
144	598	688	789
168	600	690	792

‡ No factor for climate change applied, i.e. excludes current climate change factor

Appendix B. Hydraulic modelling

B.1 Overview

Due to the flat topography of the Isaac River floodplain and the interaction of overbank flows between the various watercourses in the area of interest, a two-dimensional hydraulic model was used to ensure that the movement of water across the floodplain was adequately simulated. The TUFLOW hydrodynamic model (BMT, 2018a) was used to simulate the flow behaviour of Isaac River, Cherwell Creek, JB Gully and Conrock Gully in the vicinity of the Project.

This section of the report describes the model development, configuration and calibration.

TUFLOW represents hydraulic conditions on a fixed grid by solving the full two-dimensional depth averaged momentum and continuity equations for free surface flow (BMT, 2023). The model automatically calculates breakout points and flow directions within the study area.

The Isaac River TUFLOW model was previously calibrated against the recorded flow rate at the Deverill gauging station for the 2017 event as well as the DRNME's rating curve. The calibrated Isaac River TUFLOW Model was used to estimate design peak flood levels, depths, extents and velocities for various events from 10% AEP to the Probable Maximum Flood (PMF). The Isaac River TUFLOW model has since been truncated to end downstream of Poitrel and adjacent to Winchester South, to reduce computational timeframes.

B.2 Model extent and resolution

Figure B.1 shows the extent and configuration of the Isaac River TUFLOW model. The model was extended sufficiently downstream to negate potential downstream boundary effects. The model was configured using HPC-GPU with grid cell size of 10 metres.

The Isaac River TUFLOW Model covers an area of approximately 183 km^2. It extends north-west approximately 11 km upstream of the Project to include Cherwell Creek, JB Gully and Conrock Gully. The model outflow boundary is located 10 km south-southeast downstream of the MLA boundary.

B.3 Topographic data

Existing conditions

The TUFLOW model uses Light Detecting and Ranging (LiDAR) topographic data provided by Stanmore, covering the model extent. Flood levees for the following existing and proposed mines have been included in the existing conditions model (see Section 3 for further detail):

- Isaac Downs Mine final landform Isaac River flood levee;
- Poitrel Mine Isaac River flood levee; and
- Proposed Winchester South Mine flood levees.

Developed and final landform conditions

The following surfaces provided by Stanmore were stitched into to the existing conditions model topography to represent the developed conditions:

- Final landform mine plan surface;
- Isaac River levee;
- Cherwell Creek levee plug; and
- Mine access roads.

Ther Conrock Gully diversion and levee plug were also incorporated into the developed model surface. The development of the Conrock Gully diversion design is documented in Appendix D.

B.4 Inflow boundary

Figure B.1 shows the names and locations of 10 inflow boundaries in the Isaac River TUFLOW Model, including the Isaac River, Cherwell Creek, JB Gully and Conrock Gully. The model inflow boundaries were configured using 2D surface area (SA) polygons. Using this approach, flow is initially applied at the lowest spot within each 2D SA polygon. The model was run for the Isaac River critical durations only.

B.5 Outflow boundary

The outflow boundary of the hydraulic model is located on the Isaac River, downstream of the Project. A normal depth outflow boundary with a slope of 0.3% was adopted to represent the flood slope. To minimise the impact of tailwater conditions on flooding characteristics at the Project, the model outflow boundary was located about 10 km downstream of MLA boundaries.

B.6 Hydraulic structures

Existing structures

Figure B.1 shows the locations of existing bridge crossings (Peak Downs Highway bridge and Goonyella Railway crossing) within the TUFLOW model extent. The bridges were represented in the TUFLOW model using the 2D 'Layered Flow Constriction' approach. This allows flow area and losses to be varied both along the structure length and with water level, by representing the bridges in three layers:

- Layer 1 – natural ground level to bridge deck obvert;
- Layer 2 – bridge deck; and
- Layer 3 – handrails, guard rails or any other superstructure rising above the bridge.

The details of the two existing bridge crossings are provided in Table B.1.

Table B.1 – Existing bridge crossing details

Bridge crossing	Bridge obvert (mAHD)	Width (m)	Deck thickness (m)	Railing height (m)	Layer 1 blockage	Layer 2 blockage	Layer 3 blockage
Peak Downs Highway	206.5	10	0.75	0.5	10%	100%	25%
Goonyella Railway crossing	192.4	10	0.6	0	10%	100%	0%

Proposed structures

The following proposed hydraulic structures have been included in the developed conditions model:

- Isaac River bridge;
- Cherwell Creek bridge;
- JB Gully bed-level crossing; and
- Temporary dragline crossing.

The locations of these structures are presented in Figure B.1. The two proposed bridges are modelled using a similar approach to the existing crossings. The details of the proposed bridges are provided in Table B.2.

The JB Gully bed-level crossing and the temporary dragline crossing were modelled using design surfaces. The JB Gully bed-level crossing was assumed to raise the existing channel bed level by up to 300 mm per the DPI (2025) guidelines. The temporary dragline crossing (during operations) design surface was provided by Stanmore, which included Isaac River bank cuts and a bed level crossing. The bed level crossing will be removed and stabilised following the dragline walk, however, to give a conservative estimate of the Isaac River water level impacts, the bed level crossing has been included in the developed conditions flood model. It has been assumed that the temporary dragline crossing would be removed post-closure, and the Isaac River banks would be battered back to a 1V:3H slope.

Table B.2 – Proposed bridge crossing details

Bridge crossing	Bridge obvert (mAHD)	Width (m)	Deck thickness (m)	Railing height (m)	Layer 1 blockage	Layer 2 blockage	Layer 3 blockage
Isaac River bridge	201.0	15	3.425	2	7%	78%	100%
Cherwell Creek bridge	204.9	15	3.725	2	6%	76%	100%

Further details regarding the proposed structures are presented in Section 4.

B.7 Adopted Manning's 'n' values

The TUFLOW model uses Manning's 'n' values to represent hydraulic resistance of different material types. Figure B.1 shows the adopted land use mapping. The default land use outside of the coloured area is grazing land. The Manning's 'n' values were calibrated to the Deverill stream gauge rating curve. The adopted Manning's 'n' values are given in Table B.3.

Table B.3 – Adopted Manning's 'n' values

Land use	Manning's 'n'
Channel bed (sand)	0.030
Cleared land, grass areas (grazing)	0.040
Medium density vegetation	0.060
High density vegetation	0.100

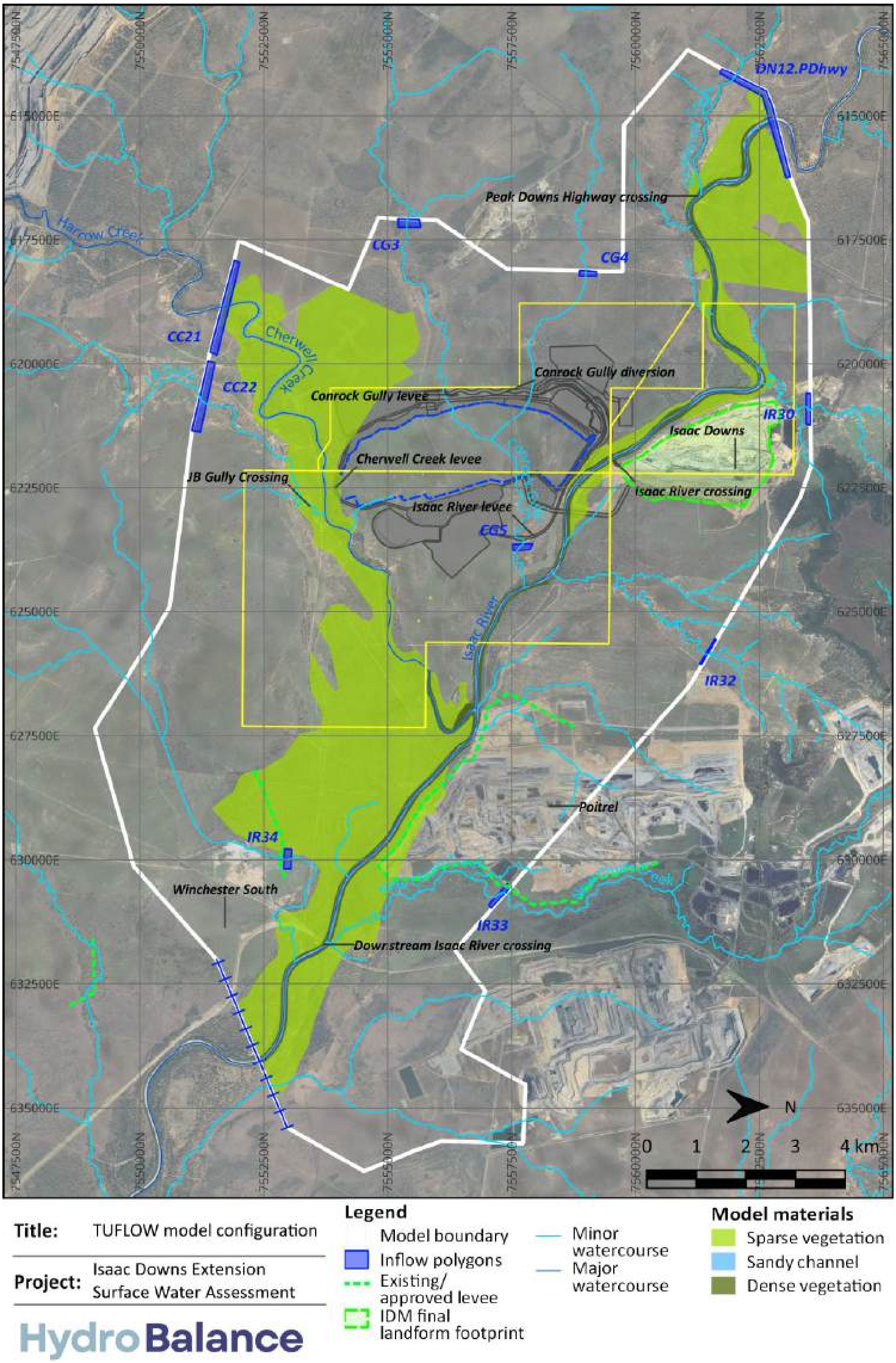


Figure B.1 – Isaac River TUFLOW model configuration

Appendix C. Flood maps

C.1 Depth and velocity mapping

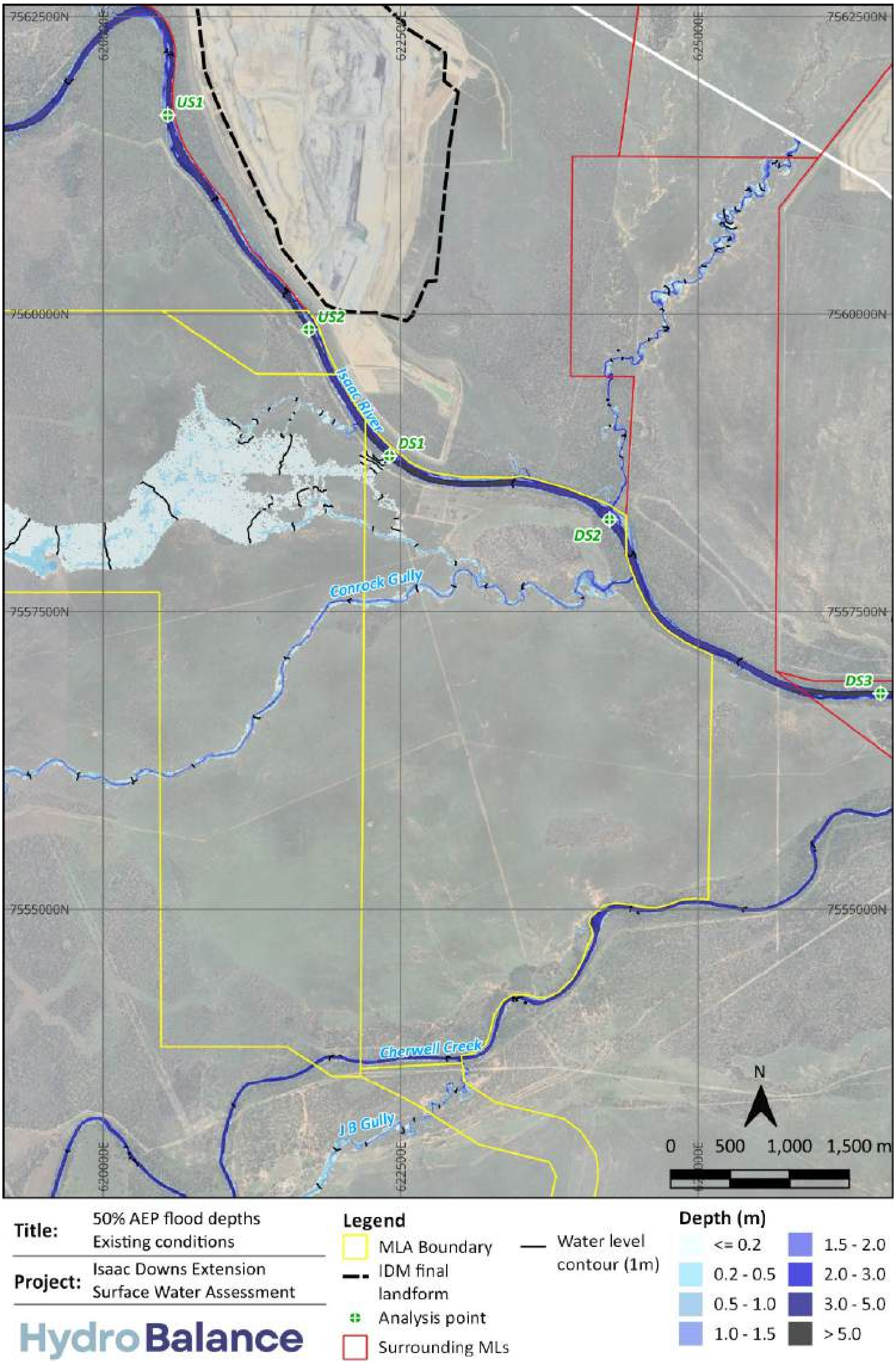
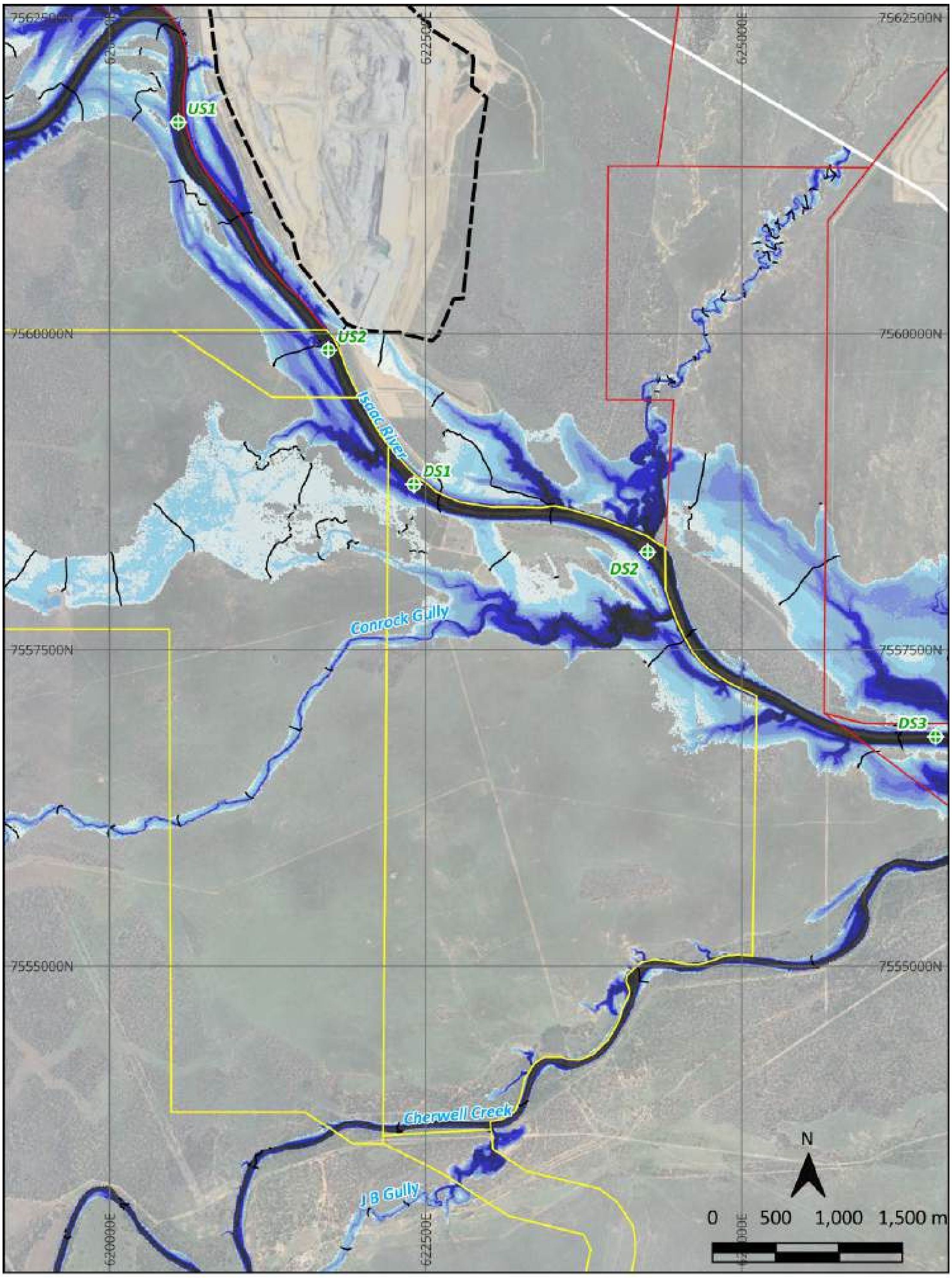


Figure C.1 – Existing conditions 50% AEP flood depths and heights



Title:	10% AEP flood depths Existing conditions
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

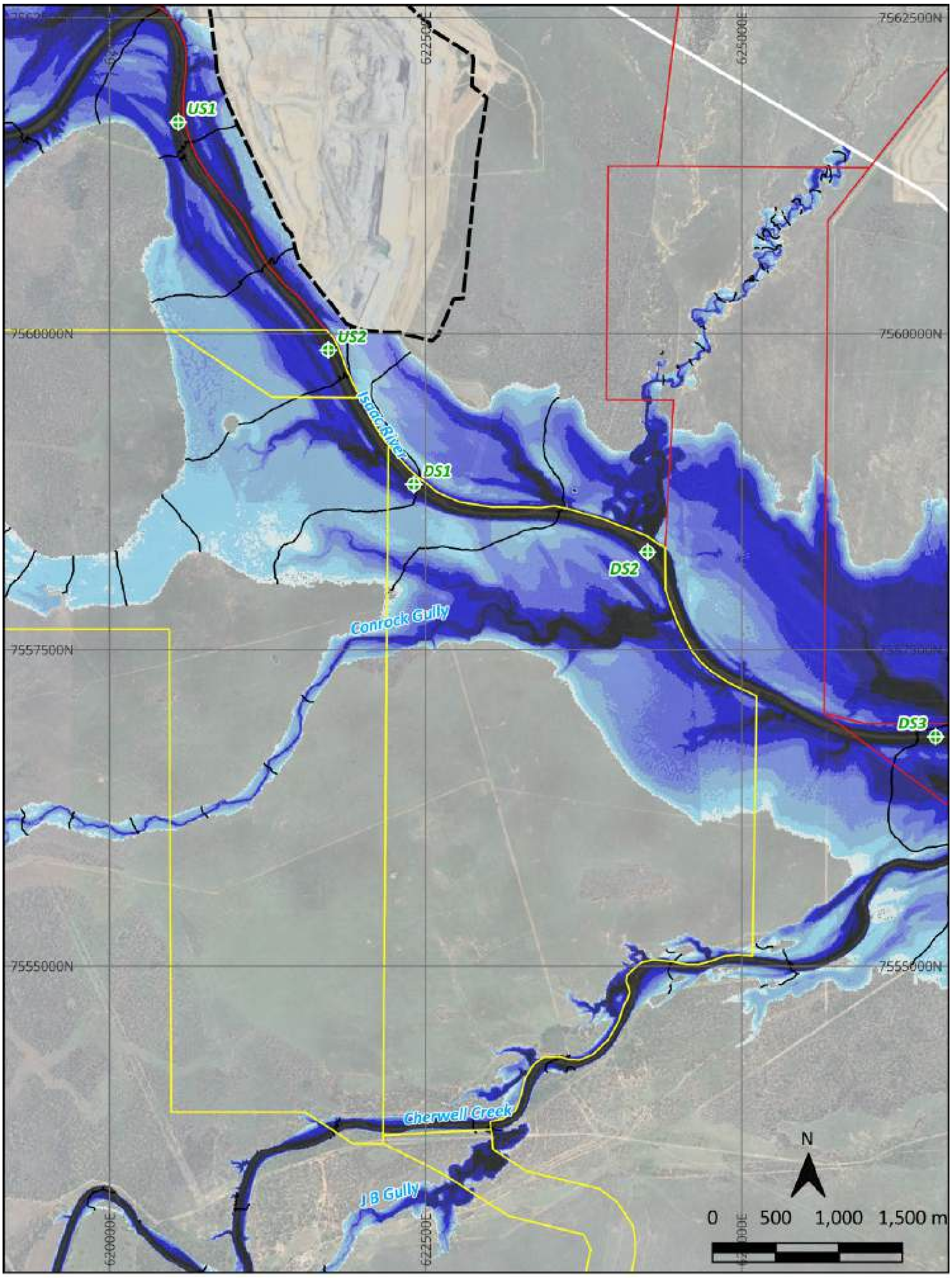
Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Water level contour (1m)

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- > 5.0

Figure C.2 – Existing conditions 10% AEP flood depths and heights



Title:	2% AEP flood depths Existing conditions
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend
- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Water level contour (1m)

Depth (m)
- <= 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- > 5.0

Figure C.3 – Existing conditions 2% AEP flood depths and heights

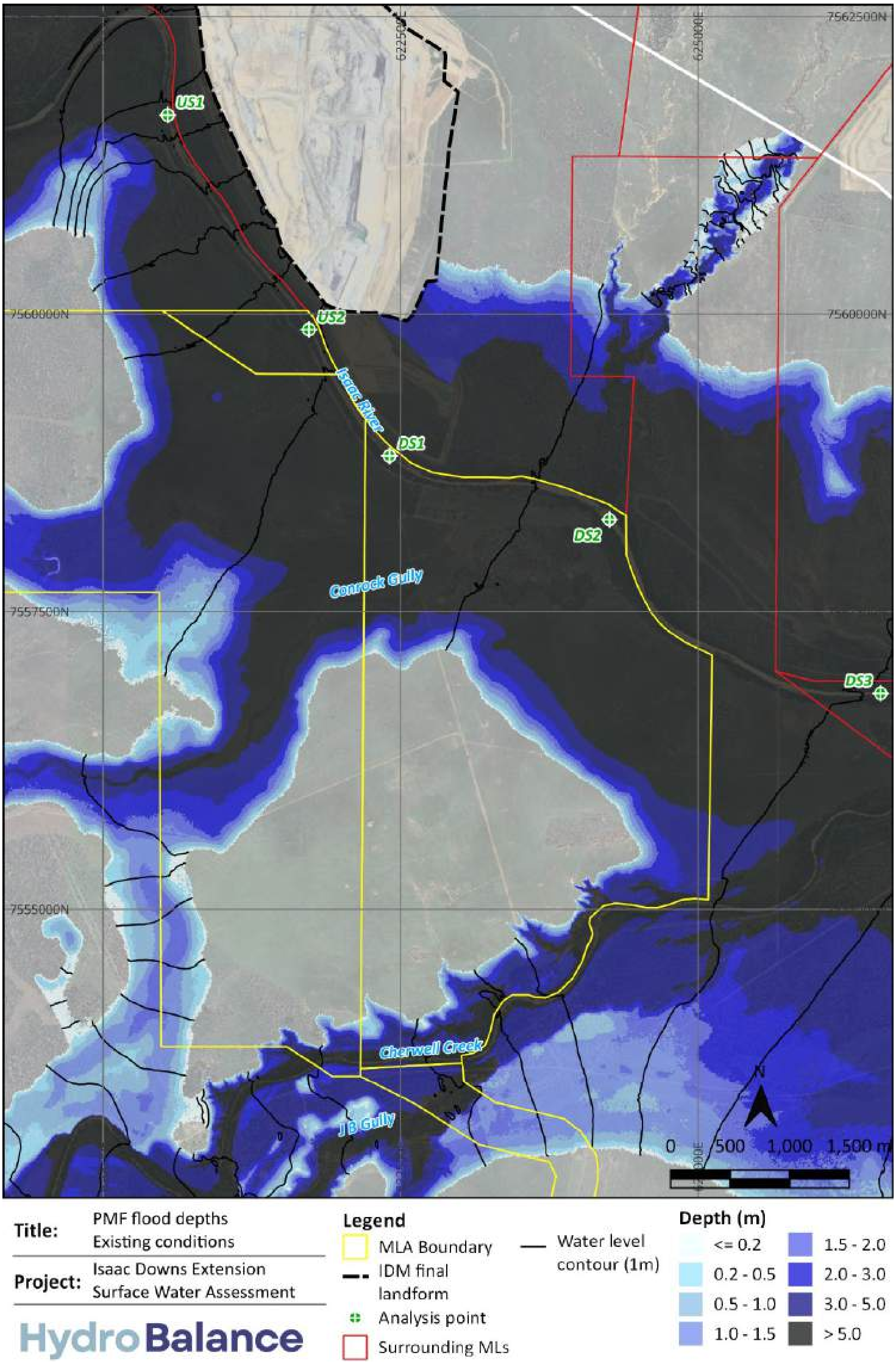


Figure C.4 – Existing conditions PMF flood depths and heights

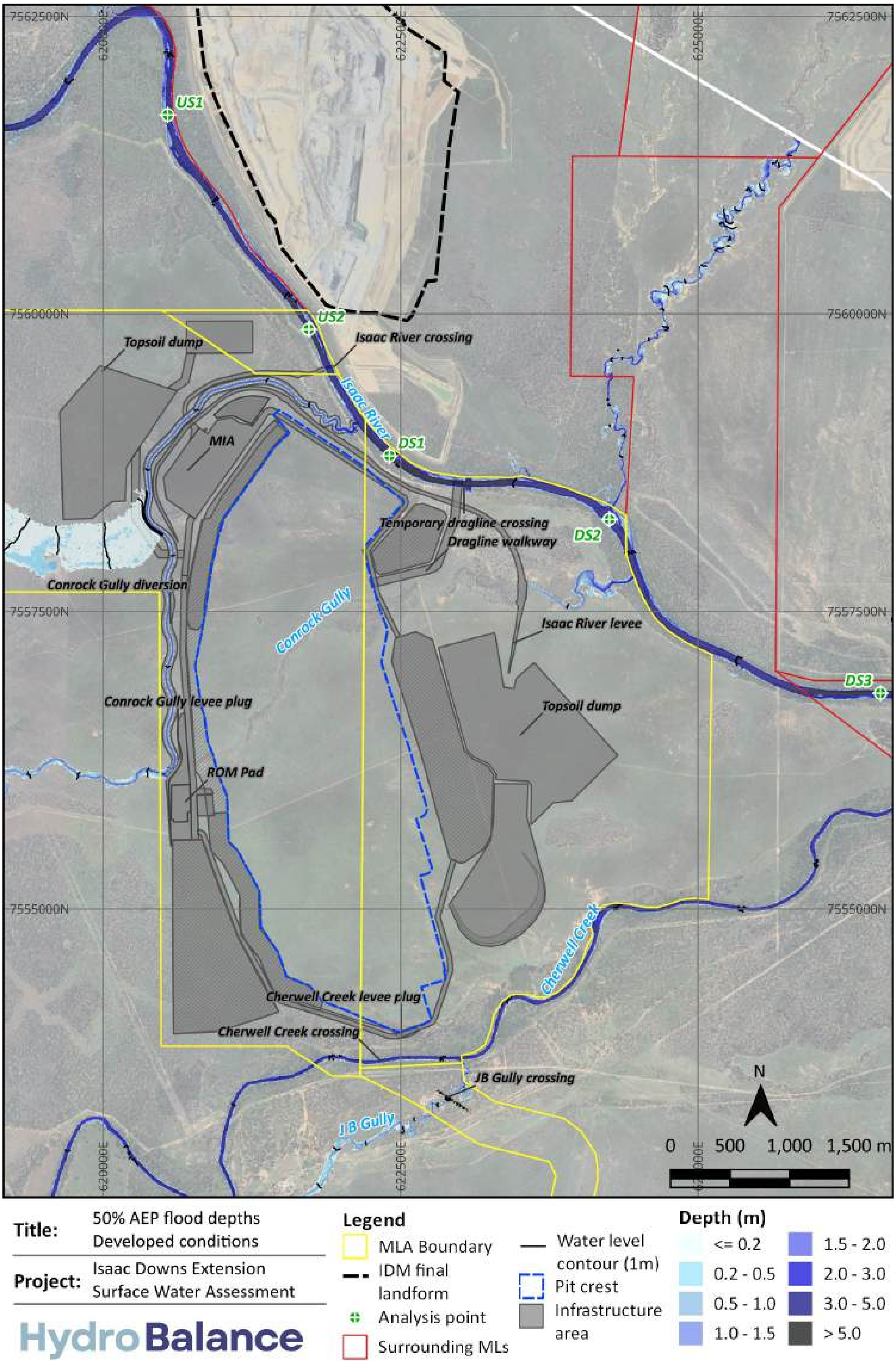
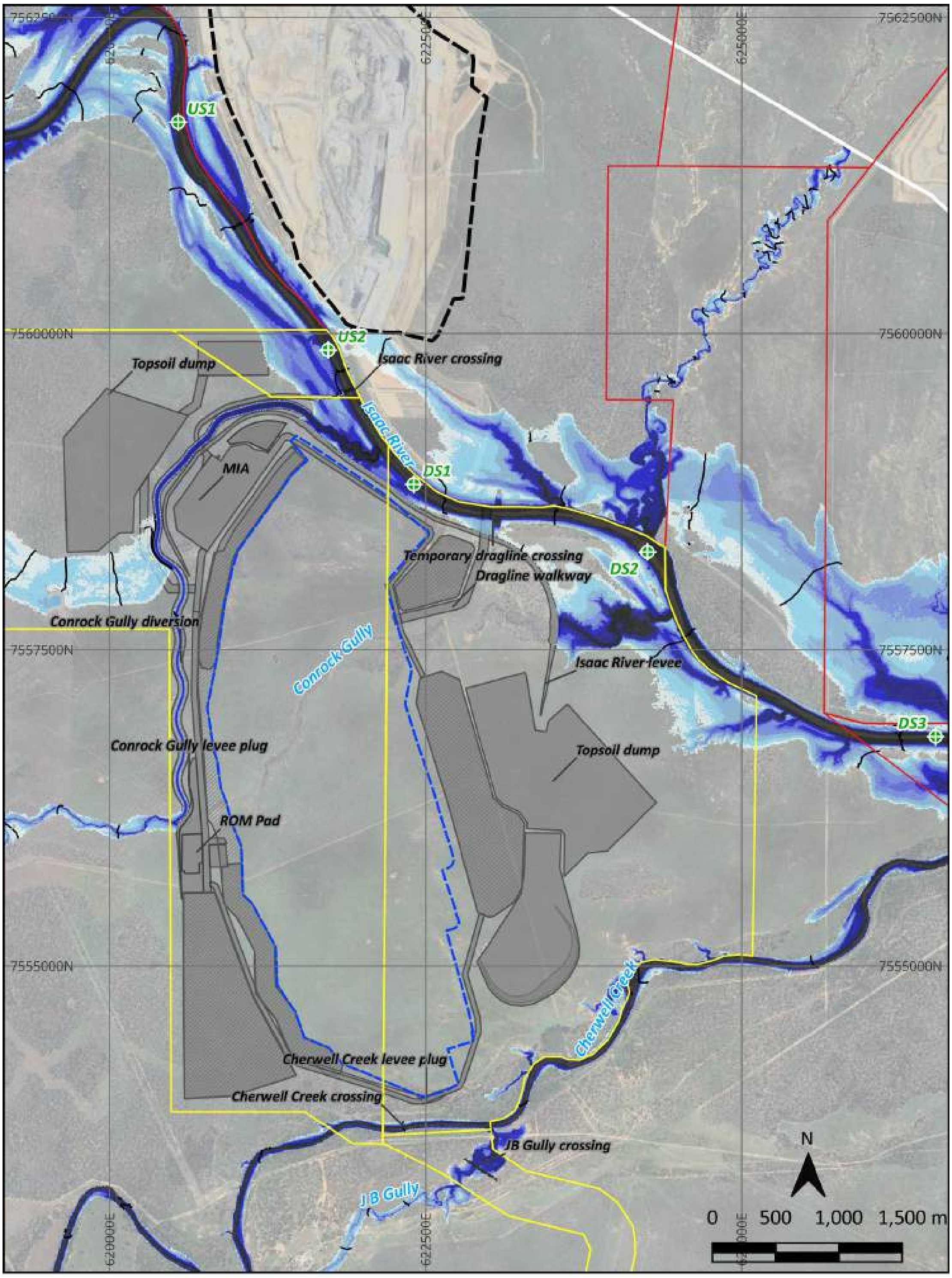


Figure C.5 – Developed conditions 50% AEP flood depths and heights



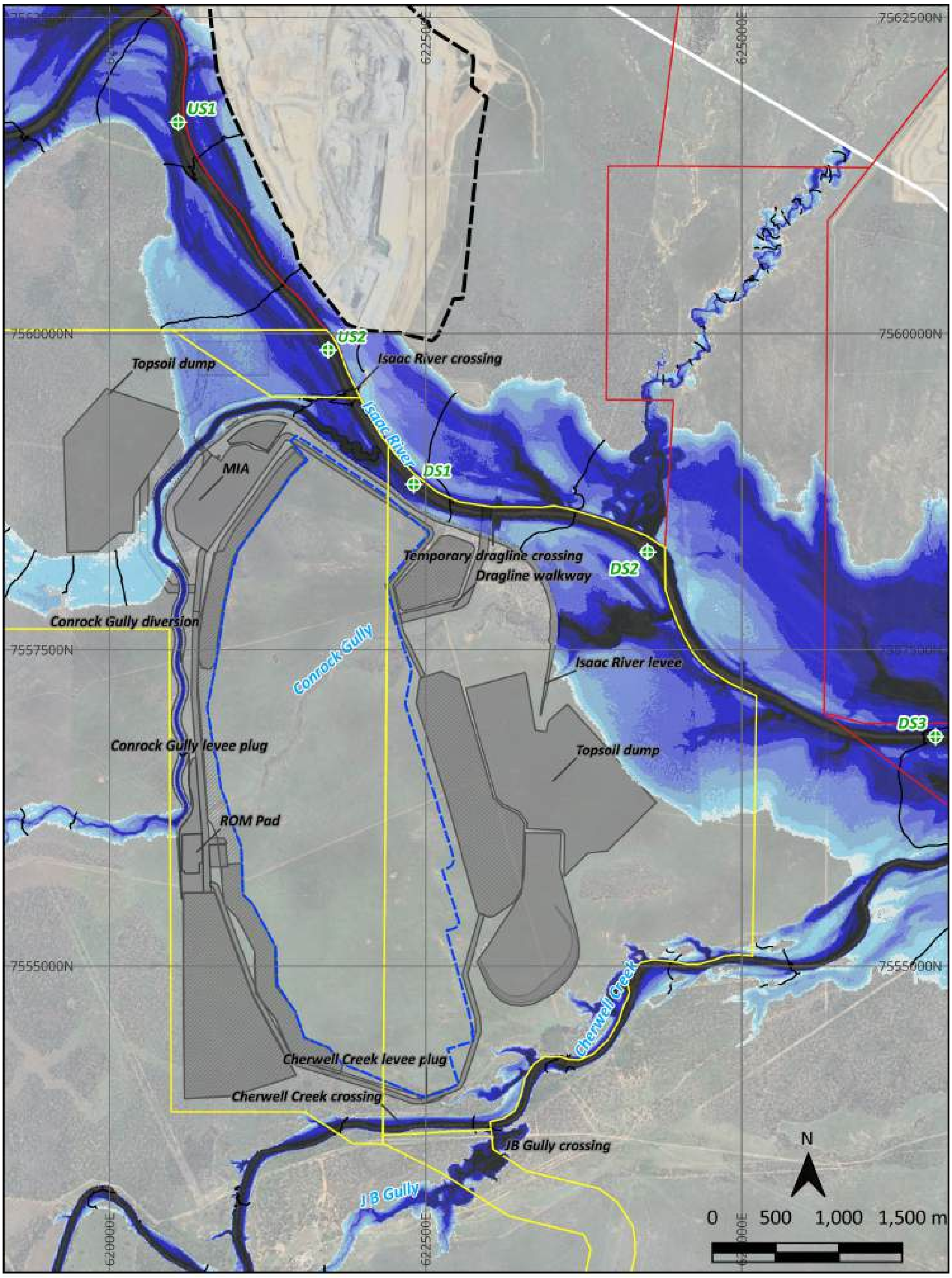
Title:	10% AEP flood depths Developed conditions
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend
- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Water level contour (1m)
- Pit crest
- Infrastructure area

Depth (m)
- <= 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- > 5.0

Figure C.6 – Developed conditions 10% AEP flood depths and heights



Title:	2% AEP flood depths Developed conditions
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Water level contour (1m)
- Pit crest
- Infrastructure area

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- > 5.0

Figure C.7 – Developed conditions 2% AEP flood depths and heights

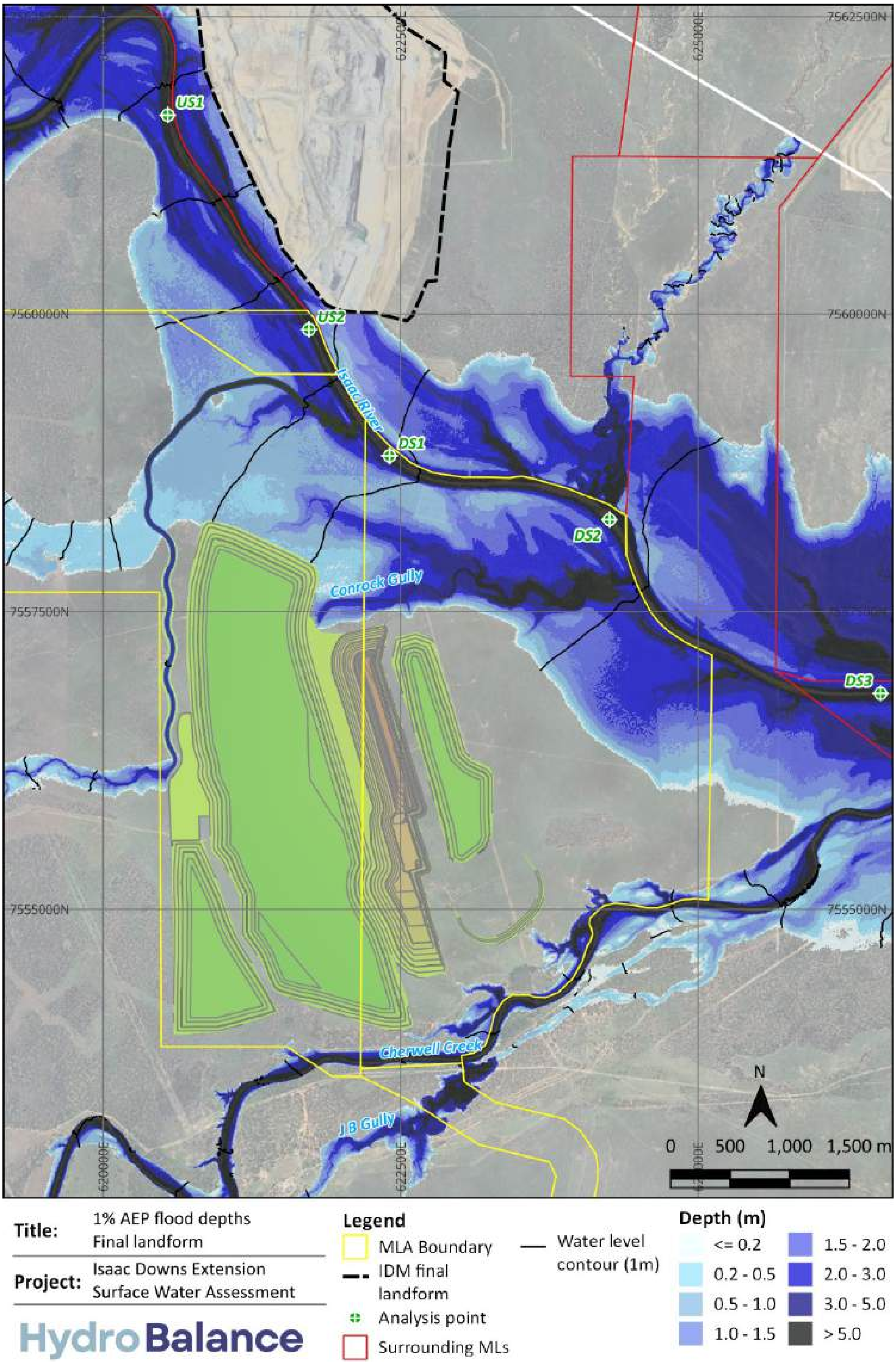


Figure C.8 – Final landform conditions 1% AEP flood depths and heights

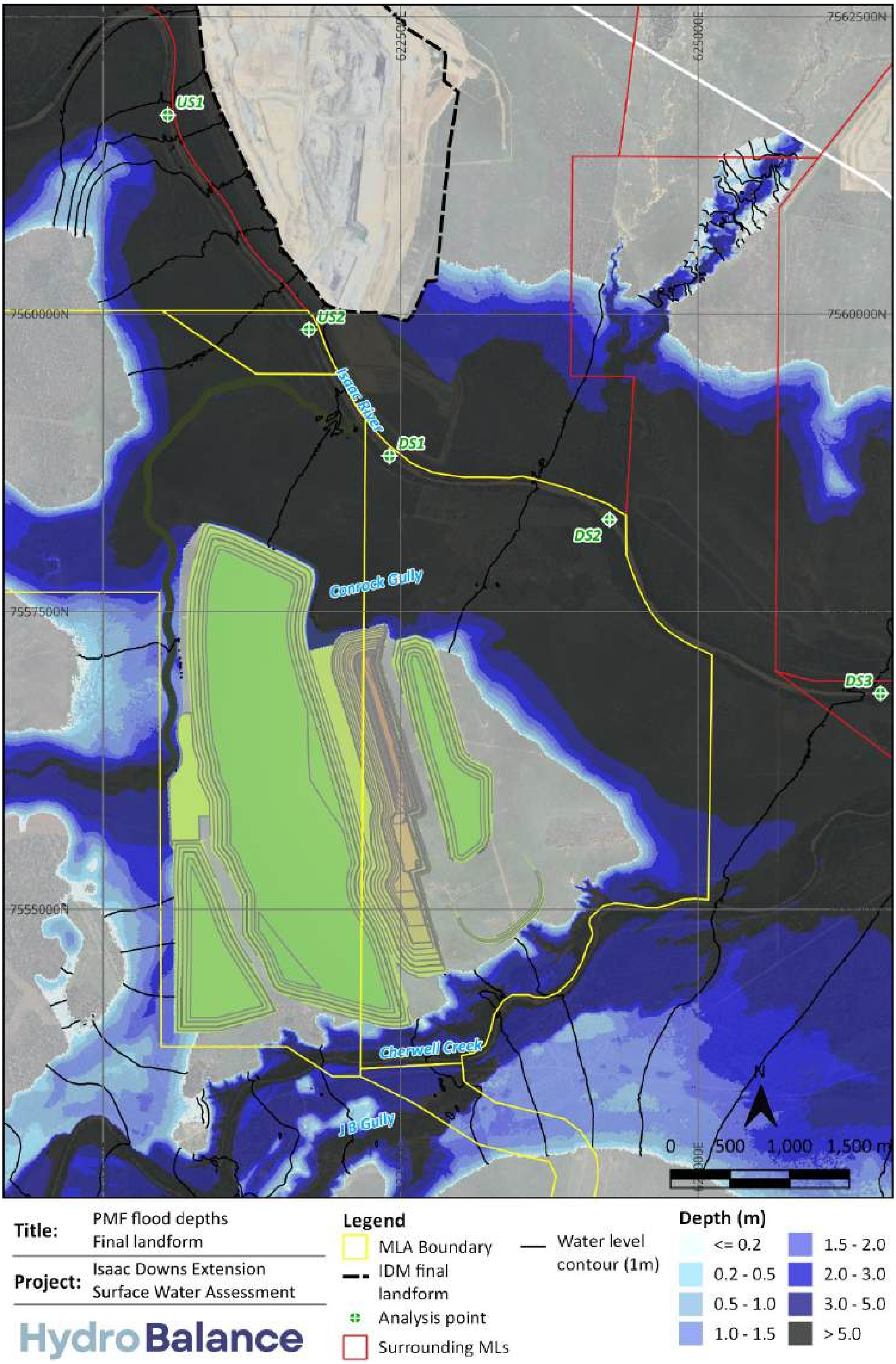


Figure C.9 – Final landform conditions PMF flood depths and heights

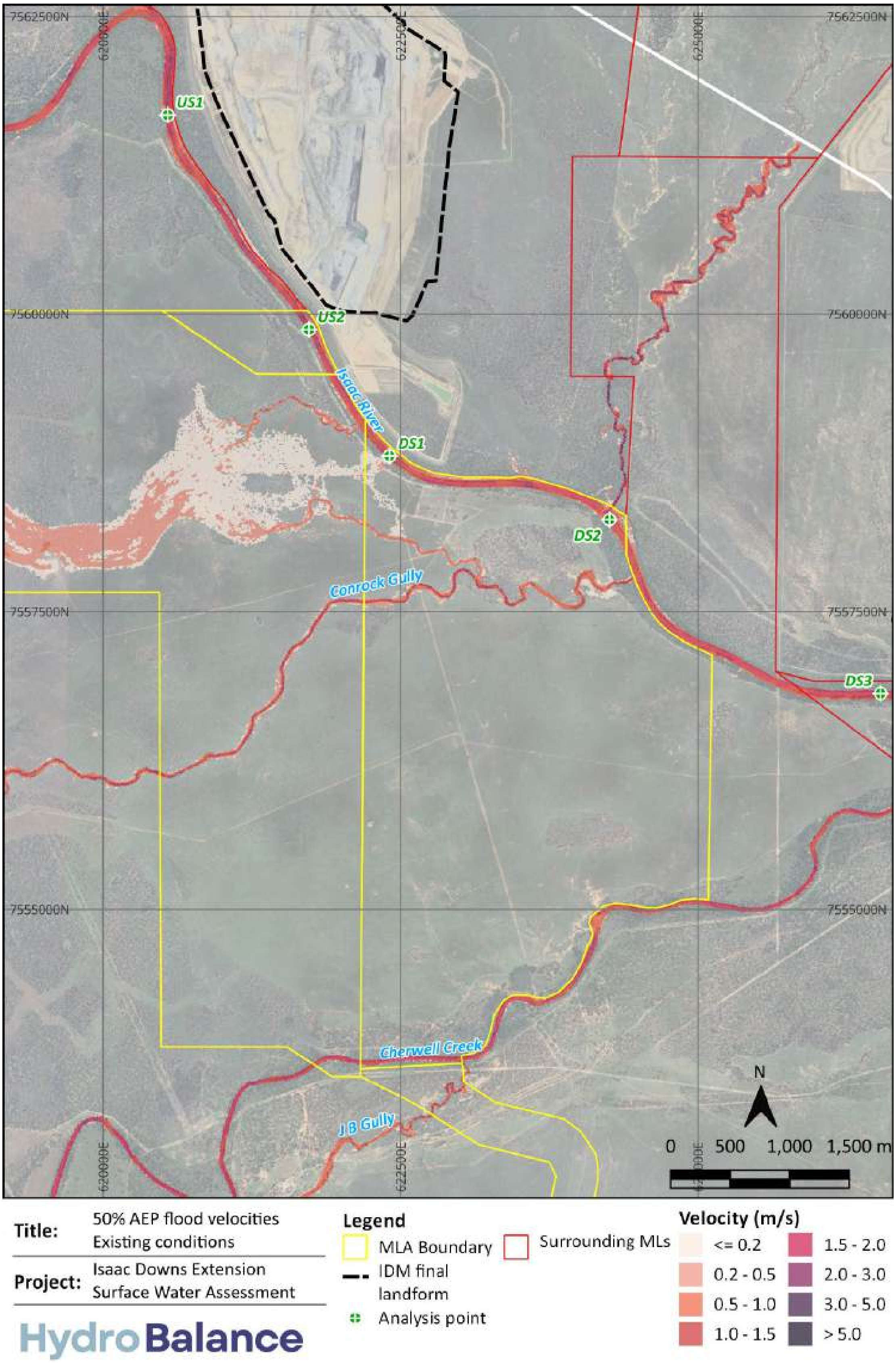
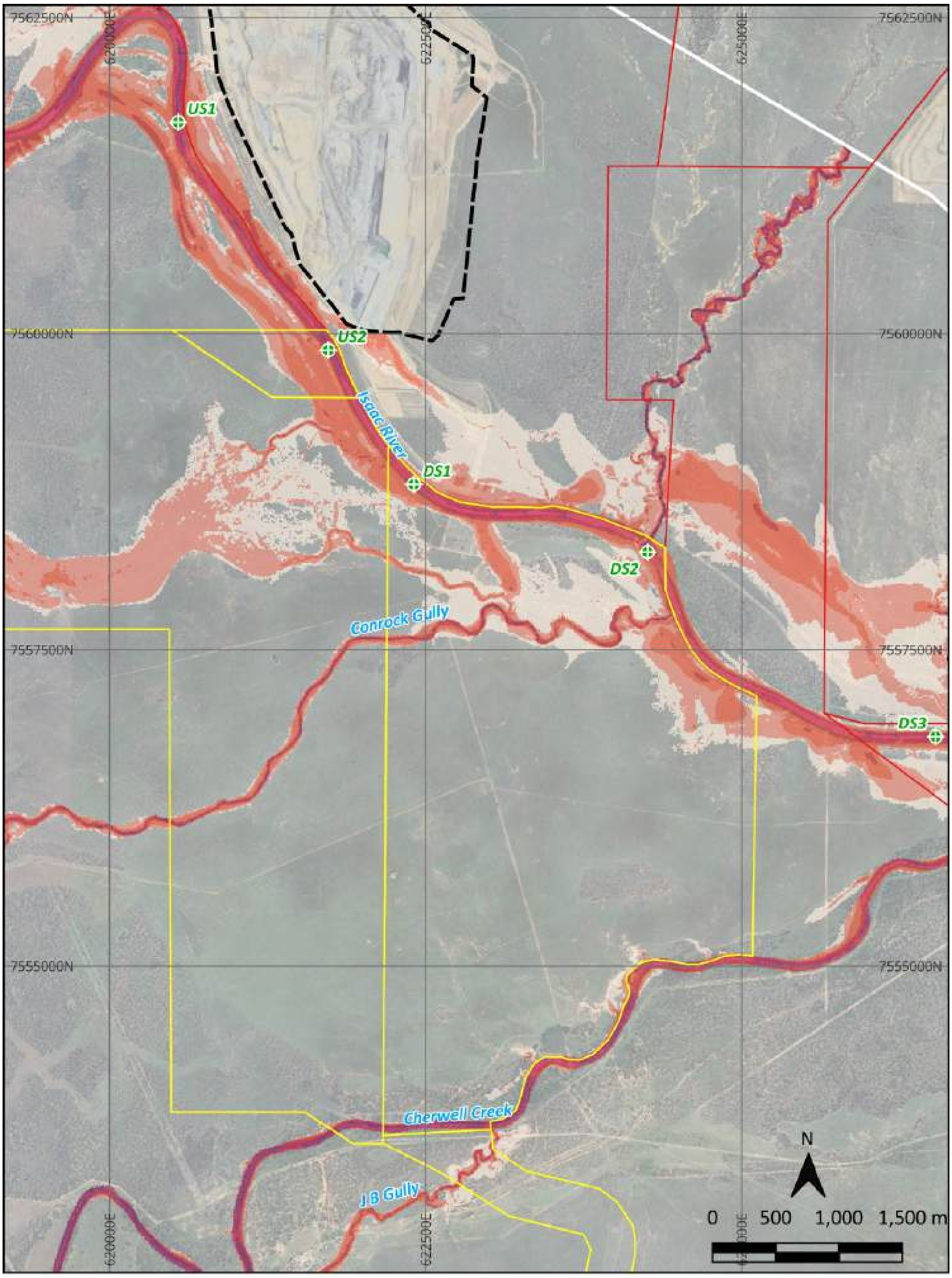


Figure C.10 – Existing conditions 50% AEP flood velocities



Title:	10% AEP flood velocities Existing conditions
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- Surrounding MLs
- IDM final landform
- Analysis point

Velocity (m/s)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- > 5.0

Figure C.11 – Existing conditions 10% AEP flood velocities

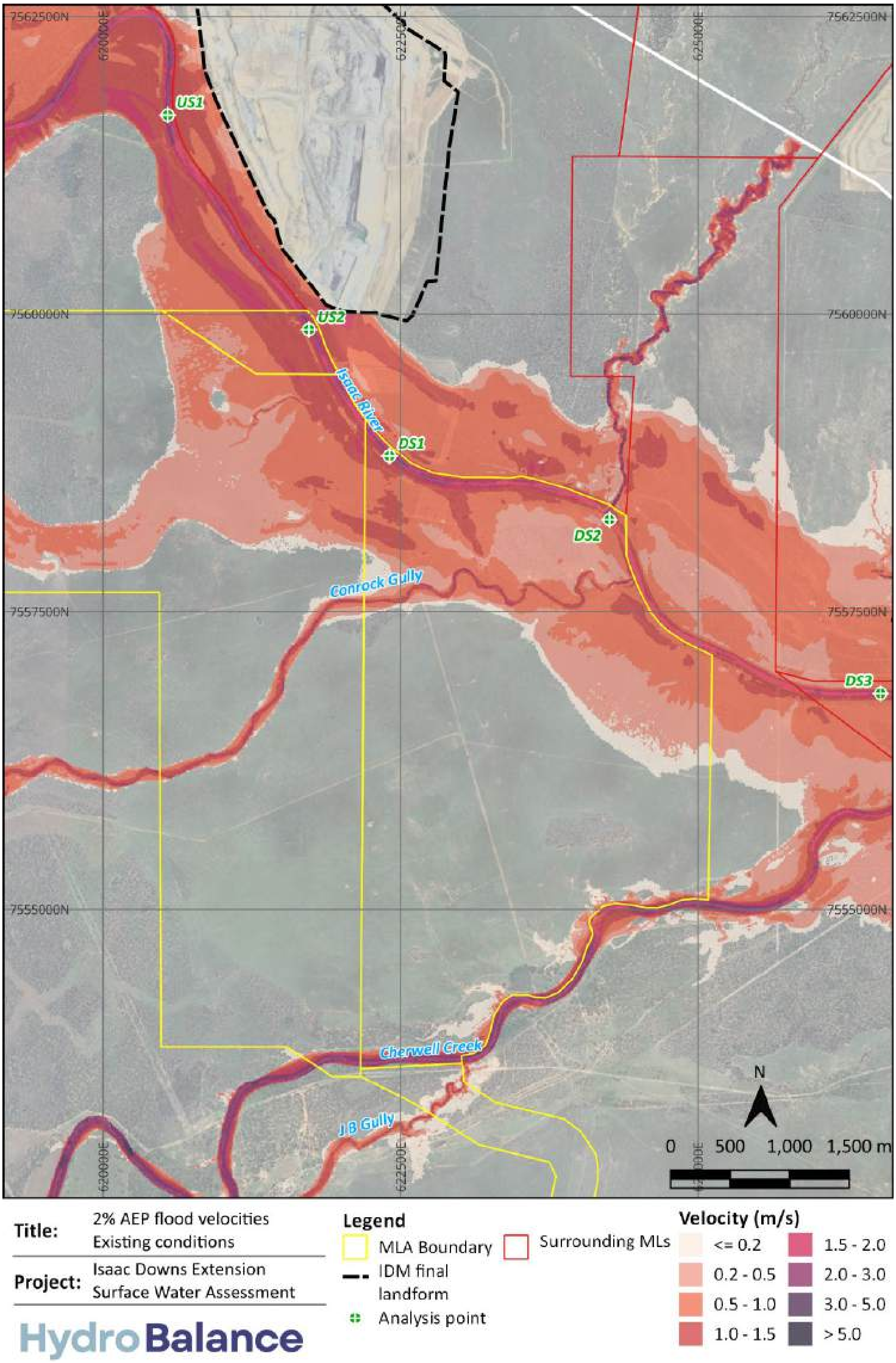


Figure C.12 – Existing conditions 2% AEP flood velocities

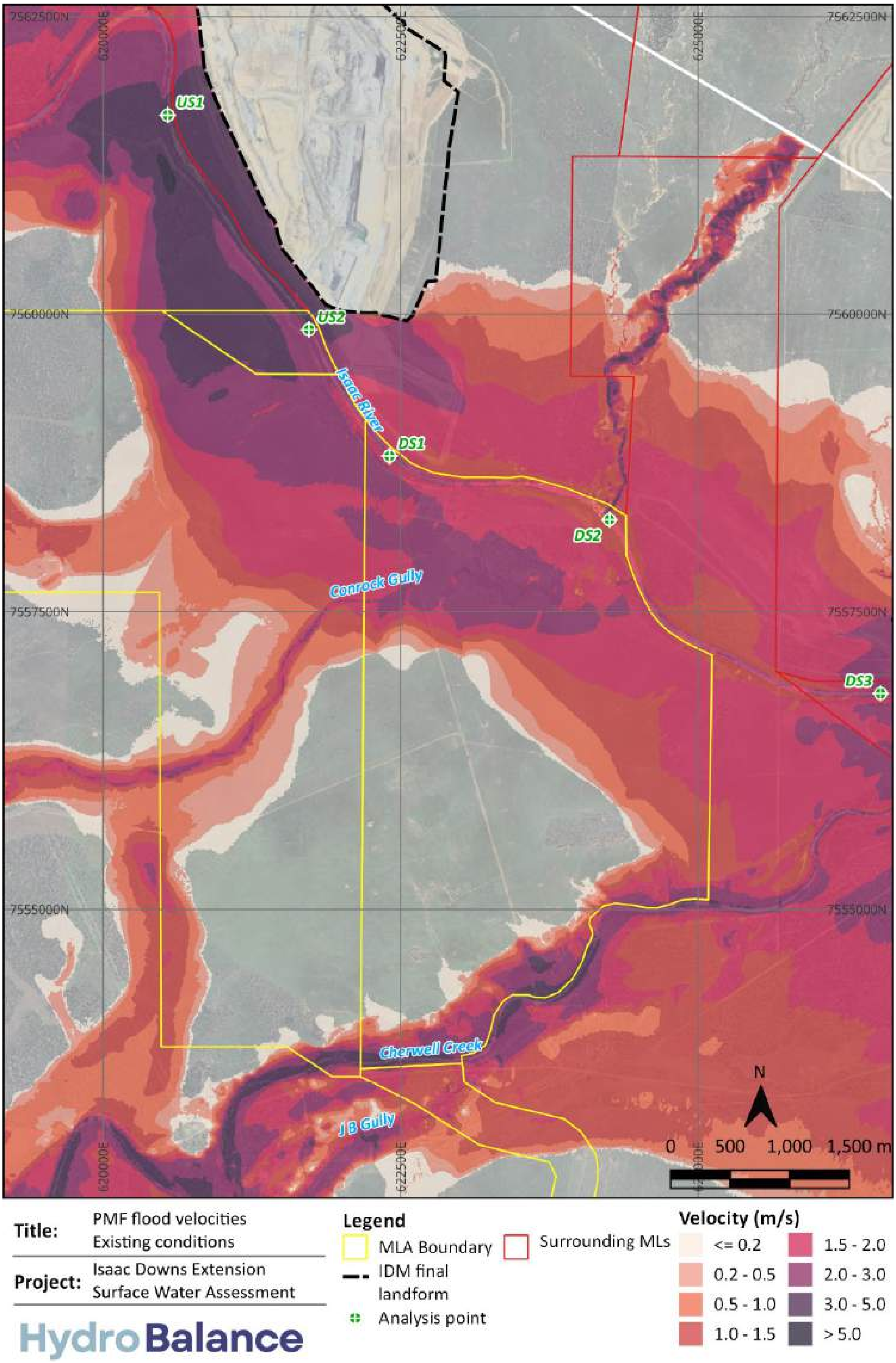
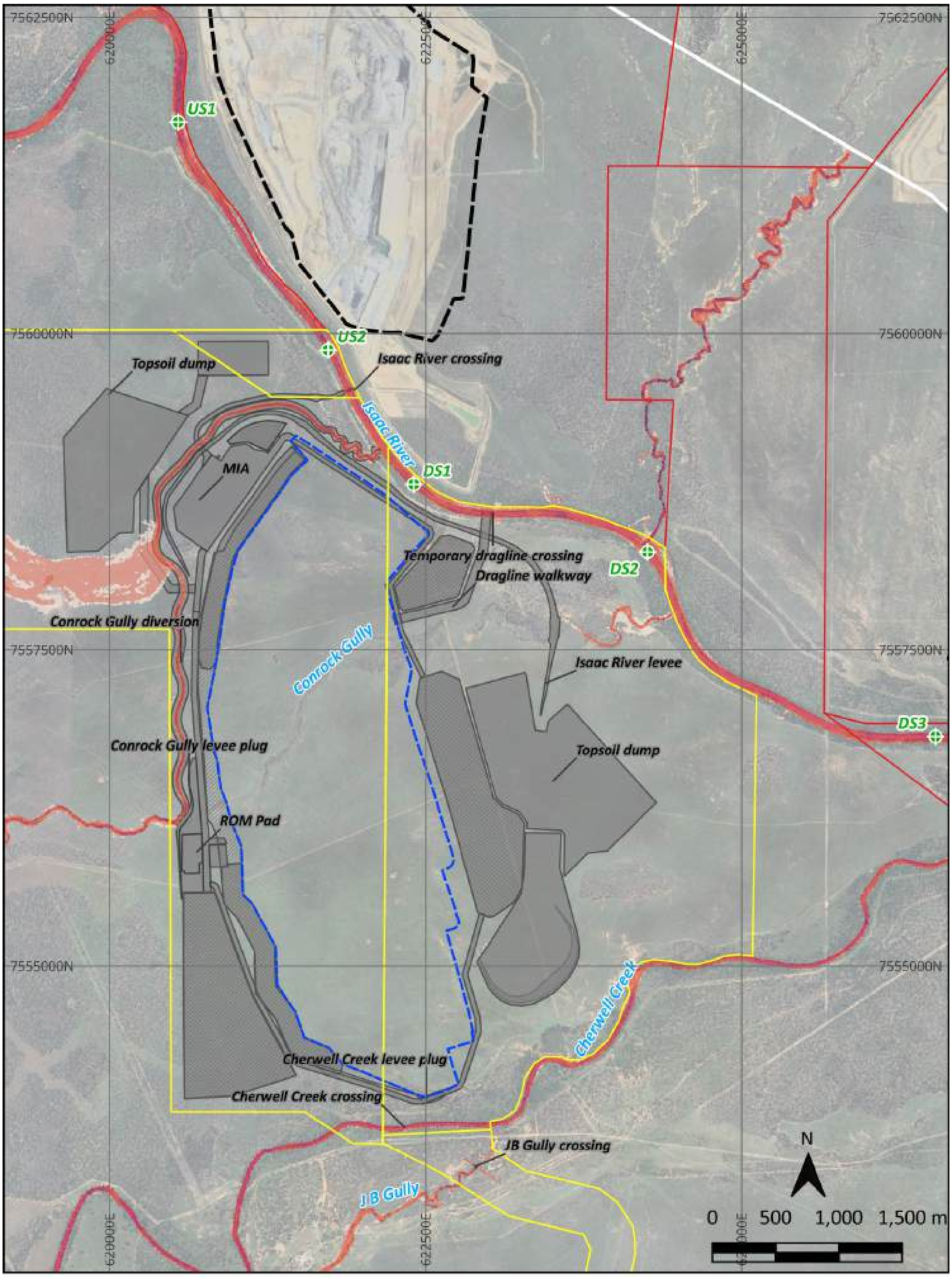


Figure C.13 – Existing conditions PMF flood velocities



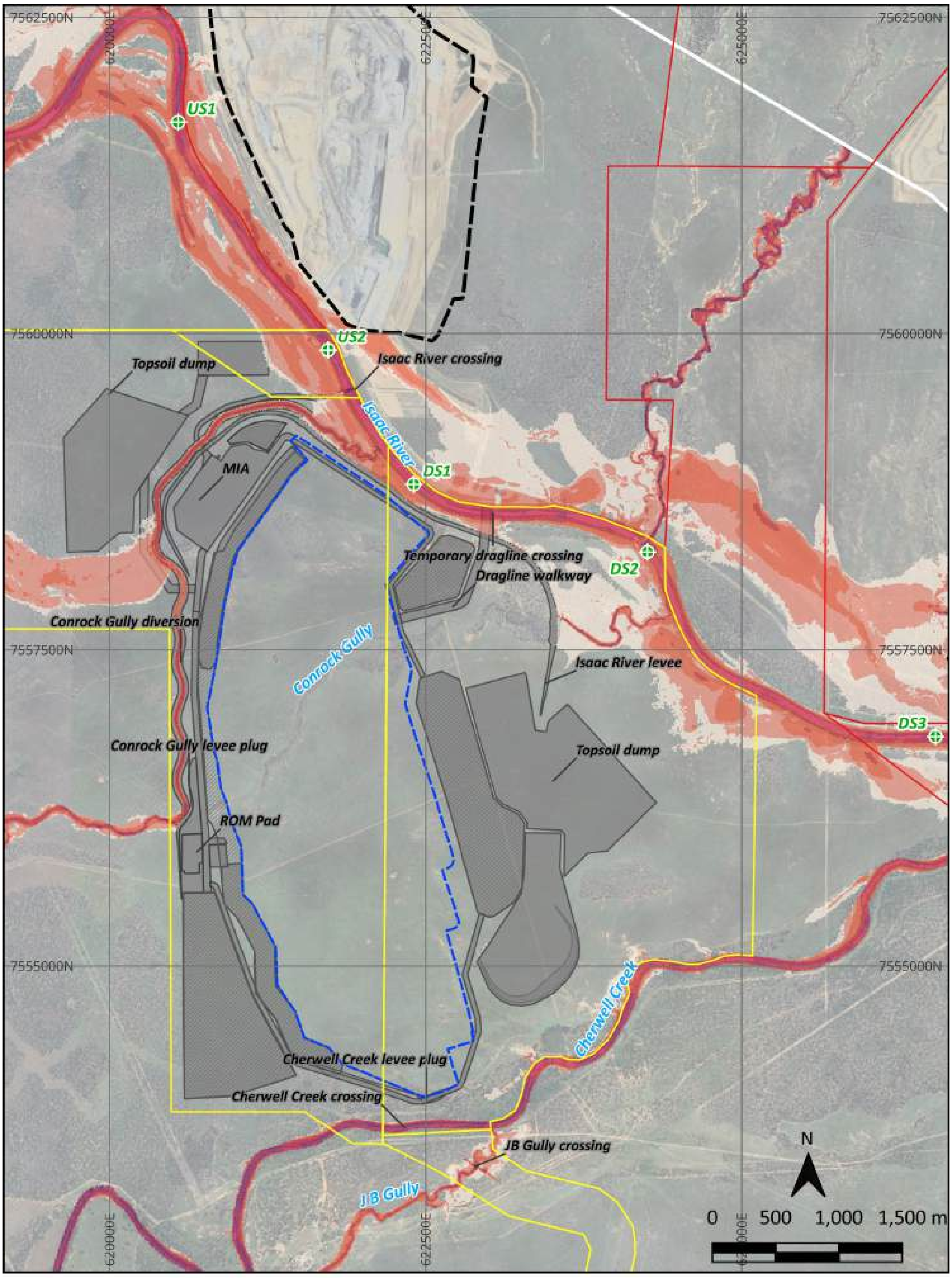
Title:	50% AEP flood velocities Developed conditions
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend
- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Pit crest
- Infrastructure area

Velocity (m/s)
- <= 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- > 5.0

Figure C.14 – Developed conditions 50% AEP flood velocities



Title:	10% AEP flood velocities Developed conditions
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Pit crest
- Infrastructure area

Velocity (m/s)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- > 5.0

Figure C.15 – Developed conditions 10% AEP flood velocities

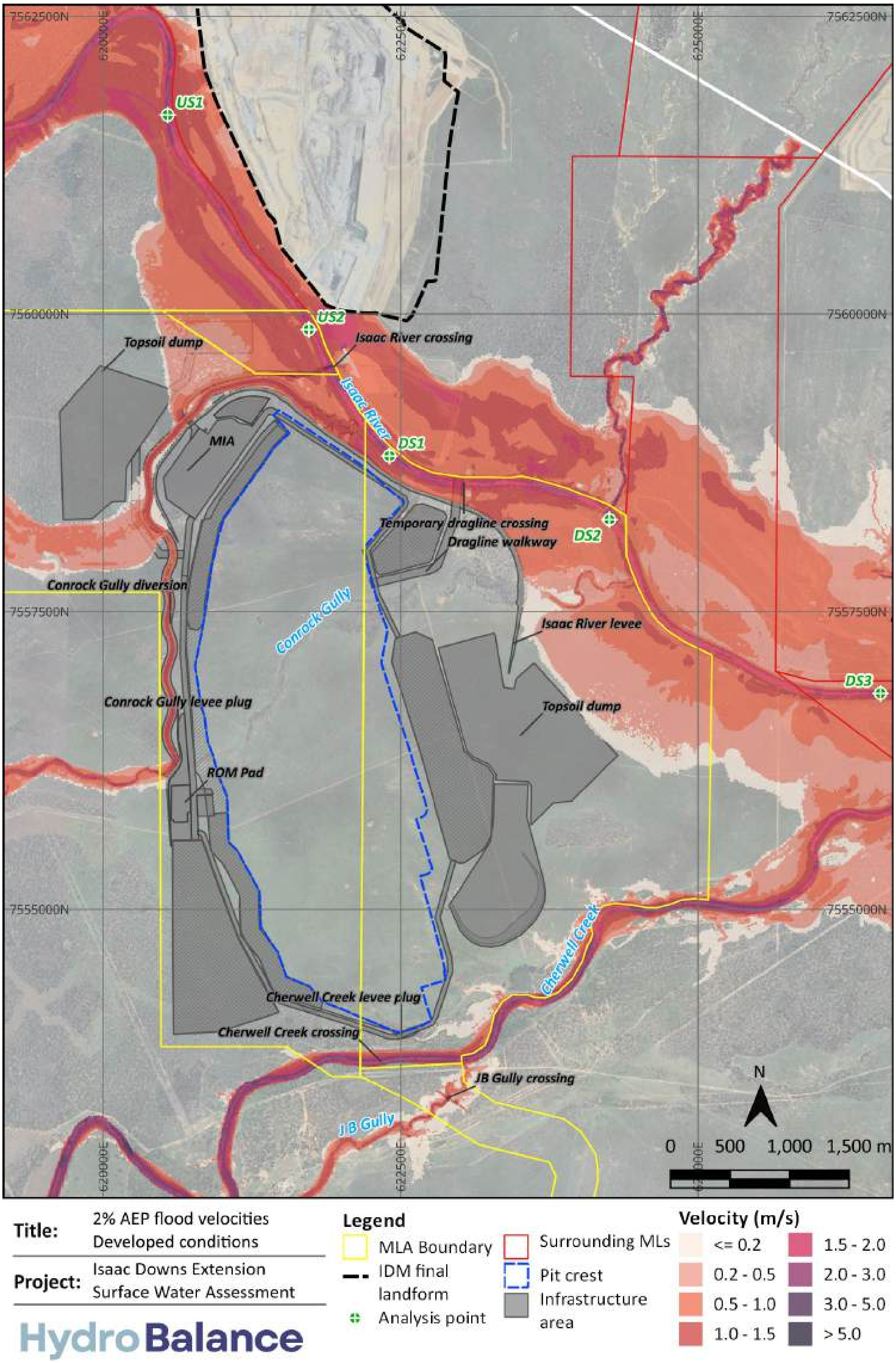


Figure C.16 – Developed conditions 2% AEP flood velocities

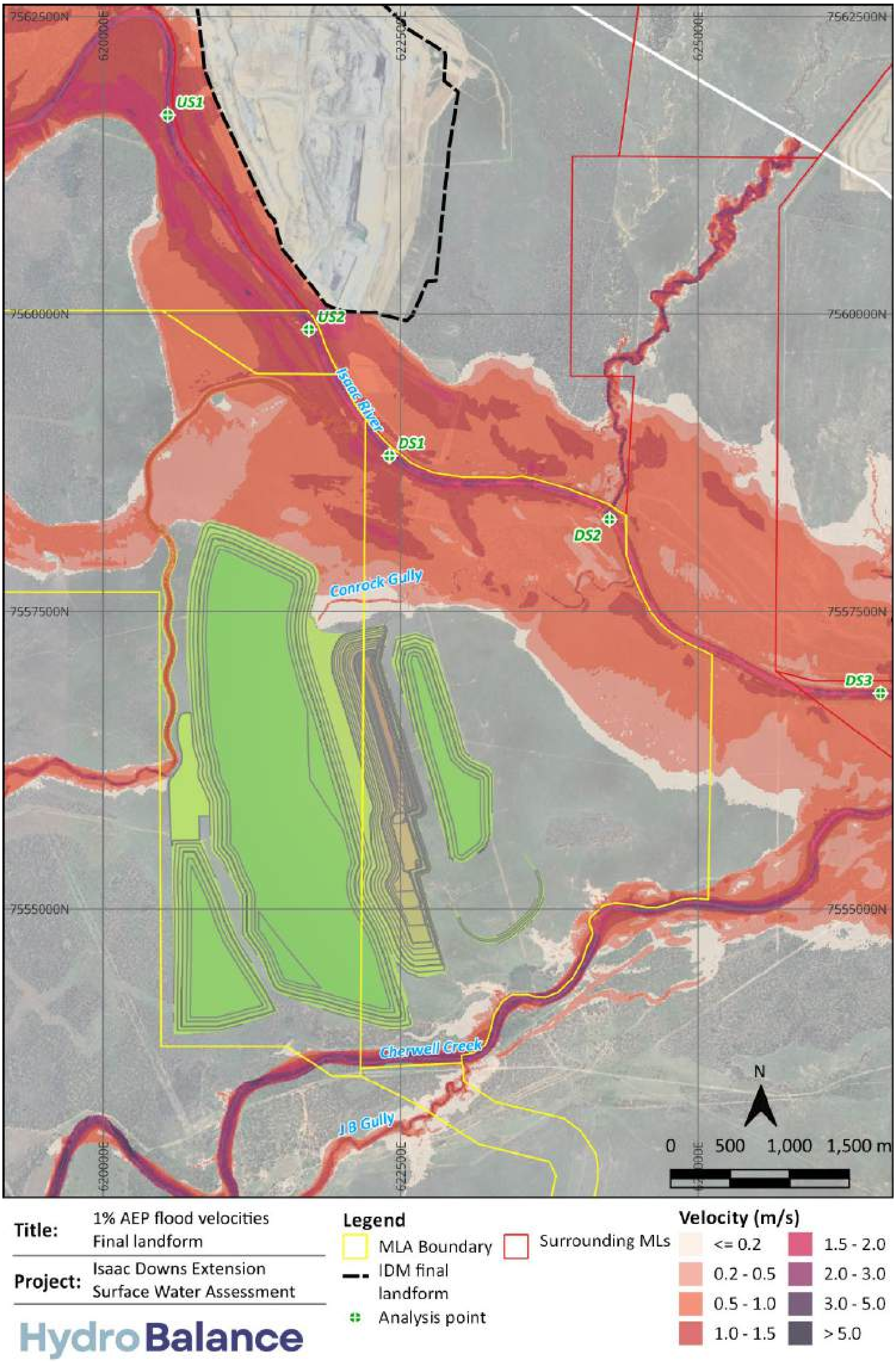


Figure C.17 – Final landform conditions 1% AEP flood velocities

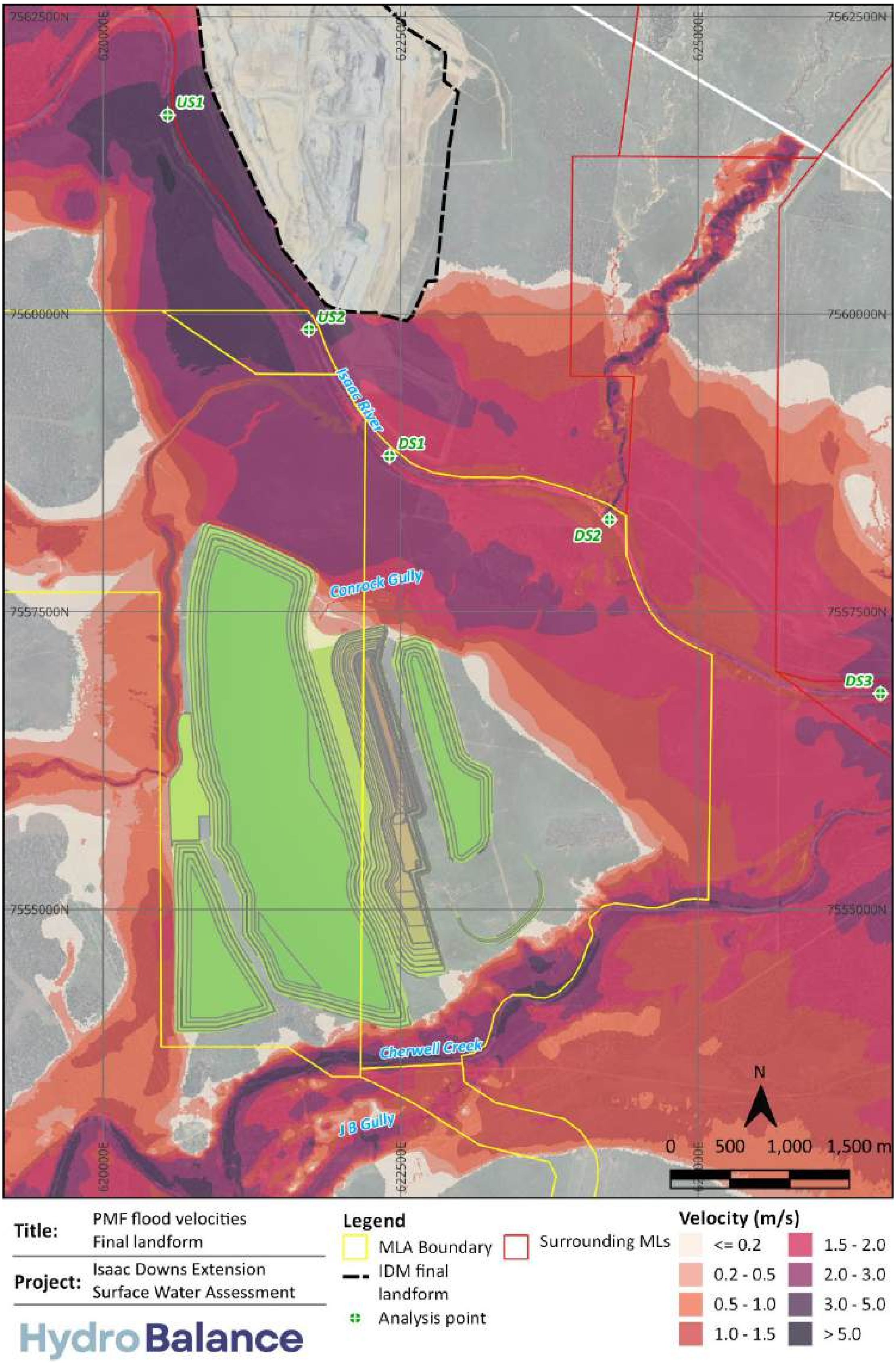
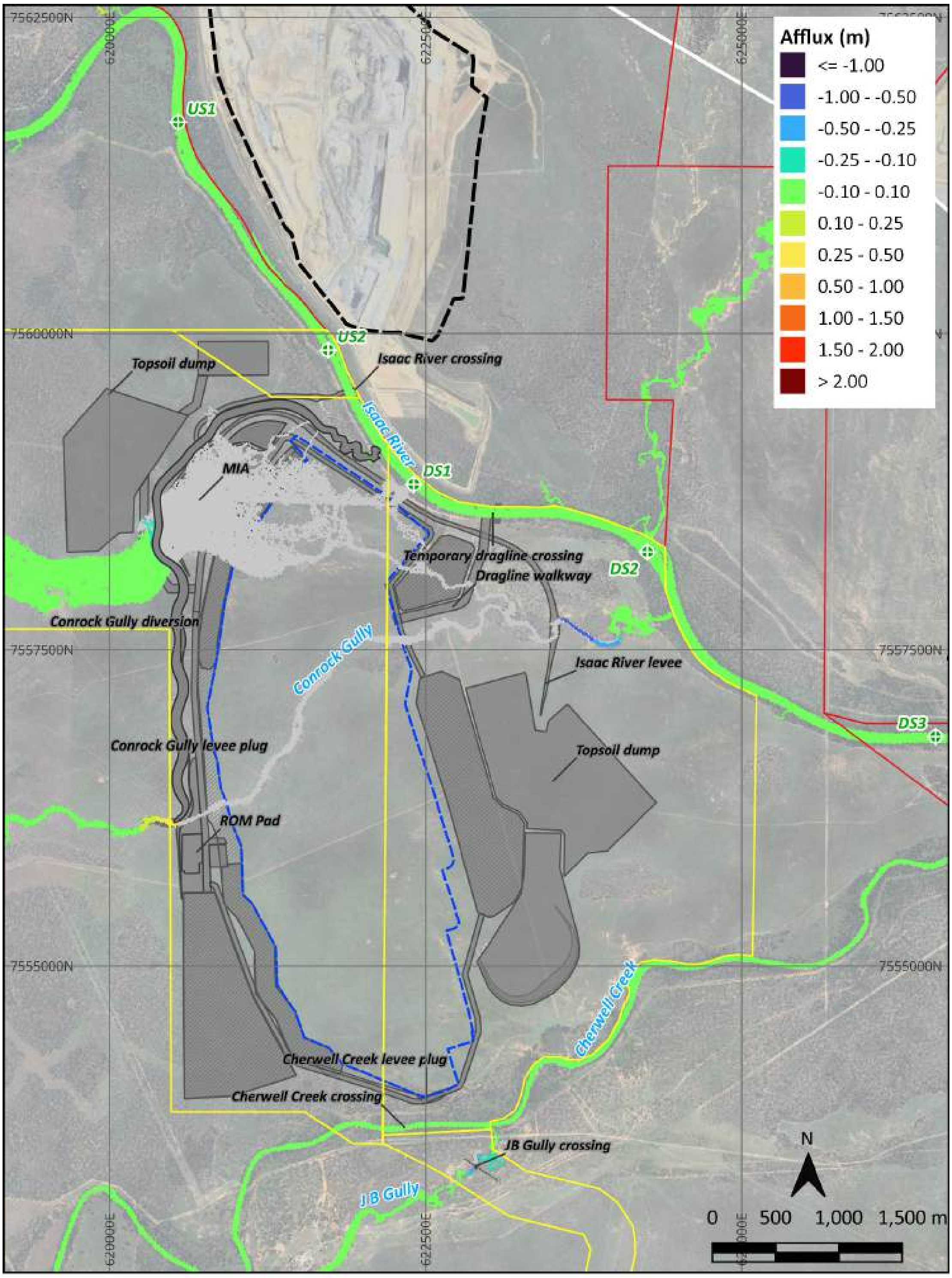


Figure C.18 – Final landform conditions PMF flood velocities



Title: 50% AEP flood level impact

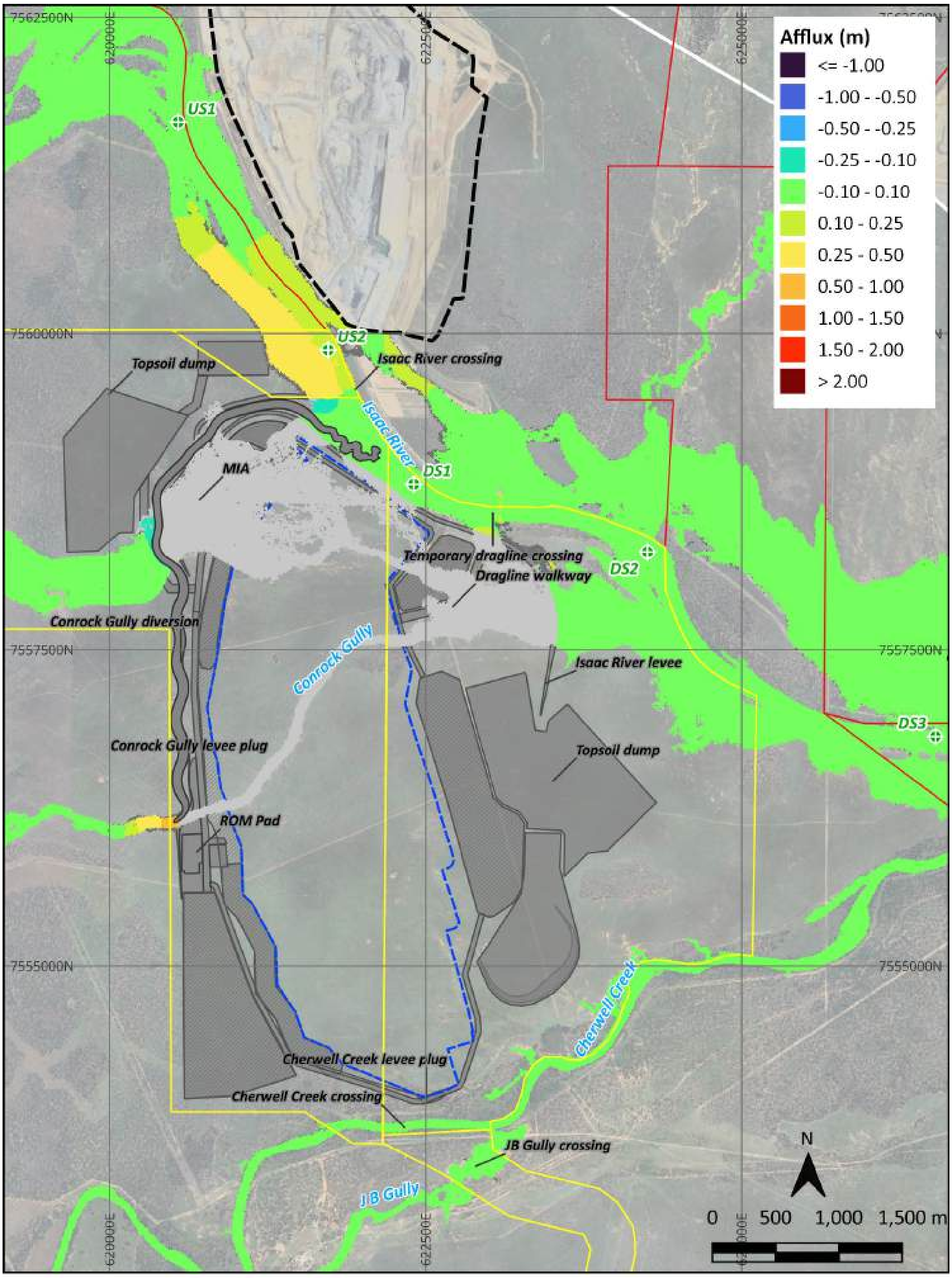
Project: Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Pit crest
- Infrastructure area
- Was wet, now dry
- Was dry, now wet

Figure C.19 – Afflux 50% AEP (developed minus existing conditions)



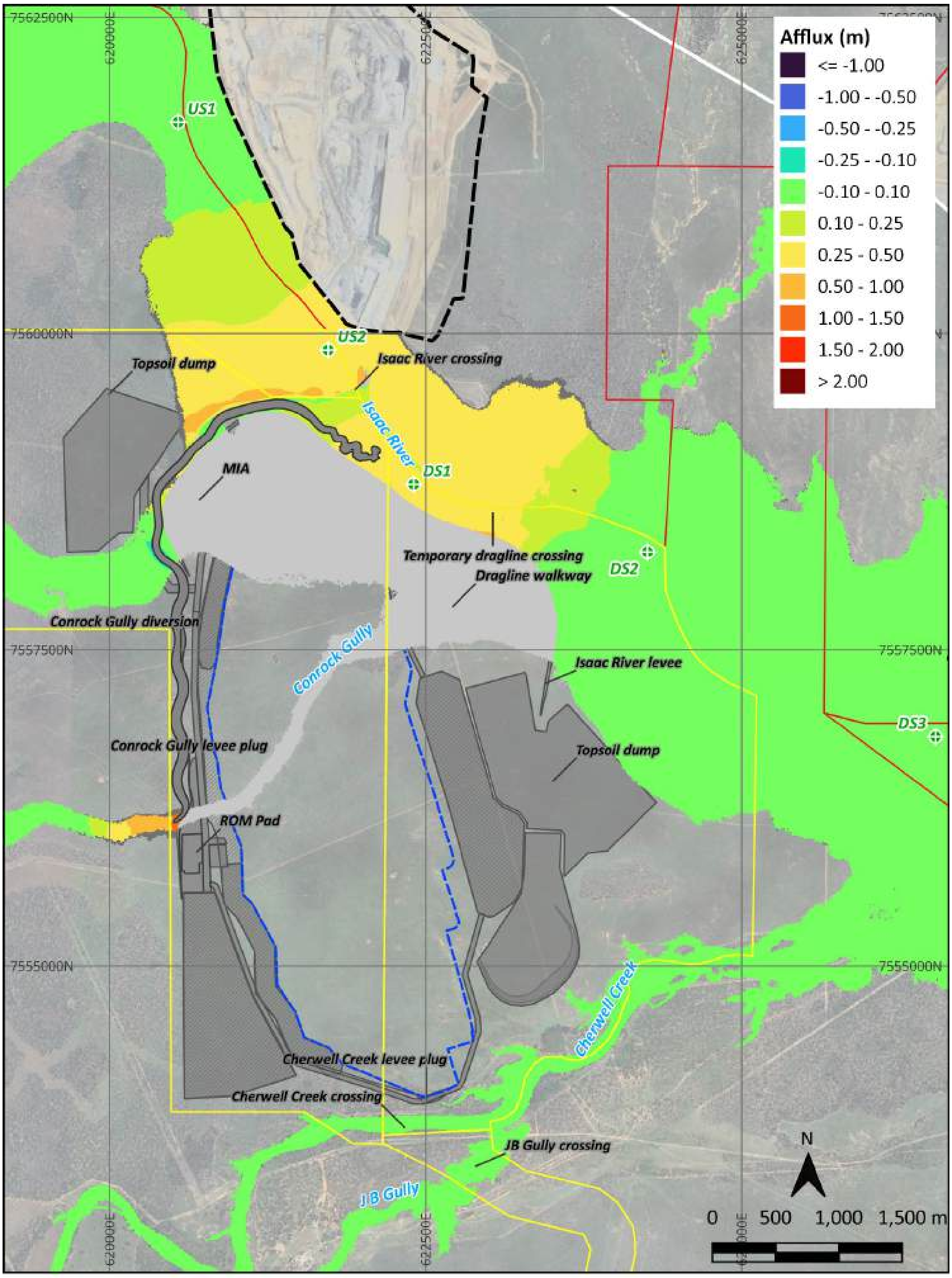
Title:	10% AEP flood level impact
Project:	Isaac Downs Extension Surface Water Assessment

Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Pit crest
- Infrastructure area
- Was wet, now dry
- Was dry, now wet

HydroBalance

Figure C.20 – Afflux 10% AEP (developed minus existing conditions)



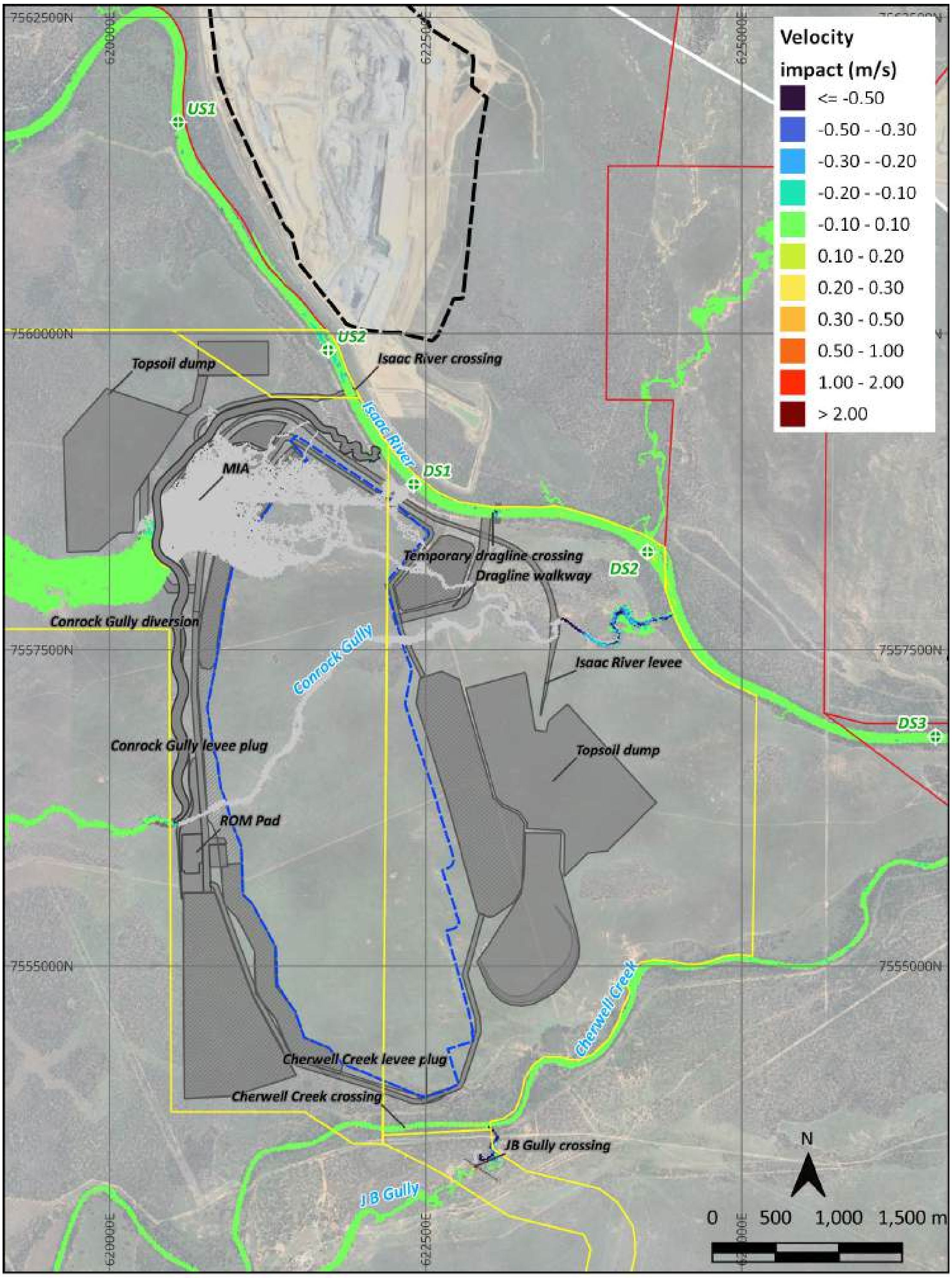
Title:	2% AEP flood level impact		
Project:	Isaac Downs Extension Surface Water Assessment		

Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Pit crest
- Infrastructure area
- Was wet, now dry
- Was dry, now wet

HydroBalance

Figure C.21 – Afflux 2% AEP (developed minus existing conditions)



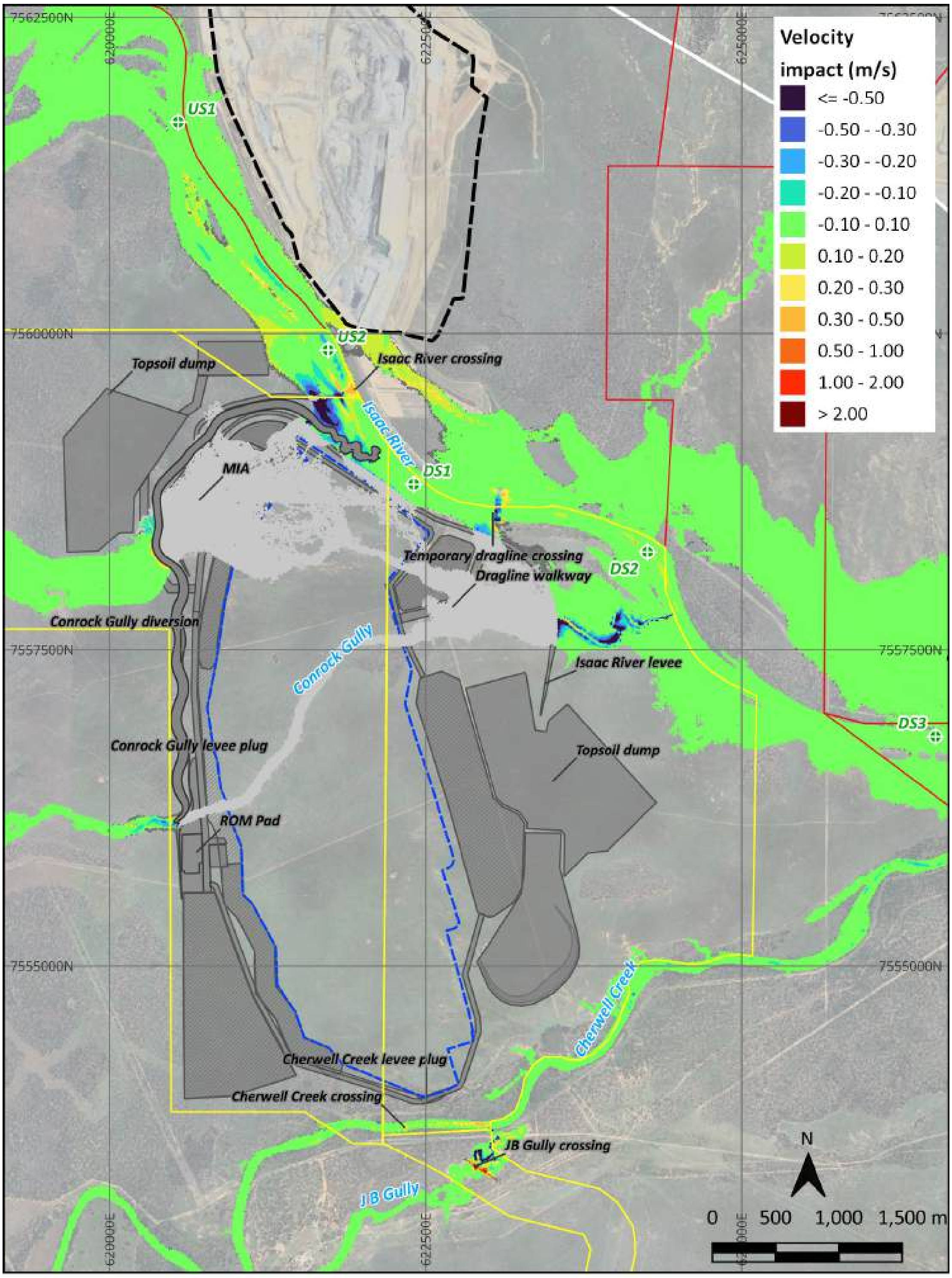
Title:	50% AEP flood velocity impact
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Pit crest
- Infrastructure area
- Was wet, now dry
- Was dry, now wet

Figure C.22 – Velocity impact 50% AEP (developed minus existing conditions)



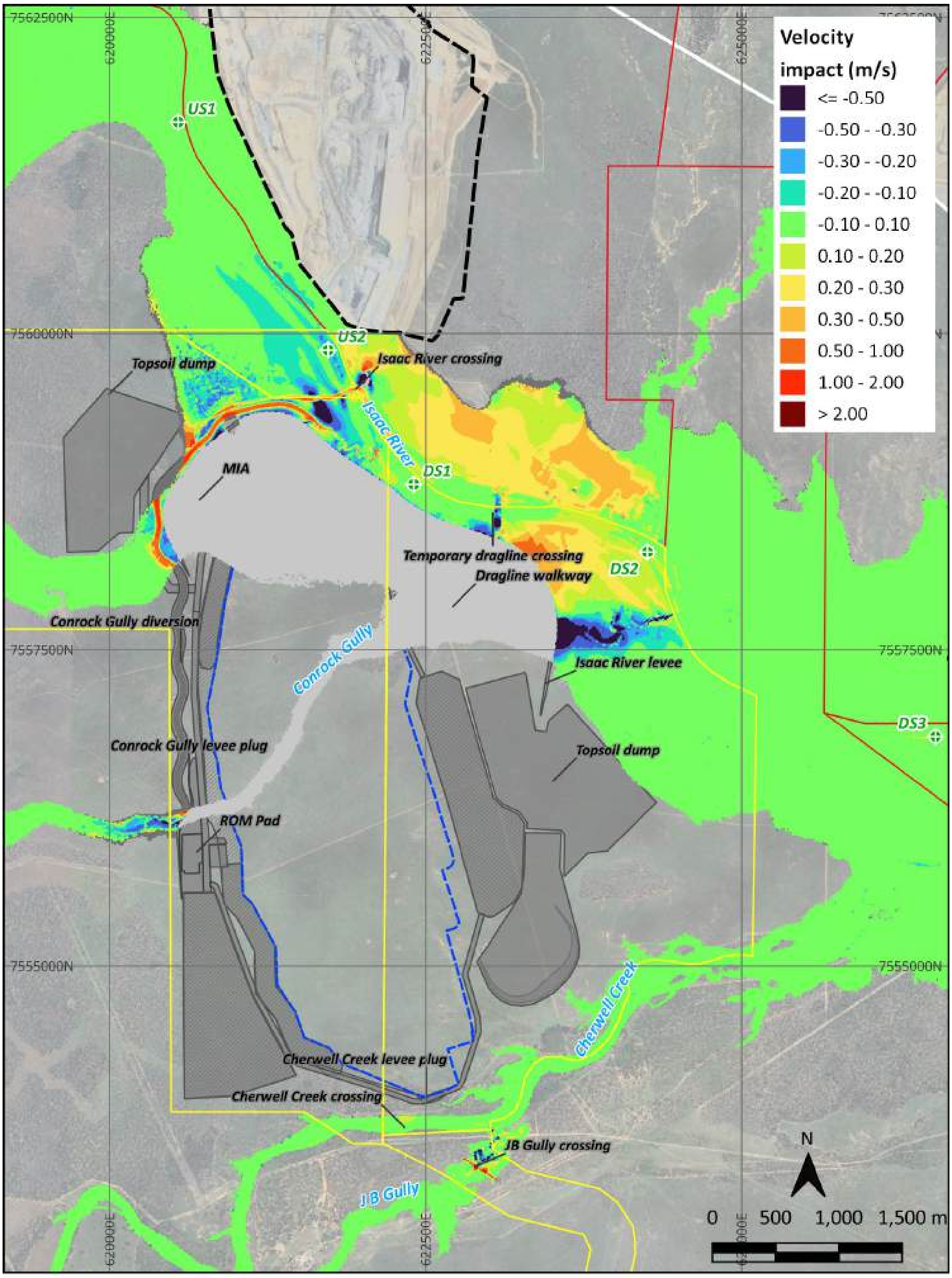
Title: 10% AEP flood velocity impact

Project: Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend
- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Pit crest
- Infrastructure area
- Was wet, now dry
- Was dry, now wet

Figure C.23 – Velocity impact 10% AEP (developed minus existing conditions)



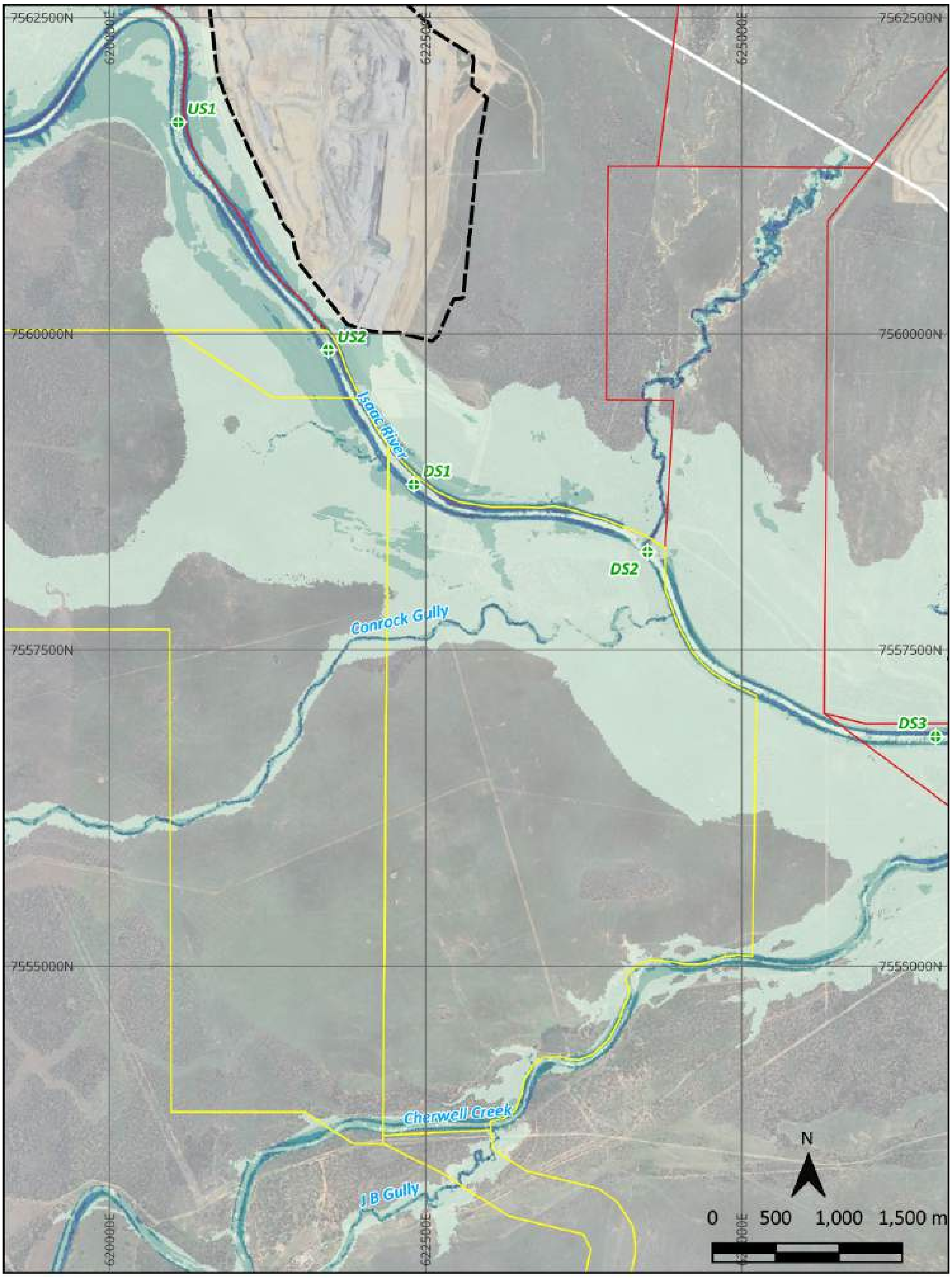
Title:	2% AEP flood velocity impact
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend
- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Pit crest
- Infrastructure area
- Was wet, now dry
- Was dry, now wet

Figure C.24 – Velocity impact 2% AEP (developed minus existing conditions)

C.2 Bed shear stress and stream power maps



Title: 2% AEP bed shear stress Existing conditions

Project: Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

MLA Boundary

Surrounding MLs

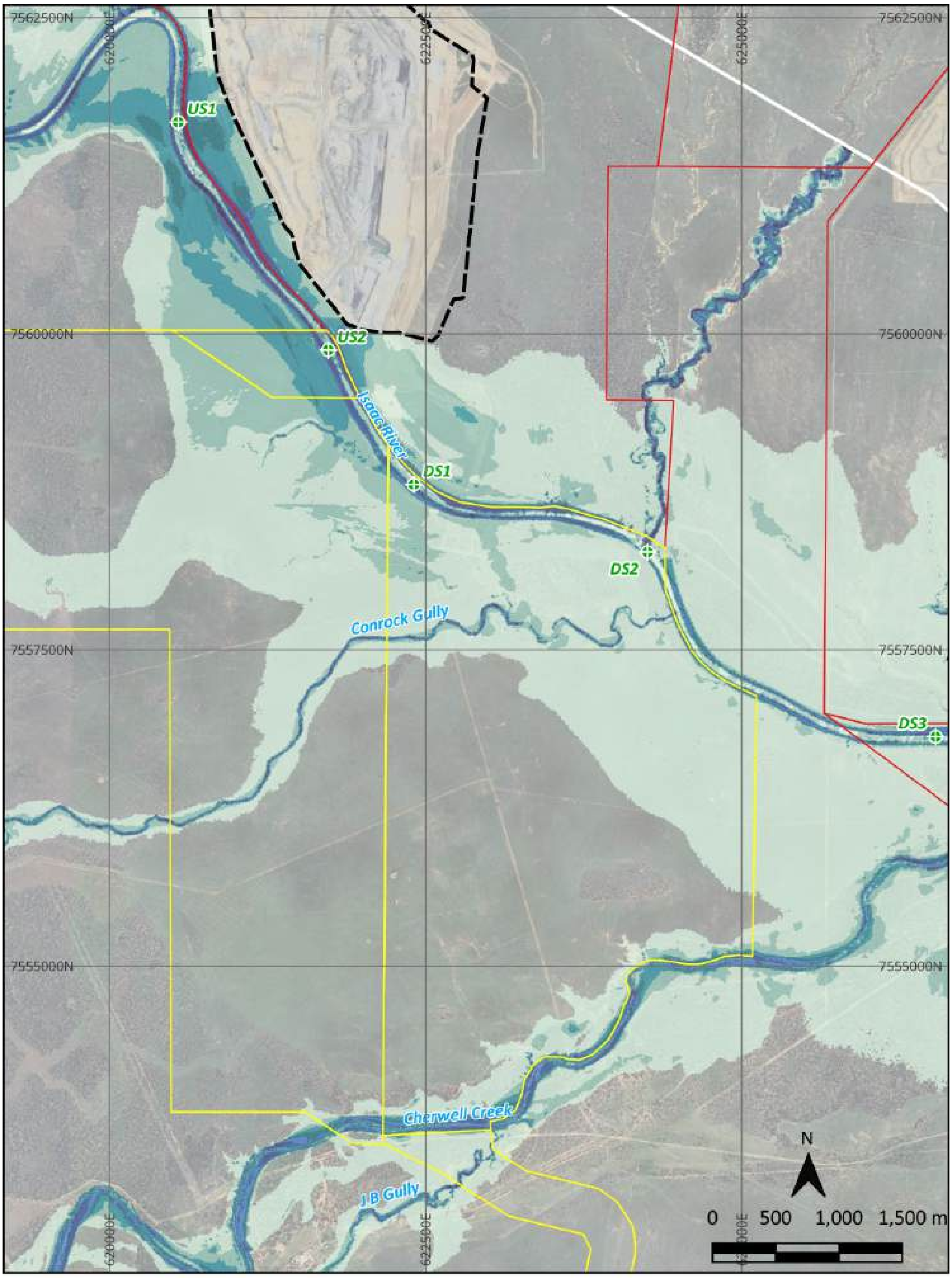
IDM final landform

Analysis point

Shear stress (N/sq. m)

<= 20	80 - 100
20 - 40	100 - 150
40 - 60	150 - 200
60 - 80	>200

Figure C.25 – Existing conditions 2% AEP flood bed shear stress



Title: 0.1% AEP bed shear stress Existing conditions

Project: Isaac Downs Extension Surface Water Assessment

Legend

MLA Boundary

Surrounding MLs

IDM final landform

Analysis point

Shear stress (N/sq. m)

<= 20

20 - 40

40 - 60

60 - 80

80 - 100

100 - 150

150 - 200

>200

HydroBalance

Figure C.26 – Existing conditions 0.1% AEP flood bed shear stress

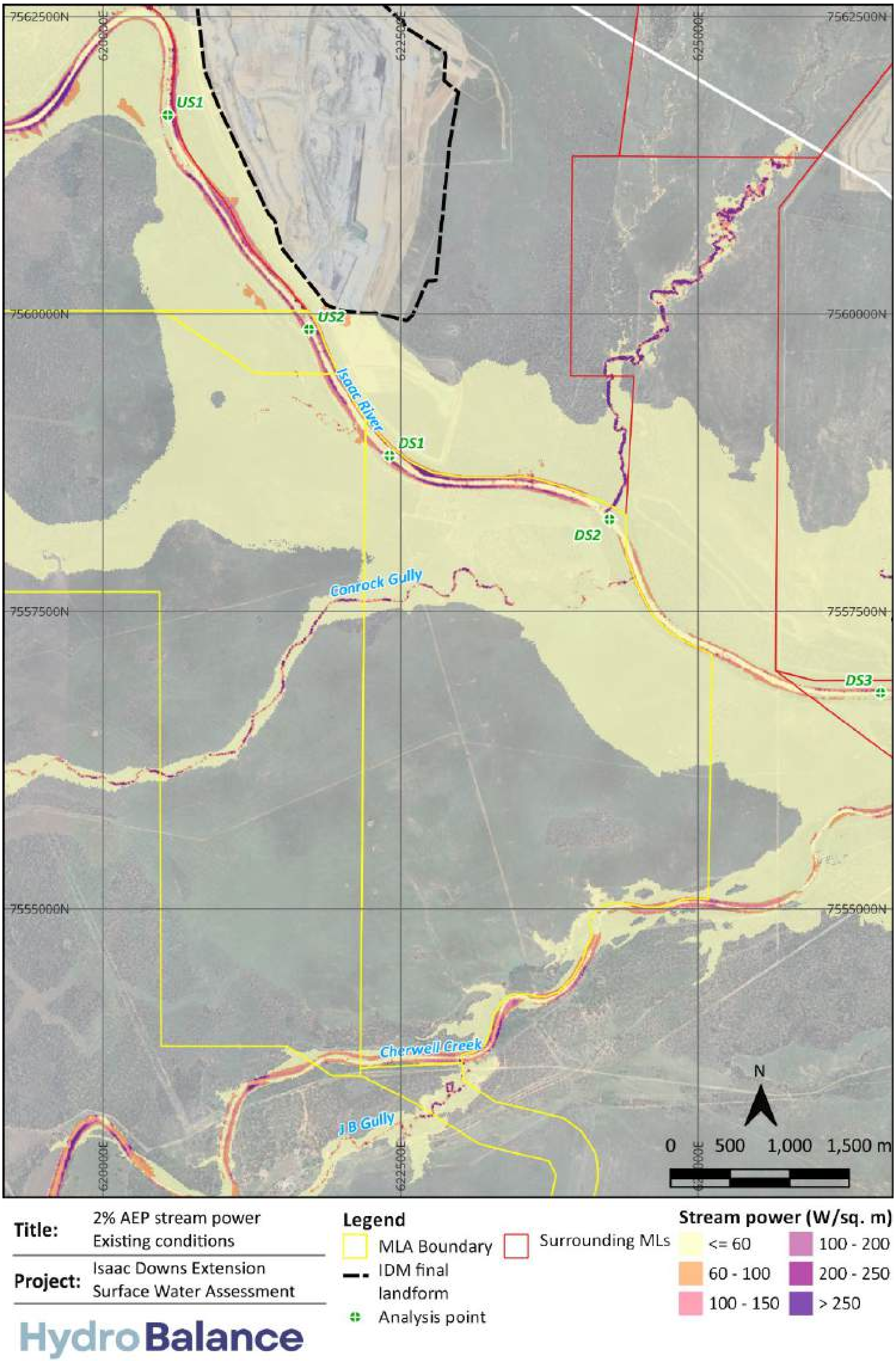


Figure C.27 – Existing conditions 2% AEP flood stream power

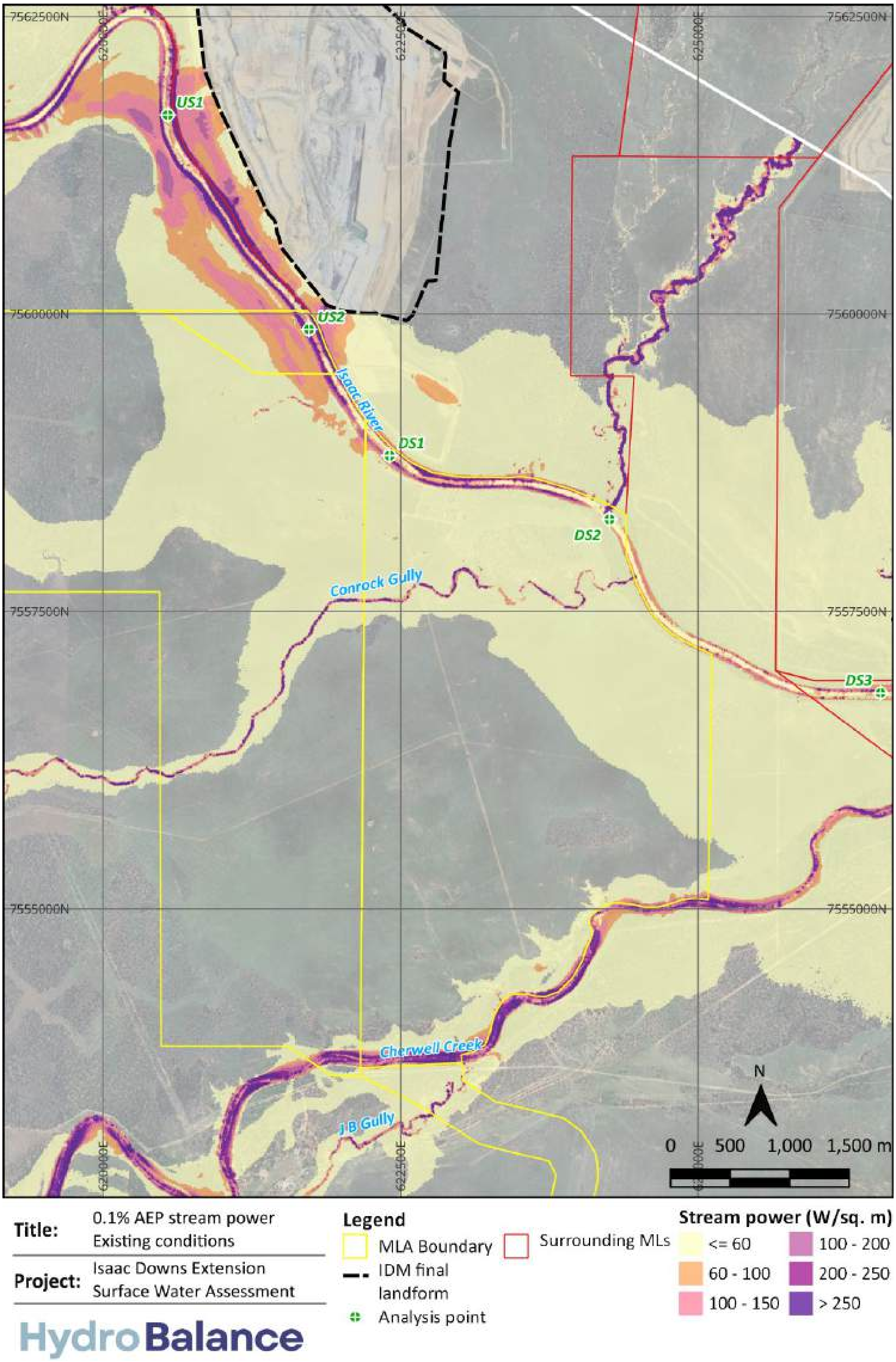


Figure C.28 – Existing conditions 0.1% AEP flood bed stream power

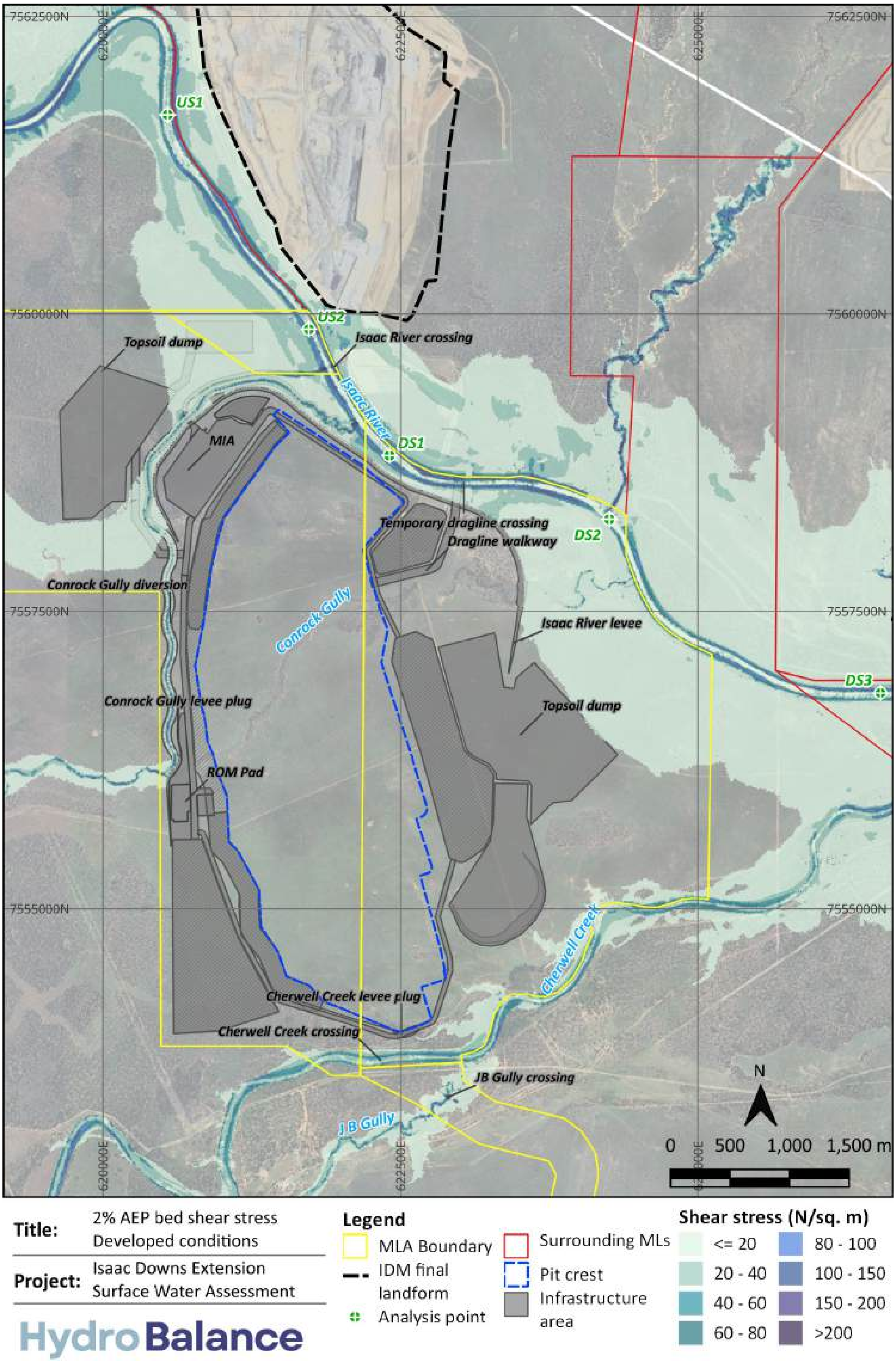


Figure C.29 – Developed conditions 2% AEP flood bed shear stress

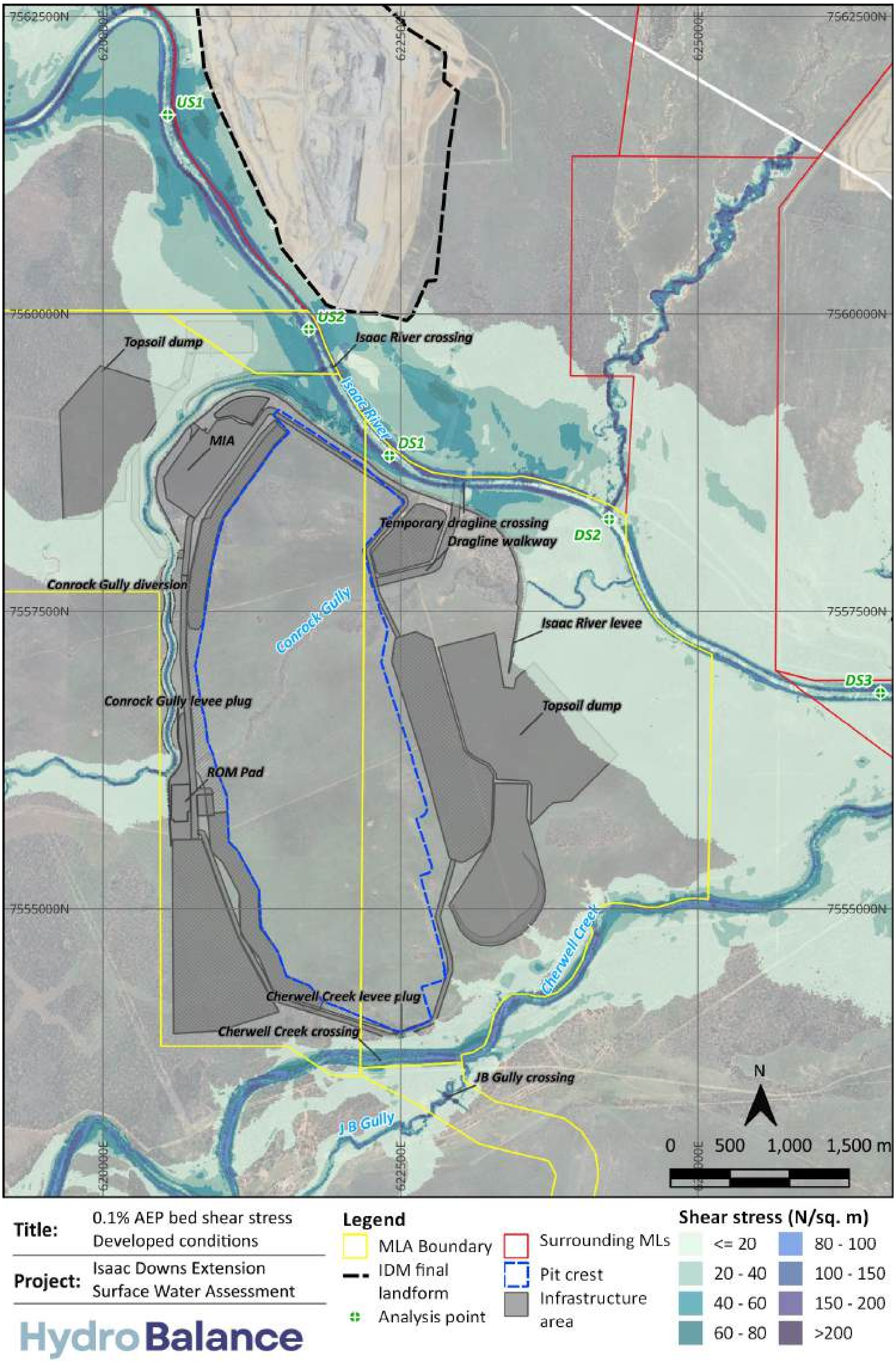
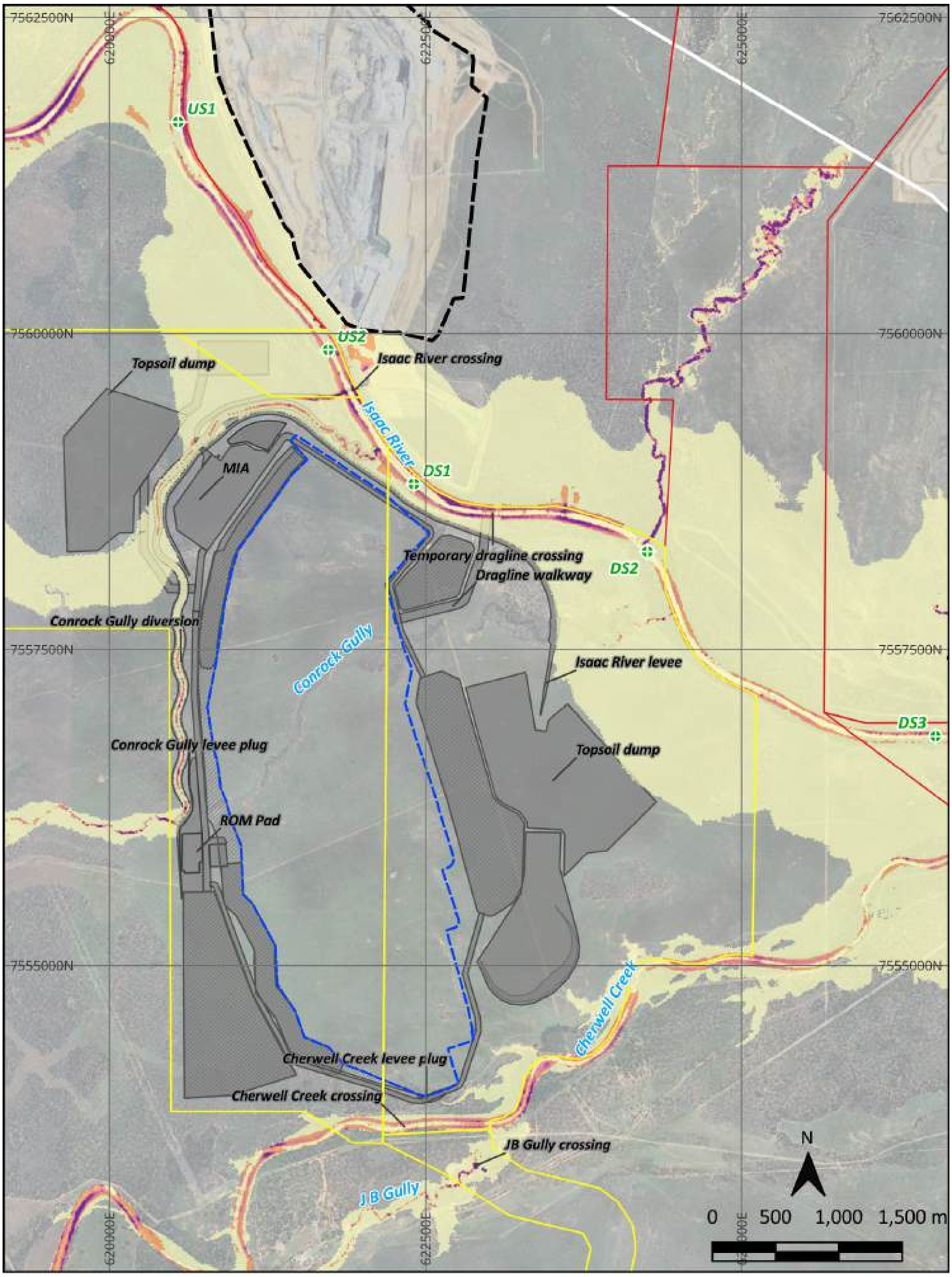


Figure C.30 – Developed conditions 0.1% AEP flood bed shear stress



Title:	2% AEP stream power Developed conditions
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- IDM final landform
- Analysis point
- Surrounding MLs
- Pit crest
- Infrastructure area

Stream power (W/sq. m)

- <= 60
- 60 - 100
- 100 - 150
- 100 - 200
- 200 - 250
- > 250

Figure C.31 – Developed conditions 2% AEP flood stream power

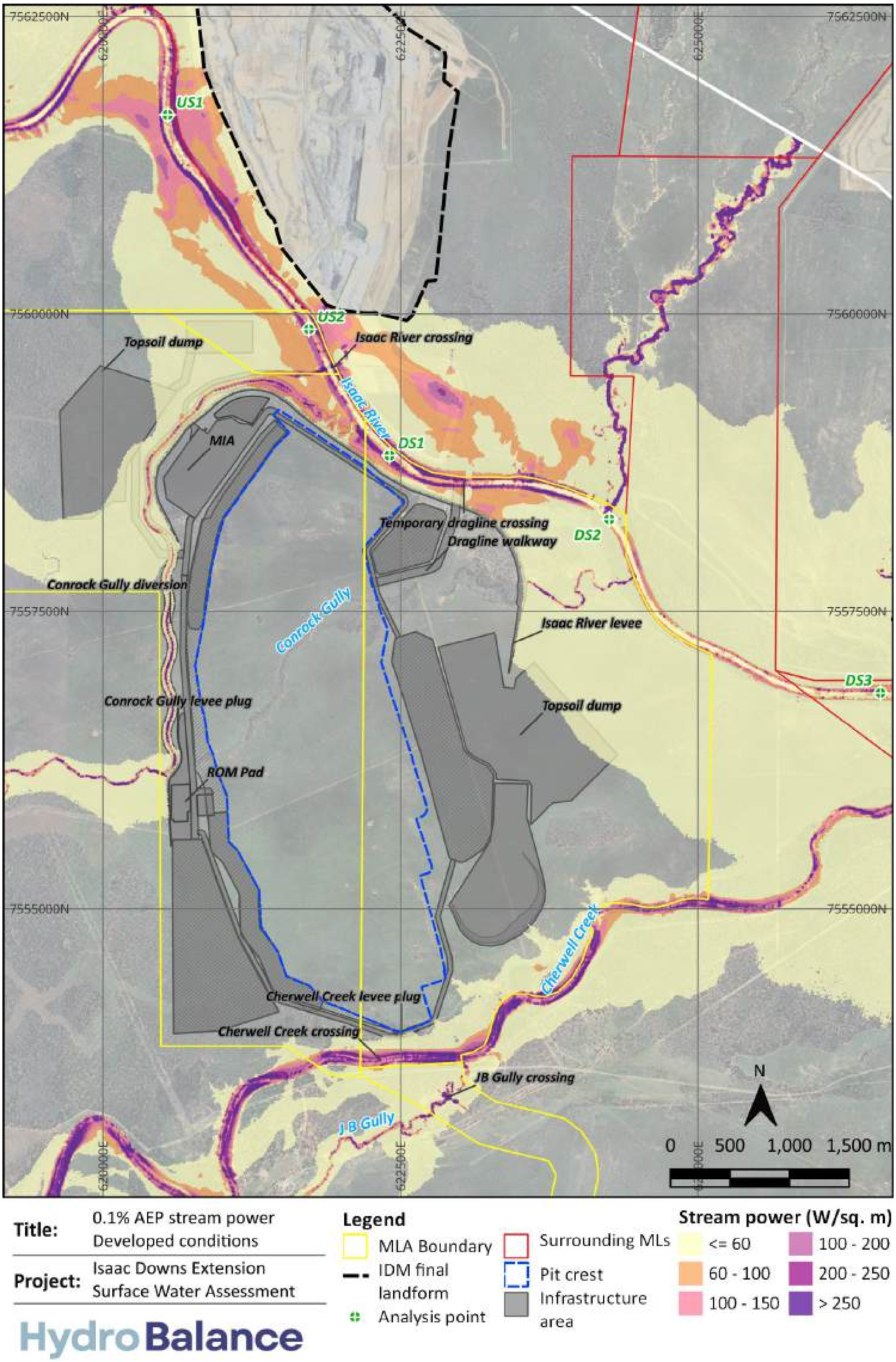


Figure C.32 – Developed conditions 0.1% AEP flood stream power

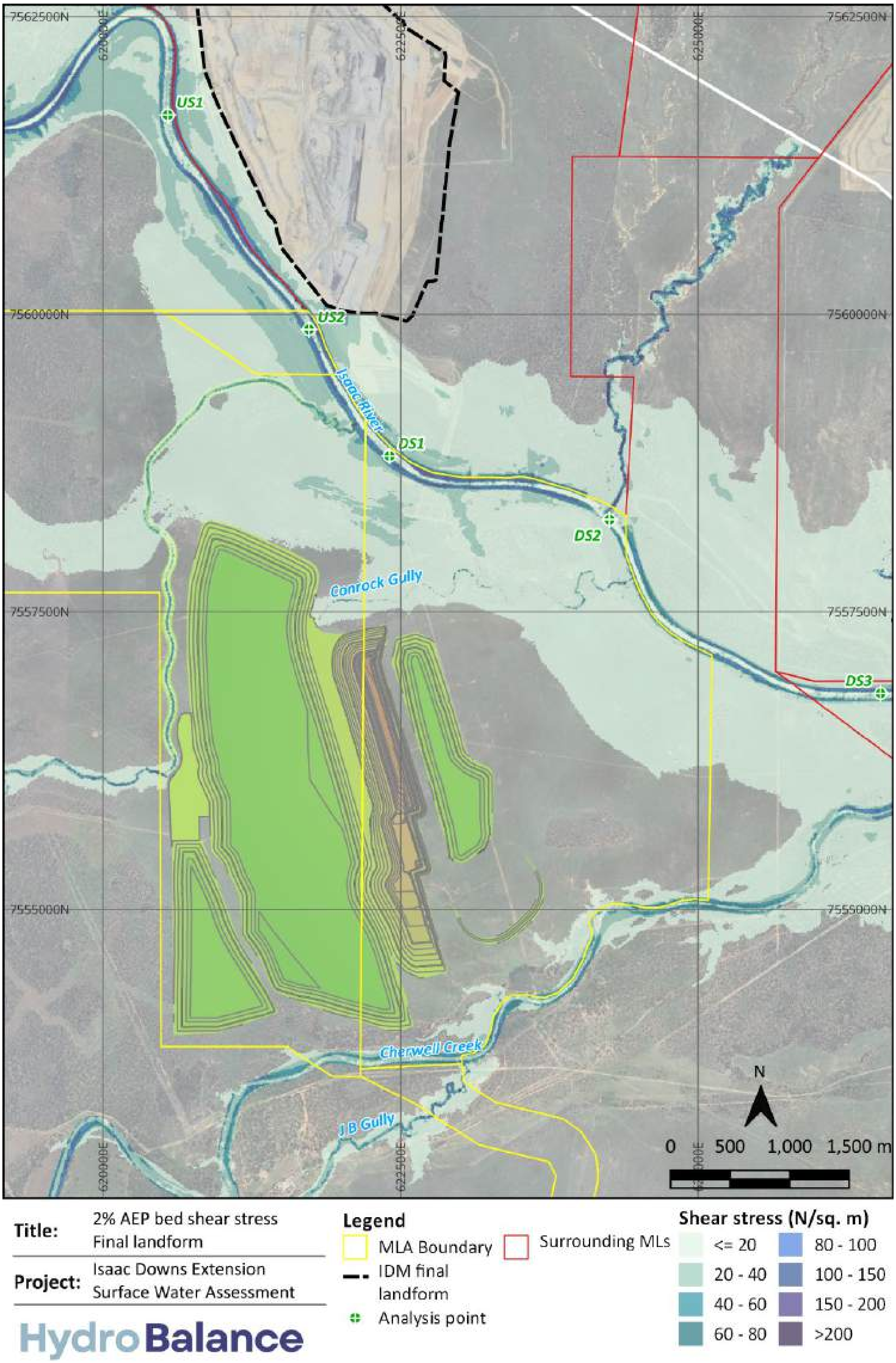
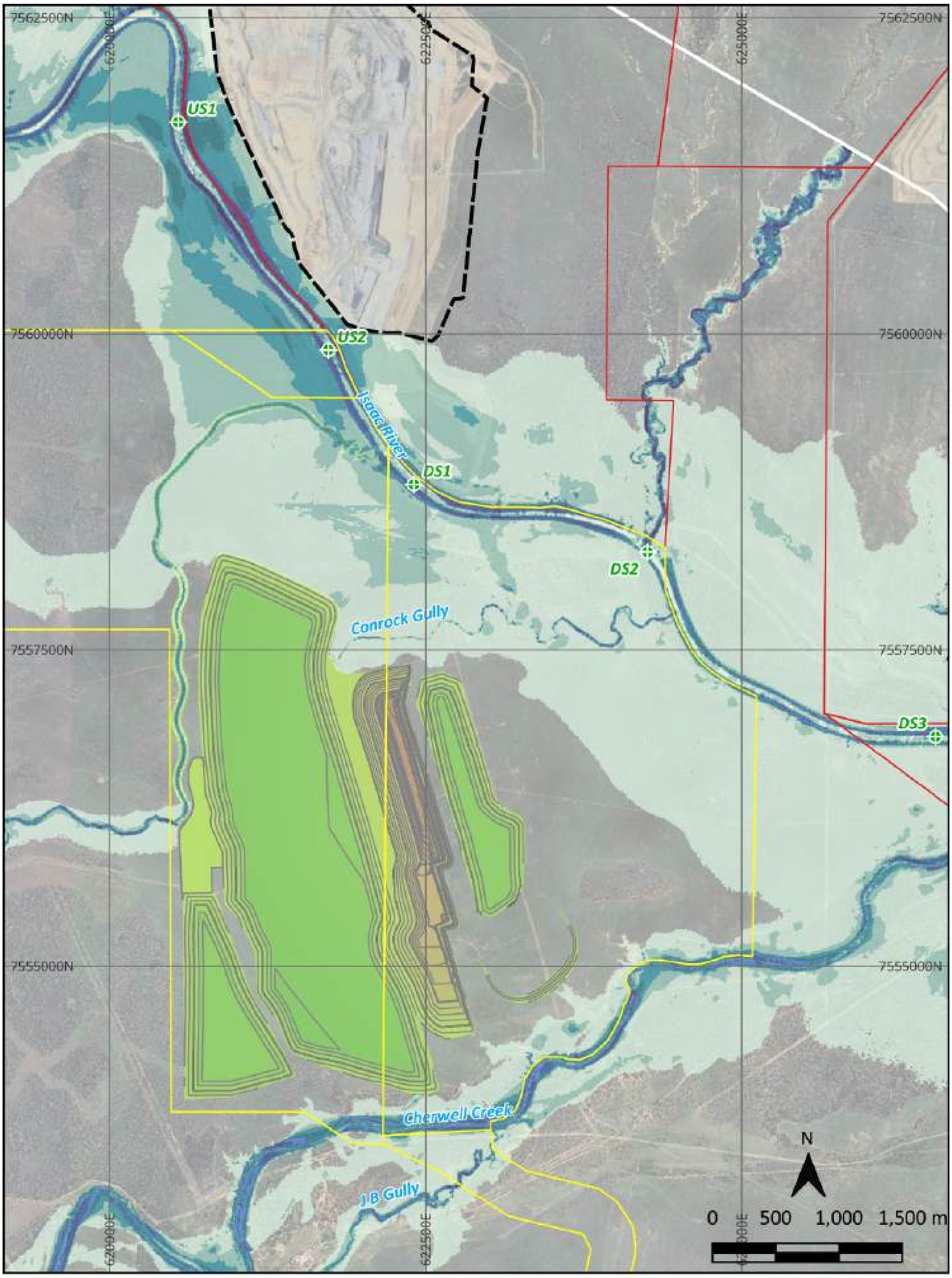


Figure C.33 – Final landform conditions 2% AEP flood bed shear stress



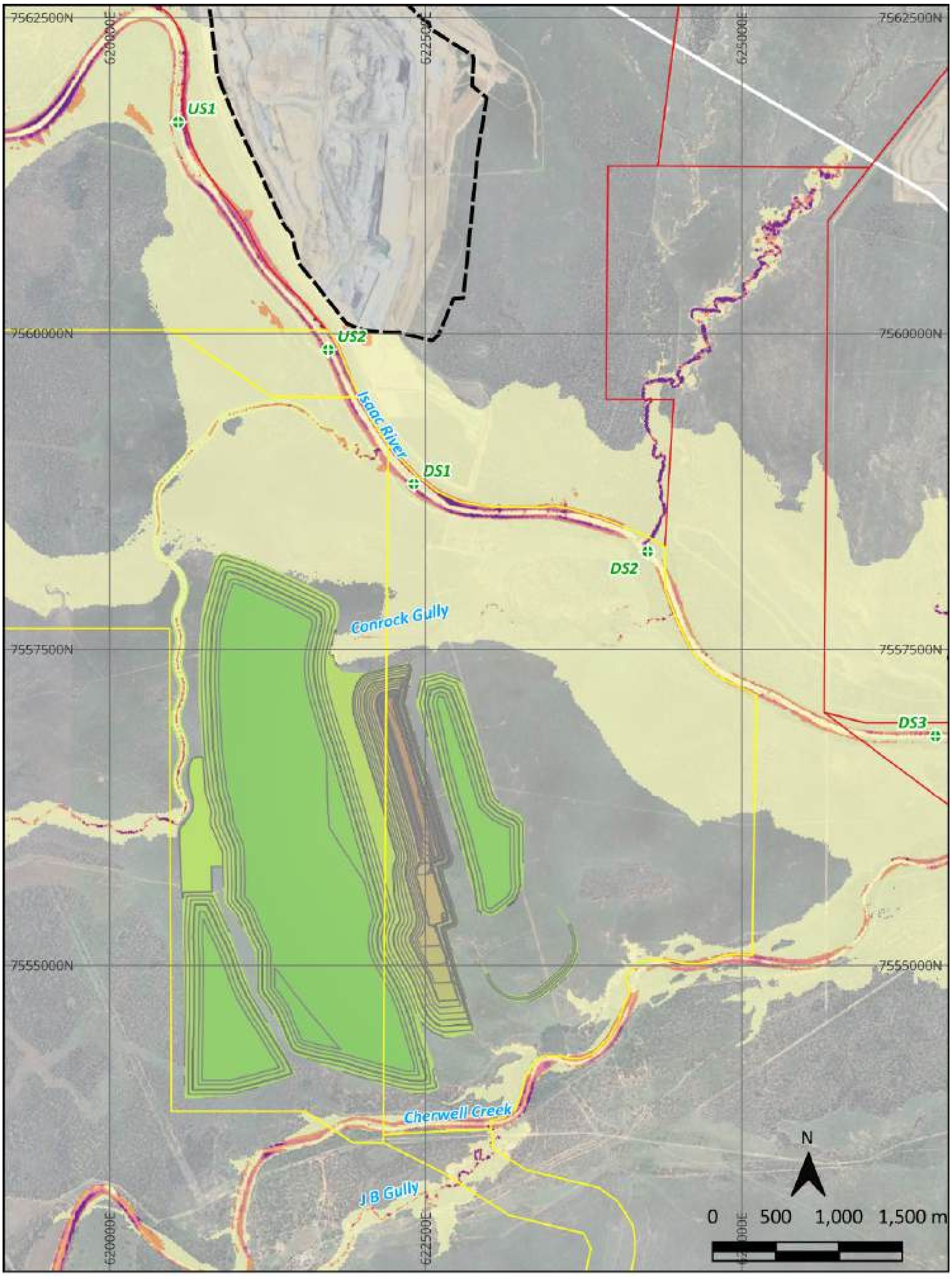
Title:	0.1% AEP bed shear stress Final landform
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend
- MLA Boundary
- Surrounding MLs
- IDM final landform
- Analysis point

Shear stress (N/sq. m)
- <= 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 150
- 150 - 200
- >200

Figure C.34 – Final landform conditions 0.1% AEP flood bed shear stress



Title:	2% AEP stream power Final landform
Project:	Isaac Downs Extension Surface Water Assessment

HydroBalance

Legend

- MLA Boundary
- Surrounding MLs
- IDM final landform
- Analysis point

Stream power (W/sq. m)

- <= 60
- 60 - 100
- 100 - 150
- 100 - 200
- 200 - 250
- > 250

Figure C.35 – Final landform conditions 2% AEP flood stream power

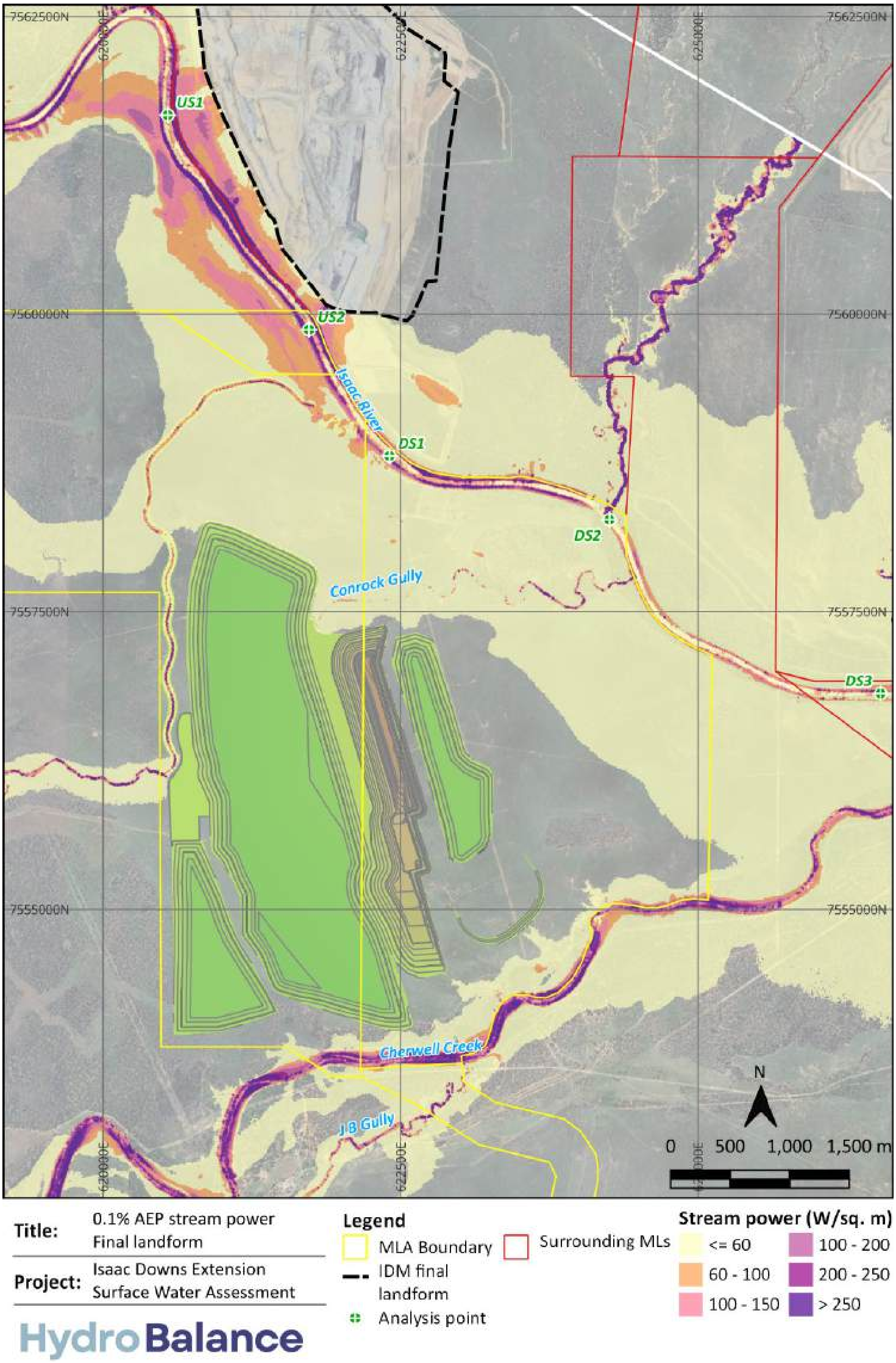


Figure C.36 – Final landform conditions 0.1% AEP flood bed stream power

Appendix D. Conrock Gully Diversion function design report

Conrock Gully Diversion

Functional Design Report

Stanmore Resources Limited

Doc. Ref.: IDE-001-C5

Date: 13 April 2026

Rev. No.	Doc Ref.	Report Date	Report Author	Reviewer
4	IDE-001-C5	13 April 2026	AH	MGB

For and on behalf of **Hydro**Balance
Environmental and Mine Water Management Solutions

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Matthew Briody
Principal Engineer

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Contents

List of Figures

List of Tables

1 Introduction

1.1 Background

Stanmore ID Extension Pty Ltd (ID Extension), a wholly owned subsidiary of Stanmore Resources Limited (Stanmore) plans to extend its existing Isaac Downs operations to the southwest and is undertaking the feasibility studies and related environmental assessments for the Isaac Downs Extension Project (the Project). The Project will be integrated into the Isaac Plains Complex, comprising Isaac Downs Mine and Isaac Plains Mine. The location of the Project is shown in the locality plan in Figure 1.1.

As part of the proposed development, Stanmore intends to mine the coal resource extending under Conrock Gully. The proposed Project area, being the Project's mining lease application (MLA) areas, and the proposed pit extent are shown in Figure 1.2. Development of the mine pits in this area will require the diversion of a 5.8 km reach of Conrock Gully and the construction an approximate 5.9 km levee associated with the Isaac River and a separate 0.9 km levee plug associated with the upstream end of the Conrock Gully diversion (see Figure 1.2) to protect the mine workings from flooding.

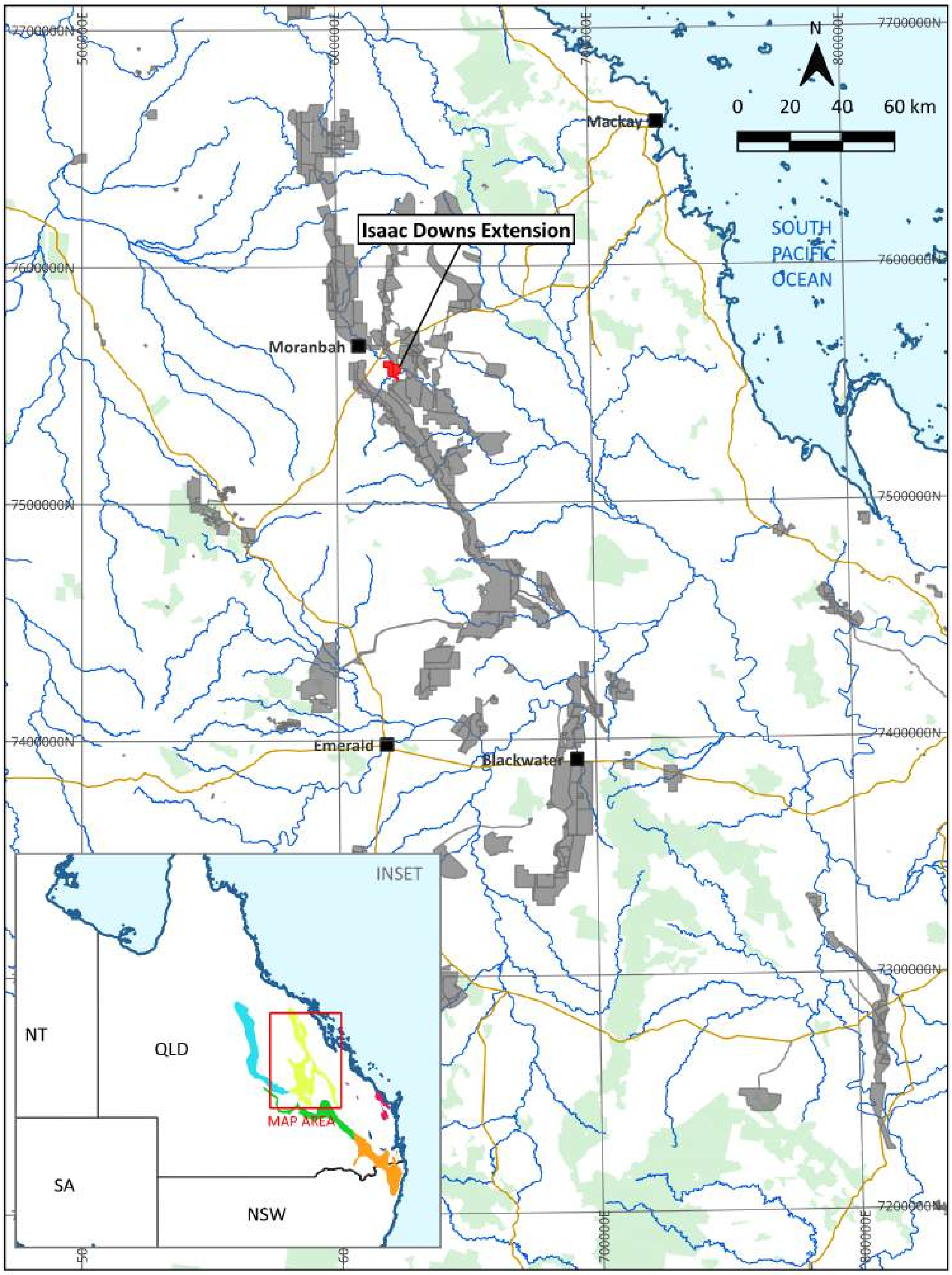
1.2 Scope of this document

Stanmore engaged HydroBalance to undertake preliminary design of the diversion and to undertake impact assessment studies. Approval of watercourse diversions occurs as part of an environmental authority (EA) under the *Environmental Protection Act 1994* (EP Act). Historically water course diversions were approved under the *Water Act 2000* (Water Act).

The Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development (DNRMMRRD) (formerly Department of Natural Resources and Mines [DNRM]) has developed the Guideline: Works that interfere with water in a watercourse: watercourse diversions (DNRM, 2019), to provide technical advice to proponents seeking approval to divert a watercourse. Proponents are encouraged to include a functional design report as a means of addressing diversion-related matters.

This report has been prepared to address the Guideline (DNRM, 2019) (the Guideline) requirements for a functional design report, namely, to document conceptually how a watercourse diversion can satisfy the outcomes identified in the guideline, including:

- Geomorphic assessment of the existing watercourse;
- Hydrologic conditions of the existing watercourse;
- The proposed watercourse diversion route;
- Hydraulic conditions of the existing watercourse and proposed watercourse diversion; and
- A statement of how the watercourse diversion meets the outcomes.



Title:	Project Locality
Project:	Conrock Gully Diversion Functional Design

HydroBalance

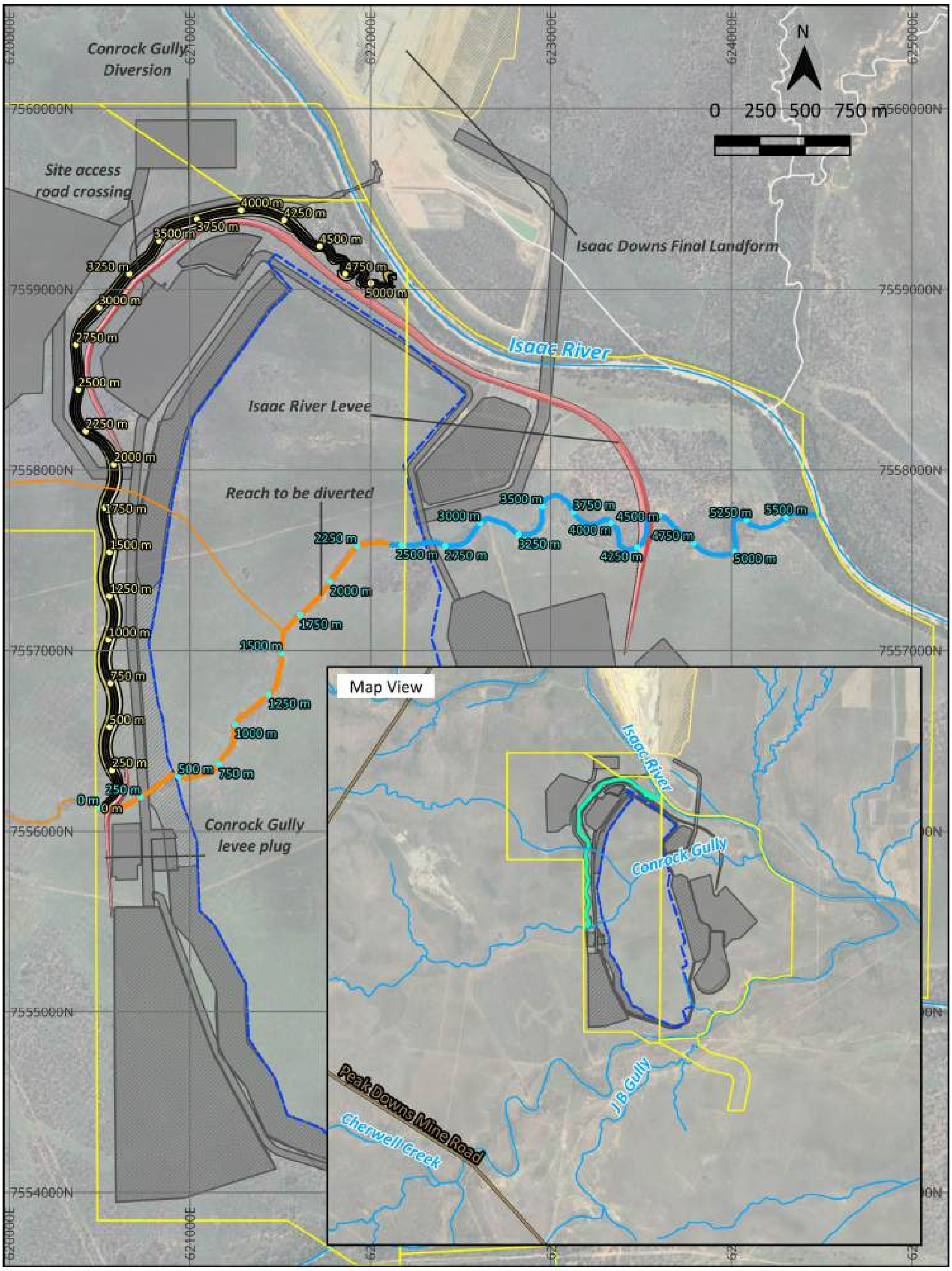
Legend

- Major watercourse
- National park
- Highway
- Surrounding MLs
- IDE MLAs

QLD Coal Measures

- Bowen Basin
- Callide Basin
- Galilee Basim
- Clarence-Moreton Basin
- Surat Basin
- Ipswich Basin
- Maryborough Basin
- Mulgildie Basin
- Tarong Basin

Figure 1.1 - Project locality



Title:	Proposed diversion layout
Project:	Conrock Gully Diversion Functional Design

HydroBalance

Legend

- MLA Boundary
- Proposed diversion footprint
- Proposed levee footprint
- Infrastructure areas
- Watercourse [defined by Water Act 2000]
- Drainage feature [defined by Water Act 2000]
- Unmapped
- IDE pit crest

Figure 1.2 – Project layout Isaac Downs Extension Project

2 Design approach

2.1 Overview

The Guideline (DNRM, 2019) provides guidance to proponents seeking approval to divert a watercourse as part of a new or amended EA application. It includes guidance on watercourse diversion design and operation including maintenance, monitoring and revegetation. The Guideline sets out key design principles and requirements for the functional designs of permanent diversions.

The watercourse determination (defined by the *Water Act 2000*) in the vicinity of the Project is shown in Figure 1.2, as well as the proposed alignment of the diversion. The majority of Conrock Gully upstream and including the beginning of the proposed diversion is defined as a drainage feature. The 3.2 km downstream reach of Conrock Gully to its confluence with Isaac River is defined as a watercourse. Diversion of a defined drainage feature does not require specific approval in an EA. Nevertheless, as the downstream reaches of Conrock Gully are a defined watercourse, design of the proposed Conrock Gully diversion is generally in accordance with the Guideline requirements. Details of how they have been addressed are provided in Section 5.

2.2 Key design principles

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

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

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

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

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

2.3 Design requirements

The following criteria have been considered when developing the proposed diversion design:

1. The watercourse diversion should tie-in with the existing or receiving watercourse within the resource tenure boundary.
2. The stability and performance of a watercourse diversion is assisted by vegetation within the watercourse diversion and adjoining floodplain and does not include artificial structures for grade control that require ongoing maintenance.
3. The channel capacity must be at least equivalent to the natural stream channel capacity existing in that vicinity.
4. The length of the channel should be equivalent to the length of the watercourse it replaces.
5. Bed grade/slope should be equivalent to the existing watercourse.
6. Batter slopes should be designed to maintain stability through different substrate.

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

Table 2.1 shows the ACARP design criteria recommended for Bowen Basin stream diversions as given in the Guideline. Stream power, stream velocity and shear stress are the main hydraulic characteristics of interest:

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

Table 2.1 – ACARP Design Criteria for Bowen Basin Stream Diversions

Scenario	Stream Power (W/m^2)	Velocity (m/s)	Bed Shear (N/m^2)
50% AEP (no vegetation)	<35	<1.0	<40
50% AEP (vegetated)	<60	<1.5	<40
2% AEP	<150	<2.5	<50

3 Existing geomorphic and vegetation conditions

3.1 Geomorphic character

The reach of Conrock Gully between the Peak Downs Mine Access Road and its confluence with the Isaac River is shown in Figure 1.2. It is an alluvial system with low to moderate sinuosity and a single channel with moderate capacity.

The length of the channel from the Peak Downs Mine Access Road to the Isaac River reach is approximately 17.7 km, of which 12.1 km is located upstream of the Project's MLAs. The reach within the Project MLAs to the Isaac River confluence is approximately 5.6 km long. The downstream 3.2 km of this reach crosses the Isaac River floodplain and is more sinuous than the upstream reaches.

3.2 Meander plan-form characteristics

Meanders in Conrock Gully within the MLAs are irregular. Meander amplitude is greatest in the proposed diverted reach (up to approximately 330 m), but the reaches within the Isaac River floodplain meander amplitude is less than 150 m. Meander wavelength ranges up to approximately 1,200 m, but small meanders have a typical wavelength of approximately 250 m across the MLA areas.

Over the full reach of Conrock Gully within the MLAs, sinuosity (channel length divided by valley length) is approximately 1.4, but the downstream reaches within the Isaac River floodplain have a sinuosity of 1.7. In the reach upstream of the Isaac River floodplain, the sinuosity index is lower (1.2).

Meander radii within the MLAs range from less than 75 m in the downstream reaches in the Isaac River floodplain to over 310 m in the upstream reaches near the beginning of the proposed diversion. The median radius in the Conrock Gully section upstream of the Isaac River floodplain approximately 240 m.

3.3 Floodplain geometry

The Conrock Gully floodplain is narrow in the vicinity of the proposed diversion, with a width between 150 m and 300 m. The floodplain widens downstream, as the reach enters the Isaac River floodplain. The channel is depressed below the surrounding floodplain as illustrated in Figure 3.1. The cross-sections show that the invert of the bed of the northern floodplain is approximately 2 m below the level of the main channel bank.

Conrock Gully consists of a single main creek channel, with very few minor breakout channels within the floodplain, due to the confined nature of the channel within the floodplain.

3.4 Channel form

The channel banks appear well vegetated and relatively stable. Digital elevation models acquired in 2012 to 2018 shows no evidence of significant channel movement when compared to photographs taken in 2011.

A long section of the Conrock Gully channel bed along the reach to be diverted is shown in Figure 3.2. The channel bed slope within the MLAs is a uniform at 0.14% (1 in 690), aside from a steeper downstream section at 0.48% (1 in 210) as Conrock Gully joins the Isaac River. The 5.8 km reach of Conrock Gully to be diverted is shown in Figure 1.2.

In the vicinity of the proposed diversion, the channel shape is relatively uniform. This is illustrated in Figure 3.1, which overlays all cross-sections extracted at 100 m intervals along a 5.8 km reach of Conrock Gully to be diverted. Side slopes are generally similar on both sides of the channel.

The channel cross-section geometry can be typified by the generalised cross-section in Figure 3.3, which was created from the cross-section data presented in Figure 3.1 (the chart shows the median channel width over the range of channel depths and the 10th and 90th percentiles. The "median" channel can be described as having:

- A base width of approximately 4 m;

- A side slope of 1V in 6H for the channel;
- A side slope of 1V in 30H on the channel overbank;

The channel is typically approximately 1.5 m to 3.5 m deep. At a depth of 2 m, the channel top width is typically approximately 50 m.

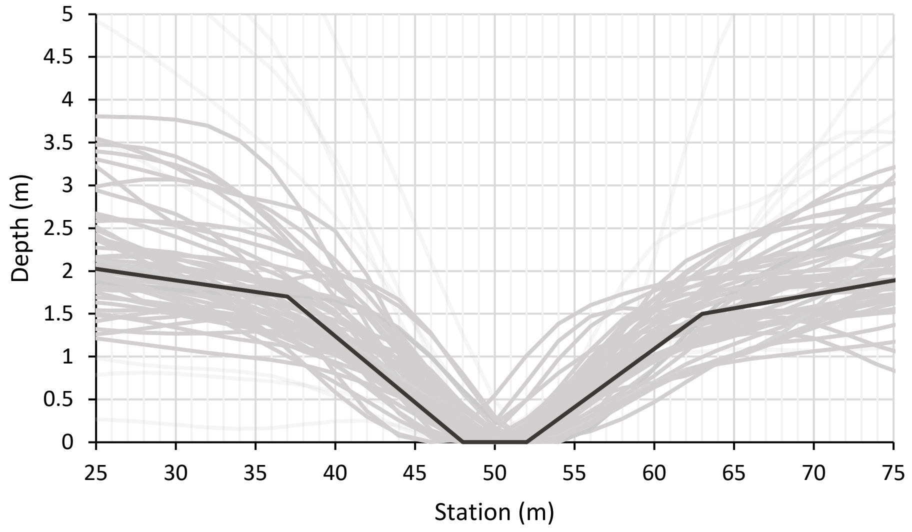


Figure 3.1 - Cross-section geometry in the vicinity of the reach to be diverted

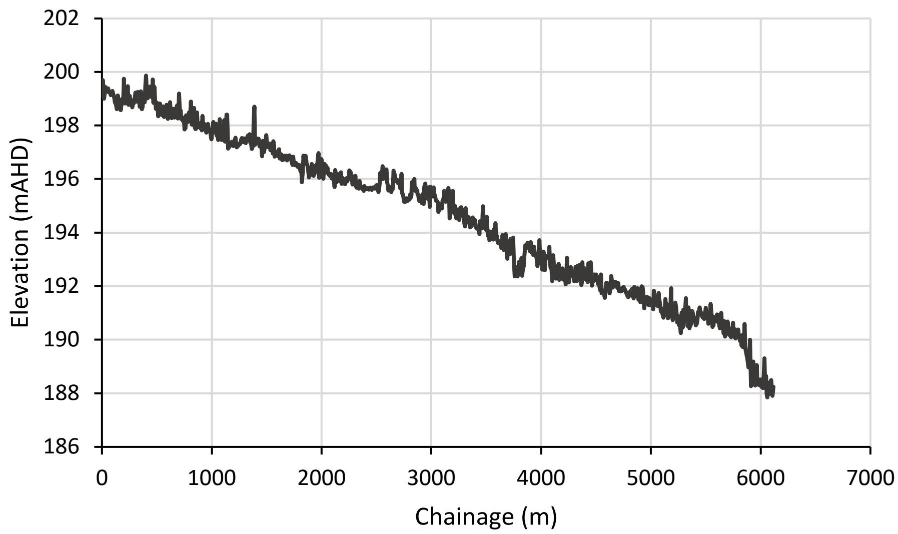


Figure 3.2 – Long-section of the Cornock Gully reach to be diverted

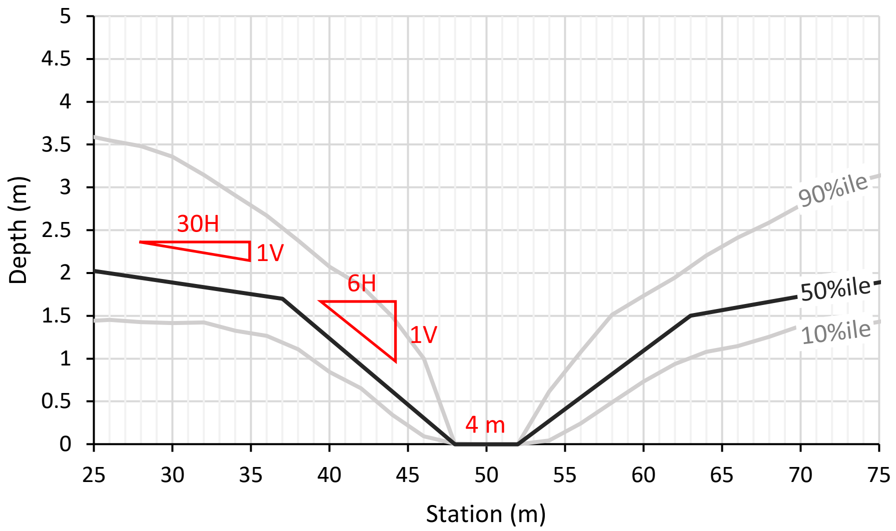


Figure 3.3 - Generalised cross-section in the vicinity of the reach to be diverted

4 Existing hydrologic and hydraulic conditions

4.1 Catchment description

Conrock Gully has a catchment area of approximately 38 km^2 upstream of the proposed stream diversion, and approximately 71 km^2 to the confluence with the Isaac River.

The catchment extends west from the western MLA boundary and east to the Isaac River confluence.

Surrounding land uses include low intensity cattle grazing and open cut mining. The Isaac Downs and Poitrel open cut coal mines are situated on the opposite side of the Isaac River in the vicinity of the Project area. Isaac Downs Mine adjoins the Project area and Poitrel is located 5 km downstream of the Project area.

4.2 Catchment hydrology

4.2.1 Flow characteristics

There are no streamflow gauges on Conrock Gully, hence there is no current or historical streamflow data for Conrock Gully.

Stanmore had operated a stream gauge on Billy's Gully at the nearby Isaac Plains Mine operation since 2013. Billy's Gully has a similar catchment area (68 km^2) and general characteristics to Conrock Gully. An analysis of the Billy's Gully streamflows has been undertaken to represent the potential flows in Conrock Gully.

The recorded streamflows in Billy's Gully, along with recorded rainfall, is shown in Figure 4.1. At Billy's Gully streamflow gauge, flows were recorded on approximately only 0.1% of days. The maximum water level recorded at Billy's Gully was 12.6 mGH in February 2016 (flow depth of around 2.6 m at the gauge).

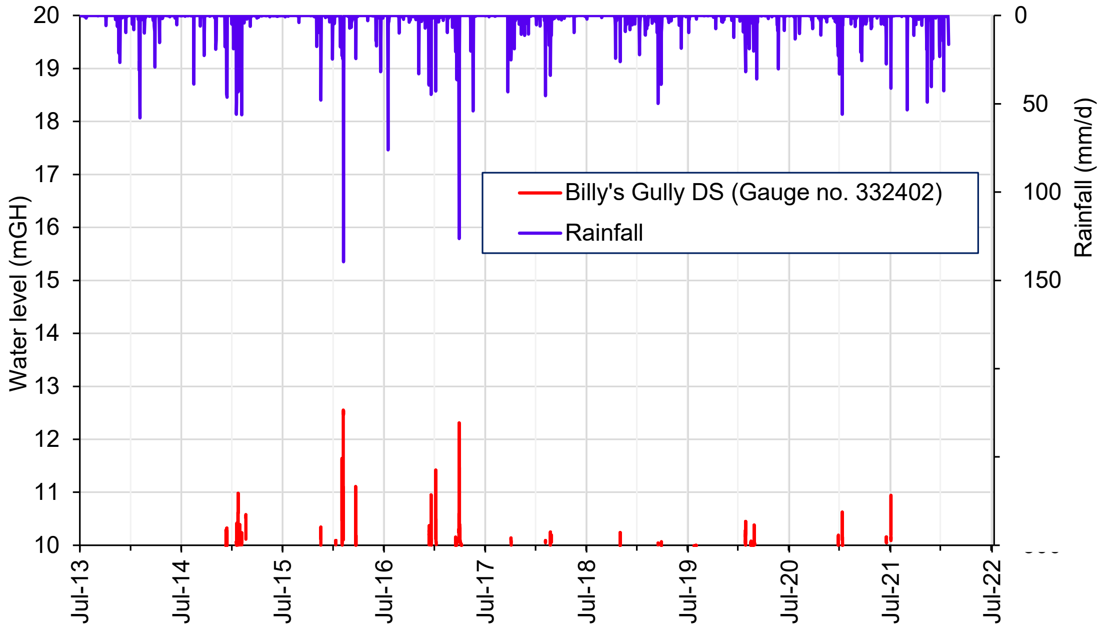


Figure 4.1 - Recorded water level at Billy's Gully DS (gauge no. 332402)

The nearest gauge on the Isaac River is located at Deverill, 25 km downstream of Conrock Gully, which is operated by the DNRMMRRD.

Figure 4.2 shows a ranked plot of the daily stream flows in the Isaac River recorded at the Deverill stream gauge. The following is of note with respect to the recorded stream flows:

- The Isaac River is ephemeral with flows recorded only on 27% of days at Deverill. Flows above 100 ML/d occur for less than 10% of days at Deverill. A flow of 100 ML/d would not fully inundate the bed of the Isaac River at Deverill.
- The mean daily flow (all days) is 430 ML/d at Deverill.
- The highest recorded flow (2,638 m^3/s) at the Deverill gauge occurred in March 1988 where the river reached a gauge height of 11.4 m.

The downstream reach of Conrock Gully, including the proposed diversion, will be impacted by Isaac River flood flows. Hydraulic modelling (presented in Section 4.3) indicates Isaac River flood flows will back up into Conrock Gully during a 50% AEP (1 in 2 year) regional flood event, which is equivalent to a 375 m^3/s (equivalent to 32 ML/d) peak discharge at the Isaac River at Deverill. Isaac River floodwaters are expected to back up into Conrock Gully for approximately 15% of total days or around 55% of Isaac River flow days.

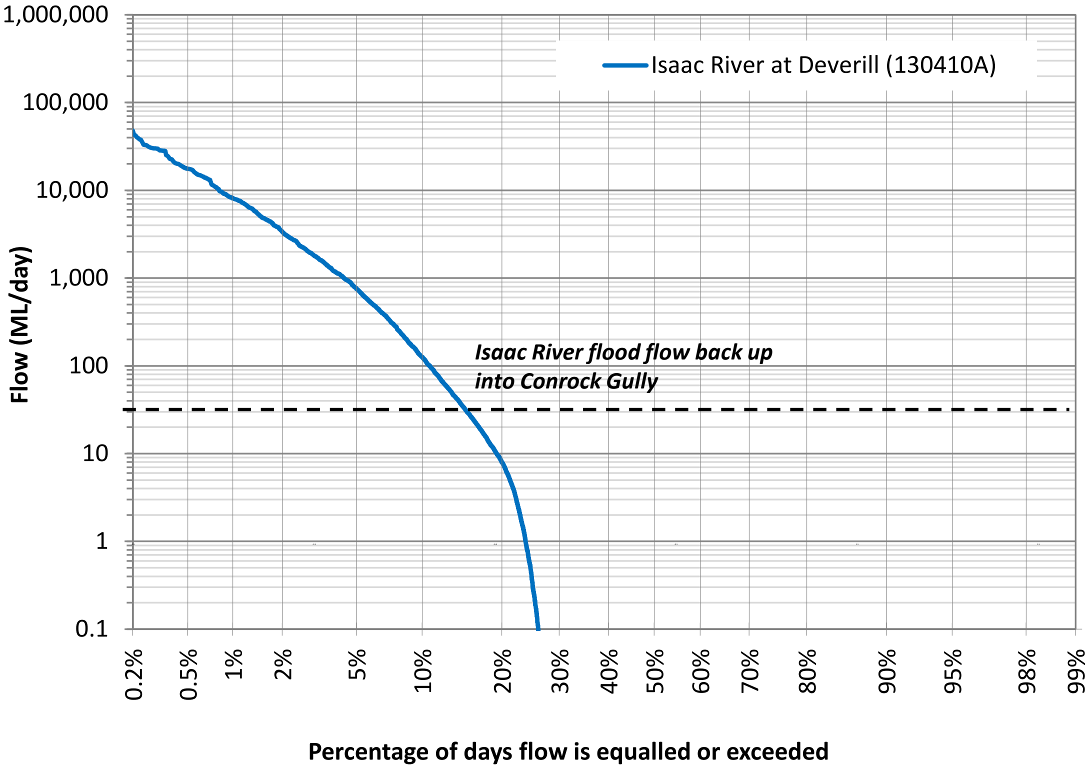


Figure 4.2 - Stream flow duration curves, Isaac River at Deverill gauge

4.2.2 Conrock Gully flood flow characteristics

An RORB runoff-routing model was used to estimate design flood discharges in the Isaac River and its tributaries. The model covers the Isaac River catchment to the Deverill gauge and consists of over 91 sub-catchments. The design flood discharges account for climate change influences for current conditions, based on the methodology provided in ARR (2019).

The configuration of the Isaac River RORB model is provided in the *Isaac Downs Extension Flood Impact Assessment* (HydroBalance, 2026). Design flood discharges were obtained from the model for the 50%, 2%, 1% and 0.1% (1 in 1,000) AEP design using procedures outlined in ARR (2019).

The critical storm duration for most design flood events is between 6 and 24 hours. Table 4.1 shows the peak design discharges for the 50%, 2%, 1% and 0.1% AEP events in Conrock Gully immediately upstream of the proposed diversion.

Table 4.1 – Modelled design flood events

ID	Source	Design event	Critical duration	Peak discharge (m^3/s)
1	Local	50% AEP	12 hour	65
2	Local	2% AEP	6 hour	256
3	Regional	0.1% AEP	24 hour	300

4.3 Hydraulic conditions

4.3.1 Methodology

A TUFLOW hydraulic model was used to simulate the flow behaviour of Conrock Gully for existing conditions and post-diversion conditions, considering the following flow regimes:

- **50% and 2% AEP local creek flows:** Local creek flows exclude regional Isaac River flooding. This would occur when either:
    - significant rainfall occurs in the Conrock Gully catchment and minimal rainfall occurs in the wider Isaac River catchment upstream of Conrock Gully.
    - the local Conrock Gully flows peak faster than the Isaac River flows, due to the quicker response times of the local creeks.

  The Isaac River floodplain velocities are lower than the channelised local creek flows, hence the modelled local flows excluding the Isaac River flood will **represent maximum possible velocities and shearing forces** in Conrock Gully.
- **0.1% AEP regional river flows**. The regional river flows include local creek flows, concurrent with regional Isaac River flooding. The regional Isaac River flooding will **represent maximum depths and flood extents** in Conrock Gully.

TUFLOW represents hydraulic conditions on a fixed grid by solving the full two-dimensional depth averaged momentum and continuity equations for free surface flow. The model automatically calculates breakout points and flow directions within the flood model study area.

Full details of the TUFLOW model are provided in the *Isaac Downs Extension Flood Impact Assessment* (HydroBalance, 2025).

4.3.2 Flood extents

The extents of flooding in the 50% and 2% AEP design local flood events are shown in Figure 4.3 and Figure 4.4.

The figures show that during the 50% AEP flood, all flow is contained in bank within the Conrock Gully main channel. There is some localised inundation on the northern floodplain, due to local catchment runoff. In the 2% AEP flood event, the extent of flooding is not significantly greater, with the majority of flows contained in bank with some breakout into the narrow floodplain.

The 0.1% AEP design regional flood extent is shown in Figure 4.5. The Isaac River floodplain is around 1.7 km wide in the vicinity of the Project, impacting the downstream reaches of Conrock Gully.

4.3.3 Flood velocity, shear stress and stream power

The modelled flood velocity for the 50% and 2% AEP design local flood events and the 0.1% AEP design regional flood events are shown in Figure 4.6, Figure 4.7 and Figure 4.8. The figure shows velocities are high (greater than 2.5 m/s) within the main channel banks. There are localised instances of high velocities on the banks of the channel, however the velocities along the majority of the channel banks are relatively low.

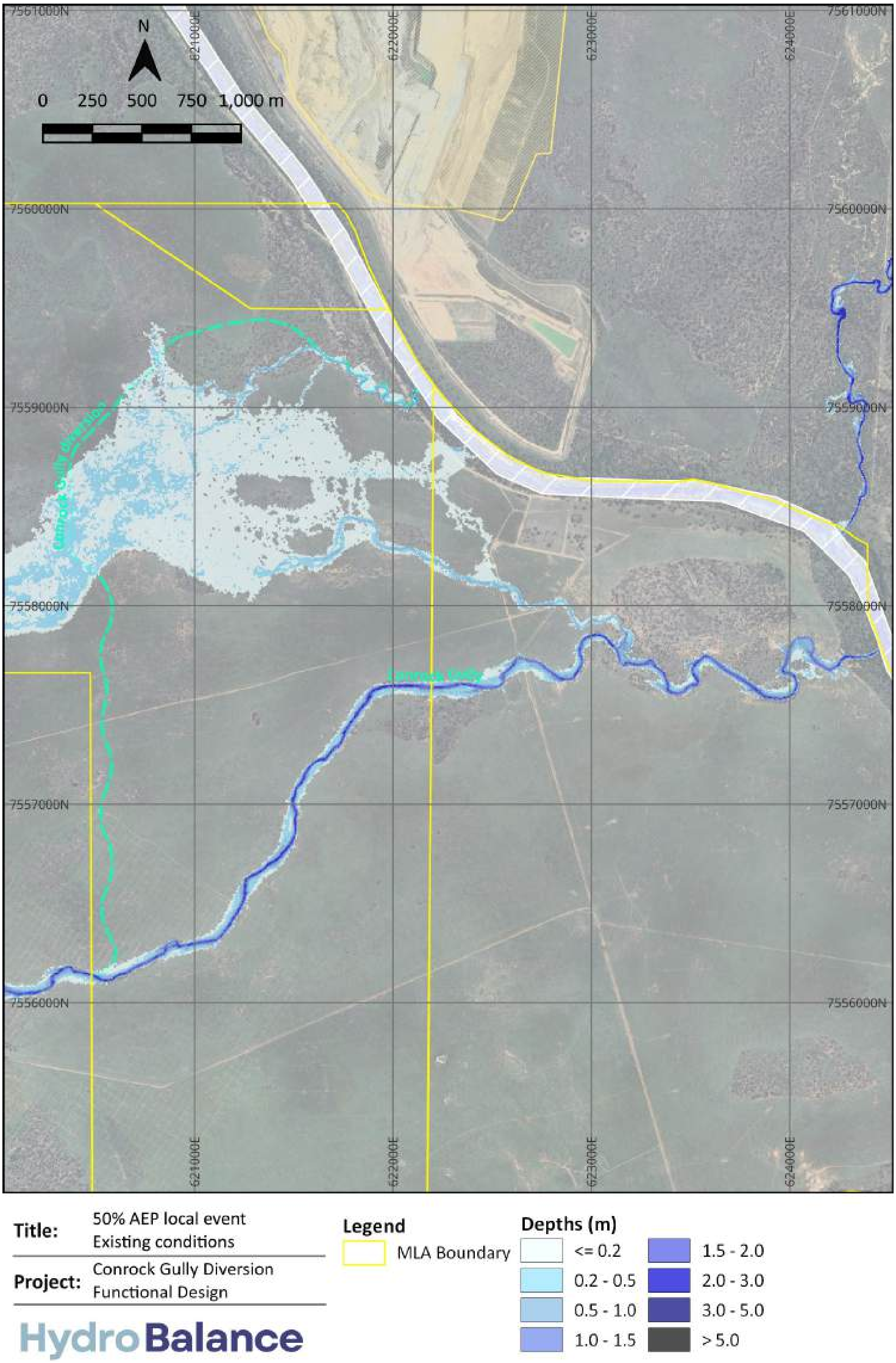


Figure 4.3 – 50% AEP existing conditions flood depth, local flood – no regional Isaac River flood

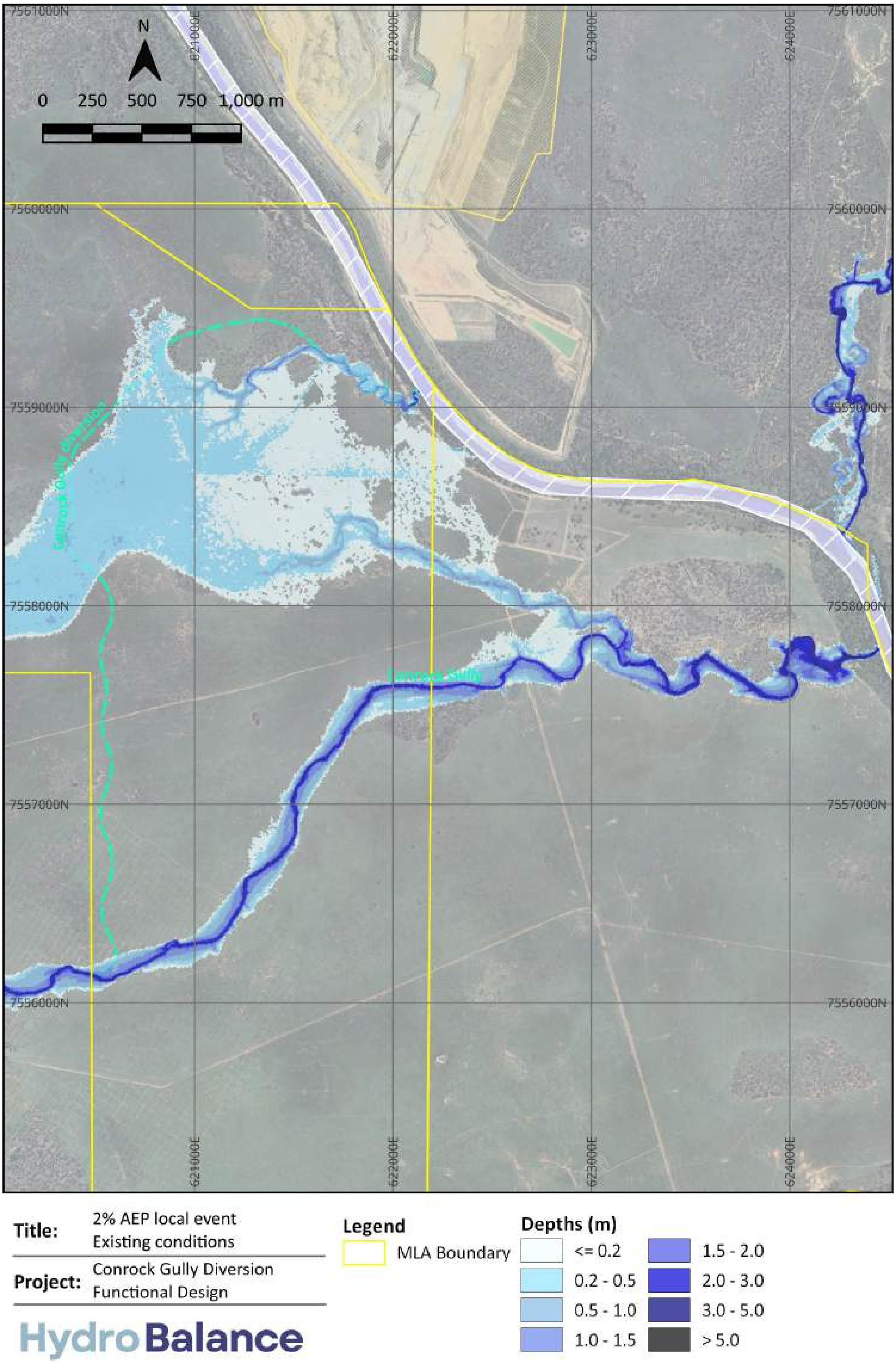


Figure 4.4 – 2% AEP existing conditions flood depth, local flood – no regional Isaac River flood

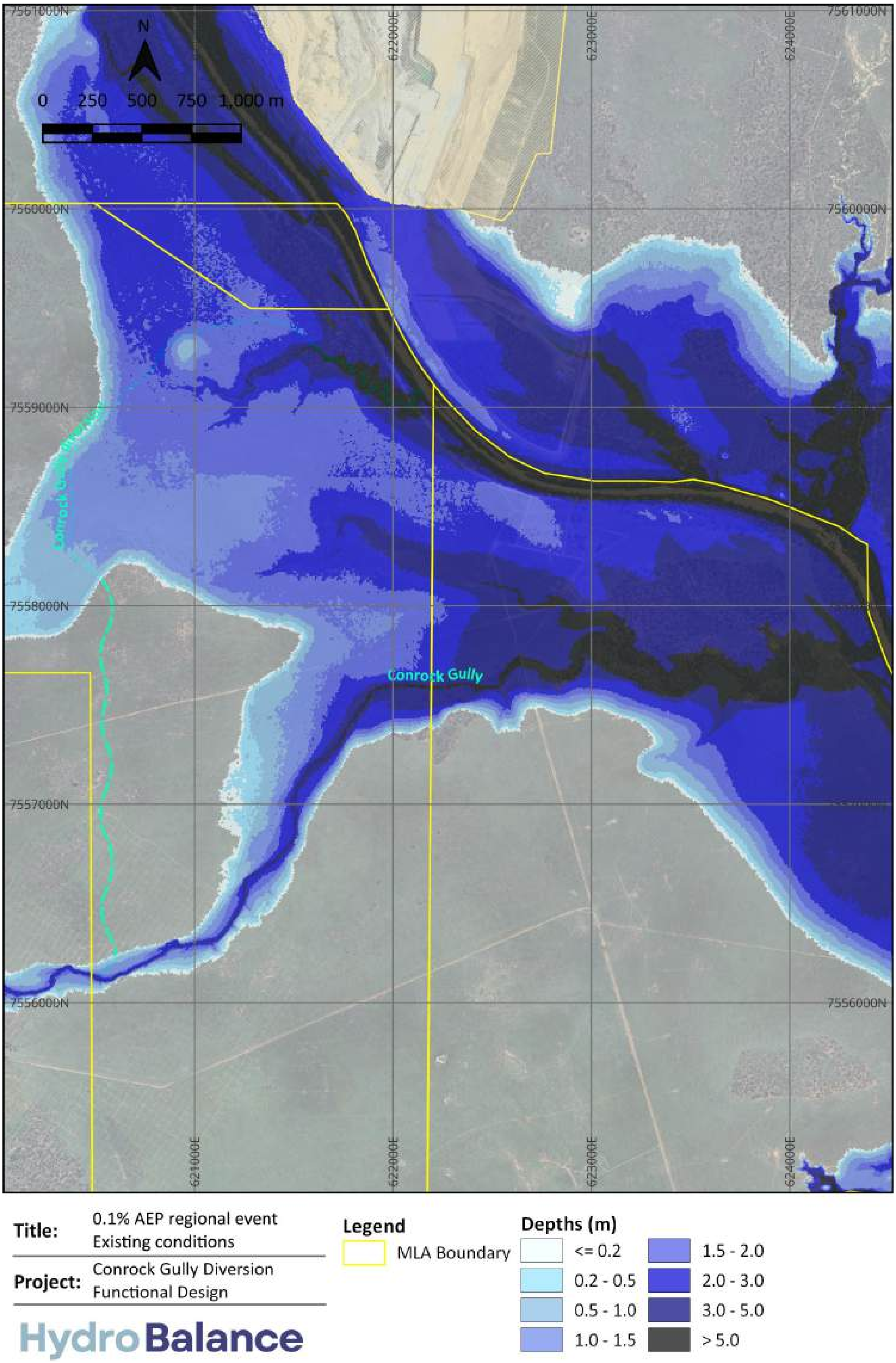


Figure 4.5 – 0.1% AEP existing conditions flood depth, local and regional flood

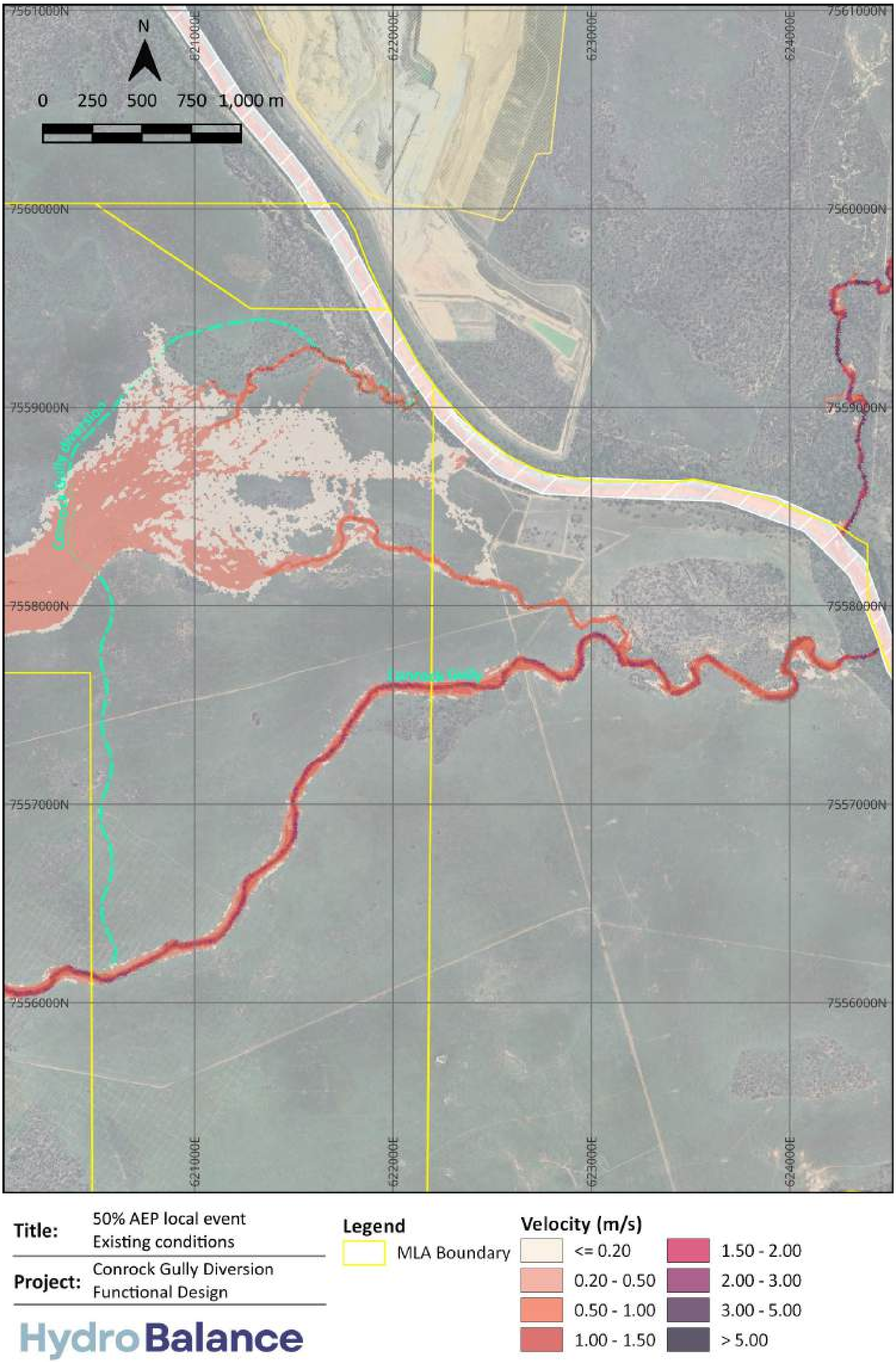


Figure 4.6 – 50% AEP existing conditions flood velocities, local flood – no regional Isaac River flood

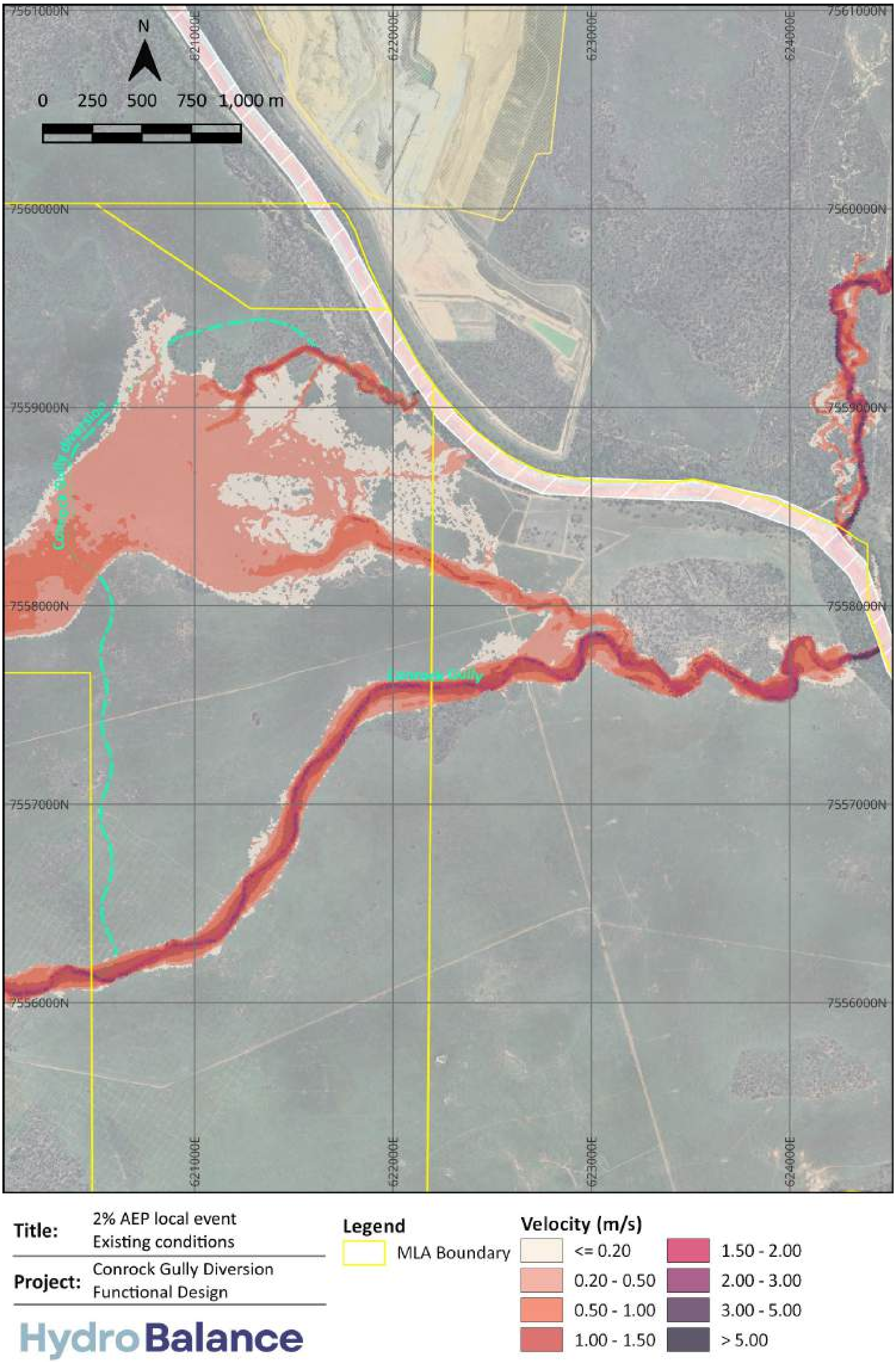


Figure 4.7 – 2% AEP existing conditions flood velocities, local flood – no regional Isaac River flood

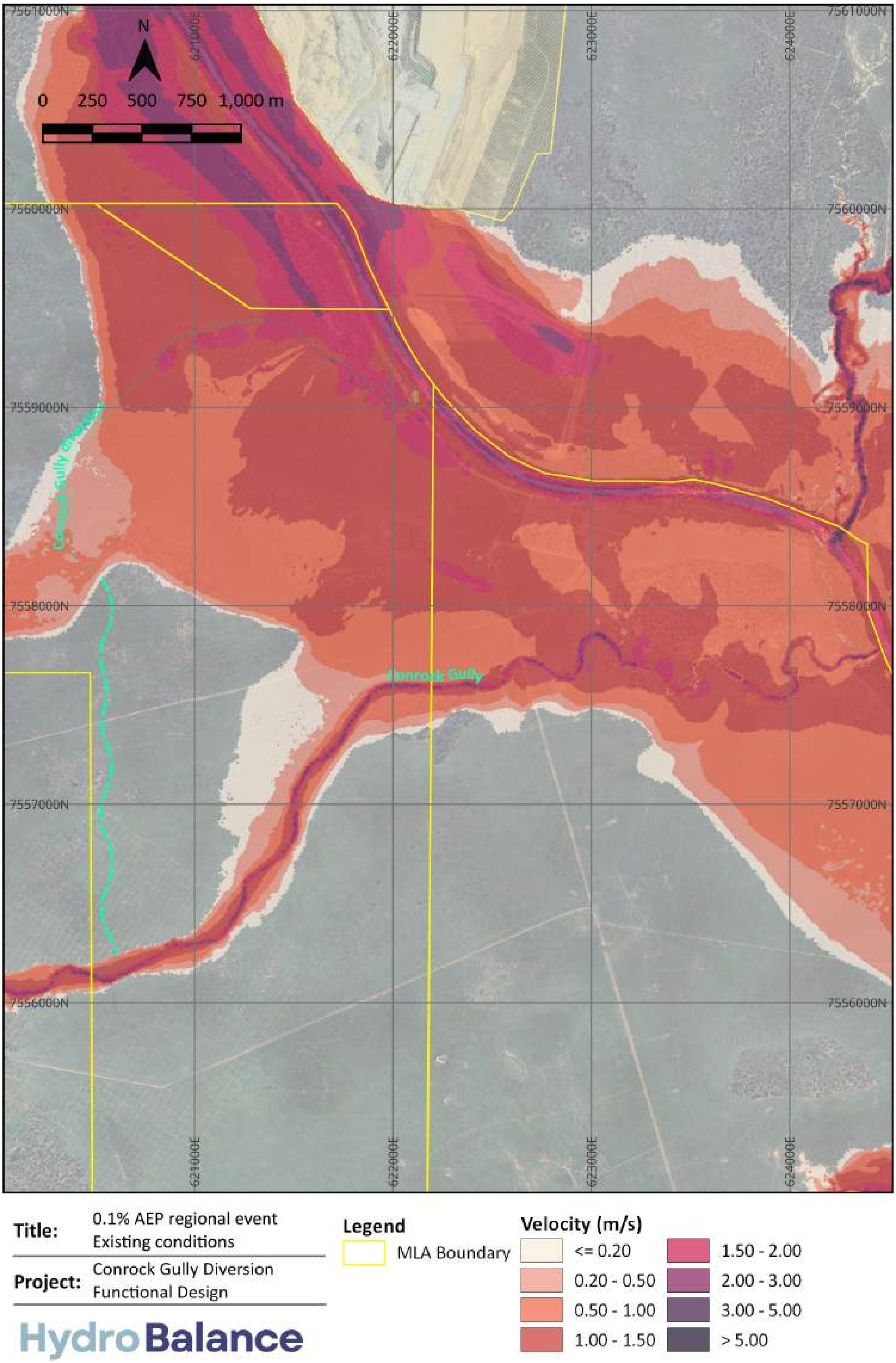


Figure 4.8 – 0.1% AEP existing conditions flood velocities, local and regional flood

5 Design details

5.1 Diversion geometry

The proposed stream diversion and levee alignments are shown in Figure 1.2. The proposed flood infrastructure configuration includes the following elements:

- **Conrock Gully Diversion**: A 5.2 km long diversion, connecting Conrock Gully upstream of the Project, to Isaac River downstream of the Project.
- **Conrock Gully levee plug**: A 0.9 km levee will be required at the upstream end of the diversion to prevent flows continuing to traverse the old Conrock Gully channel
- **Isaac River levee:** The proposed 5.9 km long levee would provide immunity from the 1 in 1,000 AEP design regional Isaac River flood, and has been located at the edge of the proposed mine disturbance area.

The following considerations have been made in developing this alignment:

- Aim to maximise access to the coal resource underlying Conrock Gully;
- Confine the diversion alignment to the MLAs;
- Achieve a diversion design which mimics the existing hydraulic conditions in the immediate reaches of Conrock Gully by:
  - Providing a main channel slope which matches the existing creek channel slope;
  - Introducing meanders which have similar amplitude, wavelength, sinuosity and bend radius to the existing creek; and
  - Providing a main channel with a similar geometry to the existing channel but with side slopes having a reasonable prospect of stabilisation through revegetation during construction.

The offset requirements from the Isaac River levee will be determined through geotechnical assessment and considered as part of the detailed design.

The intention is that the stream will be stable and require minimal maintenance during mine operations. It should ultimately achieve a state of dynamic equilibrium with the adjoining reaches such that ongoing management is not required.

To achieve the same channel slope as the existing gully, the upstream end of the diversion is located approximately 430 m upstream of the proposed pit crest. Several bends were introduced into the channel to achieve a diversion length similar to the existing reach.

Table 5.1 shows a comparison of the geomorphic characteristics for the existing gully and proposed diversion. The proposed diversion and the diverted reach are approximately 5.2 km long and 5.8 km long, respectively. The channel slope of the proposed diversion and the diverted reach is approximately 0.147% to 0.140% in the upstream reaches of the channel. The proposed diversion is marginally steeper than the diverted reach in the downstream section where the channel rejoins the Isaac River (0.341% compared to 0.330%) due to the topography at the proposed diversion outlet location. Longitudinal profiles of the bed invert of the proposed diversion and the diverted reach of the existing gully are shown in Figure 6.8. Overall, the diversion design reasonably matches the existing gully geometry.

Table 5.1 – Changes to typical channel geomorphic characteristics

Parameter		Existing gully	Proposed diversion
Length (km)		5.8	5.2
Bed Grade (%) – floodplain reach		0.140	0.147
Bed Grade (%) – downstream reach		0.330	0.341
Bed Width (m)		4	4
Top Width (m)		26	28
Depth to floodplain (m)		7	5
Meander Radius (m)		240 (median)	240 (median)
Meander Sinuosity Index		1.2-1.7	1.1
Meander Wavelength (m)		250-1,200	140-350
Meander Amplitude (m)		150-330	75-170
50% AEP	Mean Velocity (m/s)	0.95	0.93
	Mean Bed Shear Stress (N/m^2)	30.1	23.66
	Mean Stream Power (N/m s)	42.7	29.3
	Hydraulic Gradient (%)	0.17	0.14
2% AEP	Mean Velocity (m/s)	1.28	1.33
	Mean Bed Shear Stress (N/m^2)	33.5	30.9
	Mean Stream Power (N/m s)	55.7	49.6
	Hydraulic Gradient (%)	0.16	0.15

The proposed diversion channel geometry is shown in Figure 5.1. The diversion cross-section includes the following key components:

- 1.7 m deep main channel, which will convey 50% AEP local creek flows.
- 0.5 m deep overbank channel, which will convey 2% AEP local creek flows.
- Variable batter back to natural topography, which may contain local creek events rarer than the 50% AEP local creek flows. The diversion, particularly in its lower reaches, would not contain regional Isaac River flood flows for the majority of design events, which is typical of local creeks joining the Isaac River in the area.

The proposed diversion design balances matching the typical cross-section of the existing channel (which has relatively gradual overbank slopes) against minimising the diversion footprint .

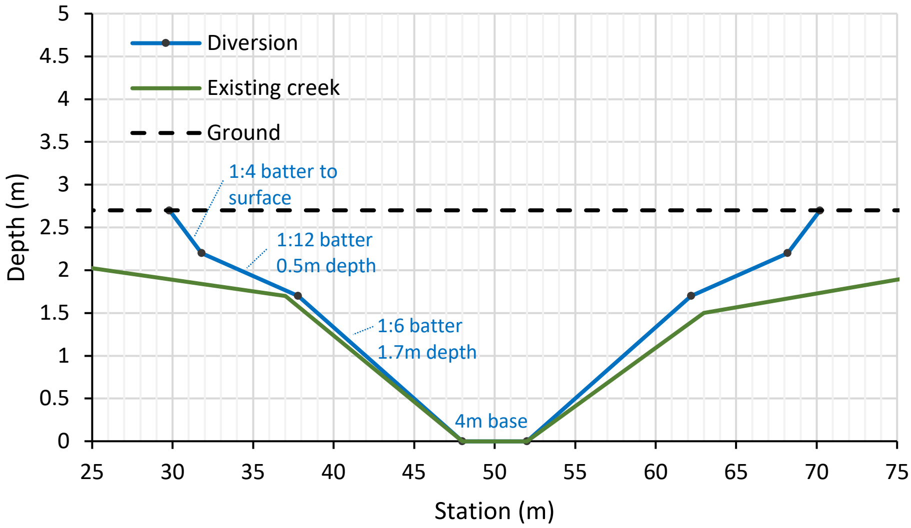


Figure 5.1 – Typical Conrock Gully diversion cross-section

5.2 Revegetation

Detailed geotechnical design of the diversion will be undertaken as part of detailed design. Proposed revegetation of the diversion is described in the Project's progressive rehabilitation and closure plan (PRCP). Revegetation will be undertaken to ultimately achieve similar conditions to the existing stream.

The establishment and maintenance of riparian vegetation will be essential for bank stability. Root systems from trees and shrubs provide much of the erosion resistance to channel widening from the shear stresses of flowing water and grasses protect the soil surface from raindrop splash erosion and overland flows.

Tree and shrub root systems take time to establish and grass root systems cannot provide sufficient depth and strength to provide the necessary erosion protection. The revegetation design must therefore provide for the rapid establishment of high strength, deep root systems to protect the soil surface from raindrop splash and overland flows and provide for long term erosion protection and ecological function.

Soils proposed for use in rehabilitation, including the soils used in diversion rehabilitation and any soils amelioration requirements, are described in the PRCP.

Revegetation works will include a combination of grasses, shrub and tree species. The potential benefits of a compost blanket (to provide soil surface protection, restart micro-biological soil processes, and retain soil moisture) to aid rapid vegetation establishment will be considered during detailed design.

Vegetation to be seeded will include cover crops and non-invasive grass species for short and medium term erosion protection and native grasses, shrubs and trees for long term erosion protection.

Consideration will be given to planting and direct seeding of Vetiver Grass (Chrysopogan zizanioides). Vetiver Grass has been developed specifically for erosion control purposes. It is a stiff barrier grass that is planted in a similar manner to a shrub or tree. This particular cultivar is sterile and is tolerant to a wide range of soil conditions. Its greatest benefit is its rapid growth and massive root structure. The roots can grow 2 to 3 m deep in the first twelve months and have been measured to have a mean tensile strength of 75 MPa.

The trees will establish over a number of years, and their root systems will take over the stream bank erosion protection role that the Vetiver Grass roots have provided in the short term. The trees may ultimately shade out the Vetiver Grass. Where possible, existing vegetation will be preserved, and fallen timber or vegetation cleared as part of mining operations will be incorporated into the new channel to rapidly establish habitat.

If possible, the diversion should be constructed "offline" until the works have stabilised, and the vegetation has become established. It is preferable that the diversion is connected to the Conrock Gully channel at least one wet season after construction. The proposed construction and revegetation schedule is shown in Table 5.2.

Table 5.2 – Indicative construction and revegetation timing schedule

<table>
<tr><th>Stage</th><th>Approximate timing</th><th>Site description</th><th>Diversion activity</th></tr>
<tr><td>Project commencement</td><td>Construction Year 1</td><td>Conrock Gully flows through site.
Begin diversion construction.</td><td>Diversion not connected with Conrock Gully upstream.</td></tr>
<tr><td>Diversion excavation completed</td><td rowspan="4">Year 2 (prior to mining Conrock Gully area)</td><td rowspan="4">Complete diversion construction activities. Conrock Gully no longer flows through site.</td><td>Complete excavation of the diversion. Not connected with Conrock Gully upstream.</td></tr>
<tr><td>Begin revegetation</td><td>Begin revegetation of the diversion.</td></tr>
<tr><td>Initial vegetation cover established</td><td>Initial vegetation cover established within the diversion.</td></tr>
<tr><td>Complete the diversion and levee</td><td>Construct the Conrock Gully levee plug and connect the diversion with Conrock Gully upstream.</td></tr>
<tr><td>Allow Conrock Gully to flow through diversion</td><td>By end Year 2</td><td>Isaac River levee constructed. Conrock Gully no longer flows through site.</td><td>Allow flows to traverse through the Conrock Gully diversion.</td></tr>
</table>

6 Hydraulic assessment

6.1 Methodology

The existing case TUFLOW hydraulic model was amended to include the Conrock Gully diversion and the proposed levees required to protect the mining area from local gully and Isaac River flooding. Full details of TUFLOW modelling can be found in the *Isaac Downs Extension Flood Impact Assessment* (HydroBalance, 2025).

The adopted Mannings 'n' value for both the existing and proposed channels in the TUFLOW model is 0.04. This value was selected based on a clean, winding main channel configuration (Chow, 1959).

The flood model configuration and setup include the following key considerations:

- The adopted Project layout includes the maximum mine footprint and the proposed associated levee / levee plug during operations.
- The final landform flooding conditions have been assessed in HydroBalance (2025). The operational conditions represent the maximum potential impact to local and regional flooding, opposed to the final landform conditions, and hence are the focus of this assessment.
- The Isaac Downs Mine final landform will be included in the flood model. The Isaac Downs Mine final landform is design to prevent Isaac River flood ingress into the final void during a Probable Maximum Flood (PMF) event.

6.2 Diversion depths and velocities

The developed conditions flood depths for the 50% and 2% AEP design local flood events are shown in Figure 6.1 and Figure 6.2. The 0.1% AEP design regional flood extent for developed conditions is shown in Figure 6.3. The flood depths are relatively uniform throughout the 4.0 km upstream reach of the diversion. The depths fluctuate slightly (± 1 m) within the downstream 1.2 km reach due to the changes to the diversion base slope and meander radii. The flood depth within the diversion is generally around 2.2 m and 3.9 m for the 50% AEP and 2% AEP local flood events, respectively.

The modelled flood velocity for the 50% and 2% AEP design local flood events and the 0.1% AEP design regional flood events are shown in Figure 6.4, Figure 6.5 and Figure 6.6. Overall, the velocities are relatively uniform throughout the diversion, increasing slightly as the diversion joins the Isaac River. Velocities within the diversion are generally around 2 m/s or lower.

6.2.1 Outlet velocities

The Conrock Gully diversion outlet is located at the Isaac River bank, at an existing confluence between a minor drainage line and the Isaac River. The banks of the Isaac River are steep; hence the outlet of the diversion may experience higher than average diversion velocities when there are low/no flows in the Isaac River. The modelled velocities at the outlet are shown in Figure 6.7. The peak velocities at this location range between 3.2 m/s (50% AEP) and 4.6 m/s (2% AEP). The peak velocities at the outlet would be far lower during Isaac River flow events due to tailwater effects, generally below 2 m/s. Isaac River flows would submerge the diversion outlet during flood events greater than or equal to the 10% AEP regional flood (the level of inundation for a range of regional flood events is shown in HydroBalance [2025]). Conrock Gully flow events are expected to occur independently of Isaac River flow events infrequently.

The velocities during local creek events at the diversion outlet are similar to those experienced in the existing waterways and drainage lines at their respective confluences with the Isaac River. Table 6.1 shows a comparison between the post-development and existing velocities. This table shows that the velocities at the diversion outlet would be close to or within the range of those experienced at the existing Conrock Gully confluence locations.

Table 6.1 – Maximum velocities at Isaac River confluence, local flows only

Location/condition	50% AEP velocity (m/s)	2% AEP velocity (m/s)
Proposed diversion outlet	3.6	4.4
Existing drainage line, north of Conrock Gully at its confluence with Isaac River	3.3	4.6
Existing Conrock Gully at its confluence with Isaac River	3.3	4.1

The velocities at the proposed diversion outlet are considered acceptable, given the following considerations:

- High velocities are only expected to occur when Conrock Gully flows independently of the Isaac River, which is unlikely to occur frequently.
- The velocities at the diversion outlet during local flows (no regional flooding) are within the range of the velocities at the existing Isaac River confluences.

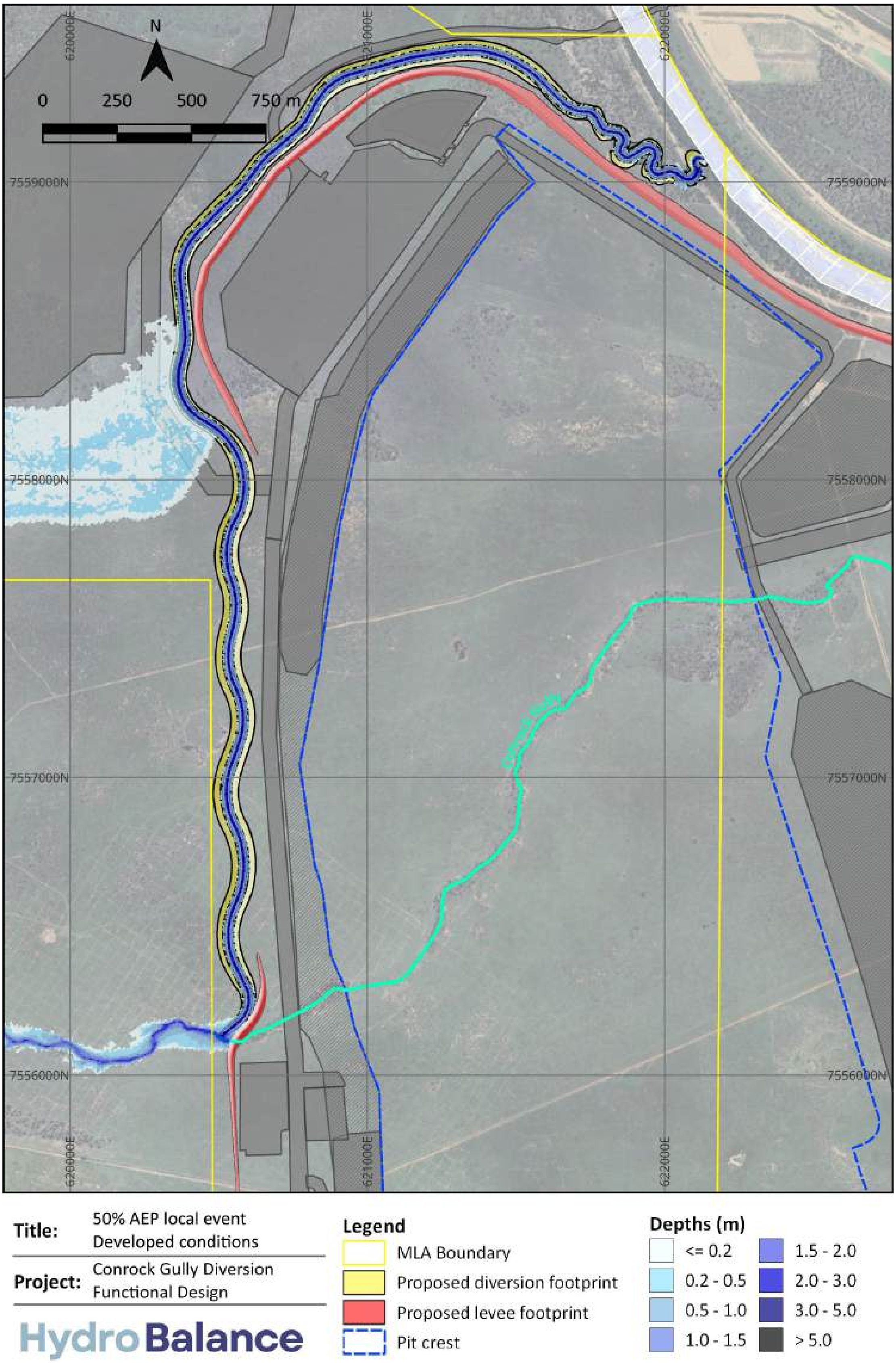


Figure 6.1 – 50% AEP developed conditions flood depth, local flood – no regional Isaac River flood

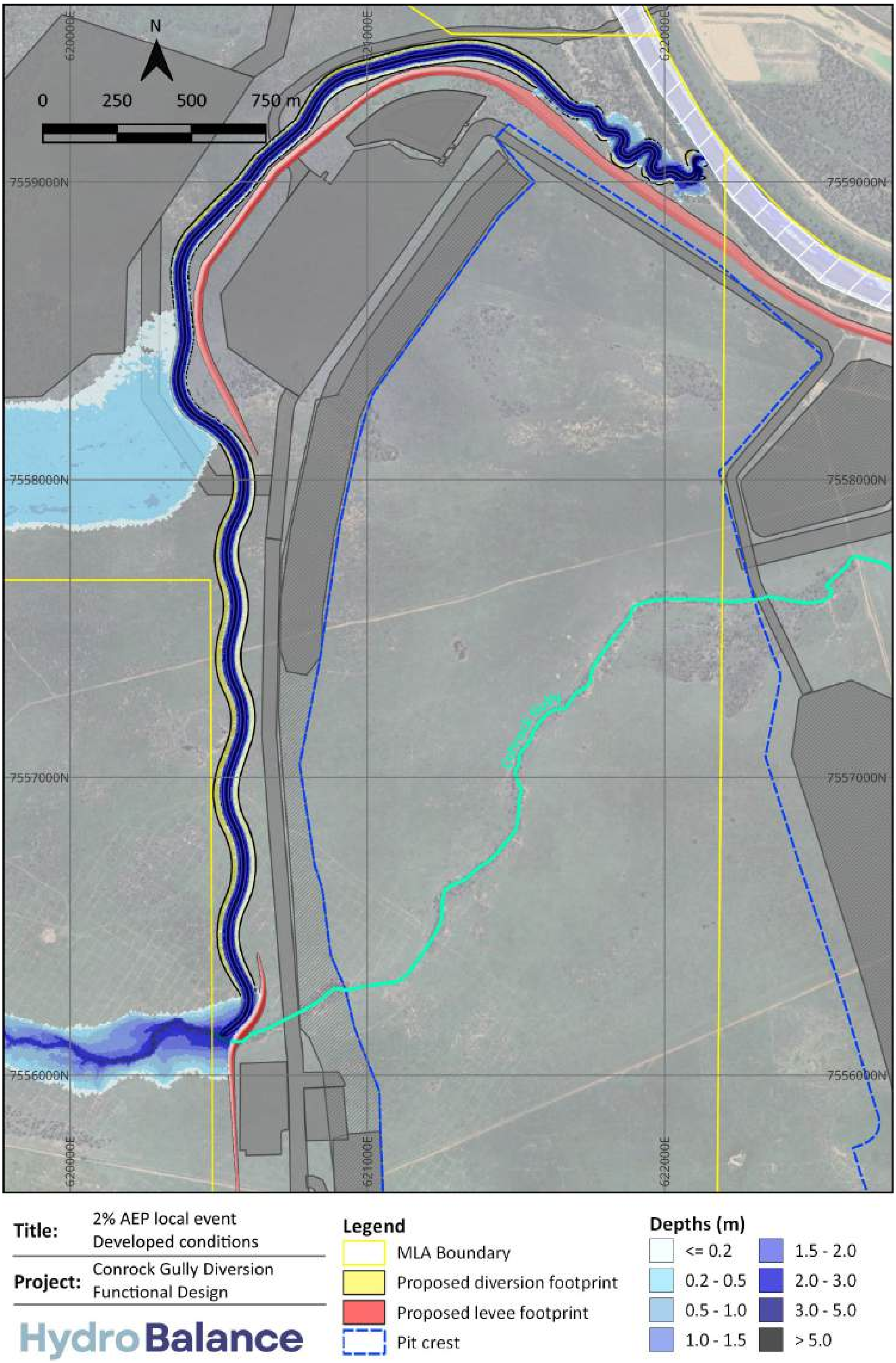


Figure 6.2 – 2% AEP developed conditions flood depth, local flood – no regional Isaac River flood

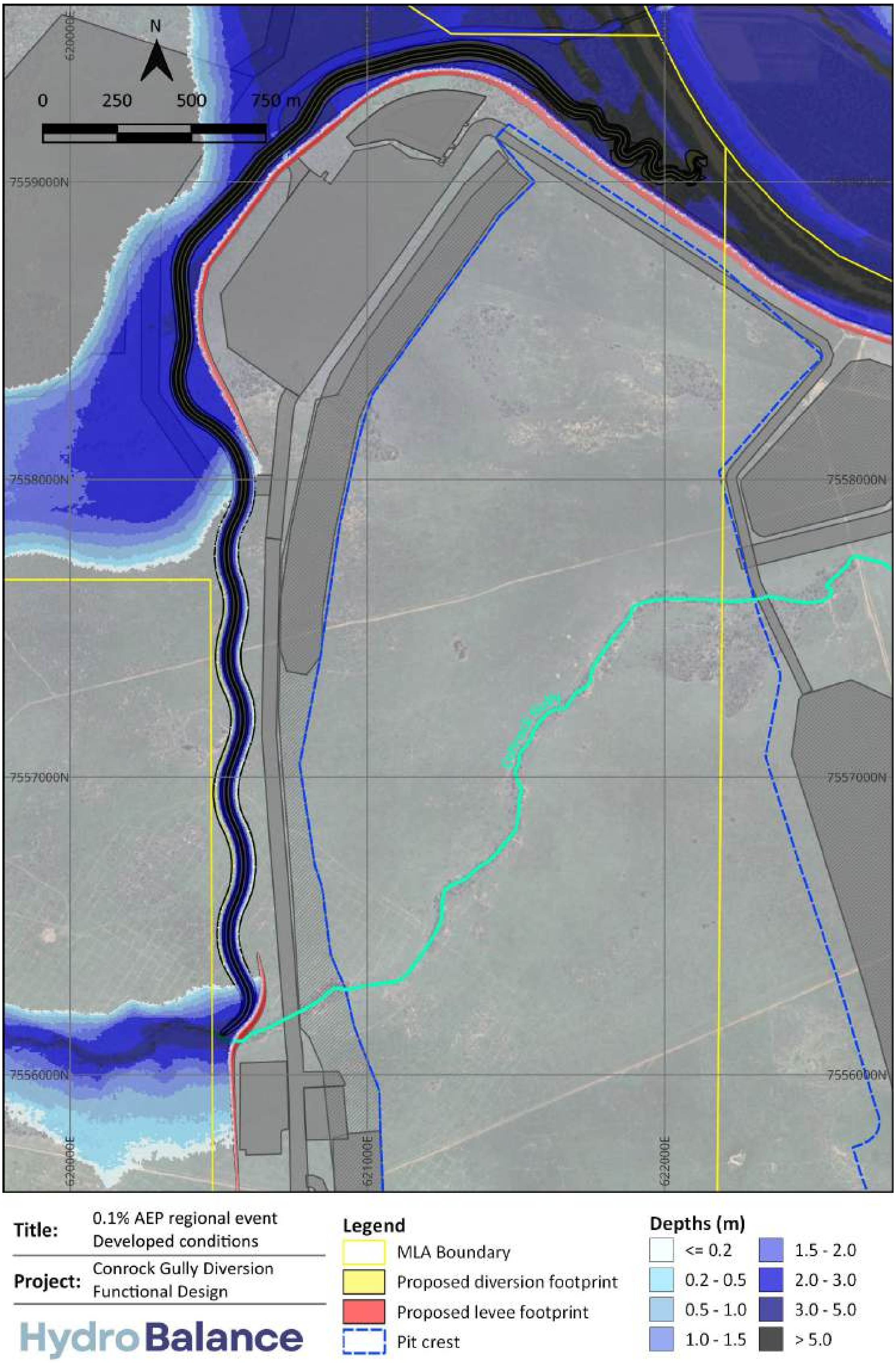


Figure 6.3 – 0.1% AEP developed conditions flood depth, local and regional flood

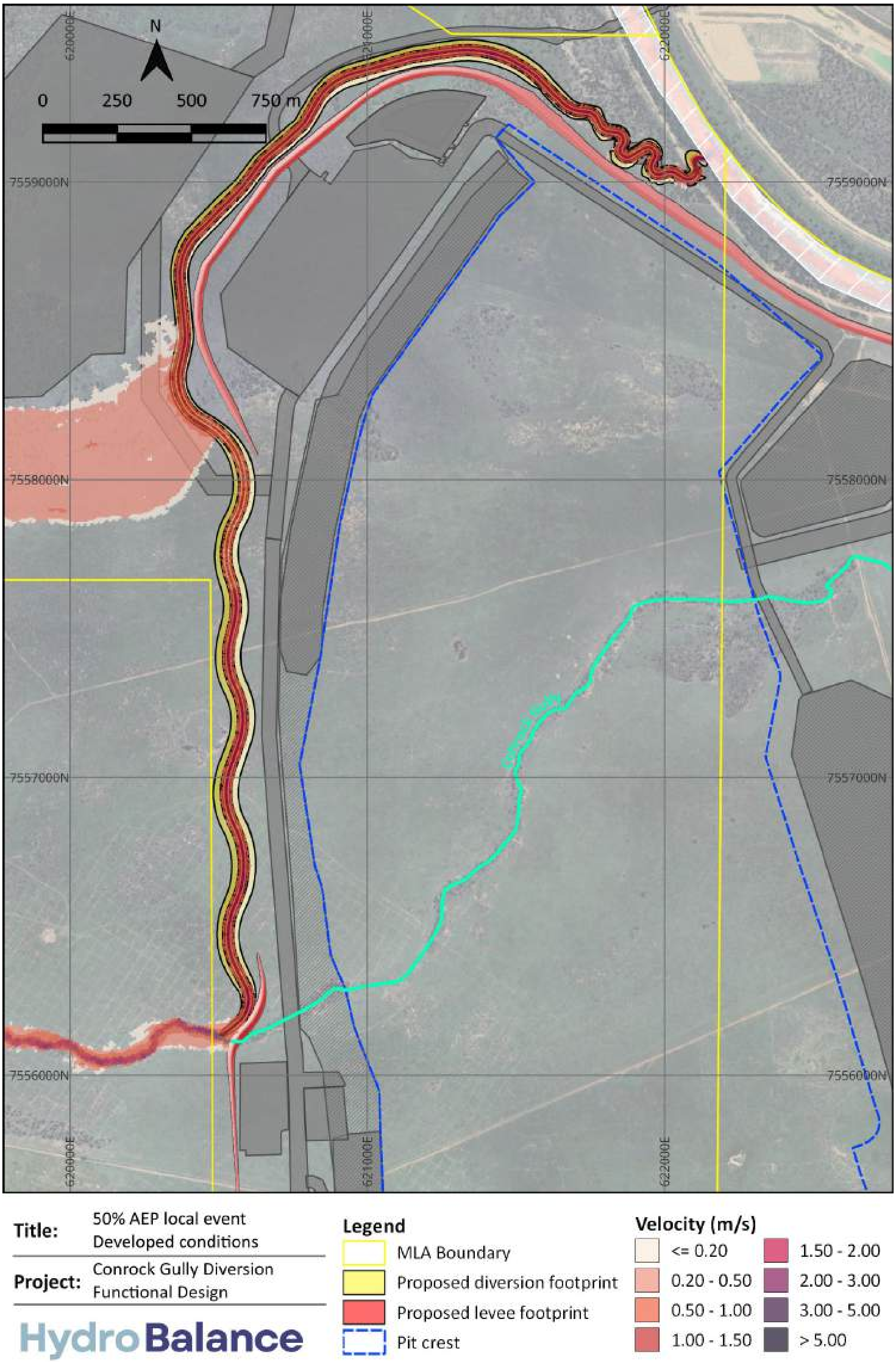
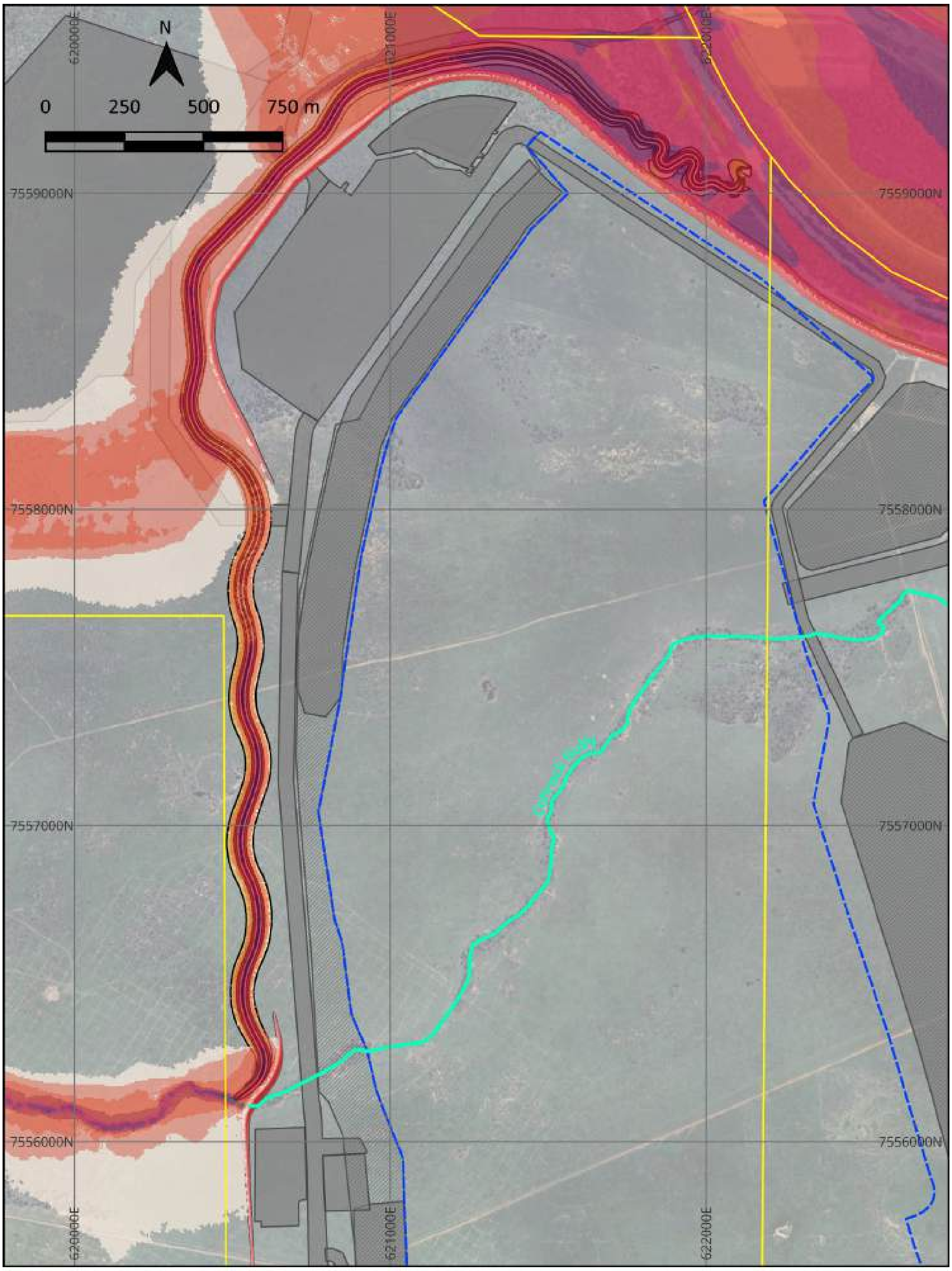


Figure 6.4 – 50% AEP developed conditions flood velocities, local flood – no regional Isaac River flood

Figure 6.5 – 2% AEP developed conditions flood velocities, local flood – no regional Isaac River flood



Title:	0.1% AEP regional event Developed conditions
Project:	Conrock Gully Diversion Functional Design

HydroBalance

Legend
- MLA Boundary
- Proposed diversion footprint
- Proposed levee footprint
- Pit crest

Velocity (m/s)
- <= 0.20
- 0.20 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 3.00
- 3.00 - 5.00
- > 5.00

Figure 6.6 – 0.1% AEP developed conditions flood velocities, local and regional flood

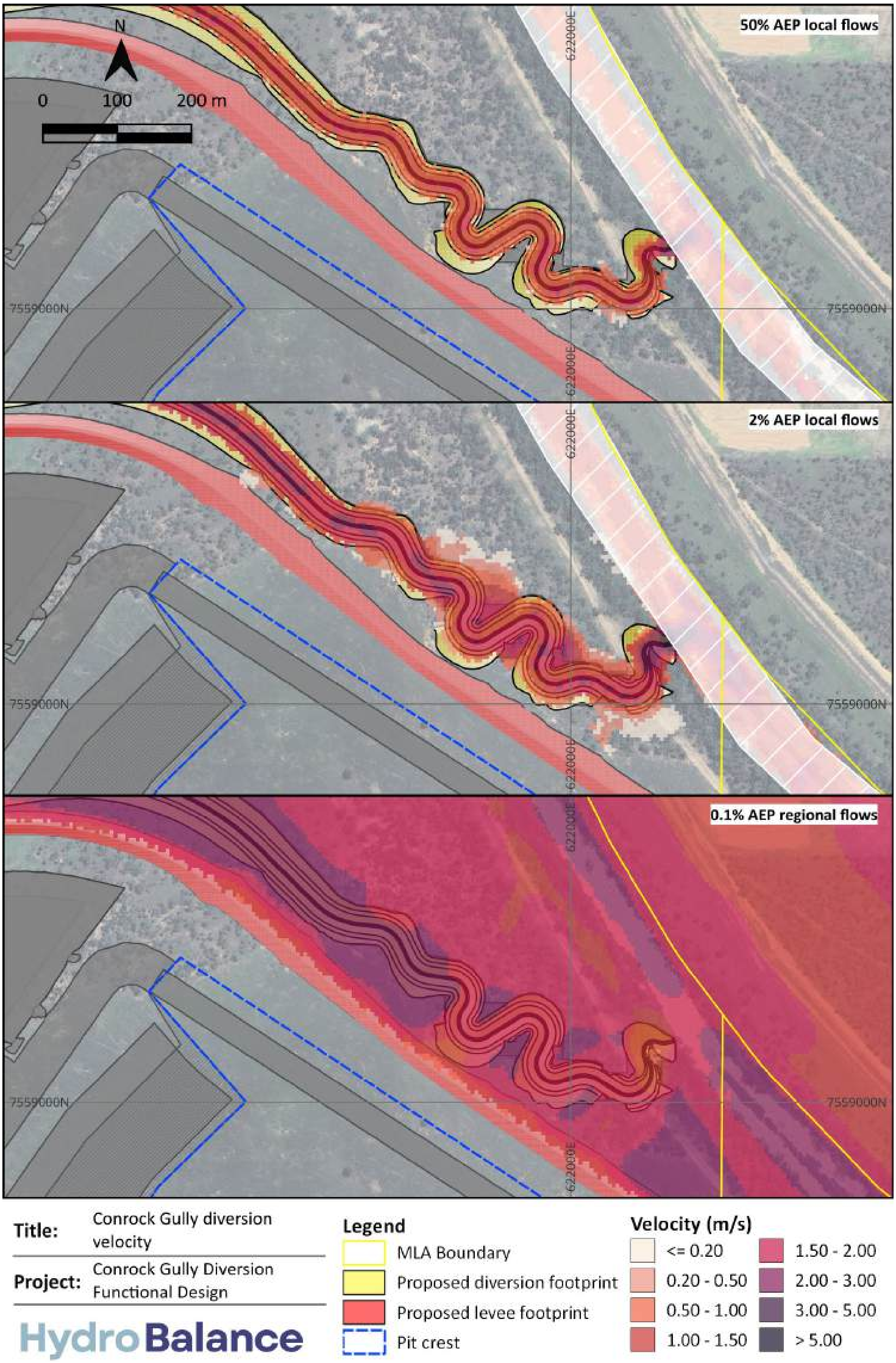


Figure 6.7 – Conrock Gully diversion outlet velocities

6.3 Impacts on flood levels

The impact of the proposed works on the 0.1% AEP flood levels in Isaac River in the vicinity of the diversion is illustrated in Figure 6.8(the adopted long section location is shown in Figure 1.2). The figure shows that:

- The 0.1% AEP water levels will be altered by the proposed diversion and Isaac River levee for a section of approximately 5 km in the vicinity of Project. The vast majority of the impact would be a result of the Isaac River levee.
- The maximum change in water level in the Isaac River, predominantly attributable to the Isaac River levee, is 0.5-0.6 m around chainages 1,500 m and 3,000 m.

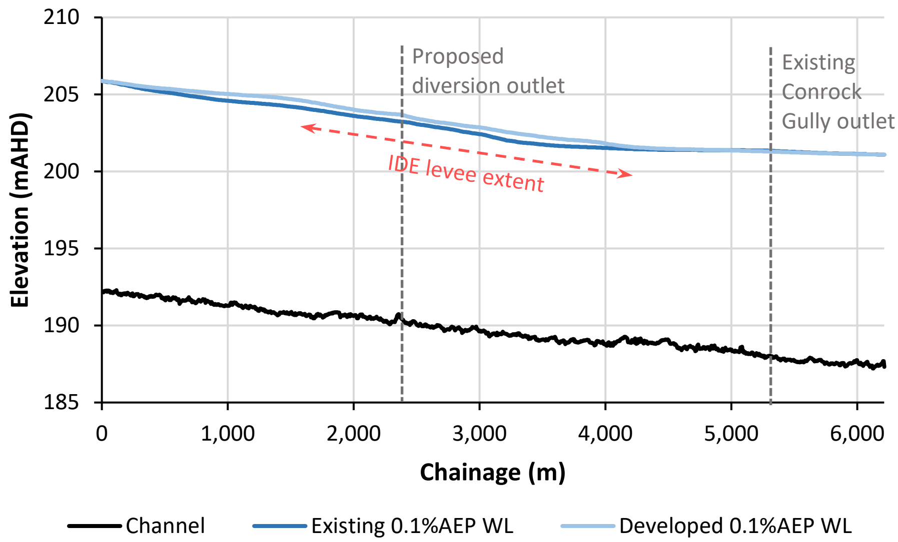


Figure 6.8 – Isaac River water level long-section, existing and developed conditions

The water level impact in Conrock Gully upstream of the diversion for the 50% AEP and 2% AEP flood events is shown in Figure 6.9 and Figure 6.10. These figures consider the local flows only (no regional Isaac River flooding).

These figures show the diversion may cause elevated water levels in a localised section of Conrock Gully approximately 200 – 700m in length, upstream of the inlet, with an increase of up to 1.1 m at the MLA boundary for the 2% AEP event. The elevated water levels would dissipate (i.e. do not cause ponding) as the Conrock Gully flows recede.

6.4 Impact on flood velocity

The velocity impact for local flows in Conrock Gully upstream of the diversion for the 50% AEP and 2% AEP flood events is shown in Figure 6.11 and Figure 6.12.

These figures show the diversion may cause reduced velocities on the Conrock Gully overbank area, upstream of the inlet. The velocities may decrease by up to 0.5 m/s at the MLA boundary for the 2% AEP event. There are also minor localised increases in velocities (around 0.3 m/s) along the fringes of the existing upstream flood extent.

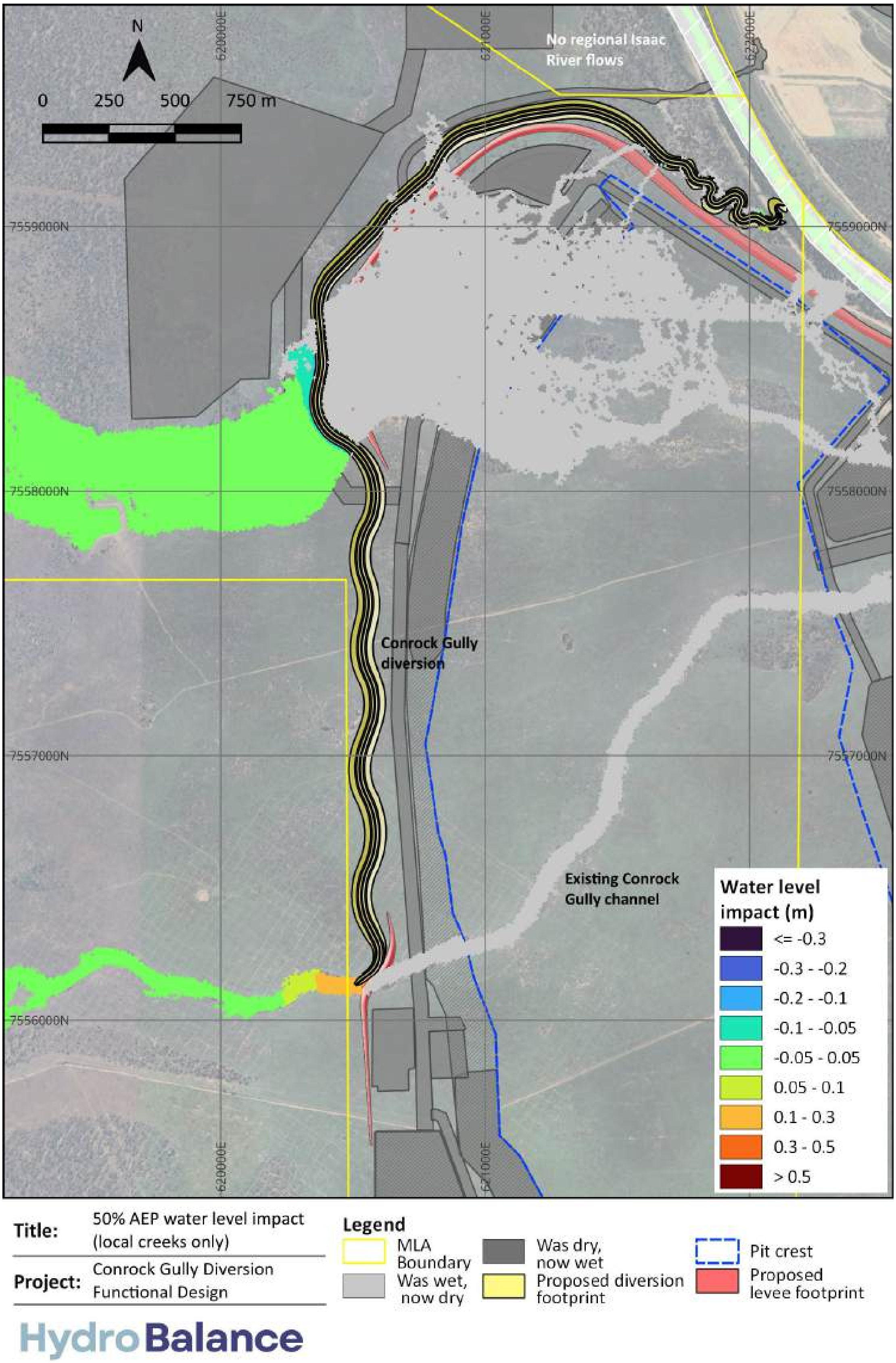


Figure 6.9 – Conrock Gully 50% AEP water level impact (local flows only)

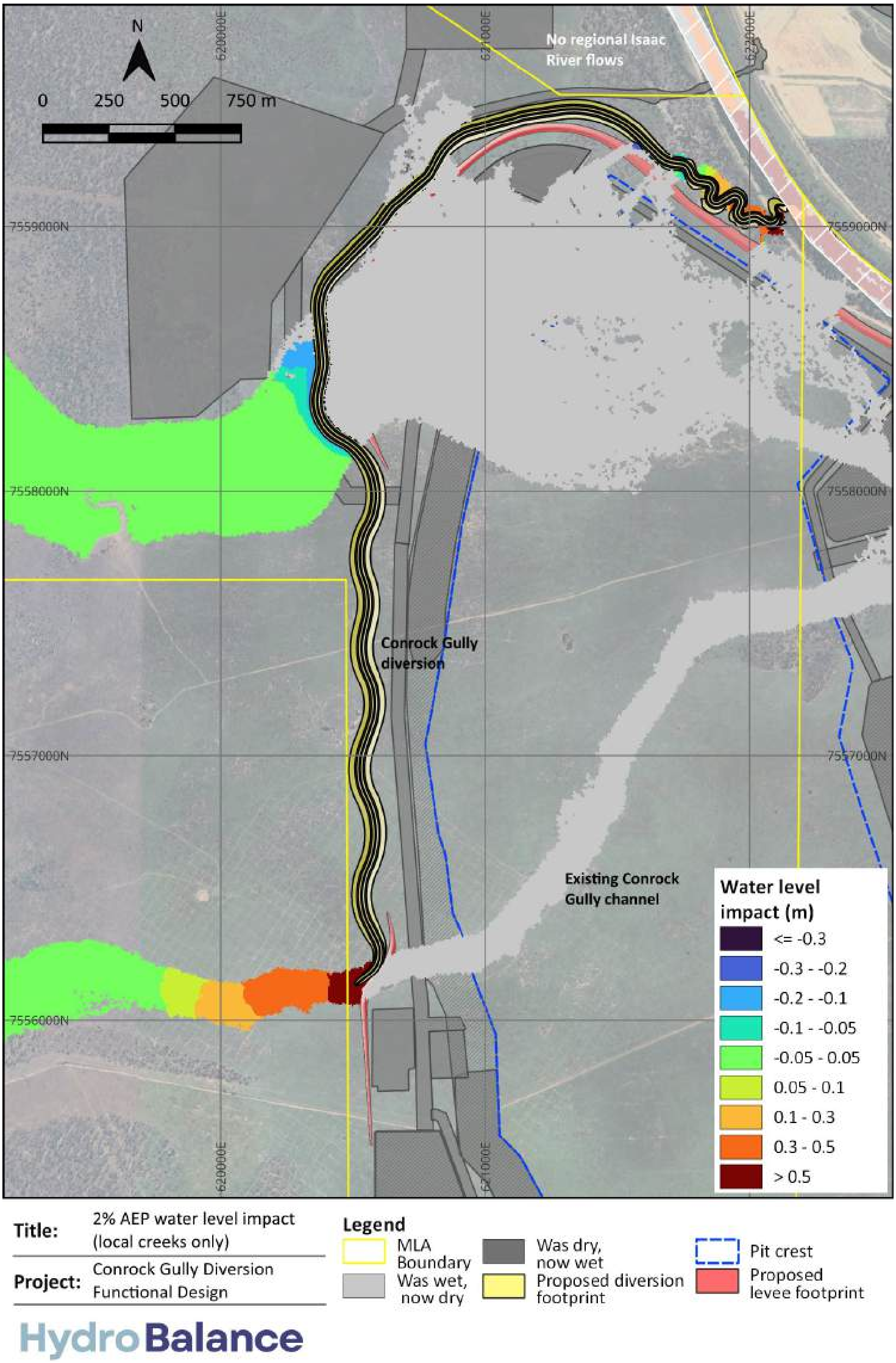


Figure 6.10 – Conrock Gully 2% AEP level impact (local flows only)

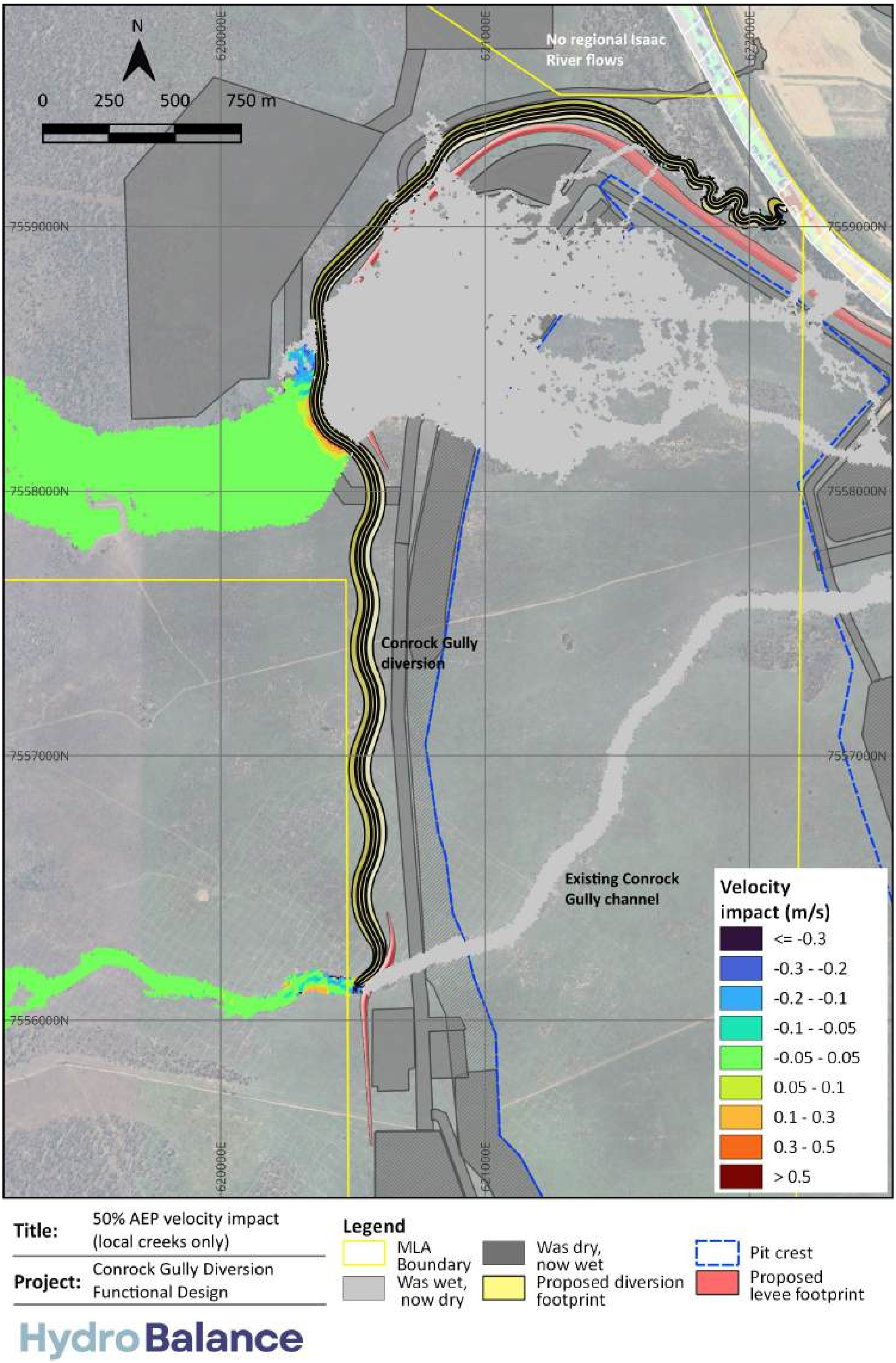


Figure 6.11 – Conrock Gully 50% AEP velocity impact (local flows only)

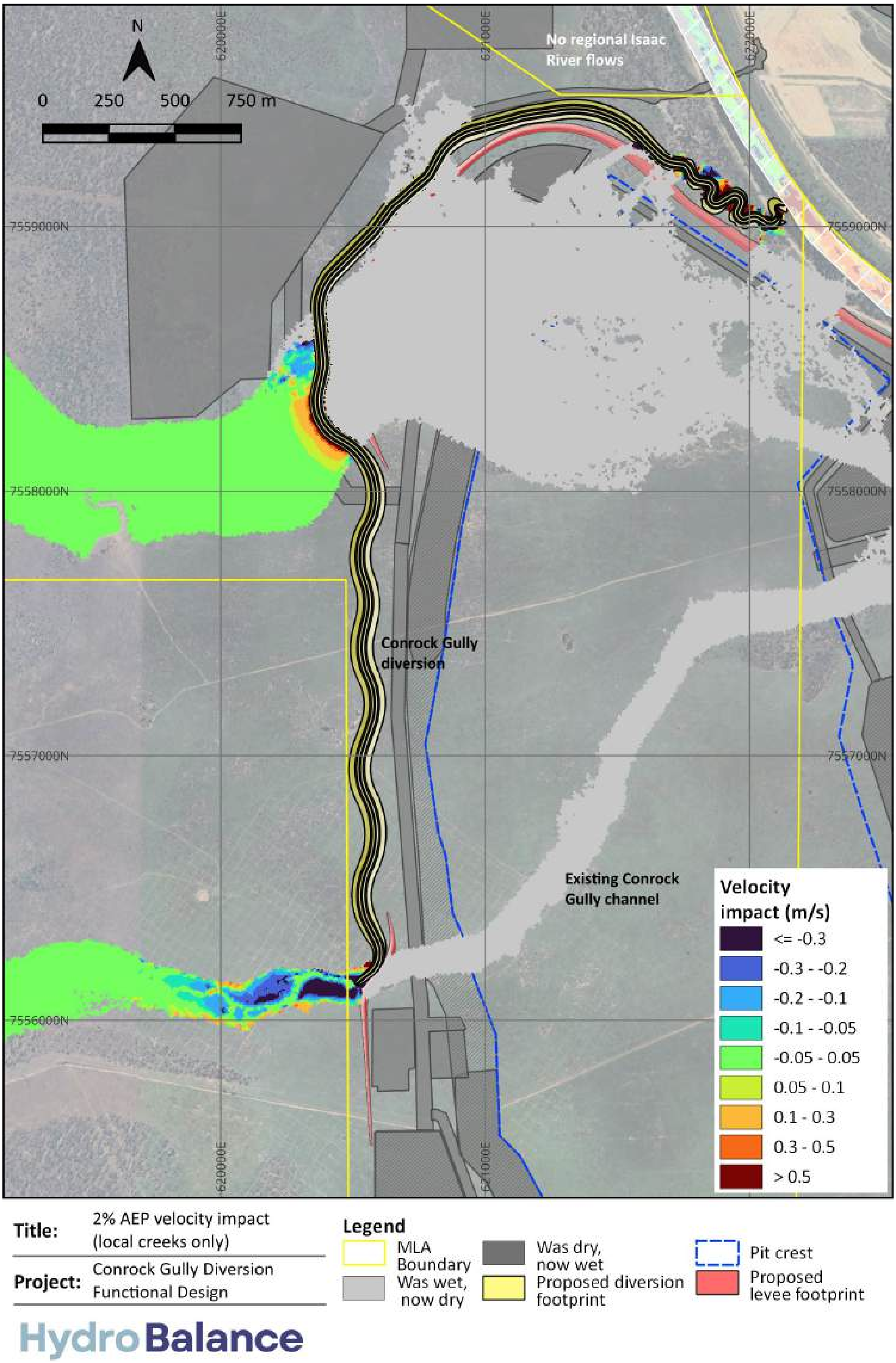


Figure 6.12 – Conrock Gully 2% AEP velocity impact (local flows only)

6.5 Guideline Hydraulic Criteria – 50% AEP

The main channel section-averaged results of the hydraulic modelling of the proposed diversion in the 50% AEP flood event shown in Figure 6.13 are summarised below. Generally, due to the uniform diversion channel shape, the values within the channel vary more uniformly than in the existing channel.

6.5.1 Vegetated diversion channel

- Velocity:
  - At most locations, the existing Conrock Gully velocity is below the Guideline value of 1.5 m/s (typical range is 0.75 m/s to 1.5 m/s).
  - The velocity in the diversion is lower than the existing Conrock Gully channel and consistently below the Guideline value of 1.5 m/s (typical range is 0.7 m/s to 1.2 m/s).
  - In the downstream of the diversion, there is a slight increase in velocity as flows traverse down the Isaac River bank, although this is still below the Guideline value. Vegetation (including trees and shrubs) will be established in this location, to manage the potential scour risk and be consistent with the existing Isaac River banks in this location.
- Shear Stress and Stream Power:
  - The values in the existing Conrock Gully channel fluctuate and periodically exceed the Guideline values throughout the length of Conrock Gully.
  - The values in the diversion are relatively uniform and are below the existing gully channel and well within the envelope of naturally occurring values. There is an exceedance of the Guideline values at the confluence with the Isaac River, which also occurs in the existing channel. The confluence shear stress and stream power is improved in the diversion compared to the existing channel.
  - The shear stress and stream power levels are improved in comparison to the existing Conrock Gully channel.

6.5.2 Non-vegetated diversion channel

The Guideline includes hydraulic criteria for un-vegetated conditions (representative of potential conditions immediately post-construction) for the 50% AEP flood event.

The modelled velocities and stream power in the diversion may exceed the Guideline value for un-vegetated conditions in some local areas, similar to, although less frequent than, the existing Conrock Gully channel.

The results indicate that post-construction there will be an elevated erosion risk, which will need to be managed through careful revegetation planning. Stabilisation works may need to be considered to manage the potential for damage during early flows, but this is likely to be mitigated by the relatively cohesive nature of the local soils. The indicative construction and revegetation schedule presented in Table 5.2 ensures that the initial vegetation cover would be established before accepting the Conrock Gully catchment.

6.6 Guideline hydraulic criteria – 2% AEP

The main channel section-averaged results of the hydraulic modelling of the proposed diversion in the 2% AEP flood event shown in Figure 6.14 are summarised below.

- Velocity:
  - The existing Conrock Gully velocity is less than guideline of 2.5 m/s (typical range is 1.0 m/s to 1.5 m/s).
  - In the diversion, the velocity is well below Guideline values and are consistently within or better than the typical range of the existing Conrock Gully channel.

- Shear Stress and Stream Power:
  - The existing Conrock Gully channel shear stress and stream power level are generally below the Guideline values aside from some exceedances, particularly as the existing channel meets the Isaac River.
  - The shear stress and stream power in the diversion is generally similar to the existing Conrock Gully condition, and below Guideline values. At the confluence with the Isaac River the diversion has lower shear stress and stream power than the existing Conrock Gully confluence, although with minor exceedances of the Guideline values.
  - The shear stress and stream power levels for the diversion are overall improved in comparison to the existing Conrock Gully channel.

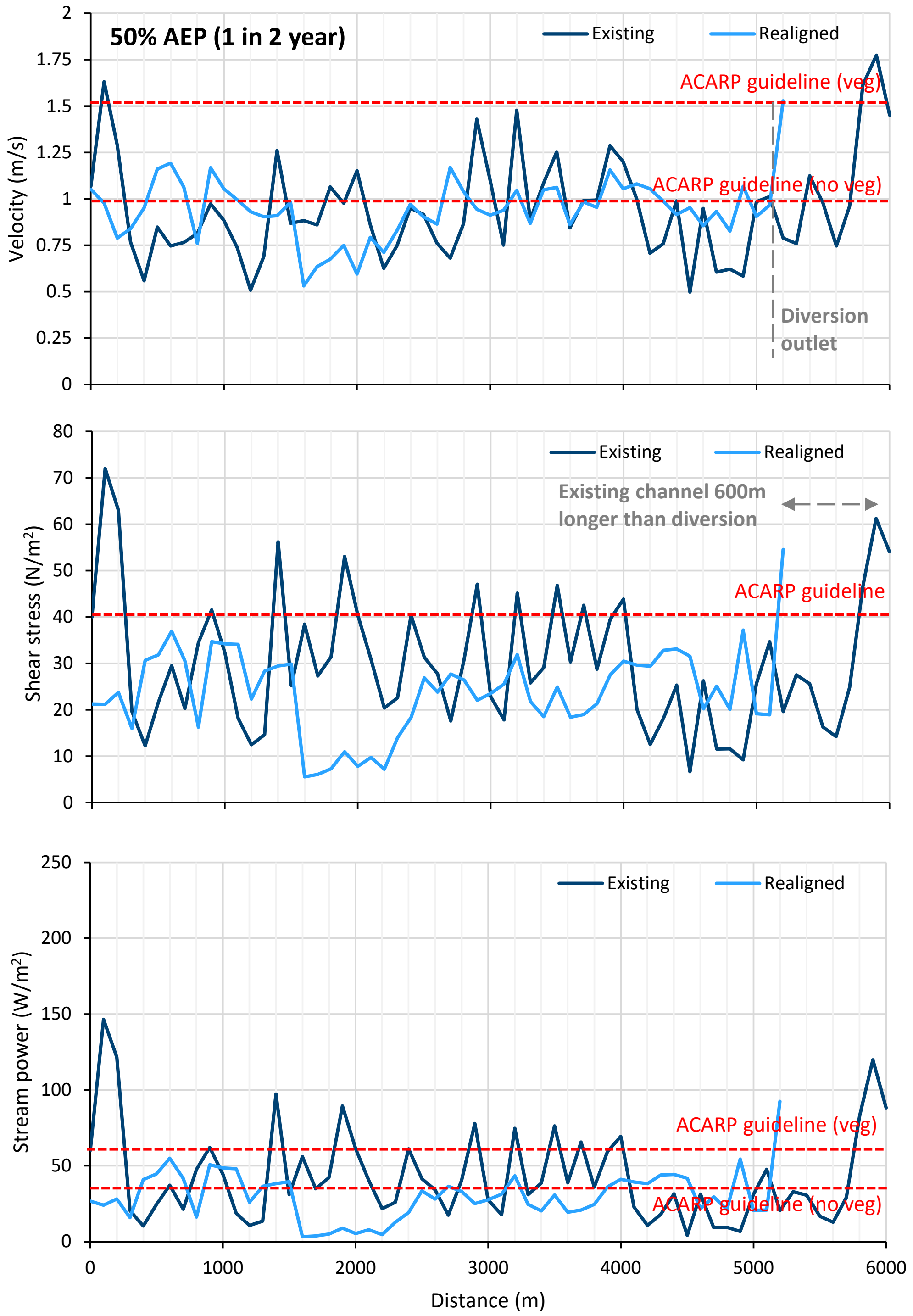


Figure 6.13 – Longitudinal profiles of 50% AEP section-averaged velocity, stream power and bed shear stress

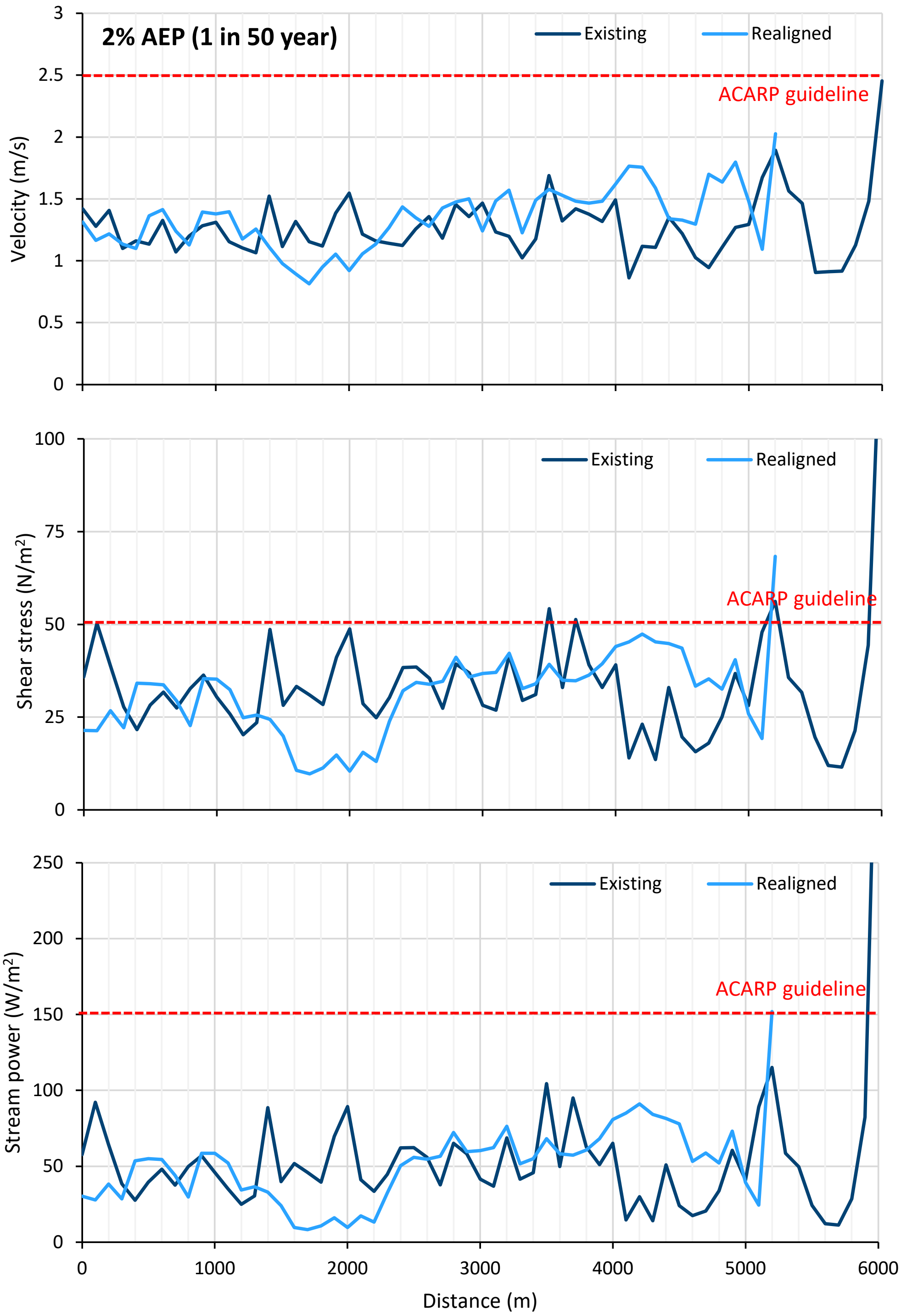


Figure 6.14 – Longitudinal profiles of 2% AEP section-averaged velocity, stream power and bed shear stress

6.7 Site road crossing assessment

A one-dimensional HEC-RAS (USACE, 2024) model has been developed to assess the proposed crossing that would allow the site access and haul road to traverse the Conrock Gully diversion. The crossing has been designed to have immunity from the 10% AEP local Conrock Gully flows. The road would be overtopped by design events rarer than the 10% AEP local Conrock Gully event. The location of the proposed road crossing is shown in Figure 1.2.

The HEC-RAS model was used to determine a conceptual crossing configuration to convey the 10% AEP local Conrock Gully flows:

- 199.5 mAHD road deck height.
- Eight (8) concrete culverts, square edge entrance with headwall.
- 2.7 m diameter culverts.

The maximum channel velocities calculated using the HEC-RAS model are presented in Table 6.2 for the following scenarios:

- **No culvert:** Conrock Gully diversion constructed without the road or the proposed crossing.
- **Culvert:** Conrock Gully diversion constructed with the road and the proposed crossing, per the conceptual specifications listed above.

This assessment shows that during frequent events within the immunity of the structure (i.e. 50% AEP), the velocities upstream of the crossing may be increased by 3% (i.e. negligible to minor change), due to the efficient flow regime through the smooth culverts. During rarer events outside of the immunity of the crossing (i.e. 2% AEP) velocities upstream of the crossing may be reduce by 3% (i.e. negligible to minor change), due to the reduced conveyance. The velocity downstream of the crossing is not impacted by the culverts.

Figure 6.15 and Figure 6.16 show longitudinal sections of the modelled maximum channel velocity and channel water level in the Conrock Gully diversion, with and without the site access road crossing in place. These figures show that the impact on velocities and water levels in the diversion due to the crossing is negligible to minor for the 50% AEP and 2% AEP local flow events. The minor impacts propagate for a short distance upstream or downstream of the crossing.

The proposed site access and haul road crossing would be fully drowned by 10% AEP regional Isaac River flood flows. Effective flows through the downstream reach of the diversion would not occur during these conditions, hence the culverts are not expected to impact diversion flows during regional Isaac River floods equal to or rarer than the 10% AEP.

Table 6.2 – Site access road culvert hydraulic assessment

Flow event	Max. channel velocity (m/s)		
	Upstream of crossing	Downstream of crossing	Within culvert
No culvert			
50% AEP local Conrock Gully flows	1.43	1.43	N/A
2% AEP local Conrock Gully flows	2.41	2.42	N/A
Culvert			
50% AEP local Conrock Gully flows	1.48	1.43	1.52
2% AEP local Conrock Gully flows	2.33	2.42	2.45

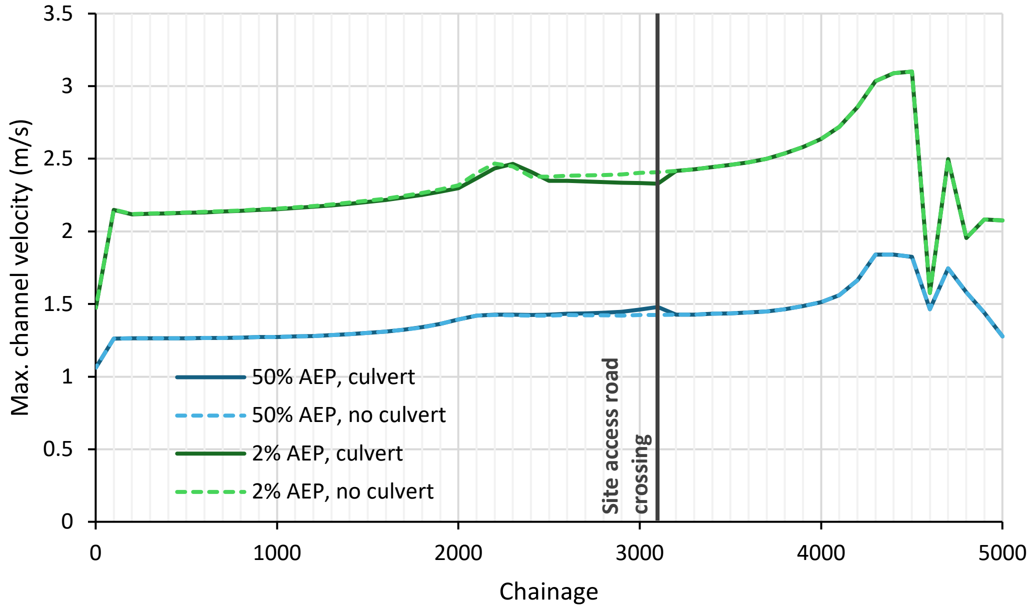


Figure 6.15 – Longitudinal profiles of maximum channel velocity[1], with and without site access road crossing

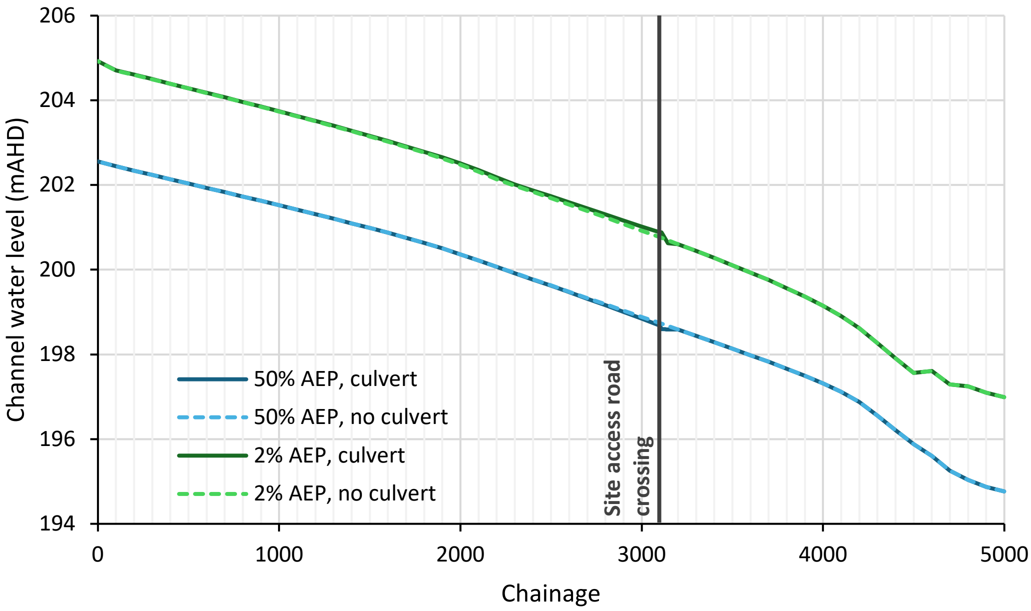


Figure 6.16 – Longitudinal profiles of channel water level, with and without site access road crossing

[1] Figure 6.15 shows the *maximum channel* velocity, which is not equivalent to the *section averaged* velocities shown in Figure 6.13 and Figure 6.14.

7 Monitoring

7.1 General

The proposed Conrock Gully diversion will be monitored regularly to collect useful data for use in evaluating the performance of the constructed diversion. Collection of monitoring data will help identify any issues with the construction of the diversion and assist with achieving rehabilitation milestones for a stable landform in accordance with PRCP requirements, and ultimately relinquish the mining leases. The monitoring program will be conducted using the process documented in DNRM (2019), described in the sections below.

7.2 Goals and objectives

The overall goal of the monitoring program is for the diversion to be considered as a reach or stream in equilibrium in order to achieve rehabilitation milestones. Early monitoring will ensure sufficient data is available to support achievement of rehabilitation milestones for the diversion. The immediate objective of the monitoring program is to evaluate the performance of the constructed diversion to ensure that any issues are identified early, and also to obtain baseline information for use in evaluating the performance of the diversion later in mine life.

7.3 Long term diversion plan

Early monitoring of the diversion and the upstream and downstream control reaches will define baseline data for the rehabilitation milestones leading to a long term stable diversion.

7.4 Baseline monitoring

Baseline monitoring will be conducted prior to the construction of the Conrock Gully diversion to provide a reference data set for evaluation of monitoring data collected throughout the life of the monitoring program. During the baseline monitoring period, a control reach located upstream of the diversion and a downstream reach will also be established. Baseline monitoring will include:

- Site photography.
- Aerial photography.
- Survey.
- Vegetation characterisation and assessment.
- Flow event monitoring.

7.5 Construction monitoring

Construction monitoring will be conducted to ensure the diversion is constructed to the design specifications. Construction monitoring will include:

- Execution database to record construction activities.
- Site photography.
- Aerial photography.

7.6 Operations monitoring

Operations monitoring will be conducted after construction works have been completed to maintain channel condition and to identify remedial works. The operations monitoring is a combination of visual assessments and survey data and will include:

- Survival of works.

- Site photography.
- Aerial photography.
- Visual assessment.
- Index of diversion condition (IDC).
- Site survey.
- Flow events monitoring.

Operations monitoring will be conducted in three reaches. The control reach, located upstream of the diversion, the diversion reach and the downstream reach, located immediately downstream of the diversion (including the diversion outlet on the Isaac River bank).

Table 7.1 shows a timeline of the monitoring requirements for the proposed Conrock Gully diversion over the first 10 years of operation.

Table 7.1 – Proposed diversion monitoring schedule

Monitoring package	Monitoring activity	Years since construction commencement									
		-1	0	1	2	3	4	5	6	7	8
Baseline monitoring	Photographs										
	Aerial photograph										
	Survey										
	Vegetation										
	Flow events										
Construction monitoring	Execution database										
	Photographs										
	Aerial photograph										
Operations monitoring	Survival of works										
	Photographs										
	Aerial photograph										
	Visual assessment										
	Index of diversion condition										
	Survey										
	Flow events										

8 Conclusions

The existing Conrock Gully main channel flows into the Isaac River from the west. To provide access to the underlying coal resource, the gully channel will be relocated to the northwest. A levee will be constructed along the southern edge of the diversion to protect the mine workings from Isaac River flood events which will result in Isaac River backwater entering the diversion.

A functional design has been prepared addressing the Guideline objectives and design criteria:

- **Outcome 1** - The design incorporates natural features present in the local watercourses, and it replicates the channel length, slope and cross-sectional shape. It incorporates meanders with radii, amplitude and magnitude similar to existing meanders in the adjacent reaches and the reach to be diverted. A revegetation plan will be established which will incorporate local vegetation to achieve bank stability.
- **Outcome 2** - As the diversion is located on the edge of the floodplain, and it incorporates the above features, it maintains the existing hydrologic characteristics of surface water systems.
- **Outcome 3** - The hydraulic characteristics of the design are comparable with those in the existing watercourse, and it is therefore suitable for the region in which the diversion is located.
- **Outcome 4** - As the hydraulic characteristics are largely unchanged, the sediment transport will allow the watercourse diversion to be self-sustaining and is unlikely to result in material or serious environmental harm on upstream and downstream reaches.
- **Outcome 5** - The watercourse diversion and associated structures maintain stability and functionality and are appropriate for all substrate conditions they encounter. This will be confirmed in later design phases.

Specifically, the following criteria have been considered when developing the proposed diversion design:

1. The diversion ties in with the existing watercourse within the MLA tenement boundary. The proposed diversion alignment has been selected to minimise interference with mining infrastructure, whilst being within the MLA boundary.
2. The stability and performance of the diversion will be assisted by vegetation within the watercourse diversion and adjoining floodplain and will not include artificial structures for grade control.
3. The proposed diversion channel has similar dimensions to the existing channel and thus has similar design capacity (see Table 8.1).
4. The existing channel includes a large meander which contributes significantly to the length of channel being diverted. A number of meanders are to be reintroduced at the upstream end of the diversion which results in a length of channel and bed slope similar to the existing channel. The meanders have similar amplitude, wavelength, sinuosity, and bend radius to bends found in the existing creek channel (see Table 8.1).
5. The main channel has a similar geometry to the existing channel, but with slightly steeper side slopes to reduce the extent of disturbance required. The hydraulic conditions within the existing Conrock Gully channel and proposed diversion channel have been compared for conditions before and after the proposed development, and to Guideline conditions (see Table 8.2).

Table 8.1 compares the average geomorphic characteristics of the existing and proposed channels. Overall, the diversion design reasonably matches the existing Conrock Gully geometry.

Table 8.1 – Changes to typical channel geomorphic characteristics

Parameter		Existing gully	Proposed diversion
Length (km)		5.8	5.2
Bed Grade (%) – floodplain reach		0.140	0.147
Bed Grade (%) – downstream reach		0.330	0.341
Bed Width (m)		4	4
Top Width (m)		26	28
Depth to floodplain (m)		7	5
Meander Radius (m)		240 (median)	240 (median)
Meander Sinuosity Index		1.2-1.7	1.1
Meander Wavelength (m)		250-1,200	140-350
Meander Amplitude (m)		150-330	75-170
50% AEP	Mean Velocity (m/s)	0.95	0.93
	Mean Bed Shear Stress (N/m^2)	30.1	23.66
	Mean Stream Power (N/m s)	42.7	29.3
	Hydraulic Gradient (%)	0.17	0.14
2% AEP	Mean Velocity (m/s)	1.28	1.33
	Mean Bed Shear Stress (N/m^2)	33.5	30.9
	Mean Stream Power (N/m s)	55.7	49.6
	Hydraulic Gradient (%)	0.16	0.15

Within the diversion, the design hydraulic conditions are similar, and generally improved, to those in the existing Conrock Gully channel, and are consistent with the ACARP Guidelines for channel-averaged shear stress, stream power and velocity. The results are summarised in more detail in Table 8.2.

Table 8.2 – Comparison of modelled Guideline hydraulic conditions before and after diversion construction

Shear stress	Stream power	Velocity
50% (1 in 2) AEP		
Upstream Decreased, due to ponding upstream.	Decreased, due to ponding upstream.	Decreased, due to ponding upstream.
Diversion Reach Generally similar to existing. Isolated locations above Guideline in both existing and proposed, although improved for proposed diversion.	Slight decrease in mid diversion. Isolated locations above Guideline in both existing and proposed although improved for proposed diversion..	Slight decrease in mid diversion. Isolated locations above Guideline in both existing and proposed although improved for proposed diversion..
Downstream Overall decrease and within range of existing values.	Overall decrease and within range of existing values.	Overall decrease and within range of existing values.
2% (1 in 50) AEP		
Upstream Decreased, due to ponding upstream.	Decreased, due to ponding upstream.	Decreased, due to ponding upstream.
Diversion Reach Generally similar to existing. Isolated locations above Guideline in both existing and proposed although improved for proposed diversion..	Slight decrease in mid diversion. Isolated locations above Guideline in both existing and proposed although improved for proposed diversion..	Generally similar to existing reach. Isolated locations above Guideline in both existing and proposed although improved for proposed diversion..
Downstream Overall decrease and within range of existing values.	Overall decrease and within range of existing values.	Overall decrease and within range of existing values.

Under close to bank-full conditions, there are small reductions in shear stress, stream power and velocity predicted for the diversion channel itself. In the downstream reaches there will be increases in these parameters as flows enter Isaac River, but they will be similar to or lower than those occurring in the adjacent reaches, including the existing Conrock Gully.

Revegetation of the diversion will occur to achieve Guideline criteria. Rehabilitation of the diversion will be scheduled to align with operational requirements for the diversion and to achieve a long term stable landform.

9 References

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