



APPENDIX 7 – SURFACE WATER AND FLOOD IMPACT ASSESSMENT

**NEW LENTON COAL PTY LTD
NEW LENTON COAL PROJECT**



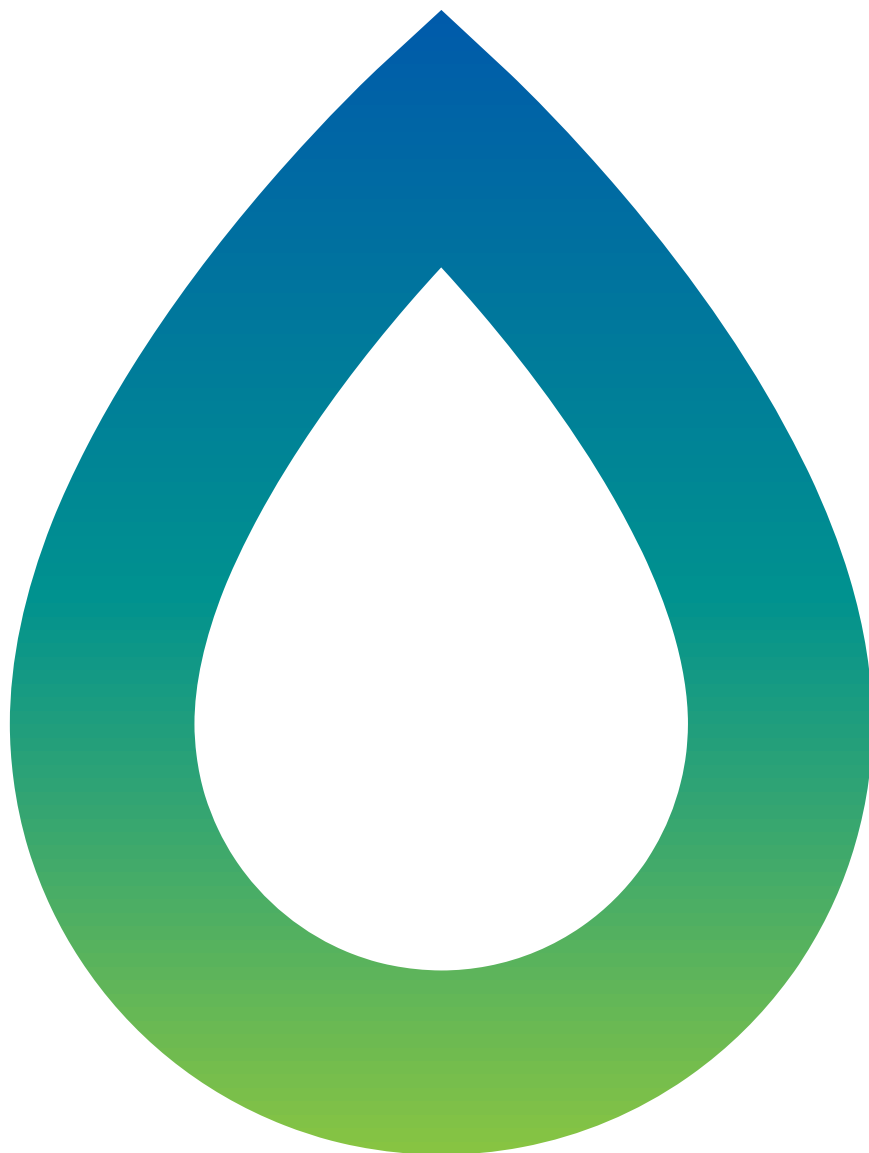
NEW LENTON COAL PROJECT

Surface Water and Flood Impact Assessment

Bowen Coking Coal Ltd

9 January 2024

1927-01-B4



DETAILS

Report Title	New Lenton Coal Project, Surface Water and Flood Impact Assessment
Client	Bowen Coking Coal Ltd

THIS REVISION

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1 INTRODUCTION

1.1 BACKGROUND

New Lenton Coal Pty Ltd (NLC) is a wholly owned subsidiary of Bowen Coking Coal Ltd (BCC). The Lenton Joint Venture (LJV) is an unincorporated joint venture between NLC and MPC Lenton Pty Ltd (MPC). NLC and MPC own the LJV assets as tenants in common in the participating interests of 90% and 10% respectively. BCC acquired NLC from the New Hope Corporation (New Hope) in July 2022.

LJV is the holder of mining lease (ML) 70337, ML 700053 and ML 700054 (referred to as the New Lenton MLs), on which the New Lenton Coal Project (the Project) is proposed. The New Lenton MLs are subject to an existing State approved environmental authority (EA) (EPML00475513) for all mining leases.

LJV is also the holder of ML 70109 and ML 70260, referred to as the Burton Mine MLs, which adjoin the New Lenton MLs, and which are subject to an existing State approved EA. Burton Mine commenced operations around 1996.

1.2 PROJECT DESCRIPTION

The New Lenton MLs are located in the Bowen Basin of central Queensland, approximately 120 km southwest of Mackay and 50 km north of Moranbah (refer to Figure 1.1). NLC is proposing to develop open cut coal mining pits on the New Lenton MLs, with supporting infrastructure (the Project). Approximately 1.9 million tonnes per annum (Mtpa) of metallurgical run of mine (ROM) coal will be mined over a period of 18 years with a total of approximately 30 Mt over the life of the mine. In some years, including during ramp up phases, less than 1.9 Mtpa ROM coal will be mined. Overburden will be placed in in-pit and out-of-pit waste rock dumps, with a final void remaining at the end of mine life. Supporting infrastructure includes a mine infrastructure area (MIA), haul roads, realignment of a public road and water management infrastructure (refer to Figure 1.2).

ROM coal will be hauled to Burton Mine for washing in Burton Mine's coal handling and processing plant (CHPP). Product coal will be hauled to Burton Mine's train load out (TLO) facility and railed to Dalrymple Bay Coal Terminal (DBCT). Rejects from washing of Project ROM coal will be stored within Burton Mine's existing co-disposal areas within old mine voids.

Proposed key infrastructure for the Project comprises:

- The two open cut mining pits;
- Two levees (for Ti-Tree Creek and the Isaac River);
- A Ti-Tree Creek diversion;
- A realignment of the Suttor Developmental Road that includes a bridge spanning the Isaac River;
- A haul road adjacent to the Suttor Developmental Road;
- Sediment dams, mine affected water (MAW) dams and a clean water dam;
- ROM coal pad;
- Mine infrastructure area (MIA).

The 'Project Disturbance Area' is shown Figure 1.2. Where the term 'Project area' is used in this report it refers to the New Lenton MLs and surrounding areas.

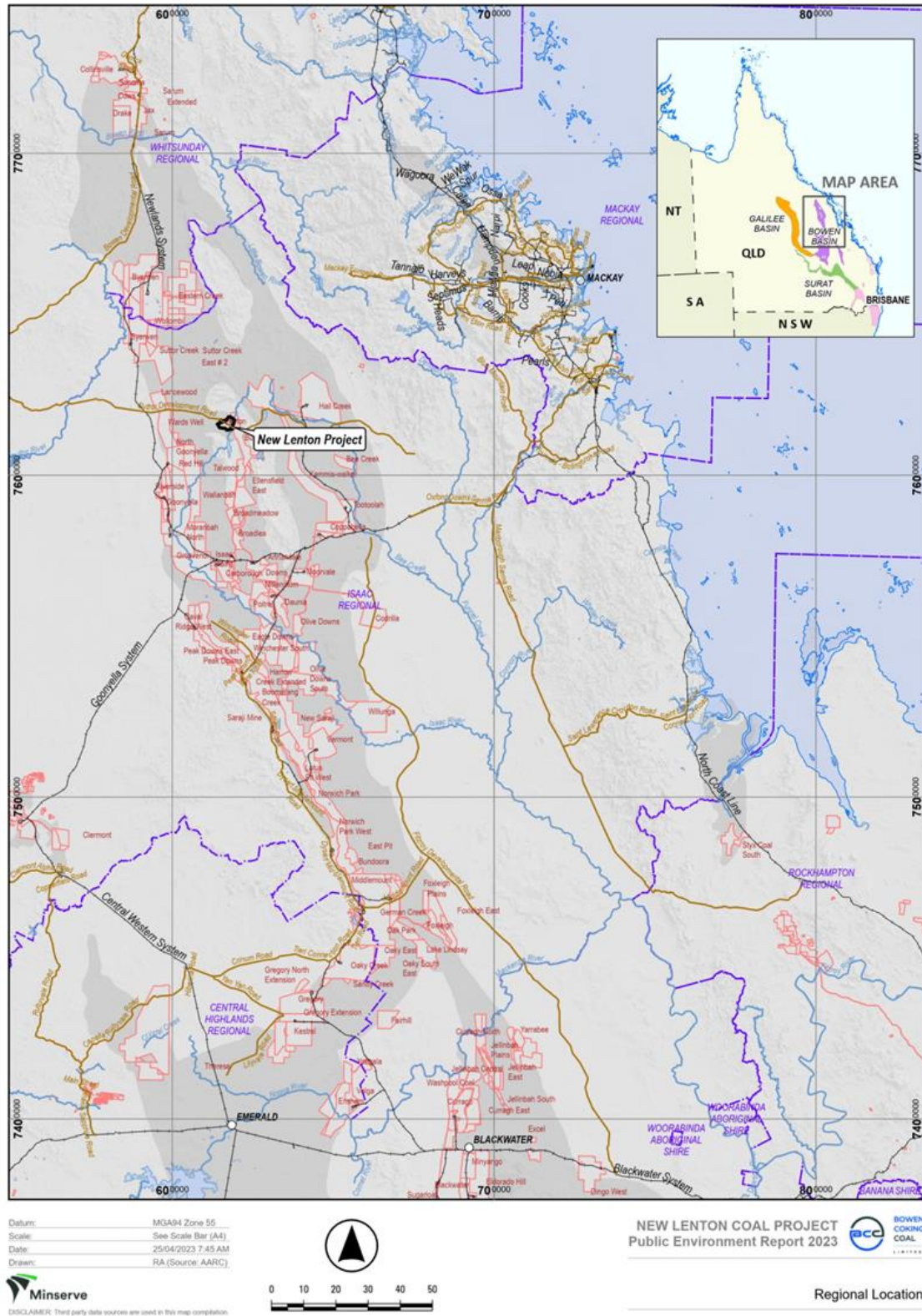


Figure 1.1 Regional locality

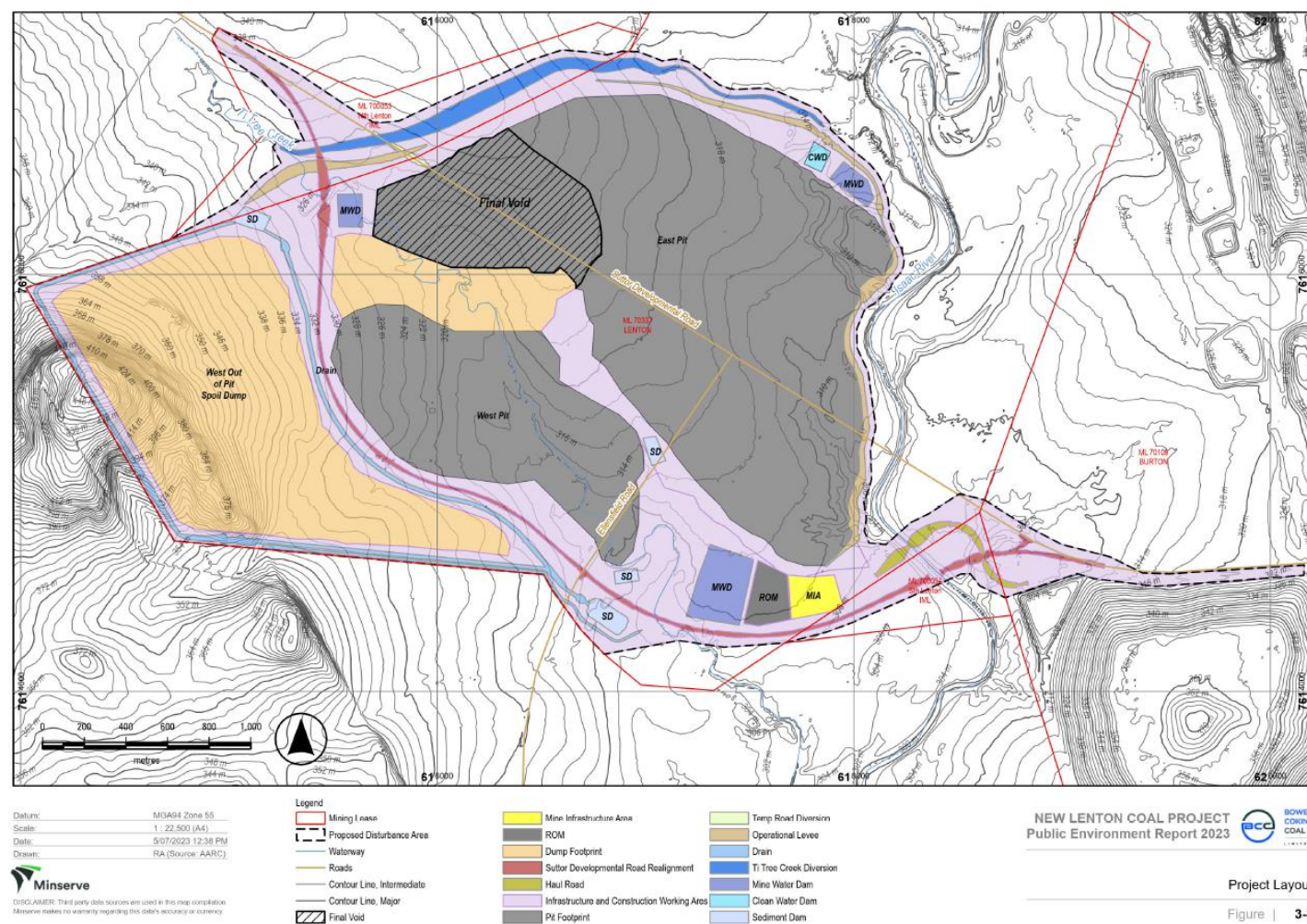


Figure 1.2 Project layout

1.3 PURPOSE OF REPORT

The purpose of this Public Environment Report (PER) is to communicate to the Australian public and stakeholders the activities planned for the Project, the potential for environmental impacts and the mitigation measures that will be in place to minimise the risk of potential impacts occurring.

This PER report, prepared by WRM Water & Environment Pty Ltd (WRM), presents an assessment of the impacts of the Project on surface water resources within the New Lenton MLs and surrounding areas. Key components of the assessment include numerical modelling of:

- water contained within the site water management system (during operations and post-mining); and
- flooding in watercourses upstream and downstream of the Project (for pre-mine conditions, during operations and post-mining).

The assessment has addressed matters identified by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) in their “Information guidelines for proponents preparing coal seam gas and large coal mining development proposals” (2018).

1.4 LEGISLATIVE FRAMEWORK

The relevant legislation in relation to surface water resources for the Project includes:

- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), including the water trigger;
- Water Act 2000 (Water Act);
- Water Reform and Other Legislation Amendment Act 2014 (Qld) (WROLA Act);
- Water Resource (Fitzroy Basin) Plan 2011 (Fitzroy Basin WRP);
- Environmental Protection Act 1994 (EP Act);
- Environmental Protection (Water) Policy 2009 (EPP Water);
- EPP Water Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River) September 2011; and
- Fisheries Act 1994 (Fisheries Act).

Given the status of the Project under the state jurisdiction (i.e. approved Environmental Authority), this surface water assessment is targeted towards meeting the requirements under Commonwealth legislation.

1.4.1 Commonwealth legislation

Under the EPBC Act, an action involving a ‘CSG development’ or ‘large coal mining development’ will require approval from the Commonwealth Environment Minister if the action has, will have or is likely to have a significant impact on a water resource (‘the water trigger’). The water trigger also requires that the action is reviewed by the IESC.

A Referral for the Project, under the EPBC Act was lodged on 23/09/2020 (EPBC 2020/8778). On 22/10/2020, the delegate for the Minister for the Environment determined that the Project was a controlled action and would be assessed by PER, with the controlling provisions including the water trigger.

The *Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments— impacts on water resources* (the Guideline) provides a self-assessment framework and exemptions to determine if a referral under the EPBC Act is required.

1.5 PREVIOUS INVESTIGATIONS AND REPORTS

A number of previous investigations have been undertaken to characterise the surface water environment in the vicinity of the Project. Data and reports from these previous investigations have been relied upon in the preparation of the current PER. Key reports referenced in this PER include:

- 'Baseline Surface Water Quality Assessment, New Lenton Coal Project', URS, July 2013.
- 'New Lenton Coal Project, Groundwater and Surface Water Monitoring Report, March 2017 – July 2018', GHD, 6 December 2018.
- 'New Lenton Mine Aquatic Ecology Assessment', AARC, August 2019.
- '2023 Receiving Environment Monitoring Program, Burton Coal Mine', SGM Environmental, 8 June 2023.

1.6 REPORT STRUCTURE

This report is structured as follows:

- Section 2 provides a table cross-referencing where the IESC information requirements and relevant sections of the PER guidelines have been addressed in this document;
- Section 3 describes the existing surface water environment including the regional and local drainage characteristics;
- Section 4 describes the proposed surface water management system including the management objectives and principles;
- Section 5 describes the site water balance model configuration;
- Section 5 provides a summary of the water balance model results for the site water management system;
- Section 6 presents the outcomes from the residual void water balance assessment;
- Section 8 presents the outcomes from the flood modelling assessment;
- Section 9 presents the outcomes from the geomorphology assessment;
- Section 10 describes the outcomes from the impact assessment for surface water (including cumulative impacts);
- Section 11 presents a summary of findings for the surface water and flooding assessment;
- Section 12 presents the references used throughout the report;
- Appendix A describes the setup and configuration of the hydrology model;
- Appendix B describes the setup and configuration of the hydraulic model;
- Appendix C presents the results of sensitivity analysis of the site water balance;
- Appendix D provides available surface water quality data;
- Appendix E presents the flood mapping.

2 INDEPENDENT EXPERT SCIENTIFIC COMMITTEE AND PER GUIDELINES

The IESC has published information guidelines (IESC, 2018) for advice on coal seam gas and large coal mining development proposals. The report sections where the IESC information requirements (relevant to surface water resources) have been addressed are outlined in Table 2.1.

Guidelines for the content of a draft Public Environment Report for the Project (PER Guidelines [Reference: 2020/8778]) also detail requirements relevant to surface water issues and impacts. The report sections where aspects of the PER Guidelines relevant to surface water have been addressed are outlined in Table 2.2.

Table 2.1 IESC information requirements

Project information	Report section
<u>Description of the proposal</u>	
Provide a regional overview of the proposed project area including a description of the geological basin; coal resource; surface water catchments; groundwater systems; water-dependent assets; and past, current and reasonably foreseeable coal mining and CSG developments.	Existing surface water environment is described in Section 3. Summary project description in Section 1.2. Refer to Chapter 3 of the PER Report for the full Project Description
Describe the proposal's location, purpose, scale, duration, disturbance area, and the means by which it is likely to have a significant impact on water resources and water-dependent assets.	Summary project description in Section 1.2. Refer to Chapter 3 of the PER Report for the full Project Description. Potential surface water impacts are discussed in Section 10.
Describe the statutory context, including information on the proposal's status within the regulatory assessment process and any applicable water management policies.	Section 1.3
Describe how impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	Section 1.3
<u>Surface water – context and conceptualisation</u>	
Describe the hydrological regime of all watercourses, standing waters and springs across the site including:	
• geomorphology, including drainage patterns, sediment regime, and floodplain features;	Section 3.9
• spatial, temporal and seasonal trends in streamflow and/or standing water levels;	Section 3.3
• spatial, temporal and seasonal trends in water quality data (such as turbidity, acidity, salinity, relevant organic chemicals, metals, metalloids and radionuclides); and	Section 3.7
• current stressors on watercourses, including impacts from any currently approved projects.	Existing surface water environment is described in Section 3.
Describe the existing flood regime, including flood volume, depth, duration, extent and velocity for a range of annual exceedance probabilities. Provide flood hydrographs and maps identifying peak flood extent, depth and velocity. This assessment should be informed by topographic data that has been acquired using lidar or other reliable survey methods with accuracy stated.	Section 8.2
Provide an assessment of the frequency, volume, seasonal variability and direction of interactions between water resources, including surface water/groundwater connectivity and connectivity with sea water.	No seawater interaction. Interaction with groundwater is described in the Groundwater Report (SLR, 2023).
<u>Surface water – analytical and numerical modelling</u>	

Project information	Report section
Provide conceptual models at an appropriate scale, including water quality, stores, flows and use of water by ecosystems.	Section 5, Appendix A, Appendix B, Appendix C
Use methods in accordance with the most recent publication of Australian Rainfall and Runoff (Ball et al. 2016).	Appendix A, Section A.2
Develop and describe a program for review and update of the models as more data and information becomes available.	Section 6.6
Describe and justify model assumptions and limitations and calibrate with appropriate surface water monitoring data.	Appendix A, Section A.2 Section 5.4
Provide an assessment of the risks and uncertainty inherent in the data used in the modelling, particularly with respect to predicted scenarios.	Section 6.5
Provide a detailed description of any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	Monitoring data relevant to surface water is provided in Section 3.
<u>Surface water – impacts to water resources and water-dependent assets</u>	
Describe all potential impacts of the proposed project on surface waters. Include a clear description of the impact to the resource, the resultant impact to any assets dependent on the resource (including water-dependent ecosystems such as riparian zones and floodplains), and the consequence or significance of the impact. Consider:	
impacts on streamflow under the full range of flow conditions.	Section 10.5
impacts associated with surface water diversions.	Section 10.2
impacts to water quality, including consideration of mixing zones.	Section 10.8 There are no modelled releases of mine-affected water to the receiving environment, therefore mixing zone assessment not required.
the quality, quantity and ecotoxicological effects of operational discharges of water (including saline water), including potential emergency discharges, and the likely impacts on water resources and water-dependent assets.	Section 10.8. Chapter 6 of the PER Report
landscape modifications such as subsidence, voids, post rehabilitation landform collapses, onsite earthworks (including disturbance of acid-forming or sodic soils, roadway and pipeline networks) and	Sections 7 & 8.

Project information	Report section
how these could affect surface water flow, surface water quality, erosion, sedimentation and habitat fragmentation of water-dependent species and communities.	
Discuss existing water quality guidelines, environmental flow objectives and requirements for the surface water catchment(s) within which the development proposal is based.	Sections 3.5 & 3.6
Identify processes to determine surface water guidelines and quantity thresholds which incorporate seasonal variation but provide early indication of potential impacts to assets.	The water quality objectives and default guideline values identified as per ANZG (2018) do not incorporate any allowance for seasonal variation.
Propose mitigation actions for each identified significant impact.	Section 10
Describe the adequacy of proposed measures to prevent or minimise impacts on water resources and water-dependent assets.	Section 10
Describe the cumulative impact of the proposal on surface water resources and water-dependent assets when all developments (past, present and/or reasonably foreseeable) are considered in combination.	Section 10.9
Provide an assessment of the risks of flooding (including channel form and stability, water level, depth, extent, velocity, shear stress and stream power), and impacts to ecosystems, project infrastructure and the final project landform.	Sections 8, 9, 10.2, 10.3, 10.6
<u>Surface water – data and monitoring</u>	
Identify monitoring sites representative of the diversity of potentially affected water-dependent assets and the nature and scale of potential impacts, and match with suitable replicated control and reference sites (BACI design) to enable detection and monitoring of potential impacts.	Section 10.10
Ensure water quality monitoring complies with relevant National Water Quality Management Strategy (NWQMS) guidelines (ANZECC/ARMCANZ 2000) and relevant legislated state protocols (e.g. QLD Government 2013).	Section 10.8
Identify data sources, including streamflow data, proximity to rainfall stations, data record duration and a description of data methods, including whether missing data has been patched.	Section 3.3, 3.4.
Develop and describe a surface water monitoring programme 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 will:	

Project information	Report section
include baseline monitoring data for physico-chemical parameters, as well as contaminants (e.g. metals);	Section 10.10
comparison of physico-chemical data to national/regional guidelines or to site- specific guidelines derived from reference condition monitoring if available; and,	Section 10.10
identify baseline contaminant concentrations and compare these to national guidelines, allowing for local background correction if required.	Section 3.7.2, Section 10.10
Describe the rationale for selected monitoring parameters, duration, frequency and methods, including the use of satellite or aerial imagery to identify and monitor large-scale impacts.	Section 10.10
Develop and describe a plan for ongoing ecotoxicological monitoring, including direct toxicity assessment of discharges to surface waters where appropriate.	Section 10.10
Identify dedicated sites to monitor hydrology, water quality, and channel and floodplain geomorphology throughout the life of the proposed project and beyond.	Section 10.10
<u>Water-dependent assets – context and conceptualisation</u>	
Identify water-dependent assets, including:	
water-dependent fauna and flora and provide surveys of habitat, flora and fauna (including stygofauna) (see Doody et al. [in press]).	Refer to Groundwater Dependent Ecosystem Report (3D Environmental, 2023) and Stygofauna Report (frc, 2023)
public health, recreation, amenity, Indigenous, tourism or agricultural values for each water resource.	Section 3.5
Identify GDEs in accordance with the method outlined by Eamus et al. (2006). Information from the GDE Toolbox15 (Richardson et al. 2011) and GDE Atlas (CoA 2017a) may assist in identification of GDEs (see Doody et al. [in press]).	Refer to Groundwater Dependent Ecosystem Report (3D Environmental, 2023) for details.
Describe the conceptualisation and rationale for likely water-dependence, impact pathways, tolerance and resilience of water-dependent assets. Examples of ecological conceptual models can be found in Commonwealth of Australia (2015).	Refer to Groundwater Dependent Ecosystem Report (3D Environmental, 2023) and Stygofauna Report (frc, 2023) for details.
Estimate the ecological water requirements of identified GDEs and other water-dependent assets (see Doody et al. [in press]).	Refer to Groundwater Dependent Ecosystem Report (3D Environmental, 2023) and Stygofauna Report (frc, 2023) and PER Chapter 6 for details

Project information	Report section
Identify the hydrogeological units on which any identified GDEs are dependent (see Doody et al. [in press]).	Refer to Groundwater Dependent Ecosystem Report (3D Environmental, 2023) and Stygofauna Report (frc, 2023) for details.
Provide an outline of the water-dependent assets and associated environmental objectives and the modelling approach to assess impacts to the assets.	Refer to Groundwater Dependent Ecosystem Report (3D Environmental, 2023) and Stygofauna Report (frc, 2023) for details.
Describe the process employed to determine water quality and quantity triggers and impact thresholds for water-dependent assets (e.g. threshold at which a significant impact on an asset may occur).	Groundwater Dependent Ecosystem Report (3D Environmental, 2023) and Stygofauna Report (frc, 2023)
<u>Water-dependent assets – impacts, risk assessment and management of risks</u>	
Provide an assessment of direct and indirect impacts on water-dependent assets, including ecological assets such as flora and fauna dependent on surface water and groundwater, springs and other GDEs (see Doody et al. [in press]).	Refer to Groundwater Dependent Ecosystem Report (3D Environmental, 2023) and Stygofauna Report (frc, 2023) and Chapter 6 for details.
Describe the potential range of drawdown at each affected bore, and clearly articulate the scale of impacts to other water users.	Refer to Groundwater Assessment Report (SLR, 2023) for details.
Indicate the vulnerability to contamination (e.g. from salt production and salinity) and the likely impacts of contamination on the identified water-dependent assets and ecological processes.	Refer to Groundwater Dependent Ecosystem Report (3D Environmental, 2023) and Stygofauna Report (frc, 2023) and Chapter 6 for details
Identify and consider landscape modifications (e.g. voids, on-site earthworks, and roadway and pipeline networks) and their potential effects on surface water flow, erosion and habitat fragmentation of water-dependent species and communities.	Section 10. Refer to Chapter 6
Provide estimates of the volume, beneficial uses and impact of operational discharges of water (particularly saline water), including potential emergency discharges due to unusual events, on water-dependent assets and ecological processes.	6.3.5.1 The water balance modelling predicts that, due to the configuration of the site WMS, neither controlled nor or uncontrolled discharges of mine-affected water would occur under any climatic scenarios.
Assess the overall level of risk to water-dependent assets through combining probability of occurrence with severity of impact.	Section 10
Identify the proposed acceptable level of impact for each water-dependent asset based on leading-practice science and site-specific data, and ideally developed in conjunction with stakeholders.	Section 10.1
Propose mitigation actions for each identified impact, including a description of the adequacy of the proposed measures and how these will be assessed.	Section 10

Project information	Report section
<u>Water-dependent assets – data and monitoring</u>	
Identify an appropriate sampling frequency and spatial coverage of monitoring sites to establish pre-development (baseline) conditions, and test potential responses to impacts of the proposal (see Doody et al. [in press]).	Section 10.10. Refer to Groundwater Dependent Ecosystem Report (3D Environmental, 2023)
Consider concurrent baseline monitoring from unimpacted control and reference sites to distinguish impacts from background variation in the region (e.g. BACI design, see Doody et al. [in press]).	Section 10.10. Refer to Groundwater Assessment Report (SLR, 2023)
Develop and describe a monitoring program that identifies impacts, evaluates the effectiveness of impact prevention or mitigation strategies, measures trends in ecological responses and detects whether ecological responses are within identified thresholds of acceptable change (see Doody et al. [in press]).	Section 10.10. Refer to Groundwater Dependent Ecosystem Report (3D Environmental, 2023)
Describe the process for regular reporting, review and revisions to the monitoring program.	Section 10.10.4 The surface water monitoring program will be reviewed as part of the annual REMP reporting process.
Ensure ecological monitoring complies with relevant state or national monitoring guidelines (e.g. the DSITI guideline for sampling stygofauna (QLD Government 2015)).	Refer to Groundwater Dependent Ecosystem Report (3D Environmental, 2023) and Stygofauna Report (frc, 2023) and Chapter 6 for details.
<u>Water and salt balance, and water management quality</u>	
Provide a quantitative site water balance model describing the total water supply and demand under a range of rainfall conditions and allocation of water for mining activities (e.g. dust suppression, coal washing etc.), including all sources and uses.	Section 5
Describe the water requirements and on-site water management infrastructure, including modelling to demonstrate adequacy under a range of potential climatic conditions.	Section 5, 6
Provide estimates of the quality and quantity of operational discharges under dry, median and wet conditions, potential emergency discharges due to unusual events and the likely impacts on water-dependent assets.	Section 6.3.5
Provide salt balance modelling that includes stores and the movement of salt between stores, and takes into account seasonal and long-term variation.	Section 6.4

Project information	Report section
<u>Cumulative impacts – context and conceptualisation</u>	
Provide cumulative impact analysis with sufficient geographic and temporal boundaries to include all potentially significant water-related impacts.	Section 10.9
Consider all past, present, and reasonably foreseeable actions, including development proposals, programs and policies that are likely to impact on the water resources of concern in the cumulative impact analysis. Where a proposed project is located within the area of a bioregional assessment consider the results of the bioregional assessment.	Section 10.9.2 and 10.9.3
<u>Cumulative impacts – impacts</u>	
Provide an assessment of the condition of affected water resources which includes:	
• identification of all water resources likely to be cumulatively impacted by the proposed development;	Section 10.9.4
• a description of the current condition and quality of water resources and information on condition trends;	Section 3.7.2, 3.9
• identification of ecological characteristics, processes, conditions, trends and values of water resources;	Section 10.9.4.
• adequate water and salt balances; and	Section 6.3, 6.4
• identification of potential thresholds for each water resource and its likely response to change and capacity to withstand adverse impacts (e.g. altered water quality, drawdown).	Section 10
Assess the cumulative impacts to water resources considering:	
• the full extent of potential impacts from the proposed project, (including whether there are alternative options for infrastructure and mine configurations which could reduce impacts), and encompassing all linkages, including both direct and indirect links, operating upstream, downstream, vertically and laterally;	Section 10.9
• all stages of the development, including exploration, operations and post closure/decommissioning;	Section 10.9
• appropriately robust, repeatable and transparent methods;	Section 10.9
• the likely spatial magnitude and timeframe over which impacts will occur, and significance of cumulative impacts; and	Section 10.9

Project information	Report section
opportunities to work with other water users to avoid, minimise or mitigate potential cumulative impacts.	Section 10.9
<u>Cumulative Impacts – Mitigation, monitoring and management</u>	
Identify modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts. Evidence of the likely success of these measures (e.g. case studies) should be provided.	Refer to PER Chapter 3
Identify measures to detect and monitor cumulative impacts, pre and post development, and assess the success of mitigation strategies.	Section 10.10
Identify cumulative impact environmental objectives.	Section 10.9.4
Describe appropriate reporting mechanisms.	Section 10.10
Propose adaptive management measures and management responses.	Section 6.6
<u>Final landform and voids – coal mines</u>	
Identify and consider landscape modifications (e.g. voids, on-site earthworks, and roadway and pipeline networks) and their potential effects on surface water flow, erosion, sedimentation and habitat fragmentation of water-dependent species and communities.	Section 7
Assess the adequacy of modelling, including surface water and groundwater quantity and quality, lake behaviour, timeframes and calibration.	Section 7
Provide an assessment of the long-term impacts to water resources and water-dependent assets posed by various options for the final landform design, including complete or partial backfilling of mining voids. Assessment of the final landform for which approval is being sought should consider:	
groundwater behaviour – sink or lateral flow from void.	Section 7.6 and Groundwater Report (SLR, 2023)
water level recovery – rate, depth, and stabilisation point (e.g. timeframe and level in relation to existing groundwater level, surface elevation).	Section 7.6
seepage – geochemistry and potential impacts.	PER Chapter 3
long-term water quality, including salinity, pH, metals and toxicity.	Section 7.7
measures to prevent migration of void water off-site.	Section 7.6

Project information	Report section
For other final landform options considered sufficient detail of potential impacts should be provided to clearly justify the proposed option.	PER Chapter 3
Assess the probability of overtopping of final voids with variable climate extremes, and management mitigations.	Section 7.9
<u>Acid-forming materials and other contaminants of concern</u>	
Identify the presence and potential exposure of acid-sulphate soils (including oxidation from groundwater drawdown).	Section 3.11
Identify the presence and volume of potentially acid-forming waste rock, fine-grained amorphous sulphide minerals and coal reject/tailings material and exposure pathways.	Section 3.11
Identify other sources of contaminants, such as high metal concentrations in groundwater, leachate generation potential and seepage paths.	Section 3.11.1.3
Describe handling and storage plans for acid-forming material (co-disposal, tailings dam, encapsulation).	Section 3.11.1.4
Assess the potential impact to water-dependent assets, taking into account dilution factors, and including solute transport modelling where relevant, representative and statistically valid sampling, and appropriate analytical techniques.	Section 3.11.1.3
Describe proposed measures to prevent/minimise impacts on water resources, water users and water-dependent ecosystems and species.	Section 3.11.1.4

Table 2.2 PER Guidelines requirements

PER Guideline requirement	Report section
<u>PER Guideline Section 5.2 - A water resource in relation to coal seam gas development and large coal mining development</u>	
Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development	See Table 2.1
<u>The hydrology relevant to the proposed action area, including surface water and groundwater</u>	Section 3
Provide a regional overview of the project area, including a description of the geological basin, coal resource, surface water catchments, groundwater systems and water-dependent assets.	
Describe any potential third-party users of water in areas potentially affected by the proposed project, including municipal, agricultural, industrial, recreational and environmental uses of water. Noting the proposed action has the potential to utilise existing infrastructure from the Burton Mine, the impacts on water resources and water-dependent assets from the transfer of mine affected water to or from Burton mine should be described.	Section 3.8
The PER must include a description and assessment of the impacts to water resources giving consideration to relevant departmental policies and guidelines, including the Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources (2013). These guidelines can be found at the following website: http://www.dcceew.gov.au/environment/epbc/publications/significant-impact-guidelines-13-coal-seam-gas-and-large-coal-mining-developments-impacts .	Section 10
The PER must provide robust scientific information and supporting evidence for every assertion, assumption and/or conclusion made in the assessment of potential impacts, or lack of impacts, on water resources.	Assumptions for various aspects of the assessment are documented throughout the report
The PER should refer to water quality objectives approved in the State environmental authority for the proposal where they are relevant to the assessment, and management and mitigation of impacts on EPBC protected matters.	Section 3.5, 3.6
<u>PER Guideline Section 5.2.2 - Final Voids</u>	
The PER must provide details on the final voids, including:	
The precise location of the proposed final voids.	Section 7.2
An assessment of the design of the final voids and how the design will minimise impacts, as well as an assessment of the water quality of those voids.	Section 7.7
Information in the referral documentation noted that the final voids will remain groundwater sinks post-mining. Provide details on the predicted water levels in the final voids, along with the expected groundwater level at which the voids will cease	Section 7.6 and Groundwater Report (SLR, 2023)

PER Guideline requirement	Report section
to be sinks and begin recharging local groundwater. Please provide and fully explain the reasoning behind the identified levels at which groundwater flows change. A discussion on whether through-flow groundwater conditions could be established. As the void water is predicted to become hyper-saline, provide discussion on whether this water has any potential to leave the pit lakes.	Section 7.6
<u>PER Guideline Section 5.2.6 – Surface water</u>	
The PER must provide details on surface water, including, but not limited to:	
A description of the surface water values of the project area and surrounding vicinity, including a discussion of the regional water quality and the local receiving environment. Further, a discussion of existing flood conditions must be provided.	Section 3
Provide flood modelling that demonstrates the flooding system for existing Ti-tree Creek and for the projected diversion channel.	Section 8
A description of the impacts to surface water, in relation to the Ti-Tree creek diversion, Isaac River and associated levees.	Section 10.2
Water quality monitoring data, including baseline data and when and where samples have been obtained. The monitoring data must be provided in full in the PER to show the temporal and spatial trends in water quality.	Section 3.7, Appendix D
Quantify current surface water flow regimes, both within and adjacent to the project site, to ensure there is sufficient baseline information to assess how the location, volume, velocity and timing of flows may change as a result of the proposed action.	Section 8.2
A discussion on changes to surface water flows and quality from proposed controlled and uncontrolled water releases.	Section 10.8
Information on the potential increase in soil instability and erosion resulting from construction and potential subsequent impacts on downstream water quality.	Section 10.8.2.3
<u>PER Guideline Section 5.2.7 – Cumulative impacts</u>	
The PER must identify and address potential and likely cumulative impacts on groundwater and surface water from the proposed action, Burton Mine and other nearby resource projects. Discussion should include cumulative impact considerations of impacts to water quality and quantity, and potential impacts to Groundwater Dependent Ecosystems in the region.	Section 10.9
<u>PER Guideline Section 6 – Proposed safeguards and mitigation measures</u>	
The PER must provide information on proposed avoidance, safeguards and mitigation measures to deal with the relevant impacts of the proposed action on MNES, including those required by other Commonwealth, State and local government approvals. Committed language (eg. 'will') rather than non-committal language (eg. 'may', 'where possible', 'if required', etc) must be used.	Section 10
The proposed measures must consider the 'S.M.A.R.T' principle:	
S – Specific (what and how);	

PER Guideline requirement	Report section
• M – Measurable (baseline information, number/value, auditable); • A – Achievable (timeframe, money, personnel); • R – Relevant (conservation advices, recovery plans, threat abatement plans); and • T – Time-bound (specific timeframe to complete).	
Specific and detailed descriptions of proposed measures must be provided and substantiated, based on best available practices, and must include the following elements: • an assessment of the predicted effectiveness and environmental outcomes of the proposed measures, including details of any baseline data or proposed monitoring required to demonstrate progress towards achieving these outcomes; • any statutory or policy basis for the proposed measures, including reference to the SPRAT Database and relevant approved conservation advices, and a discussion on whether the proposed measures are consistent with relevant recovery plans and threat abatement plans; • details of ongoing management, including monitoring programs to support an adaptive management approach and determine the effectiveness of the proposed measures; • information on the timing, frequency and duration of the measures to be implemented; and • the name of the agency responsible for endorsing or approving each measure or monitoring program.	Section 4, 10
The PER must include a copy of the amended EA issued by the Queensland Department of Environment and Science for the New Lenton Coal Project. Provide discussion, where applicable, as to how the requirements of the EA may mitigate potential impacts to water resources, noting any relevant management or monitoring plans (e.g. Receiving Environment Monitoring Program, Water Management Plan, Groundwater Management and Monitoring Plan).	Section 10.10. See PER report
An outline of any management plans beyond those required through the State assessment process, must be provided that sets out the framework for management, mitigation and monitoring of relevant impacts of the proposed action, including any provisions for independent environmental auditing.	See PER report
The outline of management plans must state the environmental objectives, performance criteria, monitoring, reporting, corrective action, responsibility and timing for each relevant MNES environmental issue. Please note the IESC will consider whether the PER has demonstrated that the risks to water resources can be either avoided or suitably mitigated and may suggest further actions to mitigate or manage residual risks.	See PER report

3 EXISTING SURFACE WATER ENVIRONMENT

3.1 REGIONAL DRAINAGE CHARACTERISTICS

The Project is located within the headwaters of the Isaac River catchment of the greater Fitzroy Basin, upstream of Burton Gorge Dam. The Isaac River catchment commences at the Denham Range located about 15 km to the northeast (upstream) of the site. The Isaac River flows in a south-westerly direction through the Carborough and Kerlong Ranges before turning in a south-easterly 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 235 km downstream of the Project. The Isaac River finally converges with the Mackenzie River a further 68 km downstream.

Figure 3.1 shows the location of the Project and Isaac River catchment, in the context of the whole Fitzroy River catchment. Figure 3.2 shows the drainage characteristics of the Upper Isaac River to the Deverill streamflow gauge.

The Isaac River flows into the northern arm of Burton Gorge Dam which is located approximately 1.5 km downstream of ML 70337. Burton Gorge Dam also receives inflows from Anna Creek (including Lake Elphinstone), Sandy Creek, Plumtree Creek and Teviot Creek (including Teviot Creek Dam). These watercourses flow into the southern arm of Burton Gorge Dam and their catchments are not affected by the Project.

Figure 3.3 illustrates the location of the Project relative to the local waterways.

The greater Isaac-Connors sub-catchment area is approximately 22,364 km² (to the Mackenzie River confluence), out of a total Fitzroy River catchment of 142,665 km². That is, it represents around 15% of the overall Fitzroy River catchment. The catchment of the Isaac River to the downstream boundary of the New Lenton MLs is about 200 km², which represents about 0.9% of the Isaac-Connors sub-catchment.

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 within the mine 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, although pools are expected to hold water for extended periods. Therefore, physical attributes, water quality, and the composition of aquatic flora and fauna communities are also expected to be highly variable over time.

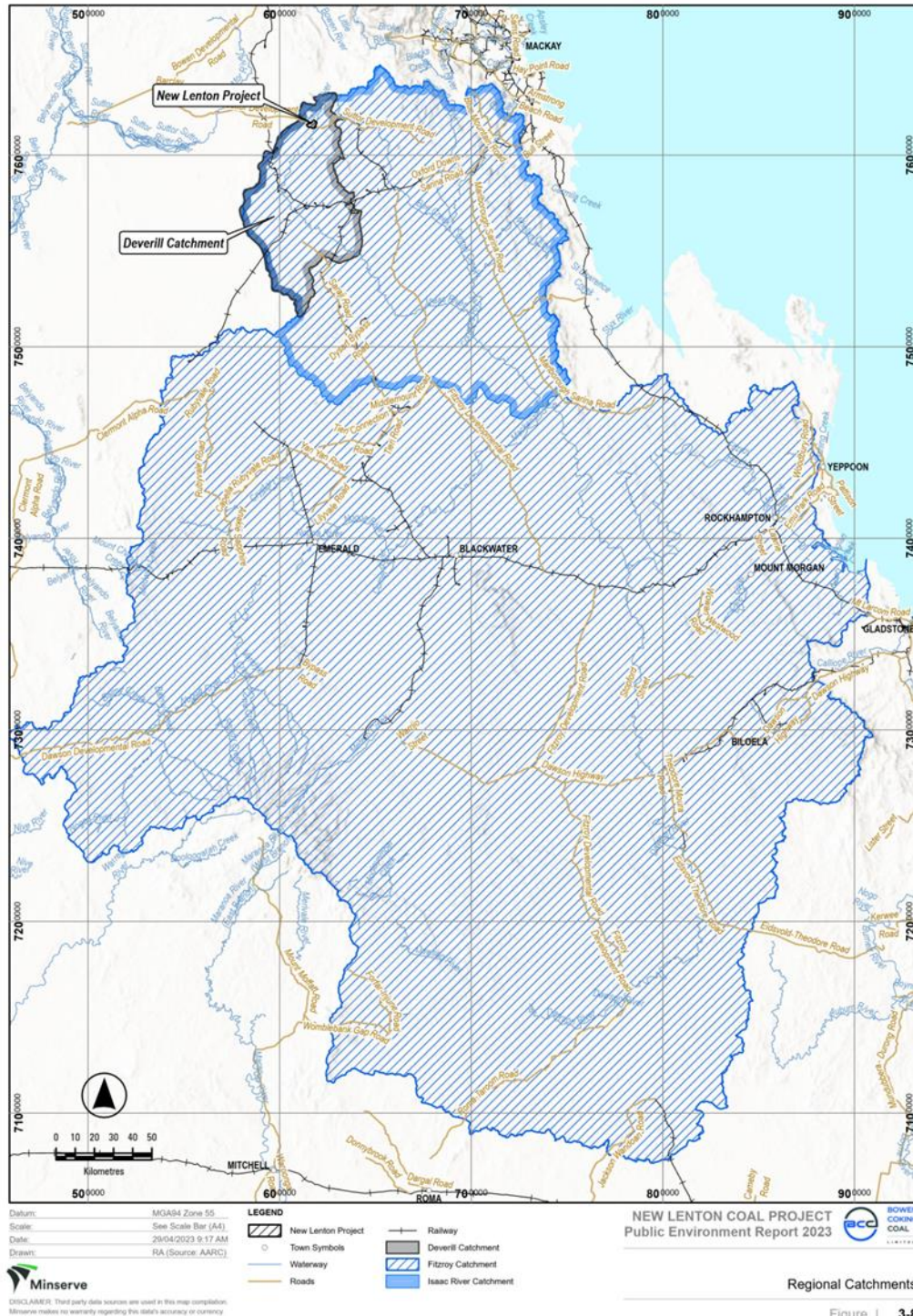


Figure 3.1 Fitzroy River catchment

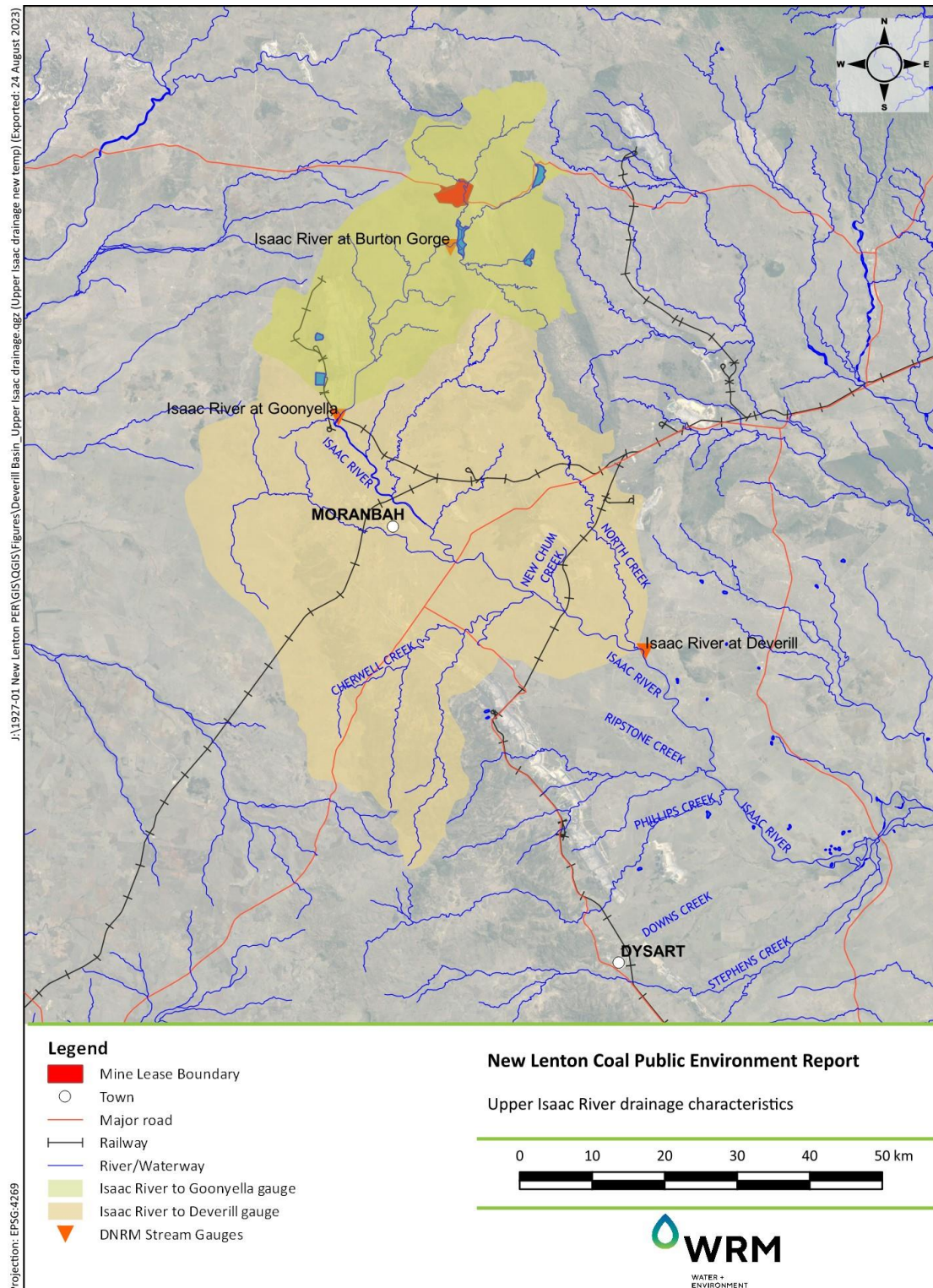


Figure 3.2 Upper Isaac River drainage characteristics

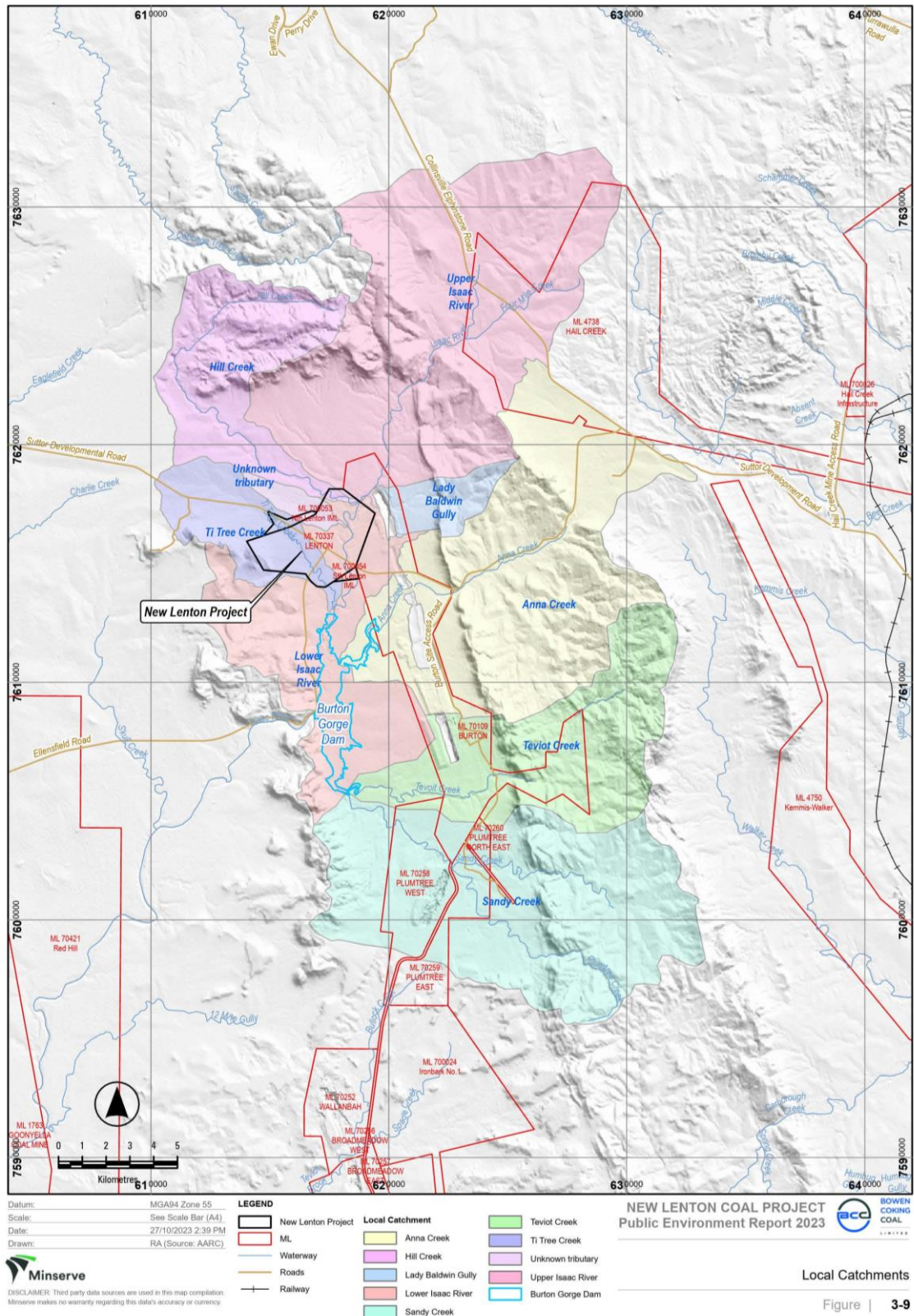


Figure 3.3 Local drainage features

3.2 LOCAL DRAINAGE NETWORK

The Isaac River is the main watercourse feature which drains through the eastern portion of ML 70337. Hill Creek joins the Isaac River from the west near the northern end of ML 70337. The Hill Creek channel is outside the Project Disturbance Area and will not be impacted by the Project. In addition to the Isaac River, key drainage features within the Project Disturbance Area are Ti-Tree Creek and an unnamed tributary of the Isaac River. The alignment of the Ti-Tree Creek channel and the unnamed tributary are shown in Figure 3.4. The Department of Natural Resources, Mines and Energy (DNRME) determined that Ti-Tree Creek is not a designated watercourse under the *Water Act 2000*.

The Project Disturbance Area is relatively flat and encompasses a section of the Isaac River floodplain. The Project Disturbance Area is located at an elevation of approximately 300 metres (m) to 340 m Australian Height Datum (AHD). The southern and eastern boundary of New Lenton MLs are generally between 300 and 315 m AHD with the highest point along the northeastern boundary.

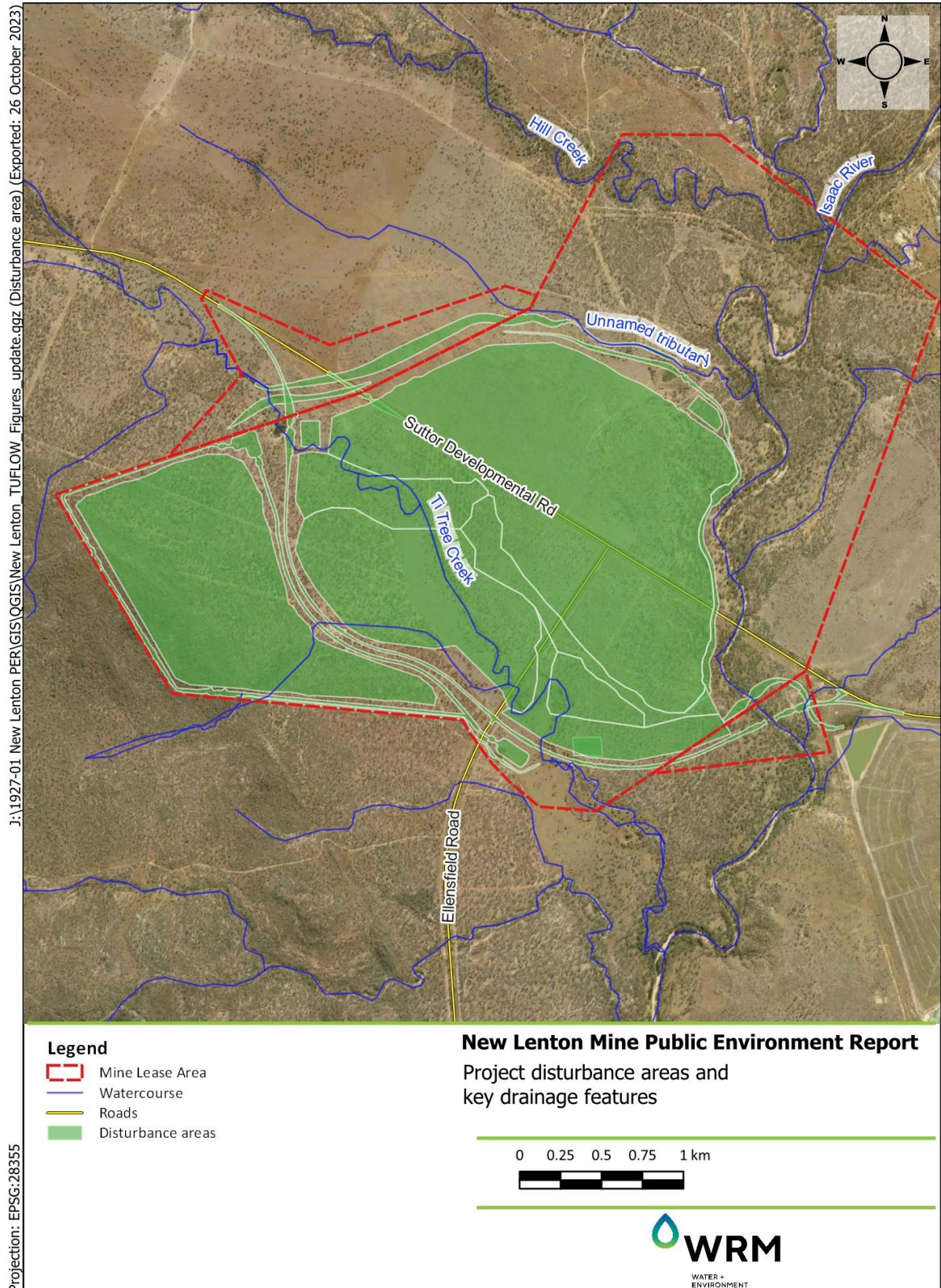


Figure 3.4 New Lenton MLs and key drainage features

3.3 RAINFALL

Long-term daily rainfall data in the vicinity of the Project is available from the following locations:

- Lake Elphinstone Station (34077) [1973-1997]: 18 km from Project;
- Glenden Station (34064) [1911-2000]: 29 km from Project;
- Suttor Creek Station (34057) [1925-1956]: 28 km from Project;
- Wollombi Station (34020) [1965-2010]: 37 km from Project;
- Turrawulla Station (33169) [1972-2017]; 50 km from Project;
- Moranbah Airport (34035) [2012-current]; 52 km from Project.

Average annual rainfall in the area is approximately 650 mm, with higher rainfall in the summer months. Annual evaporation is more than 2.5 times greater than rainfall. Further details of adopted rainfall and evaporation for the assessment of the site water balance are provided in Section 5.3.

3.4 STREAMFLOW

The nearest streamflow gauges on the Isaac River near the Project are located downstream at Burton Gorge Dam and Goonyella, both of which were operated by the Department of Resources (DoR). However, neither of these gauges are now functional, with the Burton Gorge Dam and Goonyella gauges ceasing operation in September 1988 and April 2021, respectively. The details of these gauges are provided in Table 3.1.

Table 3.1 DoR stream gauges along the Isaac River in the vicinity of the Project

Gauge No.	Gauge name	AMTD (km)	Catchment area (km ²)	Distance from Project (km)	Start	End
130402A	Burton Gorge	280.3	551	6.5 km (downstream)	1/05/1964	30/09/1988
130414A	Goonyella	242.8	1,214	43.5 km (downstream)	24/5/1983	23/04/2021

Historical flow and river height monitoring data at the Burton Gorge and Goonyella gauges provide an indication of the local flow regime (gauges shown in Figure 3.10).

The mean river height data shown in Figure 3.5 suggests that flow at the Burton Gorge gauge is more likely to occur in the wetter months from November to April, reducing to shallow subsurface flows from about May to October in an average year.

The mean river height data shown in Figure 3.6 suggests that flow at the Goonyella gauge is more likely to occur in the wetter months from November to April, reducing to shallow subsurface flows from about May to October in an average year.

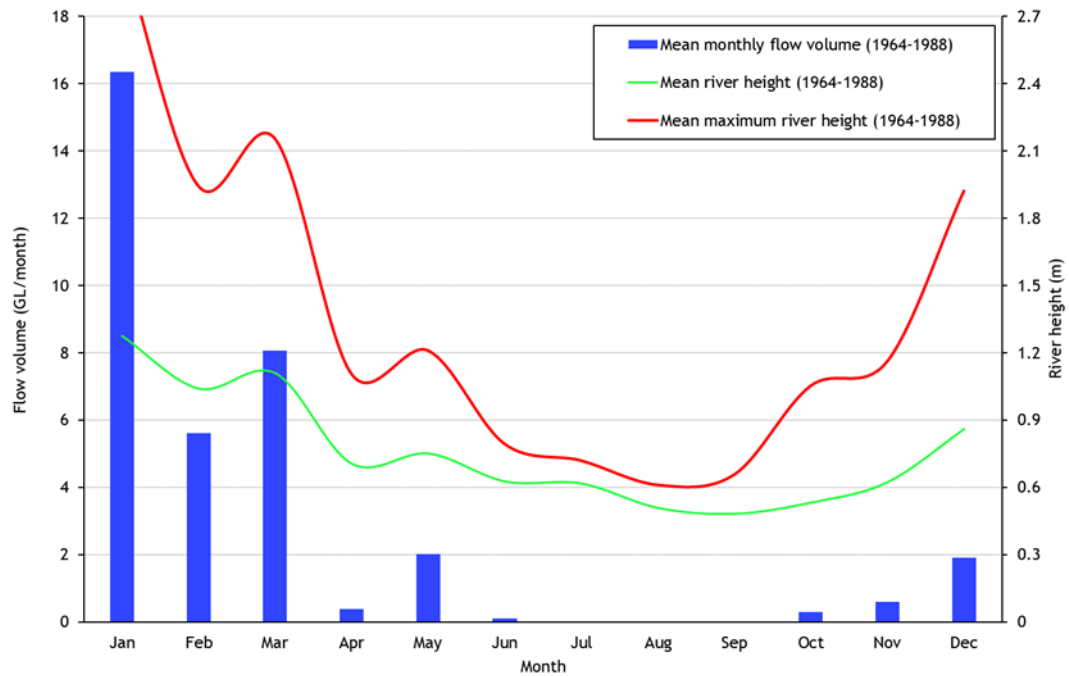


Figure 3.5 Flow volume and river height in the Isaac River at Burton Gorge (DoR station 130402A, located downstream of the mine)

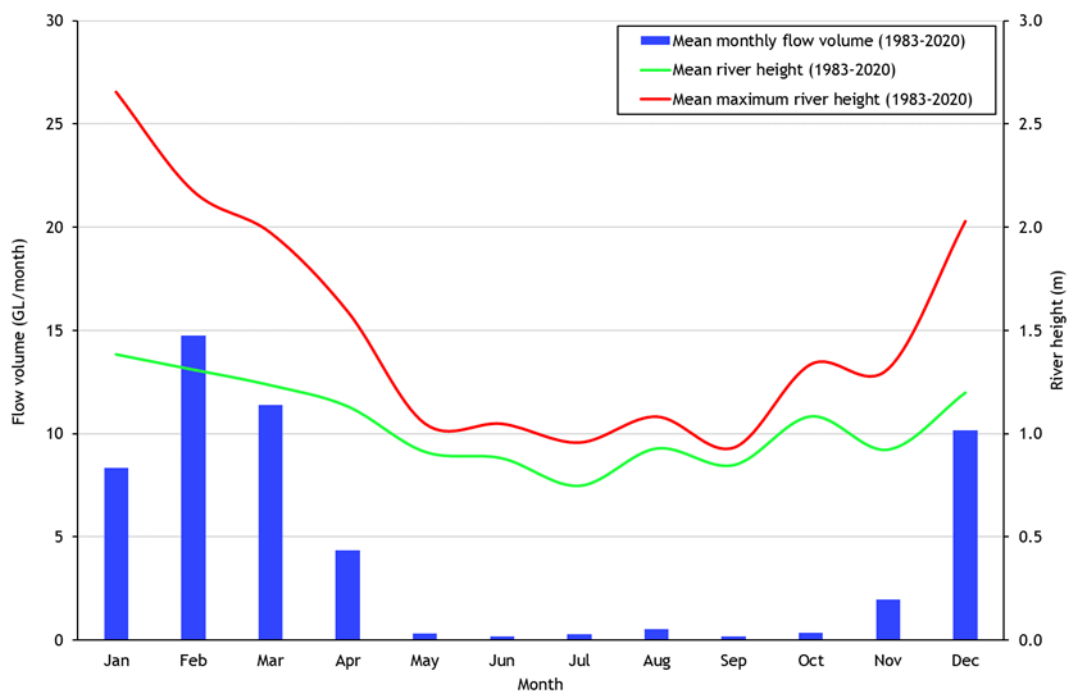


Figure 3.6 Flow volume and river height in the Isaac River at Goonyella (DoR station 130414A, located downstream of the mine)

Figure 3.7 shows a ranked plot of the daily stream flows in the Isaac River recorded at the Goonyella, Deverill and Burton Gorge stream gauges. The following is of note with respect to the recorded stream flows:

- The Isaac River is ephemeral with flows recorded only on 22% of days at Goonyella and 35% of days at Burton Gorge. Flows above 100 megalitres per day (ML/d) occur for less than 7.2% of days at Goonyella and less than 5.4% of days at Burton Gorge. A flow of 100 ML/d would not fully inundate the bed of the Isaac River at either location.
- The mean daily flow (all days) is 143 ML/d and 94 ML/d at Goonyella and Burton Gorge, respectively.
- The highest recorded flow (2,165 m³/s) at the Goonyella gauge occurred in January 2021, which reached a gauge height of 9.92 m. The highest recorded flow (803 m³/s) at the Burton Gorge gauge occurred in March 1988 where the river reached a gauge height of 7.34 m.
- The flow duration at Burton Gorge indicates that low flows are characterised by controlled environmental releases.

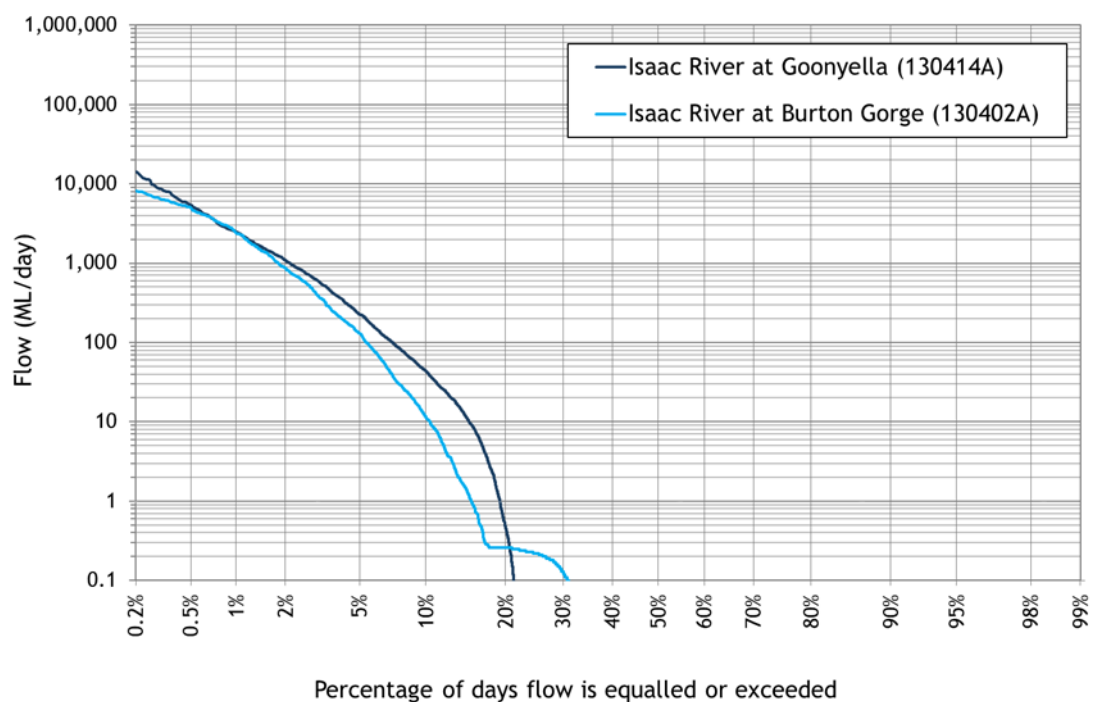


Figure 3.7 Stream flow duration curves, Isaac River at Goonyella and Burton Gorge gauges

The recorded local stream flow depth data for Hill Creek (SW01 and SW02) and Ti-Tree Creek (SW06) is presented in Figure 3.8 for the period between 2018 and 2023. The flow depth data has been filtered to remove noise from the data. The locations of these monitoring sites are presented in Figure 10.2. SW02 is located in very close proximity to the Isaac River, and may be tailwater-affected during significant Isaac River flow events. This data shows that the local creeks are highly ephemeral and would not flow for an extended time after rainfall.

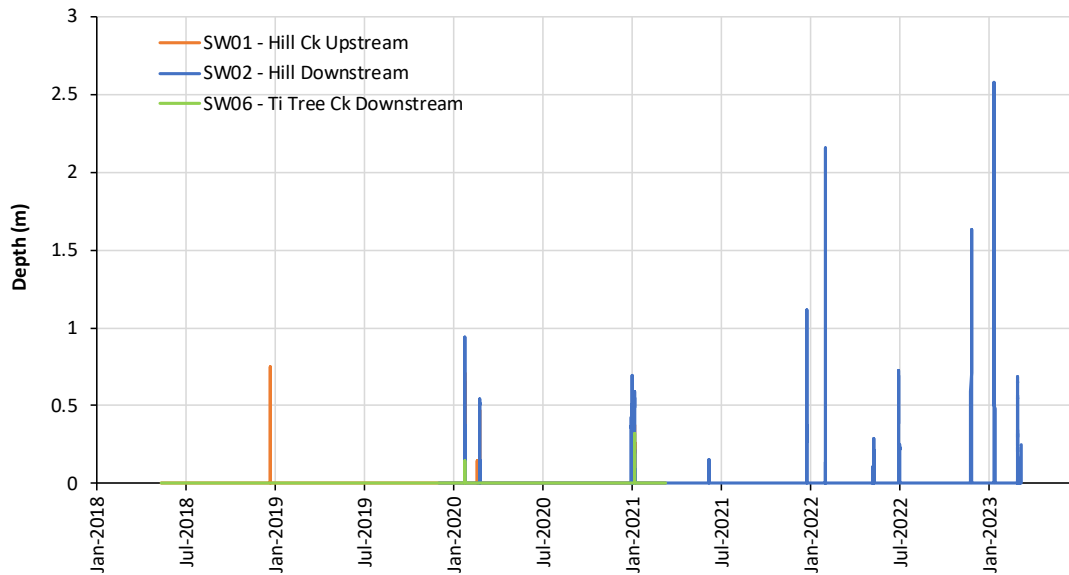


Figure 3.8 Recorded water level at local creek (SW01, SW02 and SW06) monitoring site

Recorded streamflow data for the local Isaac River monitoring site is presented in Figure 3.9. The local Isaac River flow monitoring site is located about 700 m upstream of the New Lenton ML boundary at the “USIR” monitoring site shown in Figure 3.13 (-21.537001, 148.151725 GDA94). The recorded data shows that the Isaac River at this location is also highly ephemeral and would only flow for a short duration each wet season.

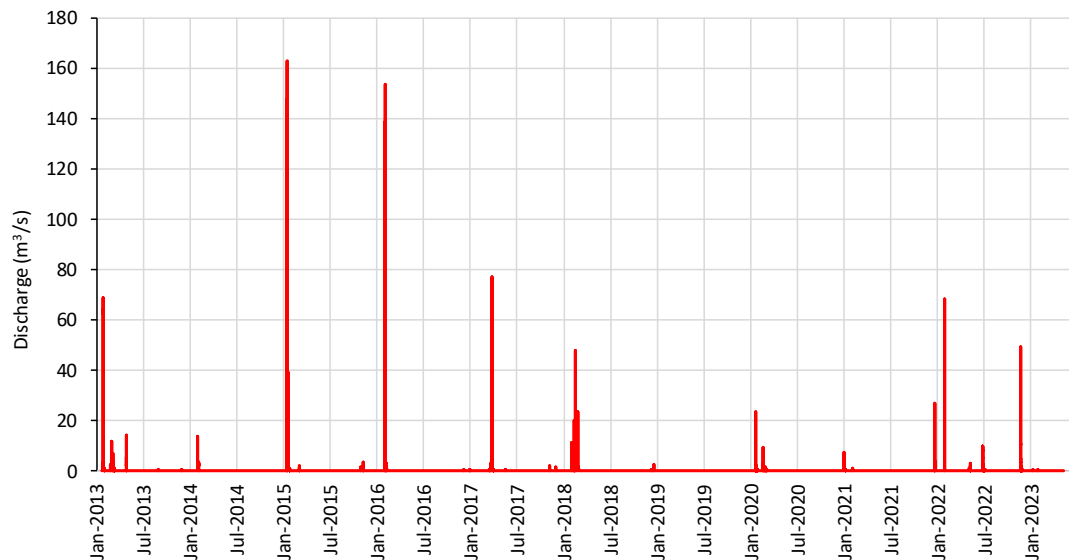


Figure 3.9 Recorded water level at Isaac River monitoring site

3.5 ENVIRONMENTAL VALUES

The *Environmental Protection Policy (Water and Wetland Biodiversity) 2019* (EPP [Water]), which is subordinate legislation to the *Environmental Protection Act 1994*, provides a framework for identifying environmental values (EV) for a waterway and deciding water quality objectives (WQO) to protect or enhance those EV's. EV's for water are the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses. These EVs need to be protected from the effects of habitat alteration, contaminated runoff and releases and changed flow to ensure healthy aquatic ecosystems and waterways that are safe for community use.

Most of the waterways in the vicinity of the Project (Anna Creek, Teviot Creek and Sandy Creek) are located within the Isaac northern tributaries region of the Isaac River Sub-Basin (WQ1301). The Isaac River, Hill Creek, Ti-Tree Creek and Lady Baldwin Gully are located within the Isaac and lower Connors River main channel region. Burton Gorge Dam has its own region and set of EVs.

The EVs selected for protection include:

- aquatic ecosystem protection (slightly to moderately disturbed ecosystems, QWQG 2009);
- irrigation, farm use and stock watering;
- human consumption;
- primary, secondary and visual recreation;
- drinking water;
- industrial use; and
- cultural and spiritual Values.

Burton Gorge Dam has the same set of EVs, with the exception of irrigation and farm use.

In summary, the key EV's for water that are to be protected are:

- physical, chemical and biological integrity of the watercourses within the catchment and their amenity as potential water sources for human use and to support aquatic ecosystems;
- the qualitative and quantitative integrity of local groundwater as a potential water source for agriculture or other suitable uses; and
- the integrity of raw water supplies and associated infrastructure in the region.

3.6 WATER QUALITY OBJECTIVES

The indicators and water quality guidelines relevant to the above environmental values are listed in the Queensland Water Quality (QWQ) Guidelines and ANZG (2018). The conditions of waterways located in the vicinity of the Project are classified as slightly to moderately disturbed ecosystems under the QWQ Guidelines (DEHP, 2013).

The WQOs relevant to the identified EV's are provided in Table 3.2 and are generally based on the trigger values or Default Guideline Values (DGVs) nominated in the QWQ guidelines and ANZG, or regional values. WQOs/DGVs are displayed for physio-chemical parameters only. Note that only the potential contaminants identified in Table C2 and Table C3 of the New Lenton EA (EPML00475513) are listed in Table 3.2.

Table 3.2 also shows the mine affected water release limits and release contaminant trigger investigation levels from Table C2 and Table C3 of the New Lenton EA.

Table 3.2 Water quality objectives/DGVs, Isaac and lower Connors River main channel and Isaac northern tributaries

Parameter	WQO/DGV	Relevant EV	EA release (r) / investigation (i) levels
Electrical conductivity (EC) – baseflow	720 µS/cm	Aquatic ecosystem ^a	
Electrical conductivity (EC) – high flow	250 µS/cm	Aquatic ecosystem ^a	<250 µS/cm (r)
pH	6.5 – 8.5	Aquatic ecosystem ^a	6.5 – 9.0 (r)
Turbidity	50 NTU	Aquatic ecosystem ^a	50 NTU (r)
Sulphate	25 mg/L	Aquatic ecosystem ^a	25 mg/L (r)
Aluminium ^j	0.055 mg/L	Aquatic ecosystem ^b	0.055 mg/L (i)
Arsenic ^j	0.013 mg/L	Aquatic ecosystem ^a	0.013 mg/L (i)
Boron ^j	0.00094 mg/L	Aquatic ecosystem ^h	0.37 mg/L (i)
Cadmium ^j	0.0002 mg/L	Aquatic ecosystem ^b	0.0002 mg/L (i)
Chromium ^j	0.001 mg/L	Aquatic ecosystem ^b	0.001 mg/L (i)
Cobalt ^j	0.0014 mg/L	Aquatic ecosystem ^e	0.0014 mg/L (i)
Copper ^j	0.0014 mg/L	Aquatic ecosystem ^b	0.0014 mg/L (i)
Iron ^j	0.7 mg/L	Aquatic ecosystem ^c	0.3 mg/L (i)
Lead ^j	0.0034 mg/L	Aquatic ecosystem ^b	0.0034 mg/L (i)
Mercury ^j	0.0002 mg/L	Aquatic ecosystem ^d	0.00006 mg/L (i)
Nickel ^j	0.011 mg/L	Aquatic ecosystem ^b	0.011 mg/L (i)
Zinc ^j	0.008 mg/L	Aquatic ecosystem ^b	0.008 mg/L (i)
Manganese ^j	1.9 mg/L	Aquatic ecosystem ^b	1.9 mg/L (i)
Molybdenum ^j	0.034 mg/L	Aquatic ecosystem ^e	0.034 mg/L (i)
Selenium ^j	0.005 mg/L:	Aquatic ecosystem ^b	0.005 mg/L (i)
Silver ^j	0.001 mg/L	Aquatic ecosystem ^b	0.00005 mg/L (i)
Uranium ^j	0.001 mg/L	Aquatic ecosystem ^d	0.0005 mg/L (i)
Vanadium ^j	0.01 mg/L	Aquatic ecosystem ^d	0.006 mg/L (i)
Ammonia	0.9 mg/L	Aquatic ecosystem ^b	0.9 mg/L (i)
Nitrate	1.1 mg/L	Stock watering ^g	1.1 mg/L (i)
Total recoverable hydrocarbons (C6-C9)	-	-	0.02 mg/L (i)
Total recoverable hydrocarbons (C10-C36)	-	-	0.1 mg/L (i)

a/ Table 2 of Isaac River Sub-basin EVs and WQOs: Aquatic ecosystem – moderately disturbed

b/ Table 3.4.1 of ANZG (2018): trigger values for slightly-moderately disturbed systems (95% level of protection)

c/ Based on 95% level of protection in Toxicant default guideline values for aquatic ecosystem protection: Total iron in fresh water (ANZG, 2020)

d/ Based on Limit of Reporting (LOR) for IPCMS/CV FIMS analytical methods

e/ Section 8.3.7 of ANZG (2018): low reliability guideline

f/ Based on ambient Qld water quality guidelines (2006) for total nitrogen

g/ Based on ambient WQGs (2006) for total nitrogen –standard trigger value for contemporary environmental authorities in Bowen Basin

h/ Based on 95% level of protection in Toxicant default guideline values for aquatic ecosystem protection: Boron in fresh water (ANZG, 2020)

j/ Trigger levels for metals/metalloids apply to the dissolved fraction.

mg/L = milligrams per litre, NTU Nephelometric Turbidity Units, µS/cm – microSiemens per centimetre

3.7 WATER QUALITY

3.7.1 Regional Isaac River water quality

Publicly available regional water quality data for the Isaac River at the Burton Gorge, Goonyella and Deverill gauging stations have been analysed and a comparison of 20th percentile, median and 80th percentile water quality at these sites to the WQOs/DGV's is displayed in Table 3.2 and their locations shown in Figure 3.10. These sites were selected because complete datasets (i.e. individual sample analysis results) are publicly available as opposed to only summary data being publicly available.

The Isaac River (Burton Gorge) and Isaac River (Goonyella) stations are located downstream of existing mining operations and therefore potentially include mine release water quality. The Isaac River (Burton Gorge) and Isaac River (Goonyella) stations are about 9 km and 46 km downstream of the Project, respectively. The Isaac River at Deverill station is 114 km downstream of the Project. However, these gauges provide an indication of water quality and in particular metals in the Isaac River downstream of the Project.

Table 3.3 shows that some readings at the Isaac River DoR monitoring locations are at or above the regional DGVs, including the following:

- Dissolved aluminium at Goonyella and Deverill (80th percentile);
- Dissolved copper at Goonyella and Deverill (median and 20th/80th percentile);
- EC at Goonyella (80th percentile) exceeds the DGV based on the model water conditions;
- Dissolved iron at Burton Gorge (median and 80th percentile);
- Nitrate at all three gauges (median and 80th percentile values);
- Total suspended solids at all Burton Gorge and Goonyella (80th percentile values);
- Turbidity at Burton Gorge (median and 20th/80th percentile) and Goonyella/Deverill (median and 80th percentile); and
- Dissolved zinc at Goonyella/Deverill (median and 20th/80th percentile).

The review of the regional water quality data indicates that there are some water quality indicators that are consistently above the DGVs, in particular aluminium (dissolved), copper (dissolved), zinc (dissolved), iron (dissolved), suspended solids and turbidity.

The available data indicates that the current DGVs may not necessarily reflect the typical background water quality within the Upper Isaac River. There are a number of exceedances at the Burton Gorge, Goonyella and Deverill stations.

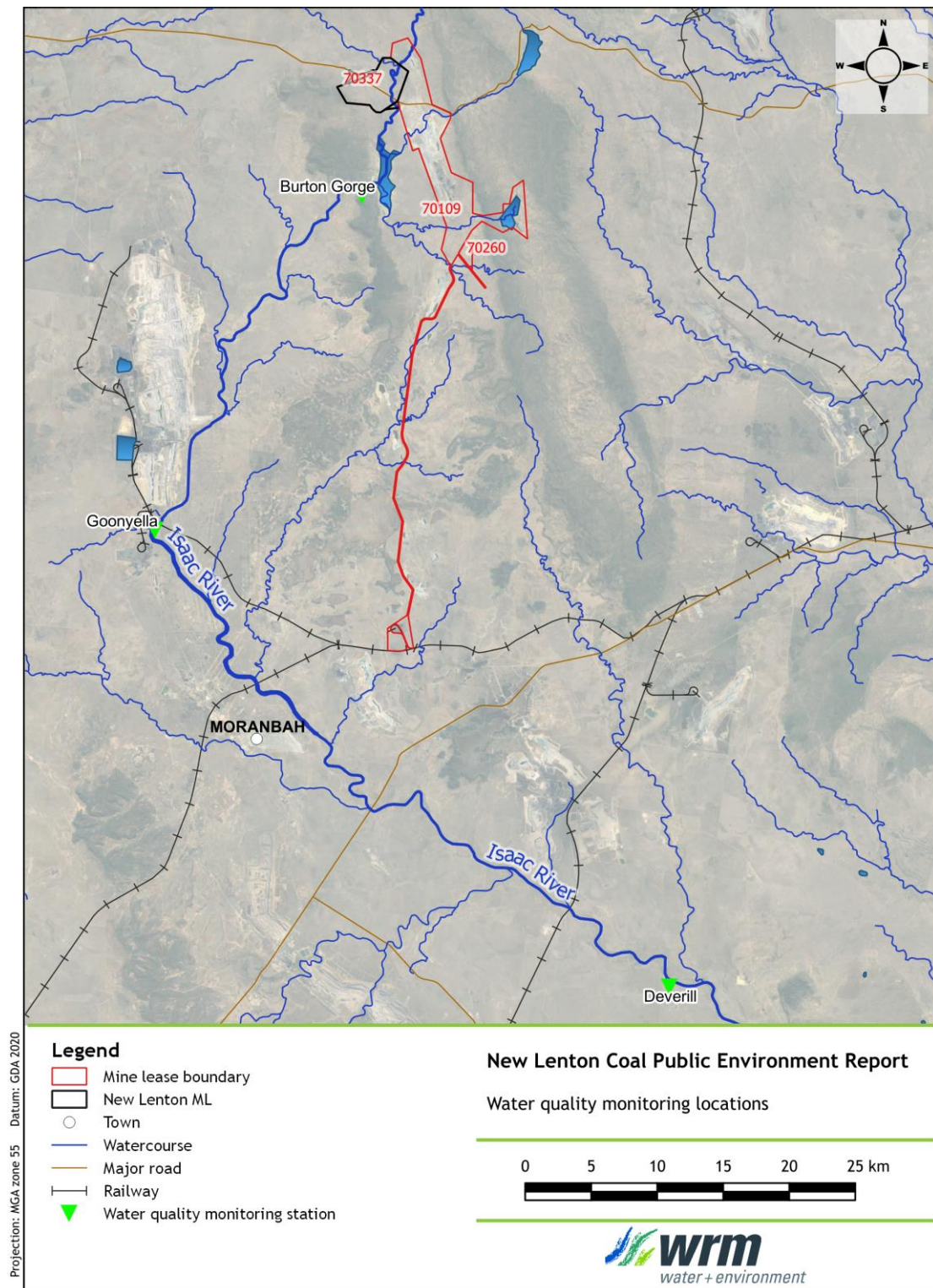


Figure 3.10 Regional water quality monitoring locations

Table 3.3 Regional Isaac River water quality summary – DoR gauges

Parameter	Unit	Isaac River @ Burton Gorge				Isaac River @ Goonyella				Isaac River @ Deverill				WQO/DGV (refer Table 3.2)
		No. of samples	20 th %ile value	Median value	80 th %ile value	No. of samples	20 th %ile value	Median value	80 th %ile value	No. of samples	20 th %ile value	Median value	80 th %ile value	
Aluminium (dissolved)	mg/L	-	-	-	-	13	0.004	0.050	0.056	14	0.03	0.05	0.15	0.055
Boron (total)	mg/L	4	0.030	0.030	0.034	30	0.04	0.08	0.12	21	0.04	0.06	0.096	0.94
Calcium (dissolved)	mg/L	19	13	36	50	33	8.2	14	24	49	6.7	16	22	-
Chloride (total)	mg/L	19	23	45	92	33	18	79	250	45	10.2	32	61	-
Copper (dissolved)	mg/L	-	-	-	-	13	0.012	0.030	0.050	16	0.006	0.030	0.036	0.0014
Electrical Conductivity	µS/cm	19	169	458	644	33	195	512	1,140	49	120	261	398	1,000
Fluoride (total)	mg/L	19	0.10	0.19	0.22	33	0.10	0.20	0.32	46	0.1	0.14	0.2	0.32
Iron (dissolved)	mg/L	5	0.4	1.0	7.0	30	0.01	0.04	0.234	17	0.02	0.06	0.34	0.7
Magnesium (dissolved)	mg/L	19	5.1	15	18	33	4.1	9.6	21.6	49	3.3	7.7	10	-
Manganese (dissolved)	mg/L	-	-	-	-	15	0.008	0.01	0.02	13	0.001	0.01	0.01	1.9
Nitrate (total)	mg/L	9	0.4	1.5	3.6	30	0.98	1.96	3.48	12	0.004	0.02	0.25	1.1
pH	-	19	7.4	7.8	8.0	33	7.2	7.7	8.0	49	7.19	7.6	8	6.5 - 8.5
Phosphorus (total)	mg/L	-	-	-	-	10	0.041	0.203	0.344	12	0.04	0.09	0.67	-
Potassium (total)	mg/L	16	3.5	5.4	6.6	33	2.8	3.8	4.6	46	3.16	4.55	5.26	-
Sodium (total)	mg/L	19	18	33	58	33	21	67	188	49	12	22	40	188
Sulphate (total)	mg/L	13	2.7	4.3	9.8	33	4.7	10.0	75.4	42	6.92	10	18.8	250
Total Alkalinity	mg/L	19	58	148	204	33	48	78	117	49	42	78	100	-
Total Dissolved Solids	mg/L	19	122	255	353	33	114	280	622	47	81	155	224	-
Total Suspended Solids	mg/L	15	10	230	2,002	33	14	74	2,752	41	10	135	1,340	1,901
Turbidity	NTU	4	66	100	100	32	16	100	147	19	11	50	910	50
Zinc (dissolved)	mg/L	-	-	-	-	12	0.01	0.015	0.02	14	0.01	0.01	0.06	0.008

Note: Cells shaded green denote a value that exceeds the relevant WGO/DGV for that parameter.

The DoR has collected daily electrical conductivity data at the Isaac River at the Deverill and Yatton gauges. Electrical conductivity (a measure of the salt concentration) at the Deverill gauge has been used to characterise the regional relationship between flow and salinity. The Deverill gauge is the closest to the Project with a long-term continuous record of stream flow and salinity.

Figure 3.11 presents a time history of recorded instantaneous EC and stream flow for the Isaac River at Deverill gauging station. Figure 3.12 details the relationship between instantaneous flow and EC at the Isaac River at Deverill gauging station. The data collected by DoR at the Deverill gauging station spans the period from 2011 to 2022 and indicates:

- The EC for high flows greater than 200 m³/s is generally below the high flow WQO EC of 250 µS/cm.
- The EC of instantaneous flows below 100 m³/s varies significantly from 50 µS/cm to 1,870 µS/cm with many recorded values exceeding the low flow WQO EC of 720 µS/cm.
- The mean daily EC has exceeded the low flow WQO on a total of 23 days over this period and all of these days experienced some flow (not stagnant flow).
- The stream flows are highly ephemeral with baseflows ceasing within a few days or weeks of a runoff event, or at least flowing below the top of the sandy bed.

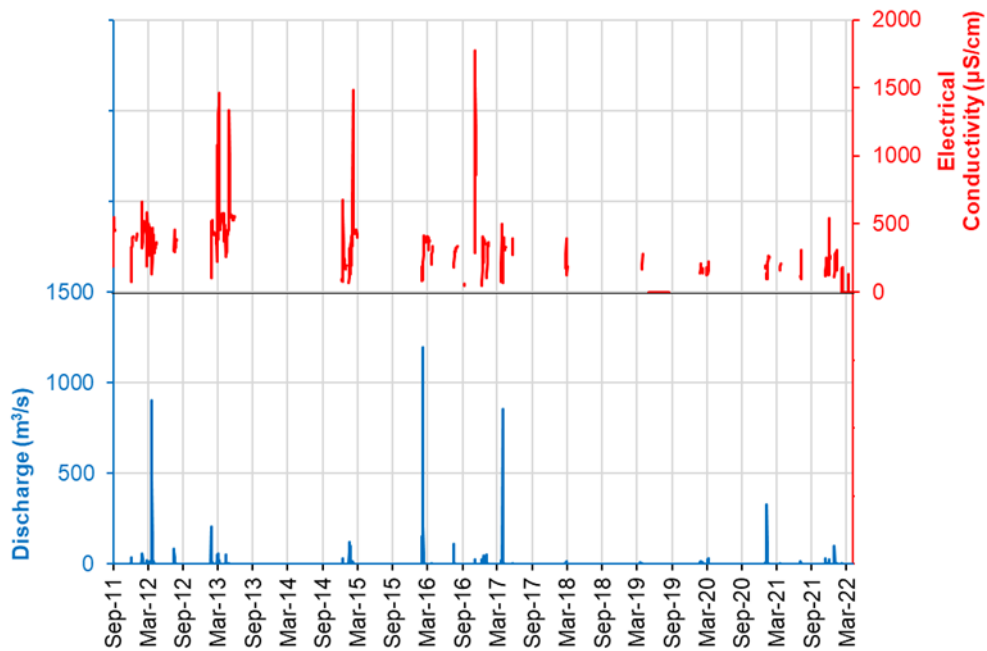


Figure 3.11 Electrical conductivity and flow (Isaac River at Deverill gauge)

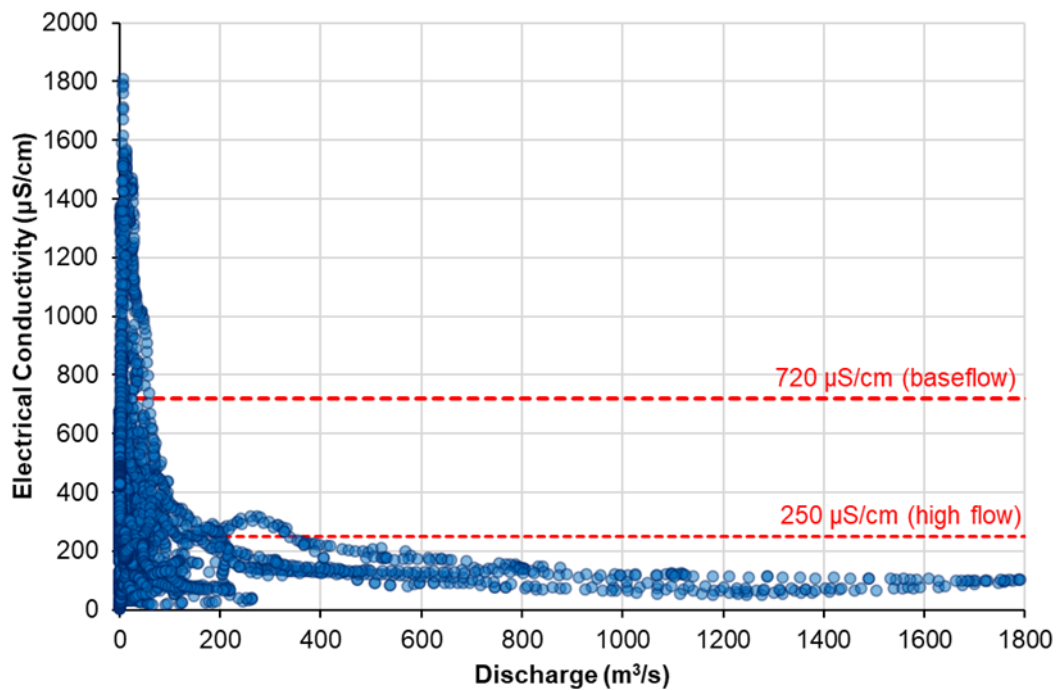


Figure 3.12 Flow vs electrical conductivity (Isaac River at Deverill gauge)

3.7.2 Local water quality

Water quality sampling was undertaken in the Isaac River, Ti-Tree Creek and Hill Creek between 2005 and 2023 by URS (2013), GHD (2018), AARC (2019) and SGME (2023). Water quality data from these reports has been included in the sampling results presented in this report. The sample collection, handling and testing methodologies are documented in the respective reports. The locations of the local water quality monitoring locations are presented in Figure 3.13

Statistical analysis of the local water quality monitoring data for Isaac River and the local creeks is presented in Table 3.4 and Table 3.5, respectively. A comparison against the WQOs presented in Table 3.2 has also been undertaken. The full suite of water quality records is presented in Appendix D. The following should be considered when interpreting the local water quality data:

- All metal and metalloid samples collected by URS (2013) (at locations ISR01, HCK01, HCK02, TTCK01, TTCK02 and TTCK03) represent total metals only (no dissolved metals samples were measured). For the purpose of this assessment, the total metal readings collected by URS (2013) have been included in the statistical analysis, as they form the majority of the Hill Creek and Ti-Tree Creek data. However, total metals are not applicable for comparison against the WQOs presented in Table 3.2 of this report.
- Laboratory electrical conductivity (EC) readings were unavailable for the majority of the URS (2013) samples. Field EC readings were adopted for this assessment instead.
- The locations for a number of water monitoring points were either unknown or not provided in the accompanying documentation. These points include 'Creek' and Isaac River (GW07) in GHD (2018) and IRS02 in URS (2013). These points have been excluded from this assessment, as their locations relative to the Project are unknown.

The following is of note regarding the local water quality monitoring data:

- Isaac River
 - 3 samples were collected upstream of the Project between 2018 and 2022 and 9 samples were collected downstream of the Project between 2010 and 2023.
 - Upstream of the Project, exceedances of WQOs were recorded for EC, Turbidity, Aluminium (filtered), Copper (filtered), Iron (filtered), Nickel (filtered), Zinc (filtered) and Vanadium (filtered).
 - Downstream of the Project, exceedances were recorded for EC, Turbidity, Aluminium (filtered), Copper (filtered), Iron (filtered), Nickel (filtered), Zinc (filtered) and Vanadium (filtered).
- Hill Creek
 - 9 samples were collected in Hill Creek between 2008 and 2013, all of which were upstream of the Project.
 - No exceedances were recorded in Hill Creek (excluding total metal samples).
- Ti-Tree Creek
 - 14 samples were collected upstream of the Project between 2005 and 2018 and 4 samples were collected downstream of the Project between 2010 and 2018.
 - Upstream of the Project, no exceedances were recorded in Ti-Tree Creek (excluding total metal samples).
 - Downstream of the Project, exceedances were recorded for pH and TPH C10-C36.

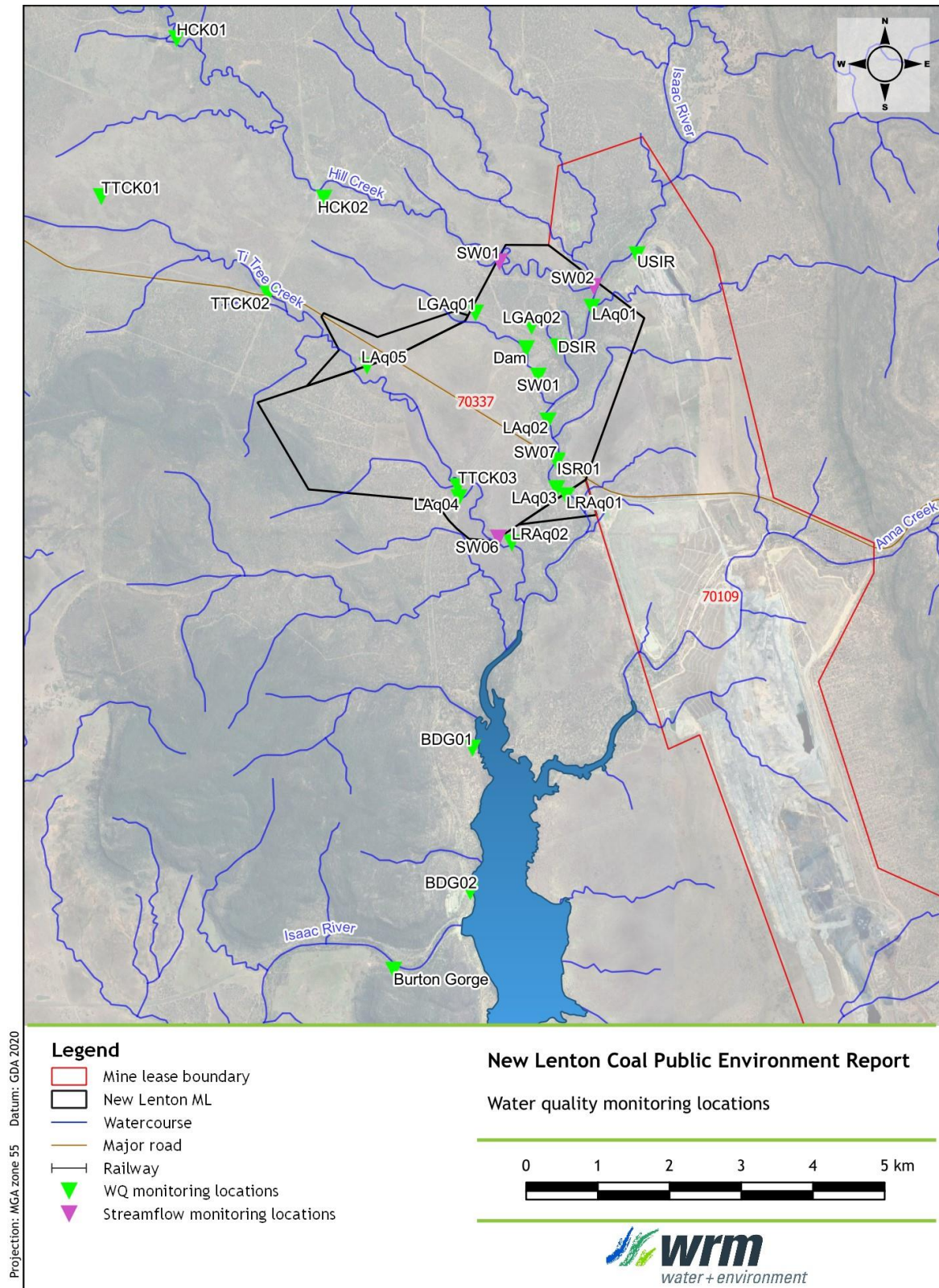


Figure 3.13 Surface water monitoring locations

Table 3.4 Local water quality data summary – Isaac River

Parameter	U/S Isaac River				D/S Isaac River				WQO
Statistics	No. Samples	Min	50%ile	Max	No. Samples	20%ile	50%ile	80%ile	Table 3.2
Electrical conductivity	3	144	166	370	9	145	182	315	
pH	3	7.22	7.28	8.1	9	7.36	7.97	8.2	6.5-8.5
Turbidity	3	70	123	290	7	58.42	139.7	709.8	50
Sulphate	2	2	-	9	7	1	2	4	25
Aluminium	3	<0.01	0.5	2.3	9	0.01	0.84	3.37	0.055
Arsenic	3	<0.001	<0.001	<0.001	9	<0.001	<0.001	<0.001	0.013
Cadmium	3	<0.0001	<0.0001	<0.0001	9	<0.0001	<0.0001	<0.0001	0.0002
Chromium	3	<0.001	<0.001	<0.001	9	<0.001	<0.001	0.004	0.001
Copper	3	<0.001	<0.001	0.002	9	<0.001	0.002	0.004	0.0014
Iron	2	0.05	-	0.31	7	0.062	0.84	4.452	0.7
Lead	3	<0.001	<0.001	<0.001	9	<0.001	<0.001	0.002	0.0034
Mercury	3	<0.0001	<0.0001	<0.0001	9	<0.0001	<0.0001	<0.0001	0.0002
Nickel	3	<0.001	0.001	0.001	9	<0.001	0.002	0.005	0.011
Zinc	3	<0.005	<0.005	0.023	9	<0.005	0.01	0.018	0.008
Boron	3	<0.05	<0.05	0.06	9	<0.05	<0.05	0.05	
Cobalt	3	<0.001	<0.001	<0.001	9	<0.001	<0.001	0.002	
Manganese	3	0.033	0.056	0.1	9	0.003	0.035	0.185	1.9
Molybdenum	3	<0.001	<0.001	<0.001	7	<0.001	<0.001	<0.001	0.034
Selenium	3	<0.01	<0.01	<0.01	9	<0.01	<0.01	<0.01	0.005
Silver	3	<0.001	<0.001	<0.001	9	<0.001	<0.001	<0.001	0.001
Uranium	3	<0.001	<0.001	<0.001	4	<0.001	<0.001	<0.001	0.001

Parameter	U/S Isaac River				D/S Isaac River				WQO
Statistics	No. Samples	Min	50%ile	Max	No. Samples	20%ile	50%ile	80%ile	Table 3.2
Vanadium	3	<0.01	<0.01	0.02	6	<0.01	<0.01	<0.01	0.01
Ammonia	2	0.01	-	0.21	6	<0.01	0.04	0.084	0.9
Nitrate	2	0.00001	-	0.62	7	<0.01	0.05	0.608	1.1
TRC C6-C9	3	<20	<20	<20	9	<20	<20	<20	20
TRC C10-C36	3	<50	<50	<100	9	<50	<50	<50	100

< indicates values at the limit of reporting

Grey highlighted text represents exceedances of the WQOs

Red text represents exceedances triggered by total metal samples

Table 3.5 Local water quality data summary – Local creeks

Parameter	Hill Creek				U/S Ti-Tree Creek				D/S Ti-Tree Creek				WQO
Statistics	No. Samples	20%ile	50%ile	80%ile	No. Samples	20%ile	50%ile	80%ile	No. Samples	20%ile	50%ile	80%ile	Table 3.2
Electrical conductivity	8	87.2	123	179.4	14	120	207	1940	4	187	621	1810	250
pH	9	7.196	7.55	7.796	14	7.84	8.19	8.28	4	7.52	8.065	8.6	6.5-8.5
Turbidity	6	58.4	79.3	122.8	6	0.296	4.65	301	4	3	53.16	164.5	50
Sulphate	8	1.8	2	3	13	1	2	18.2	3	-	8	-	25
Aluminium	8	0.718	1.505	2.002	11	0.06	1.06	2.162	4	0.13	1.25	3.26	0.055
Arsenic	8	<0.001	<0.001	<0.001	11	<0.001	<0.001	<0.001	4	<0.001	<0.001	<0.001	0.013
Cadmium	8	<0.0001	<0.0001	<0.0001	11	<0.0001	<0.0001	<0.0001	4	<0.0001	<0.0001	<0.0001	0.0002
Chromium	8	<0.001	0.002	0.004	11	<0.001	0.002	0.004	4	<0.001	0.0015	0.006	0.001
Copper	8	0.0014	0.002	0.004	11	0.002	0.004	0.0052	4	0.002	0.0035	0.004	0.0014
Iron	7	0.704	1.765	3.094	8	0.05	0.385	0.994	2	-	0.3	-	0.7
Lead	8	<0.001	<0.001	0.0026	11	<0.001	<0.001	<0.001	4	<0.001	<0.001	0.001	0.0034

Parameter	Hill Creek				U/S Ti-Tree Creek				D/S Ti-Tree Creek				WQO
Statistics	No. Samples	20%ile	50%ile	80%ile	No. Samples	20%ile	50%ile	80%ile	No. Samples	20%ile	50%ile	80%ile	Table 3.2
Mercury	8	<0.0001	<0.0001	<0.0001	9	<0.0001	<0.0001	<0.0001	3	-	<0.001	-	0.0002
Nickel	8	0.002	0.0045	0.0062	11	0.0024	0.008	0.0112	4	0.002	0.006	0.01	0.011
Zinc	8	<0.005	0.0055	0.0072	11	<0.005	0.009	0.0842	4	<0.005	0.0115	0.018	0.008
Boron	8	<0.05	<0.05	<0.05	11	<0.05	0.06	0.172	4	<0.05	0.065	0.13	
Cobalt	8	0.001	0.002	0.0062	11	<0.001	0.002	0.0036	4	<0.001	0.0015	0.002	
Manganese	8	0.0282	0.0675	0.3054	11	0.0146	0.038	0.1196	4	0.017	0.0405	0.18	1.9
Molybdenum	7	<0.001	<0.001	<0.001	11	<0.001	<0.001	<0.001	4	<0.001	<0.001	<0.001	0.034
Selenium	8	<0.01	<0.01	<0.01	11	<0.01	<0.01	<0.01	4	<0.01	<0.01	<0.01	0.005
Silver	7	<0.001	<0.001	<0.001	11	<0.001	<0.001	<0.001	4	<0.001	<0.001	<0.001	0.001
Uranium	1	-	-	-	1	-	<0.001	-	1	-	<0.001	-	0.001
Vanadium	7	<0.01	<0.01	<0.01	7	0.04	0.05	0.054	3	-	0.03	-	0.01
Ammonia	5	0.03	0.045	0.06	6	0.034	0.06	0.088	3	-	0.07	-	0.9
Nitrate	7	0.01	0.143	0.278	11	0.018	0.04	0.208	3	-	0.09	-	1.1
TRC C6-C9	8	<20	<20	<20	11	<20	<20	<20	4	<20	<20	<20	20
TRC C10-C36	8	<50	<50	<50	11	<50	<50	<50	4	<50	<50	300	100

< indicates values at the limit of reporting

Grey highlighted text represents exceedances of the WQOs

Red text represents exceedances triggered by total metal samples

3.8 EXISTING WATER USE ENTITLEMENTS

3.8.1 Licensed Water Users

A search of the Queensland Government database for licensed water users was undertaken on the 4th of September 2019 and no licensed surface water users were identified within a 20 km radius of the Project area. No downstream water users were identified between the Project area and Burton Gorge Dam.

Aerial photography was also reviewed, and no farm dams were identified. Downstream water users are therefore expected to be limited to stock and water uses from Burton Gorge Dam, noting that the Dam was constructed to service mining operations.

3.8.2 Burton Gorge Dam

The purpose of the dam is to provide water supply for the nearby North Goonyella Coal Mine and township. The storage capacity of the dam is 14,829 ML at a Full Supply level of RL 297.5 m and the dam has a catchment of 540 km². The dam is owned and operated by North Goonyella Coal Properties, a subsidiary of Peabody Australia. Isaac Regional Council is also involved in some of the dam operation activities. Burton Gorge Dam is a Category 1 referable dam in accordance with the Water Supply Act 2008.

The dam releases water to the Isaac River. Regional water users downstream of Burton Gorge Dam include a number of townships, agricultural and industrial water users.

3.9 CREEK GEOMORPHOLOGY

The Project area is located within the Isaac River, Hill Creek and Ti-Tree Creek catchments. The majority of the terrain within these catchments is undulating and land use is predominately grazing. Ti-Tree Creek in particular has been heavily grazed with very little remnant vegetation remaining. All waterways show evidence of stock movement.

The watercourses in and around the New Lenton MLs are ephemeral, since they are dry (or mostly dry) during prolonged periods. After these dry periods, a significant rainfall event is typically required to generate flow in the watercourses.

The assessment described here focuses on the Isaac River, Ti-Tree Creek and the un-named tributary of the Isaac River which are the drainage features potentially impacted by the Project.

The Isaac River has a wide sand-lined base channel with steep vegetated banks. A typical cross section of the Isaac River is shown in Figure 3.14 and Figure 3.15. The location of these cross sections is shown in Figure 3.18. The Isaac River has defined benches along straight sections. In locations where the river meanders significantly, well-defined high-flow channels are observed. These channels become engaged during large events causing short cuts to the meander. Along the length of the streams adjacent to the Project Disturbance Area, the riparian vegetation cover is generally good.

Beyond the riparian zone, the vegetation mainly consists of grazed grasslands and native vegetation. Cattle have formed numerous access tracks along the banks which in some cases has led to localised gully erosion.

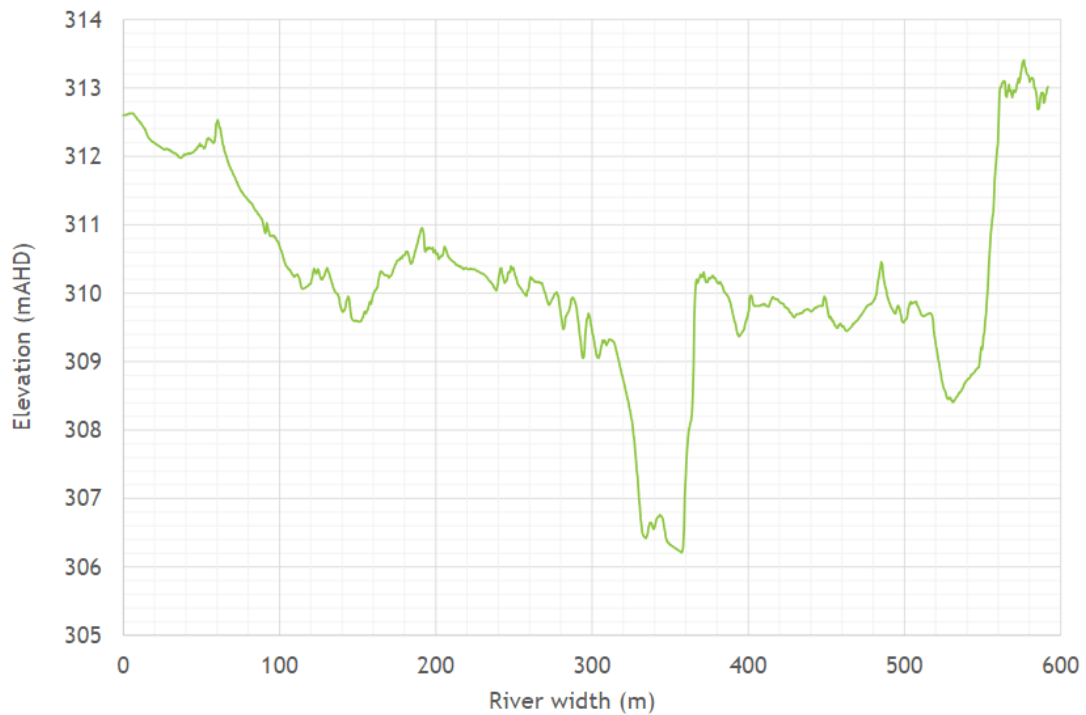


Figure 3.14 Isaac River typical cross-section in the Project area – showing break out channels near bends



Figure 3.15 Isaac River typical cross-section in the Project area – showing benching along straight river sections

Ti-Tree Creek has a narrow base width with steep banks which are heavily eroded. The upper sections lack riparian vegetation or ground cover on the bed and banks, with evidence of bank slumping. The channel can typically convey only a relatively small event before spilling onto the floodplain or adjacent high flow channels.

A typical view of a cross section of Ti-Tree Creek is shown in Figure 3.16 and Figure 3.17. The location of these cross-sections is shown in Figure 3.18. The downstream reaches near the confluence with Isaac River have improved stability. This is due to erosion down to bedrock which reduces future erosion, as well as less evidence of extensive grazing and inclusion of a riparian vegetation corridor (as shown in Figure 3.27).

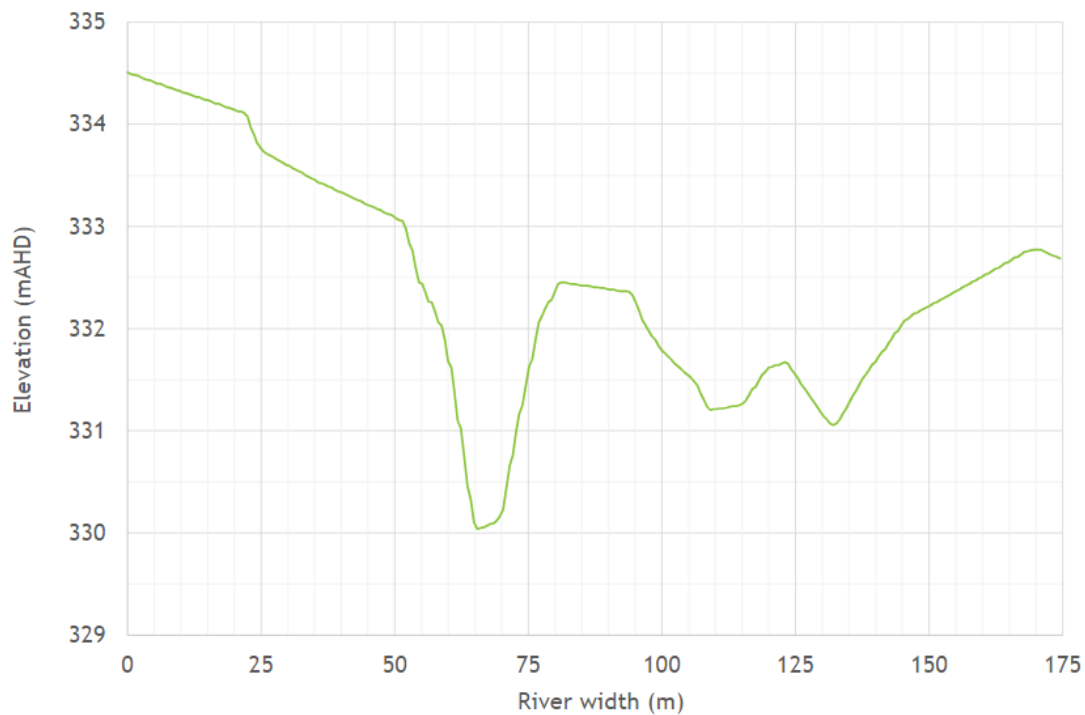


Figure 3.16 Ti-Tree Creek typical cross-section – showing wide floodplain with primary and secondary high flow channels (upper reaches)

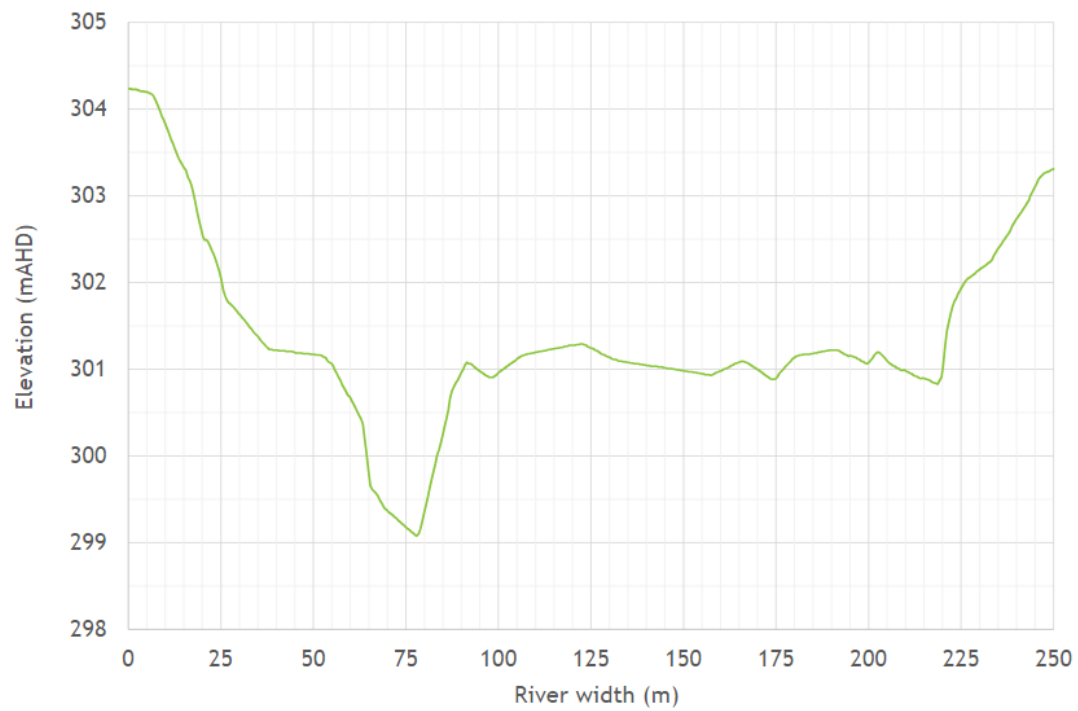


Figure 3.17 Ti-Tree Creek typical cross-section – showing wide floodplain (lower reaches)

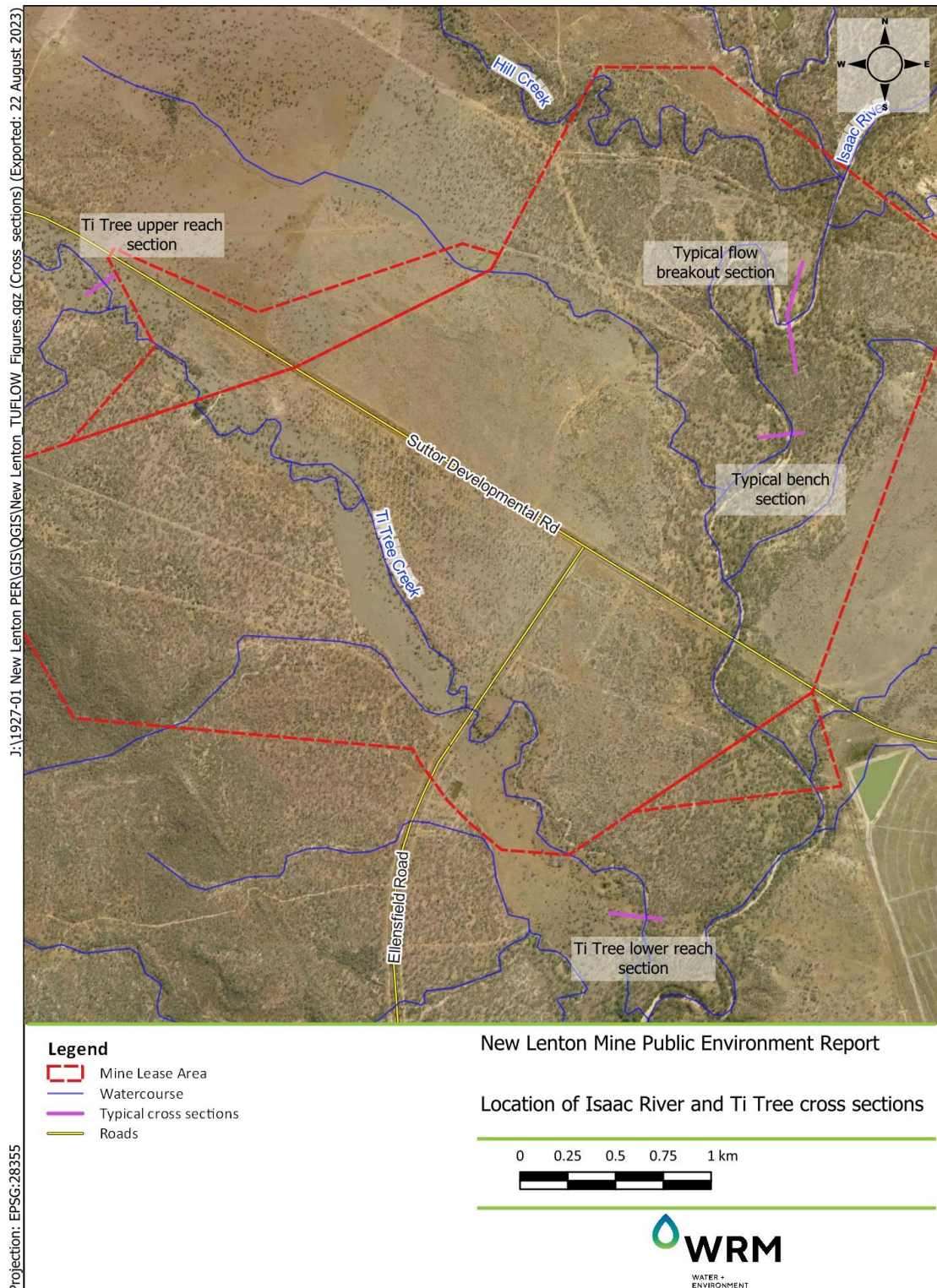


Figure 3.18 Location of cross sections on the Isaac River and Ti-Tree Creek

3.9.1 Previous Reports

A baseline Stream Geomorphology Technical Report was completed by URS in 2013 (URS, 2013). The report outlined the relevant geomorphological data for the watercourses in the study area. A summary of the baseline data is provided in the following sections.

3.9.2 Comparison of Baseline Data

A comprehensive baseline data assessment was carried out by URS in 2013. This was compared with the data collected by SLR in March 2019. Together this forms a baseline assessment of the creeks' geomorphic characteristics and system changes which are evident without the influence of mining activities.

The URS 2013 study noted some areas with significant erosion. Queensland Government Soils mapping identifies the dominating soil profile as being highly sodic (GHD, 2019b). Sodic soils are highly dispersive due to negatively charged sodium ions attached to clay particles repelling each other once in contact with water. This can lead to extensive erosion which can progress quickly once the soil becomes saturated. Ti-Tree Creek and the banks of the Isaac River showed areas of significant erosion.

3.9.2.1 Isaac River Channel

The Isaac River has a consistent cross section and longitudinal section with an overall bed slope of 0.2%. Small irregularities in the bed profile appear to be from bedrock outcrops in the river bed. A geomorphic feature summary comparing the URS 2013 survey with field notes from SLR 2019 is provided in Table 3.6. The SLR 2019 site inspection found some minor changes in the geomorphic features. However, these are likely to be attributable to the length of the channel surveyed which varied from that undertaken by URS in 2013. The length of the channel surveyed varied due to the narrowing of the focus area for the study and restrictions regarding safe access at the time of the inspection. Therefore, the Isaac River was assessed from 1.1 km upstream of the confluence with Hill Creek through to the confluence with Ti-Tree Creek. Review of aerial photography indicates the surveyed area is typical of the reach surveyed by URS in 2013.

Table 3.6 Isaac River channel geomorphic feature summary

Channel characteristics	URS 2013 description	SLR 2019 description
Length of channel in study area	13.25 km (commencing at 350 mAHD)	8.2 km (commencing at 320 mAHD)
Sinuosity Index	SI = 1.35; sinuous	SI = 1.2; slightly sinuous
Bed slope	Upper reaches: 0.25-0.5%; Lower reaches: 0.13 – 0.25%	Consistent 0.15% slope over investigated reach
Channel planform and type	Single thread	Single thread – no anabranches
Active bed character	Uniform sand sheet, aggradation occurring. Some bedrock controls in upstream parts of the study area.	Unchanged, uniform sand sheet aggradation occurring. No bedrock observed.
Width of bed	15-20 m; 37 n in lower reaches	15-29 m
Flow depth in 10% Annual Exceedance Probability (AEP) Flood	3 m to 5 m	4 m to 6 m
Sediment type	Medium – coarse sand	Unchanged

Channel characteristics	URS 2013 description	SLR 2019 description
Sediment sources	Tributaries and floodplain gully erosion mainly in downstream part of the study area.	Unchanged
Channel banks	Low, moderately sloping well grasses with some trees. In-channel benches present.	Unchanged. Some bank slumping observed.
Bankfull conditions	Top width 200-500 m Depth 7-10 m	Top width 100-200 m; Depth 8-10 m
Floodplains	Floodplain not active until occurrence of approximately 1 in 500 AEP event	Flood modelling carried out for 1% and 0.1% AEP indicates that it is likely to be activated between these events and as such remains unchanged.

In both the URS 2013 and SLR 2019 site visits, bank erosion was evident, mainly on the outer edge of river bends located south of the confluence with Hill Creek. This is illustrated in Figure 3.19 which shows bank erosion on the outer banks and Figure 3.20 which shows evidence of bank erosion slumping and gully erosion as well as aggradation of sediments on the river bed.



Figure 3.19 Bank erosion evident on outer banks of the Isaac River



Figure 3.20 Evidence of bank erosion, slumping, gully erosion and aggradation of sediments on the Isaac River

3.9.2.2 Unnamed Tributary

The un-named tributary of the Isaac River (see Figure 3.4) with a relatively small catchment which enters the river from the west, south of the confluence with Hill Creek. This un-named tributary has significant gully erosion over its entire length. Observations from the SLR site visit in March 2019 noted that tracks made by cattle, outflows from farm dams or any other cause for concentration of flows had resulted in the formation of gully erosion. It is considered that the sodic soils located throughout this area suffered structural decline due to the current farming practices. It was also noted during the site visit that some localised earthworks had been undertaken to direct catchment flows away from areas of extensive gully erosion. This is evident in aerial photographs (Figure 3.21 and Figure 3.22) which show erosion due to concentration of flows and the bund in Figure 3.23 with subsequent downstream erosion in Figure 3.24.



Figure 3.21 Aerial photography showing existing conditions along un-named tributary of the Isaac River



Figure 3.22 Aerial photography showing existing conditions along un-named tributary of the Isaac River



Figure 3.23 Construction of bund to re-direct overland flow away from gully



Figure 3.24 Gully erosion to un-named tributary upstream of confluence with Isaac River

3.9.2.3 Ti-Tree Creek channel

As noted in the previous URS 2013 report, Ti-Tree Creek is formed in a black soil plain, is heavily eroded and lacks any significant riparian vegetation. The geomorphic feature summary is provided in Table 3.7 and compares the 2013 URS survey to the 2019 SLR site inspection. The inspection found an increase in the erosion of bed and banks and decrease in vegetation cover leading to an increase in channel depths, bed widths and channel widths. While the length of the creek inspected was shorter than the 2013 URS study, aerial photography indicates the geomorphic features indicative of the broader channel. Figure 3.25 and Figure 3.26 illustrate gully erosion in Ti-Tree Creek.

Table 3.7 Ti-Tree Creek channel geomorphic feature summary

Channel characteristics	URS 2013 description	SLR 2019 description
Length of channel in study area	10.7 km	6.2 km
Sinuosity Index	SI = 1.31; sinuous	SI = 1.4; sinuous
Bed slope	Upper reaches: 0.4-2.0%; Lower reaches: 0.2 – 1.0%	Project area – 0.5%
Channel planform and type	Single thread	Single thread
Active bed character	Grassed	Sparse vegetation mostly grass with heavily eroded banks
Width of bed	2-5 m	10-12 m
Flow depth in 10% Annual Exceedance Probability (AEP) Flood	1 m to 1.5 m	1-2 m (up to 3 m at confluence with Isaac River)
Sediment type	Silty mud, occasional sand and gravel bars	Unchanged
Sediment sources	Tributaries and bank erosion	Unchanged
Channel banks	0.5-1.5 m high, vertical eroding banks	0.5 m-3.0 m high, vertical eroding banks
Bankfull conditions	Top width 5-10 m Depth 1-2 m	Top width 15-20 m; Depth 3 m
Floodplains	Floodplain up to 300 m wide; active in 10% AEP events	Floodplain 250-300 m wide; active in 10% AEP events



Figure 3.25 **Gully erosion to Ti-Tree Creek in upper reaches**



Figure 3.26 **Erosion to bank of Ti-Tree Creek – typical for length of upper and mid-section**



Figure 3.27 **Improvement to stability of Ti-Tree Creek – typical for lower sections**

3.9.3 Summary of findings

The SLR site inspection in March 2019 found that the existing waterways of Ti-Tree Creek, the Isaac River and other unnamed tributaries running through the New Lenton MLs, had significant issues with erosion. This is likely due to the highly dispersive soil types and historical disturbance of ground cover vegetation from pastoral practices which can lead to erosion propagating along the waterway.

In most cases, it was apparent that a change in flow regime (such as concentration of a flow path from a dam outlet or along a cattle track) allowed gully and sheet erosion to take place. Therefore, the highly dispersive nature of the soils will need to be considered and managed for any proposed waterway works.

3.10 SOIL CLASSIFICATION

A site inspection of the Project area in April 2019 by SLR, in conjunction with a desktop assessment, has shown that cattle grazing of native and introduced pastures is the dominant agricultural enterprise on areas cleared of remnant vegetation.

The soil field program for the Project area was designed to satisfy a 1:25,000 survey scale intensity, with the survey area comprising approximately 618 hectares. Within the Project area, a total of three soil map units (SMUs) have been identified based on the dominant soil types. The three SMUs (Table 3.8) were surveyed within the majority of the Project disturbance area, and were identified as:

- **SMU 1: Brown Sodosol** – Within this SMU, the dominant soil unit is Brown Sodosol; however, there are minor soil units comprising Grey, Red and Yellow Chromosols. These are soils with strong texture contrast between the A horizon and B horizon, which, for Sodosols, is sodic but not strongly acidic (pH is greater than 5.5). The strongly sodic nature of the B horizon in Sodosols makes them prone to dispersion and tunnel erosion if left exposed for prolonged periods to water movement or rainfall. Both the topsoil and sodic subsoil of this SMU may be stockpiled/windrowed for use in rehabilitation; however, the topsoil would need to be stripped from 100 mm to 400 mm, as appropriate for each individual soil unit and ameliorated with organic matter (e.g. manure) and fertiliser, and the sodic subsoils would need to be treated with a considerable volume of gypsum to ameliorate the sodicity. Both materials should only be used to rehabilitate areas of SMU 1. SMU 1 has an area identified with significant amounts of surface and sub-surface rock located at the edge of an escarpment as there are no soil resources available for re-use.
- **SMU 2: Black Vertosol** - these are clay soils with shrink-swell properties that exhibit strong cracking when dry and at depth have slickensides and/or lenticular structural aggregates. These soils have topsoil material that can be stripped from 100 mm to 200 mm from the surface and subsoils that may be stripped from 100-200 down to 500-600 mm (exchangeable sodium percentage [ESP] <20) and from 500-600 down to 1,000 mm (ESP >20).
- **SMU 3: Brown Vertosol** - these are clay soils with shrink-swell properties that exhibit strong cracking when dry and at depth have slickensides and/or lenticular structural aggregates. These soils have topsoil material that can be stripped from 100 mm to 200 mm from the surface and subsoils that may be stripped from 100-200 down to 500-600 mm (ESP <20) and from 500-600 down to 1,000 mm (ESP >20).

All soil profiles were above pH 5.5 and are considered nil risk as Acid Sulfate Soils, given their landscape position and also vegetation types present across the Project area. All soil profiles contained moderately dispersive and dispersive horizons according to their ESP score, which will be likely require ameliorated (e.g using gypsum) for use of soils as growth medium in rehabilitation.

Table 3.8 Dominant soil types per soil map unit

SMU	Dominant soil type	Area (ha)	%
1	Brown sodosol	238	39
	Rocky brown sodosol	76	12
2	Black vertosol	147	24
3	Brown vertosol	157	25
TOTAL		618	100

3.11 OVERBURDEN GEOCHEMISTRY

The area comprising ML 70337, and adjacent tenements, have been the subject of two previous geochemistry assessments. Within ML 70337, four drill holes were sampled and analysed. This section summarises the findings of the report *Geochemical Characterisation and Assessment of Overburden and Reject Materials at the Lenton Coal Project* (MEMS, 2005).

The geochemical assessment involved:

- Review of previous geochemical investigations conducted in the area;
- Geochemical testing of 18 overburden samples, including testing of pH (1:5), EC (1:5), acid neutralising capacity (ANC), total sulphur, sulphide-sulphur, net acid producing potential (NAPP), net acid generation (NAG) test, and sodicity; and
- Assessing the potential environmental risk associated with mine waste.

3.11.1.1 Geochemistry Methodology

A total of 37 drill chip and 14 drill core samples were selected from four drill holes to represent overburden (sandstone, mudstone and siltstone) and potential reject (coal seam roof and floor) samples. Sample selection was skewed towards the unweathered Permian material at a depth of greater than 25m (the indicated depth of weathering) as this material is more likely to be geochemically active (compared to weathered near-surface material) if exposed to oxidising conditions.

Drill chips were generally sub-sampled to generate a sample weight of approximately 2 kg. Reject samples consisted of full core generally taken from drill core intervals no greater than 1m. Samples were initially screened using a series of standard static geochemical tests including pH, Electrical Conductivity (EC), Acidity or Alkalinity, Total Sulfur, Sulfate Sulfur, Acid Neutralising Capacity (ANC) and Net Acid Producing Potential.

Following initial screening results, forty selected samples were combined into ten composite samples according to rock type and geochemical nature. Composite samples represented depth intervals of up to 10 m within specific rock types, the practical limit for material handling during overburden removal. The multielement composition of the composite samples was determined to identify the presence of any elements at concentrations of environmental significance. The Exchangeable Sodium Percentage (ESP) was also determined these samples. Water extracts from the composite samples were also subjected to multi-element analyses to determine the solubility and potential mobility of any elements of concern from materials.

3.11.1.2 Geochemistry Results

The results of the geochemical assessment are summarised below:

- Overburden has negligible sulphide-sulphur concentrations (<0.1 %);
- All samples tested were non-acid forming (NAF) or acid consuming (AC);

- Geochemical classification was not found to be dependent on rock type or sample depth;
- The risk of overburden materials causing significant water quality impacts in downstream receiving environments is low and is unlikely to cause any adverse effects on plant growth associated with postmining revegetation and rehabilitation; and
- Overburden material may be susceptible to dispersion during wet weather or after mechanical working.

Acid-base test results determined that overburden at the Project is non-acid forming. Acid-Base test results for the thirty-seven overburden samples representing specific lithological rock types are summarised below:

- The pH of the samples is moderately alkaline (median pH 9.0) and ranges from 8.1 to 9.6. The alkalinity is relatively low (ranges from 0.2 to 1.2 kg H₂SO₄/t) and has a median value of 0.4 kg H₂SO₄/t; and
- The conductivity is relatively low and ranges from 190 to 690 µS/cm, with a median value of 350 µS/cm.

The total sulfur content of the samples ranges from low to moderate (<0.01 to 2.10%, median 0.03%), and is mostly present in the sulfide (unoxidised) form.

To evaluate the immediate solubility of multi-elements in solids, water extract tests were completed for ten composite samples. These results indicate that initial leachate from composite samples contains metal concentrations well within those recommended in the ANZECC guidelines.

3.11.1.3 Geochemistry Conclusions

- Overburden at the Project is likely to be benign and will generate moderately alkaline and fresh (nonsaline) runoff following surface exposure;
- Majority of the overburden will have very low sulfur content (<0.1%) and can be classified as barren;
- A small amount of overburden has elevated sulfur content and is located close to coal seams;
- Acid generation from overburden is unlikely given the high acid neutralising capacity of the materials;
- The concentration of metals in overburden is unlikely to present any environmental risks for revegetation and overall rehabilitation of any out-of-pit overburden dump;
- The concentration of soluble metals and salts in runoff and seepage from overburden is likely to remain well within relevant water quality guideline concentration limits and has a low risk of impacting upon downstream water quality;
- Some overburden (mudstone) is likely to be sodic and could therefore be prone to crusting;
- Most rejects generated should be relatively benign and will initially generate moderately alkaline and nonsaline runoff following surface exposure (noting that rejects will be managed at the Burton Mine by disposal within the existing void utilised for that purpose); and
- Total sulfur content and buffering capacity of rejects is variable. Most reject will remain alkaline.

3.11.1.4 Mitigation Measures

- The water quality monitoring program for runoff and seepage from overburden dumps will focus on pH, EC and Total Suspended Solids (TSS). If the pH of runoff or seepage from dump areas drops below pH 6.0 or the EC value increases by more than 50%, then a more comprehensive range of water quality analysis may be warranted.

- Overburden dumps will be progressively rehabilitated in accordance with the approved progressive rehabilitation and closure plan (PRCP) schedule approved for the Project by the Department of Environment and Science. This sets specific rehabilitation criteria for overburden slope angles, cover of overburden with growth medium and revegetation. These measures are designed to limit erosion through progressive rehabilitation of overburden dumps. Furthermore, a network of sediment drains and dams will operate to manage runoff from overburden dumps.
- An operational management strategy should be developed for sodic overburden.

4 PROPOSED SURFACE WATER MANAGEMENT STRATEGY AND INFRASTRUCTURE

4.1 OVERVIEW

This section describes the objectives and principles of the proposed water management system for the proposed mining operations at the Project, including a description of the infrastructure and systems that have been designed to achieve the objectives and principles.

4.2 TYPES OF WATER GENERATED ON-SITE

Land disturbance associated with mining, if not suitably managed, has the potential to adversely affect the quality of surface runoff in downstream receiving waters through increased sediment loads. In addition, runoff from active mining areas (including coal stockpiles, etc.), if not suitably managed, may have increased concentrations of salts and other pollutants when compared to natural runoff. The proposed strategy for the management of surface water at the Project is based on the separation of water from different sources based on anticipated water quality.

Definitions of the types of water generated within the Project are shown in Table 4.1.

Table 4.1 Type of water

Water type	Definition
Mine-affected water (also referred to as mine water)	In accordance with the DES's Model Mining Conditions, mine-affected water means the following types of water: i. pit water, tailings dam water, processing plant water ii. water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the Environmental Protection Regulation 2008 if it had not formed part of the mining activity iii. rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage such runoff, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water iv. groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated v. groundwater from the mine dewatering activities vi. a mix of mine-affected water (under any of paragraphs i to v) and other water.
Sediment water	Surface water runoff from areas that are disturbed by mining operations (including out-of-pit waste rock emplacements). This runoff does not come into contact with coal or other carbonaceous material and may contain high sediment loads but does not contain elevated level of other water quality parameters (e.g. EC, pH, metals, metalloids, non-metals). This runoff must be managed to ensure adequate sediment removal prior to release to receiving waters.
Clean catchment water	Surface runoff from areas unaffected by mining operations. Clean catchment water includes runoff from undisturbed areas and fully rehabilitated areas.

Water type	Definition
Raw water	Untreated water, generally from an external water supply, that has not been contaminated by mining activities.
Contaminated water	Contaminated water includes runoff from areas containing hazardous chemicals, corrosive substances, toxic substances, gases and dangerous goods, as well as flammable and combustible liquids (including petroleum products), generally associated with the MIA
Potable water	Treated water suitable for human consumption.

4.3 SURFACE WATER MANAGEMENT OBJECTIVES

The objective of the Project water management system is to manage all types of water on-site to meet operational, social and environmental objectives.

There are three key water management system objectives:

- Minimise mine-affected water accumulation and the risk of uncontrolled discharges;
- Maintain sufficient water for the operation in dry times; and
- Successfully engage with external stakeholders to be a good custodian of society's water resources. The priority issues are the Project's impact on surface water and groundwater.

Specific objectives for each water type are as follows:

- **External water:** Ensure that external water allocation and associated infrastructure is sufficient to meet Project demands particularly under low rainfall conditions.
- Mine-affected water:
 - Manage controlled releases of mine-affected water in accordance with EA approval conditions which are designed to prevent environmental harm.
 - Minimise uncontrolled discharges in wet periods to maintain adequate water supplies for site demand during dry periods.
 - Understand, manage and minimise the potential impact of the water management system on the regional groundwater system.
- **Sediment water:** Maintain the quality of water discharging from erosion and sediment control structures to as close to background levels as reasonably possible.
- **Clean water:** Separate from the mine-affected and sediment water systems as much as reasonable and feasible and allow it to pass uninterrupted through the catchment.
- **Contaminated water:** Ensure full separation from other water sources and manage under the requirements of AS1940 – *Storage and Handling of Flammable and Combustible Liquids*.

4.4 SURFACE WATER MANAGEMENT PRINCIPLES

The general principles to manage surface water for the Project are as follows:

- The fullest separation possible of clean, sediment water, mine-affected water runoff, within the limitations of operational requirements.
- Minimise the area of surface disturbance, thus minimising the volume of sediment or mine-affected runoff.
- Collect and contain on-site all potential mine-affected water into dedicated mine water storages. The mine water storages will be used as the primary water source for the dust suppression requirements.
- Retain and reuse on-site any sediment water runoff that has high sediment concentrations whenever possible. If not, release it in a controlled manner (i.e. following settlement) in compliance with the EA requirements for an erosion and sediment control plan.
- Prioritise the use of poor-quality water over better quality water, where practical.

4.5 PROPOSED WATER MANAGEMENT INFRASTRUCTURE

Figure 4.1 to Figure 4.4 show indicative locations of the key features of the Project, including infrastructure related to the management of water within the Project Disturbance Area for four different phases (also referred to as stages) of mining (Phase 1 to Phase 4). The main components of water-related infrastructure include:

- a mine-affected water system to store water pumped out of the open cut mining areas and to collect runoff from the ROM coal stockpile and Mine Infrastructure Area (MIA).
- sediment dams to collect and treat runoff from out-of-pit waste rock emplacement areas;
- clean water diversion drains and Ti-Tree Creek waterway diversion to divert runoff from undisturbed catchments around areas disturbed by mining;
- new waterway crossings, including a haul road crossing of the Isaac River, and a new bridge across the Isaac River and culvert crossing of the Ti-Tree Creek diversion associated with realignment of the Suttor Developmental Road;
- drains to divert sediment-laden runoff from out-of-pit waste rock emplacement areas to sediment dams; and
- localised sediment controls around active construction areas.

Details of proposed water storages, including indicative storage sizes and pumping rules are provided in Section 5.7. Figure 4.5 shows the indicative timing of water storages over the life of the Project. The named dams in Figure 4.5 are shown in Figure 5.3 to Figure 5.6.

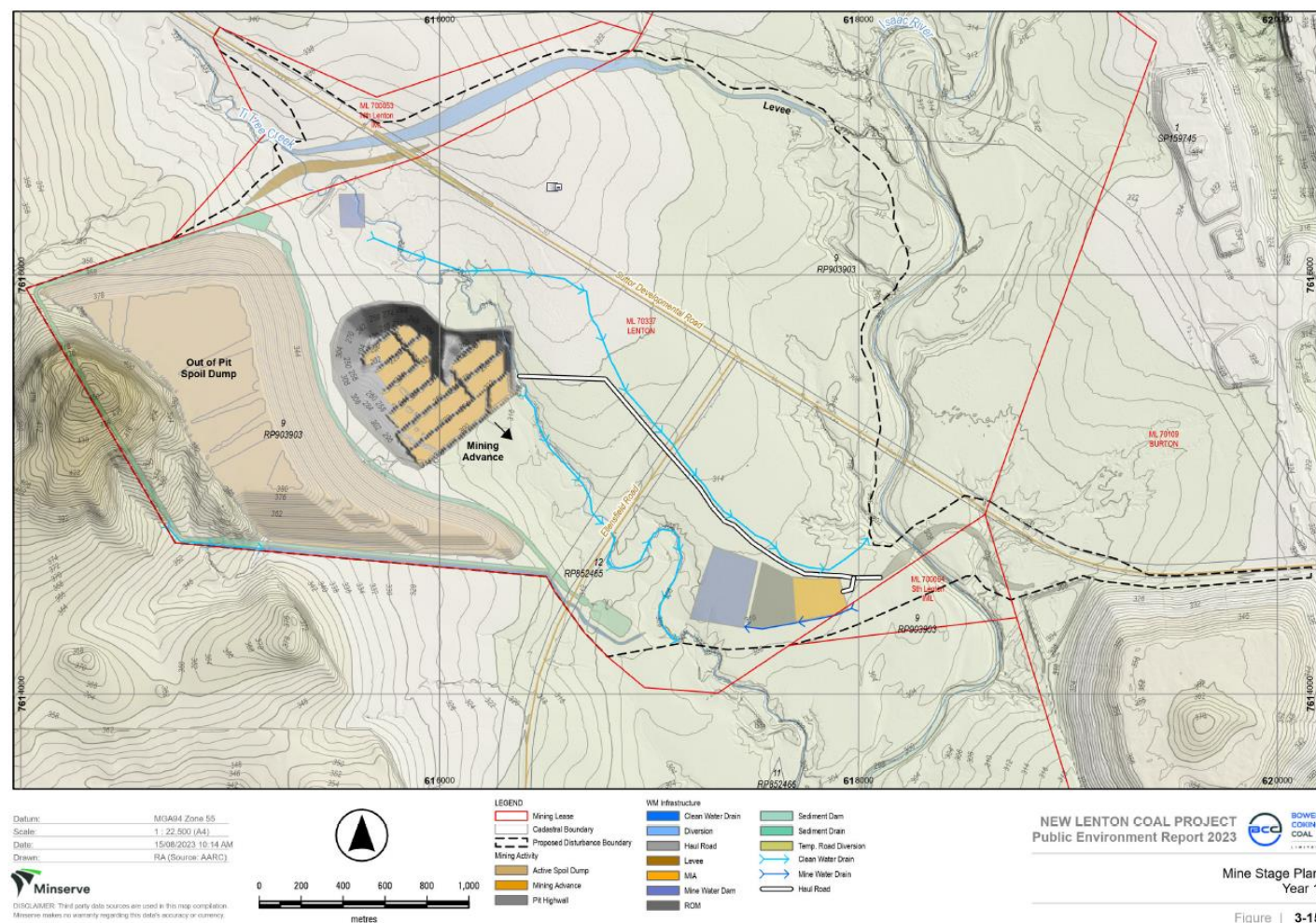


Figure 4.1 Proposed Project water management system – Project Year 1 (Phase 1)

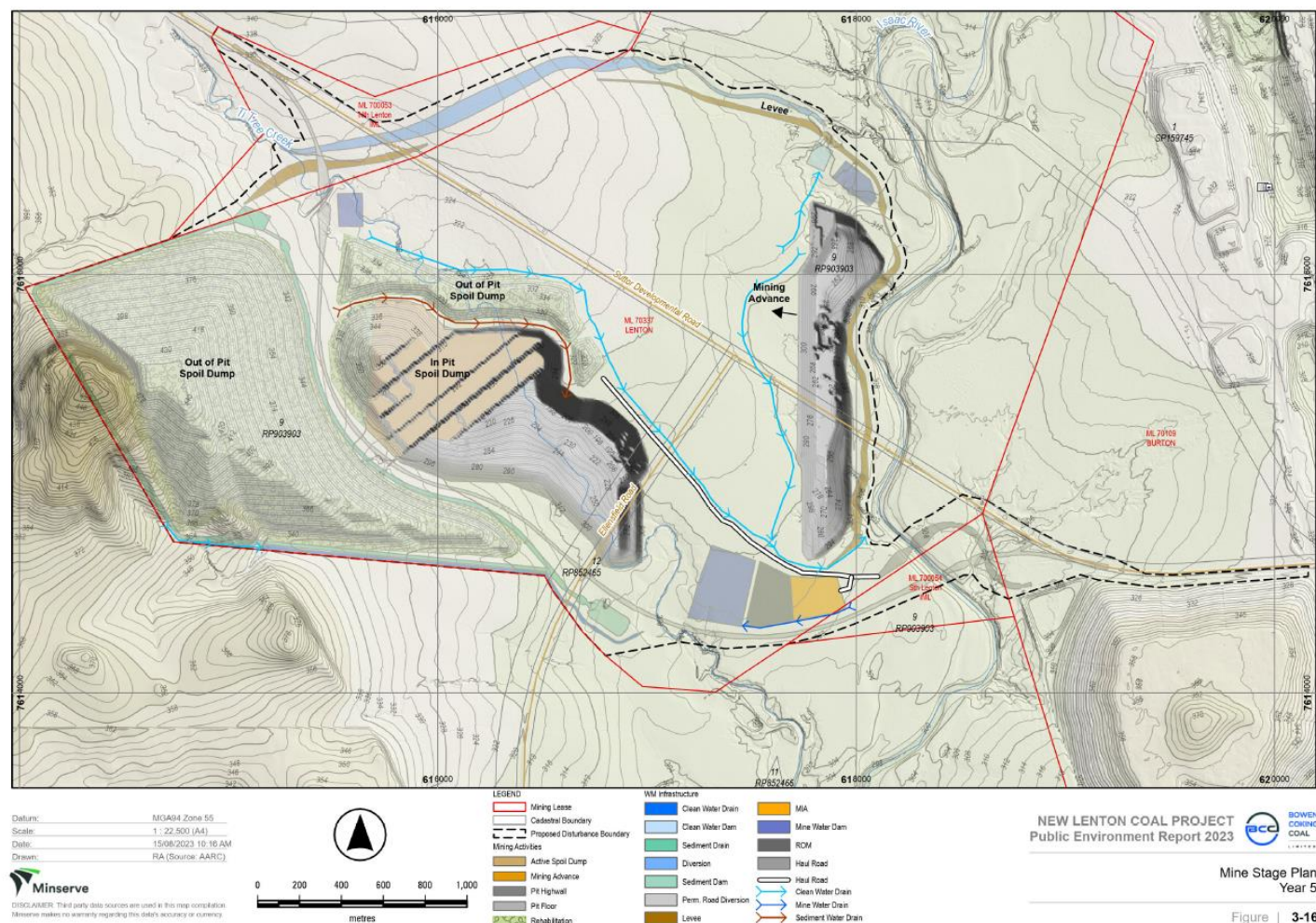


Figure 4.2 Proposed Project water management system – Project Year 5 (Phase 2)

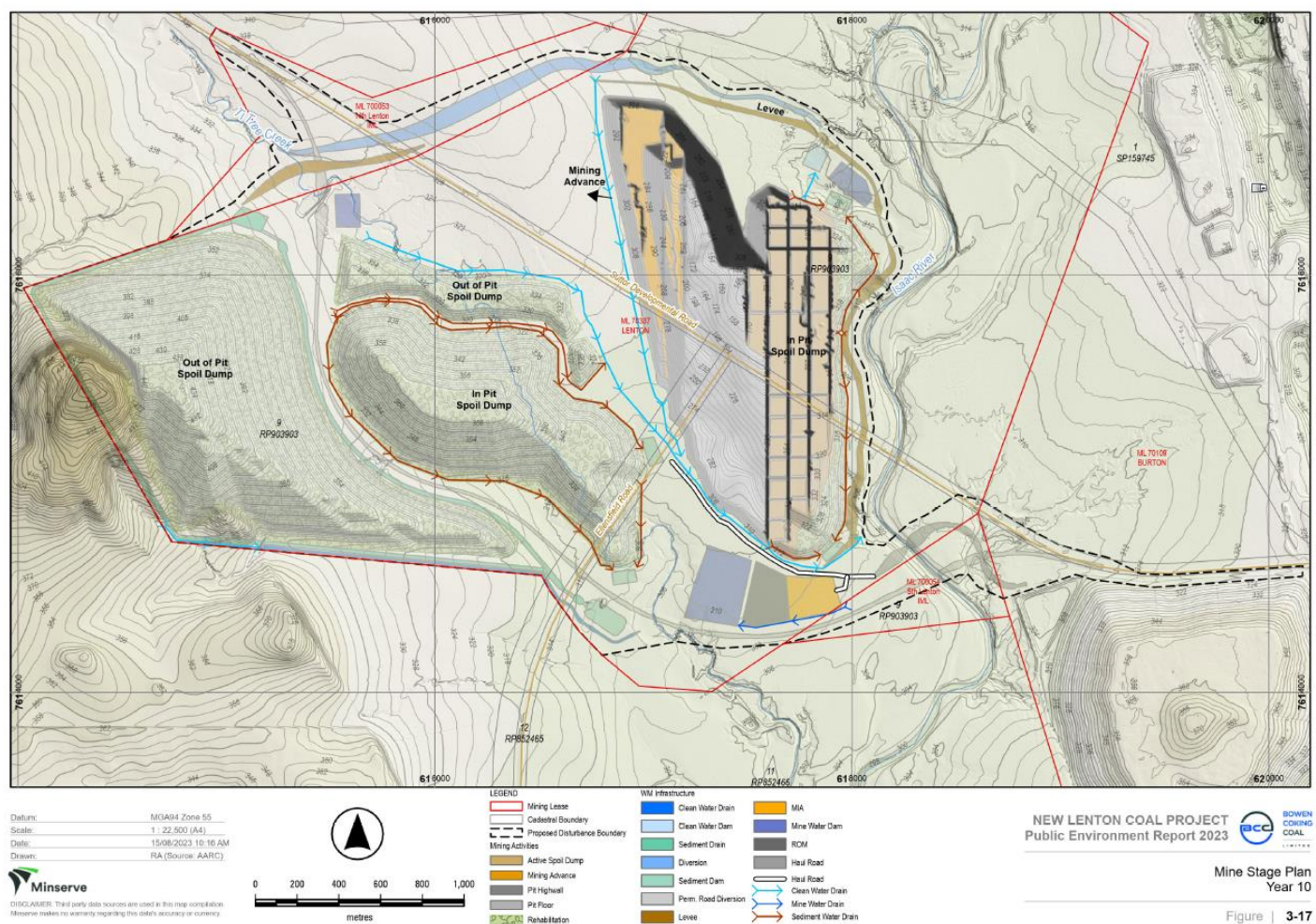


Figure 4.3 Proposed Project water management system – Project Year 10 (Phase 3)

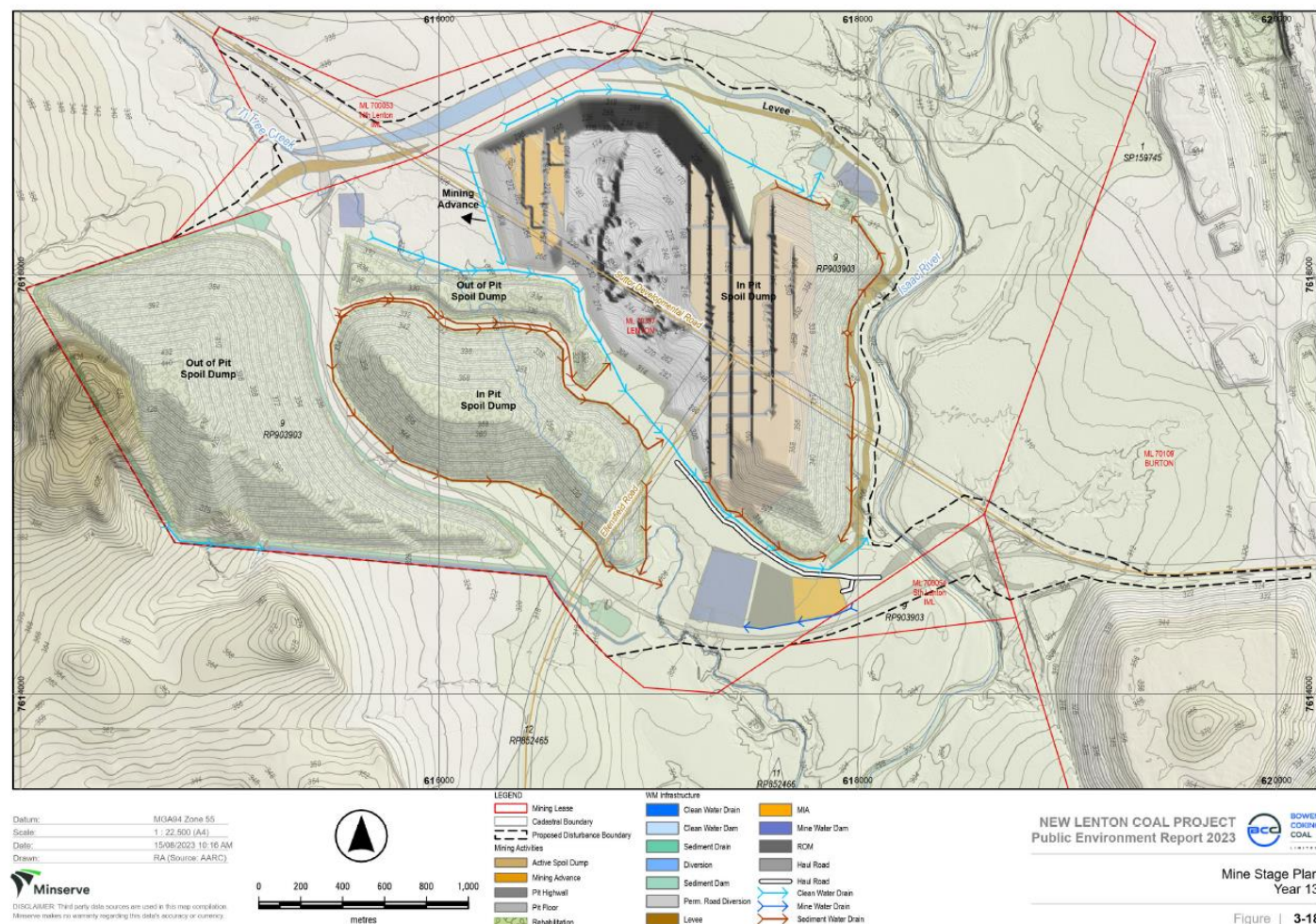


Figure 4.4 Proposed Project water management system – Project Year 13 (Phase 4)

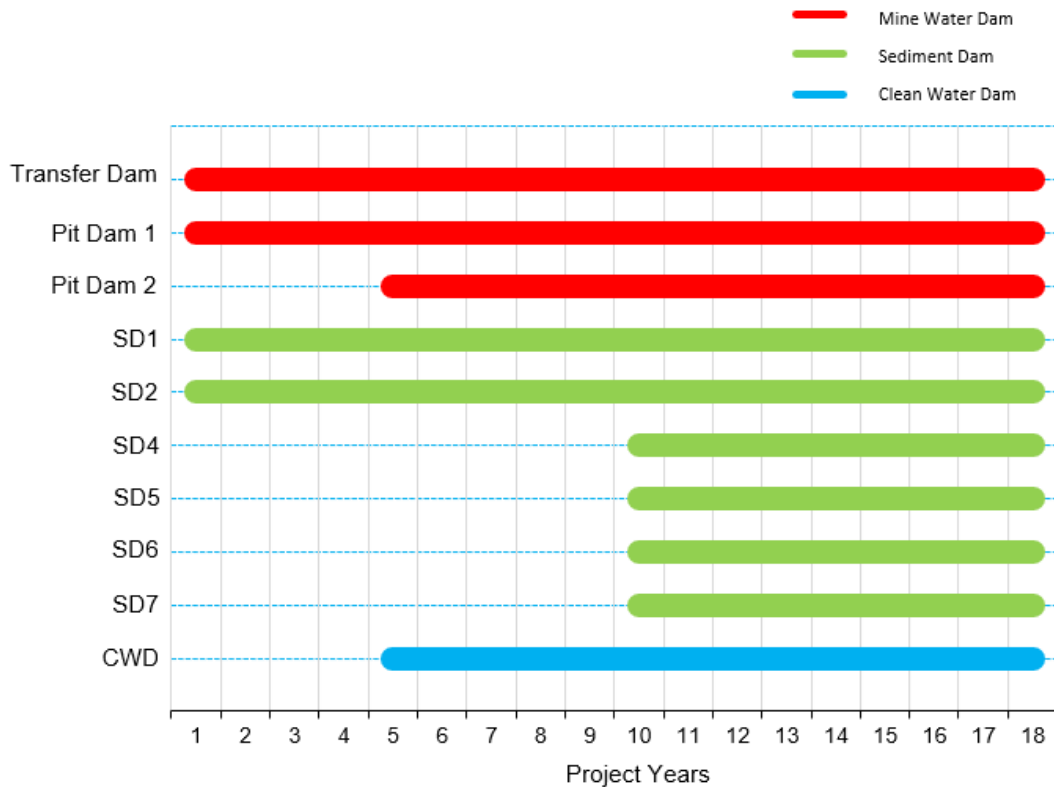


Figure 4.5 Indicative timing of water storage dams at New Lenton Mine

4.6 MINE-AFFECTED WATER MANAGEMENT

Containment of mine-affected water is provided by the following proposed storages:

- Transfer Dam;
- Pit Dam 1; and
- Pit Dam 2.

Pit dewatering will be pumped to Pit Dam 1 and Pit Dam 2, where it will then be pumped for storage and use within Transfer Dam. Transfer Dam functions as the primary mine-affected water storage for the water management system (WMS), as well as capturing potentially mine-affected runoff from the MIA and ROM stockpile area.

Transfer Dam will have the ability to pump mine-affected water between the Project and Burton Mine, depending on the water supply or containment needs for the Project.

4.7 SEDIMENT WATER MANAGEMENT SYSTEM

4.7.1 Overview

Sediment water containment (runoff from spoil [i.e. waste rock] and areas yet to be rehabilitated) will be managed in accordance with an ESCP. The ESCP will adopt the three cornerstones of erosion and sediment control.

- Drainage control – prevention or reduction of soil erosion caused by concentrated flows and appropriate management and separation of the movement of diverted and surface water through the area of concern.

- Erosion control – prevention or minimisation of soil erosion (from dispersive, nondispersive or competent material) caused by rain drop impact and exacerbated overland flow on disturbed surfaces.
- Sediment control – trapping or retention of sediment either moving along the land surface, contained within runoff (i.e. from up-slope erosion) or from windborne particles.

The Project will require a combination of the three control measures to effectively manage sediment and erosion within the Project Disturbance Area. The locations and number of sediment dams provided in this assessment is conceptual and would not significantly affect the overall mine water balance provided the dam volumes remain consistent. Details of final sizing and placement of sediment dams will be determined during detailed design of the Project.

Detailed information relating to the proposed ESC measures will be developed prior to the commencement of operations in accordance with the EA requirements. This will include the development of ESC implementation plans during both the construction phase and operations.

4.7.2 Sediment dam locations and sizing

Catchment runoff from both active and newly rehabilitated waste rock emplacements will be managed in accordance with an ESCP incorporating the conceptual design of sediment drains and dams described below. The sediment dams have been sized in accordance with the International Erosion Control Association (IECA) method (IECA, 2018), and have been based on the following design standards and methodology:

- “Type D” sediment dams ;
- total sediment dam volume = settling zone + sediment storage volume. The sediment storage volume is the portion of the basin storage volume that progressively fills with sediment until the basin is de-silted. The settling zone is the minimum required free storage capacity that must be restored within 5 days after a runoff event;
- sediment dam settling volume based on 85th percentile 5-day duration rainfall (36.7 mm) with an adopted volumetric event runoff coefficient for disturbed catchments of 0.49 (Group C soils – loamy clay); and
- solids storage volume = 50% of settling zone volume.

The adopted design standard does not provide 100% containment for runoff from disturbed areas. Hence, it is possible that overflows will occur from sediment dams if rainfall exceeds the design standard. Further, the water collected by the sediment dams will be preferentially retained for reuse on-site (e.g. dust suppression).

A summary of the conceptual sediment dam capacities and the surface areas (based on average 5 m depth) is provided in Table 4.2.

Table 4.2 Conceptual sediment dam capacities and surface areas

Dam name	Max. catchment area (ha)	Settling volume (ML)	Solids storage volume (ML)	Total volume required (ML)	Dam surface area (ha)
SD1	88.8	15.9	7.9	23.8	0.63
SD2	102.7	18.4	9.2	27.6	0.74
SD4	50.1	9.0	4.5	13.4	0.36
SD5	59.9	10.7	5.4	16.1	0.43
SD6	44.9	8.0	4.0	12.1	0.32
SD7	27.7	5.0	2.5	7.4	0.20

4.8 CLEAN WATER MANAGEMENT SYSTEM

4.8.1 Clean water diversions drains

A series of clean water drains are proposed to capture and divert clean catchment runoff through the mining areas. The indicative locations of the proposed drains for the various mine phases are shown on Figure 4.1 to Figure 4.4. The purpose of the clean water diversions is to divert runoff from upslope catchment areas away from the mine water management system and directly into the downstream receiving waters.

The proposed design criteria for the clean water diversion drains have been set to minimise the risk of overflows into the water management system and minimise the risk of scour and erosion within the drains during flow events. The adopted design criteria are as follows:

- 1% AEP design event discharge
- Batter slopes of 1 vertical to 3 horizontal (1V:3H)
- Bed width of 10 m
- Scour protection at appropriate locations

The final alignment and sizing of the clean water diversion drains will be confirmed as part of the detailed design process.

4.8.2 Clean Water Dam

From Phase 2 onwards, a clean water dam (CWD) (and associated clean water drain) is proposed to capture clean runoff from the northern section of the Project disturbance area between the Ti-Tree Creek levee and mining progression.

Runoff captured within the dam will be discharged to the receiving environment via a pumping system, as it is not feasible to provide gravity overflows due to the Ti-Tree Creek levee. Clean runoff captured within CWD will be pumped to Ti-Tree Creek diversion as soon as practicable following an inflow event. Prior to discharging, the water stored within CWD will be monitored using field equipment to ensure it has similar quality to other clean water prior to discharge.

In the unlikely event that the water captured within CWD is unsuitable for discharge, it will be managed within the sediment or mine water systems.

4.9 CONTAMINATED WATER MANAGEMENT

Contaminated water collected within the MIA will be collected and treated for reuse via an oil and water separator or similar device. All treated contaminated water will be contained and reused within site operations.

4.10 FLOOD PROTECTION LEVEES AND CREEK DIVERSION

As described in previous sections, the Isaac River is the main watercourse within the Project area, which extends along the eastern boundary of ML70337. In addition, there are two other watercourses passing through the Project area; Ti-Tree Creek and Hill Creek. Both are tributaries of the Isaac River.

Hill Creek extends along the north eastern boundary of the New Lenton MLs, until its confluence with the Isaac River, is upstream of the Project disturbance area and hence will not be impacted by surface water management for the Project. Ti-Tree Creek crosses ML70337 diagonally further south through an area proposed for mining, where it joins the Isaac River before flowing into the northern inlet of Burton Gorge Dam.

An options analysis was undertaken by GHD (2018) as part of the Front End Engineering Design (FEED) study to determine the most appropriate design to provide flood protection to the Project

operations while minimising the environmental impact and risk. The option selected requires the diversion of Ti-Tree Creek to the east, north of East Pit. The diverted Ti-Tree Creek then flows into the Isaac River approximately 4.7 km upstream of the current Ti-Tree Creek and Isaac River confluence.

Key components of the proposed flood protection infrastructure are:

- A constructed channel to divert Ti-Tree Creek;
- A levee to protect mine operations from Ti-Tree Creek flooding; and
- A levee to protect mine operations from Isaac River flooding.

The locations of the diversion channel and levees are shown in Figure 4.6.

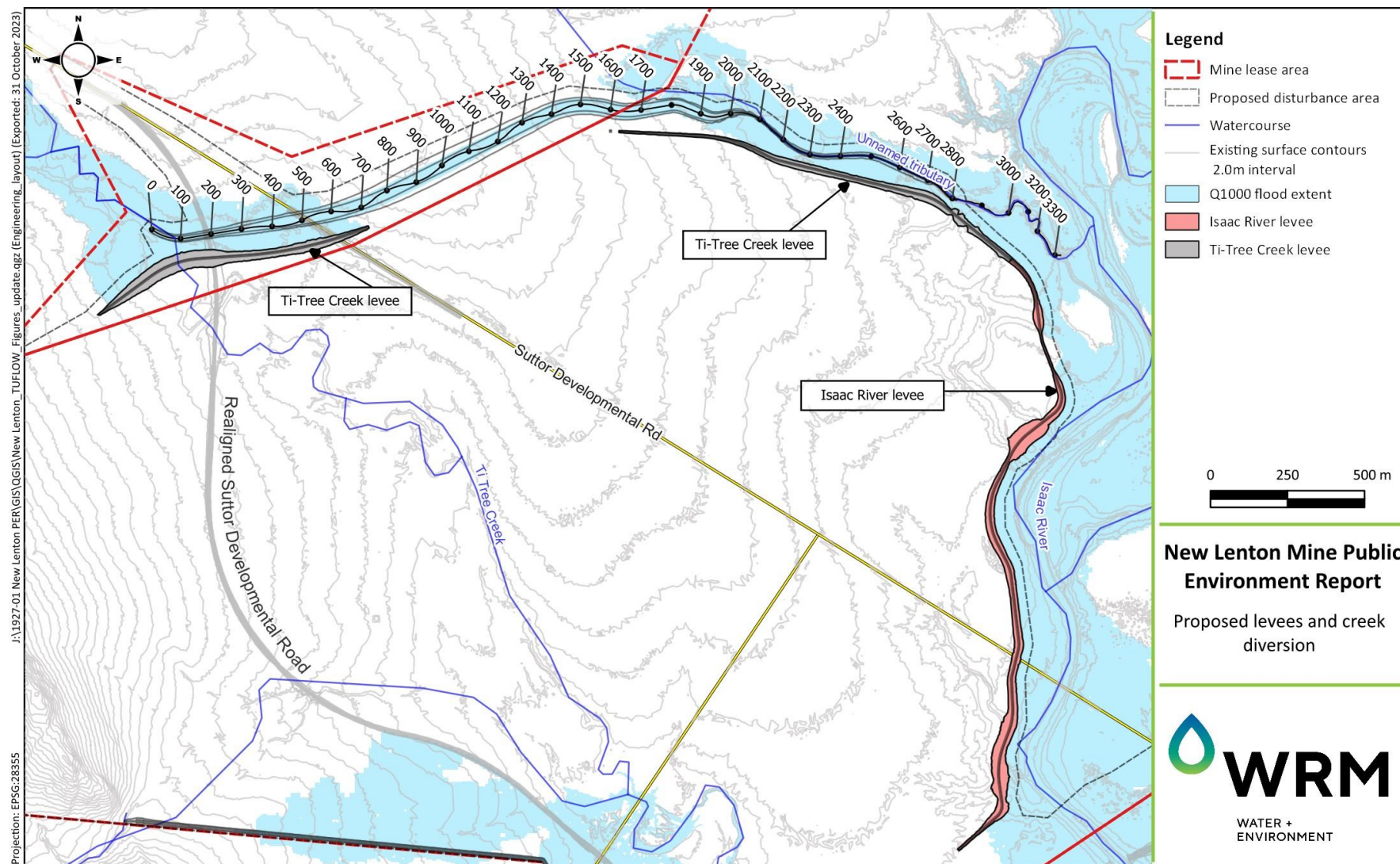


Figure 4.6 Proposed flood protection infrastructure

4.10.1 Ti-Tree Creek Diversion

The following design criteria were proposed for the diversion of Ti-Tree Creek:

- 1 in 1000 (0.1%) Annual Exceedance Probability (AEP) flood protection to the operations in accordance with industry standards (DEHP, 2016);
- conveyance of the 1 in 10 (10%) AEP event within the diverted channel;
- freeboard of 600 mm;
- afflux to be minimised with no resulting constraints to adjacent landowners; and
- Probable Maximum Precipitation Design Flood (PMP DF) flood immunity for the final void.

The existing Ti-Tree Creek channel through the Project Disturbance Area has a length of 4.95 km and a fall of 26 m with an average bed grade of 0.52%. The proposed diversion design seeks to maintain a similar bed grade with the existing channel being 2.8 km with a fall of 18 m resulting in an average bed grade of 0.6%. This design aims to control the flood velocities to mimic the existing channel and subsequent impacts on Ti-Tree Creek and the Isaac River. The channel will have a low flow channel width of 5 m with a base width of 35 m. Batters will be at 1H:3V with topsoil consisting of local grasses and vegetation.

Upon completion of mining, Ti-Tree Creek has been designed to remain in its diverted state with the Ti-Tree Creek levee developed into a final stable landform to protect the final void during a PMP DF event.

4.10.2 Ti-Tree Creek Levee

Associated with the diversion, a Ti-Tree Creek flood levee would be constructed to the north of East Pit to prevent the ingress of water into the pit from flows that exceed the capacity of the Ti-Tree Creek diversion channel. The levee will be designed and constructed to manage a 0.1% AEP flood event in accordance with EA conditions for regulated structures and industry guidelines. To achieve this immunity and the necessary freeboard, the levee is proposed to be constructed to a height of between 333 and 334 mAHD in the vicinity of the existing Ti-Tree Creek channel. Further east, close to the confluence with the Isaac River, the levee height will range from 325 mAHD to 315 mAHD (0.8 m to 3.6 m high) in line with the adjacent flood surface gradient. The levee will be a fully engineered structure and will be constructed using compacted clay lifts and top-soiled and grass-covered to minimise the potential for erosion.

4.10.3 Isaac River Levee

A flood levee will also be required on the Isaac River floodplain along the eastern side of the Project Disturbance Area. This levee will protect the eastern and southern extent of East Pit from flood ingress from the Isaac River. Crest heights along this portion of the levee will range from 315 mAHD at the upstream extent to 310 mAHD at the downstream extent (0.8 m to 3.6 m high).

As mining is progressed in East Pit a waste rock dump will be formed between the Isaac River levee and the pit, and will form the final landform structure providing flood immunity during mining and post closure. The Isaac River will be incorporated into the final rehabilitated closure landform.

No proposed diversion or flood protection works are required for Hill Creek as part of this Project.

4.11 WATERWAY CROSSINGS

The Project will also include a haul road bed level crossing of the Isaac River, as well as a new bridge crossing associated with the Suttor Developmental Road realignment. The Suttor Developmental Road realignment includes:

- a new bridge across the Isaac River

- crossing of culverts within the Ti-Tree Creek diversion
- crossing of the Ti-Tree Creek levee.

Whilst the existing Suttor Developmental Road is in use, culverts will be used for the crossing of Ti-Tree Creek diversion.

4.12 RELEASE OF WATER TO THE RECEIVING ENVIRONMENT

Water from the Project may only enter the receiving environment via sediment dam overflows or controlled releases from the mine affected water management system. Model predictions of volumes and salt concentration from sediment dam overflows are provided in Section 6.3.5.2.

Whilst the release of mine affected water to receiving waters is permitted under the approved New Lenton Mine EA, the water balance model (see Section 5) demonstrates that controlled releases are not required as part of the water management strategy due to the balancing of mine affected water with Burton Mine. That is, the water management system does not rely on using controlled releases to manage water inventories.

4.13 SEWAGE AND EFFLUENT DISPOSAL

The MIA will be serviced by a sewage collection system, which will be serviced by local contractors. Sewage will be collected by an appropriately licensed waste disposal contractor and transported off-site to a licensed waste disposal facility.

5 WATER BALANCE MODEL CONFIGURATION

5.1 OVERVIEW

A computer-based daily simulation water balance model was used to assess the dynamics of the water balance under historical rainfall and catchment conditions throughout the development of the Project. The GoldSim model dynamically simulates the operation of the water management system and keeps account of all site water volumes and salt loads on a daily time step. The simulated inflows and outflows included in the model are given in Table 5.1.

The Project water management system has been integrated with the existing Burton Mine GoldSim model, to accurately simulate the connectivity between the two mines. The development of the Burton Mine GoldSim model is documented in the Burton Mine Water Management Plan, which has been authorised and approved under the EA for Burton Mine.

Table 5.1 Simulated inflows and outflows to the water management system

Inflows	Outflows
Direct rainfall on water surface of storages	Evaporation from water surface of storages
Catchment runoff	Dust suppression demand
Groundwater inflows to the open cut pits	Miscellaneous water demand
External water supply (from Burton Mine)	Transfer to Burton Mine
	Offsite releases from sediment dams in accordance with design criteria
	Clean water dam discharges

The model incorporates the Australian Water Balance Model (AWBM) rainfall runoff model (Boughton, 2003) to determine the runoff characteristics of the various catchment types in the Project area. The water balance model was used to determine the behaviour of the mine affected water management system over time.

5.2 SIMULATION METHODOLOGY

The Project water management system will change over the approximate 18-year mine life, including changes in catchment areas, mining progression and site water demands. To represent the evolution of the mine layout over time, the Project was modelled in four discrete phases. Three-year to five-year representative periods have been selected to reflect the average conditions over the mine phase.

The modelled mining phases are summarised in Table 5.2 and shown in Figure 4.1 to Figure 4.4.

Table 5.2 Representative mine phases

Phase	Model Period	Duration (years)
1	PY1 – PY4	4
2	PY5 – PY9	5
3	PY10 – PY12	3
4	PY13 – PY18	6

5.3 RAINFALL AND EVAPORATION

Long term daily rainfall and evaporation data for the Project area was obtained from the SILO database (<https://www.longpaddock.qld.gov.au/silo/>) for the period January 1889 to December 2022 (133 years). The long-term monthly rainfall statistics are presented in Figure 5.1. The Project would experience distinct wet seasons (November to May), with median rainfalls reaching up to 111 mm/month. The long-term average evaporation and evapotranspiration is presented in Figure 5.2. Morton's lake evaporation was adopted to represent evaporation from dam water surfaces. Morton's wet evapotranspiration was used to estimate losses from soil, which forms part of the runoff generation rate calculations.

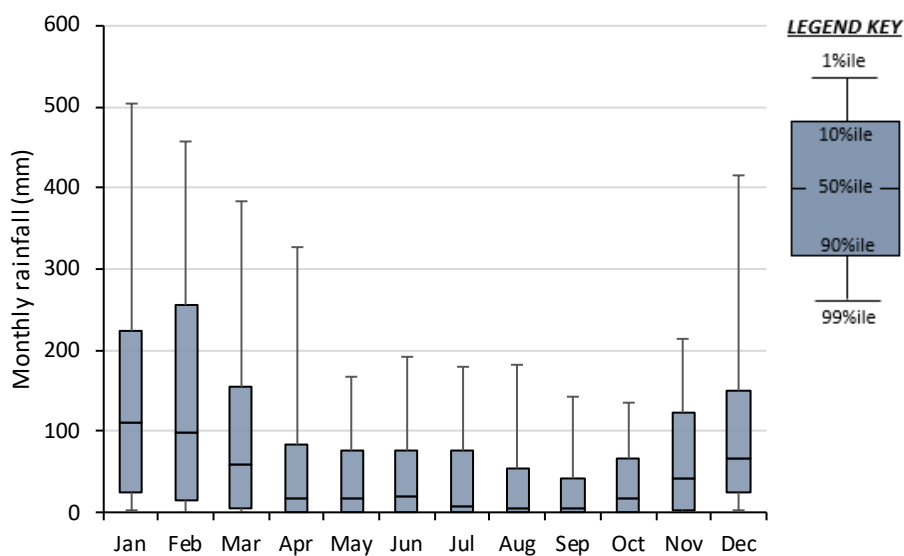


Figure 5.1 Long-term rainfall statistics at New Lenton

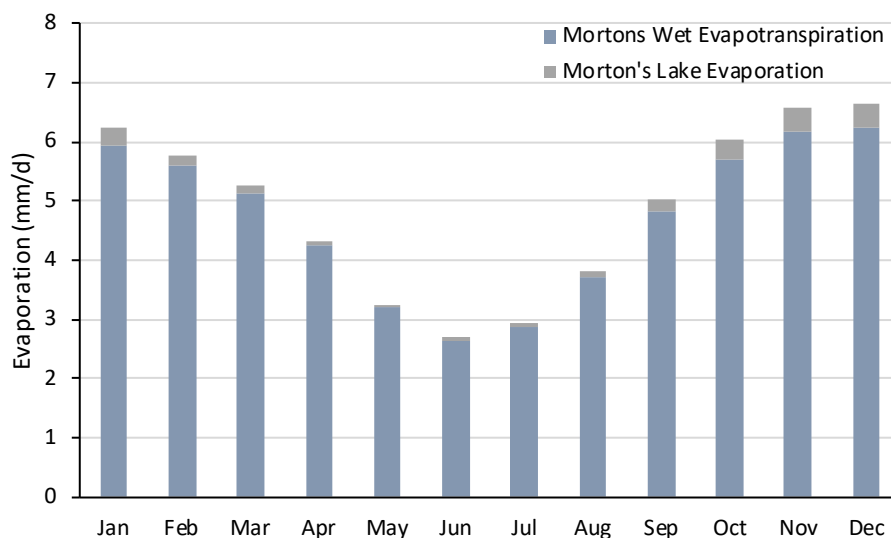


Figure 5.2 Long-term average evaporation and evapotranspiration rates at New Lenton

5.4 CATCHMENT YIELD PARAMETERS

The AWBM model was used to represent the runoff characteristics of mine site catchments. AWBM uses a group of connected conceptual storages (3 surface storages and 1 groundwater storage) to represent catchment runoff. Water in the conceptual storages is replenished by rainfall and reduced by evapotranspiration. Simulated surface runoff occurs when any of these storages fill and overflow. The model parameters define the depth and relative area of each of the storages, as well as the rate of water flux from/between storages.

5.4.1 AWBM parameters

To adequately simulate the site water balance, it is necessary to define the runoff characteristics of the various catchment surface types. Catchments affected by the Project Disturbance Area were characterised into the following land use types:

- Natural, representing areas undisturbed by mining;
- Hardstand, representing hauls roads and hardstand areas;
- Pit, representing the pit floor;
- Stockpile, representing the ROM and product stockpile areas;
- Spoil, representing uncompacted dumped overburden material;
- Rehab; representing rehabilitated emplacement areas; and
- Tailings, representing the co-disposal surfaces.

The AWBM parameters adopted for this assessment have been based on previous modelling undertaken for the Burton Mine. A summary of the parameters is provided in Table 5.3.

Table 5.3 Adopted AWBM parameters

Parameter	Natural/ Undisturbed	Hardstand	Pit	Stockpile	Spoil	Rehab	Tailings
A1	0.13	0.13	0.13	0.13	0.15	0.13	0.13
A2	0.43	0.43	0.43	0.43	0.35	0.43	0.43
A3	0.43	0.43	0.43	0.43	0.50	0.43	0.43
C1	20	5	5	5	5	5	5
C2	120	15	15	15	30	55	15
C3	180	30	30	30	120	140	30
Cav	133	20	20	20	71	85	20
BFI	0.35	-	-	-	0.3	0.3	-
Kbase	0.7	-	-	-	0.85	0.85	-
Ksurf	0.1	0.1	0.1	0.1	0.2	0.2	0.1

5.5 CATCHMENT AREAS AND LANDUSE CLASSIFICATION

Catchment areas for the mine pit and site water management infrastructure have been based on the topographic survey and mine plans provided by BCC. The adopted catchment areas and land use types for each modelled stage for the Project are provided in Figure 5.3 to Figure 5.6.

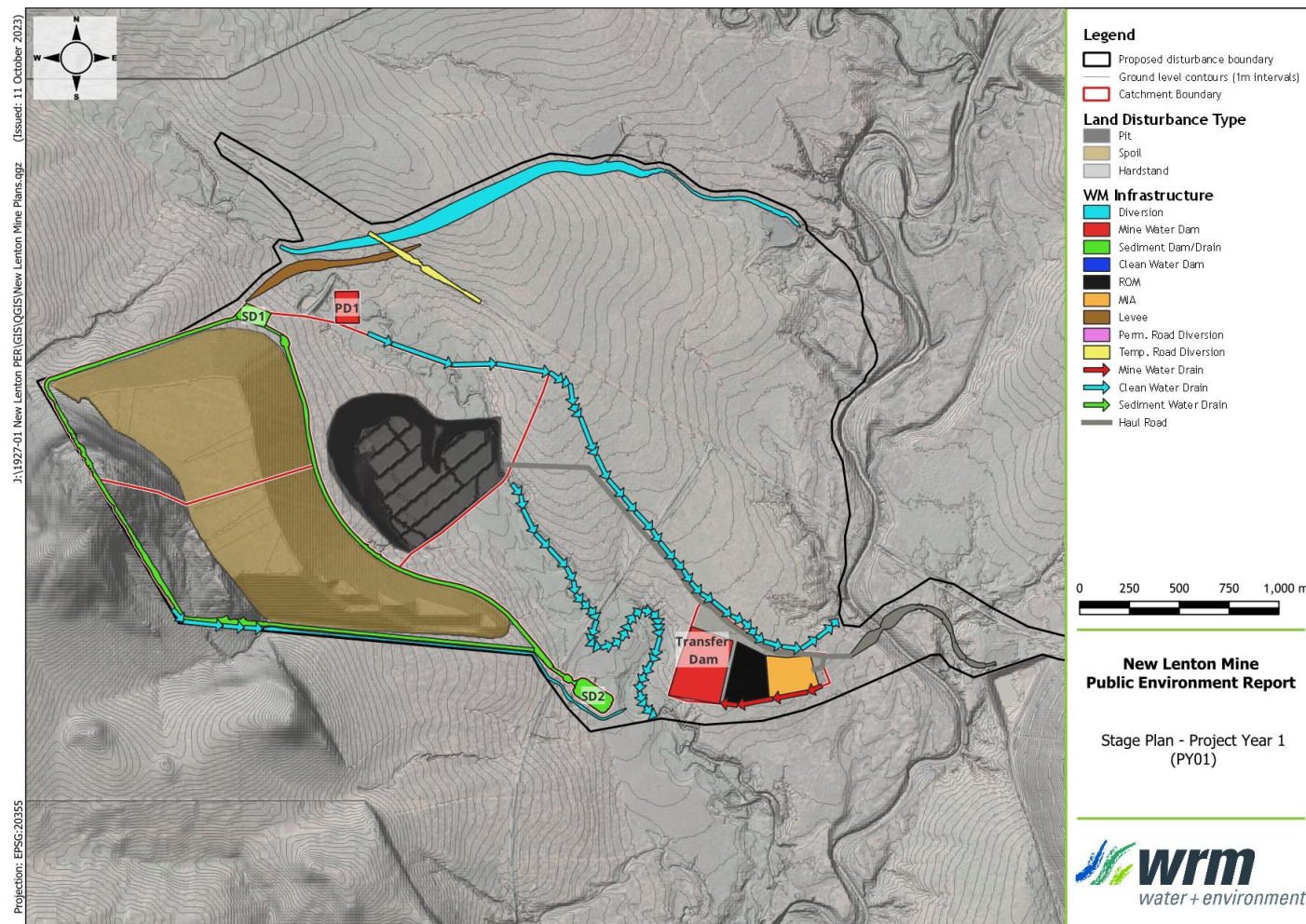


Figure 5.3 Project catchment and land use mapping – Project Year 1 (Phase 1)

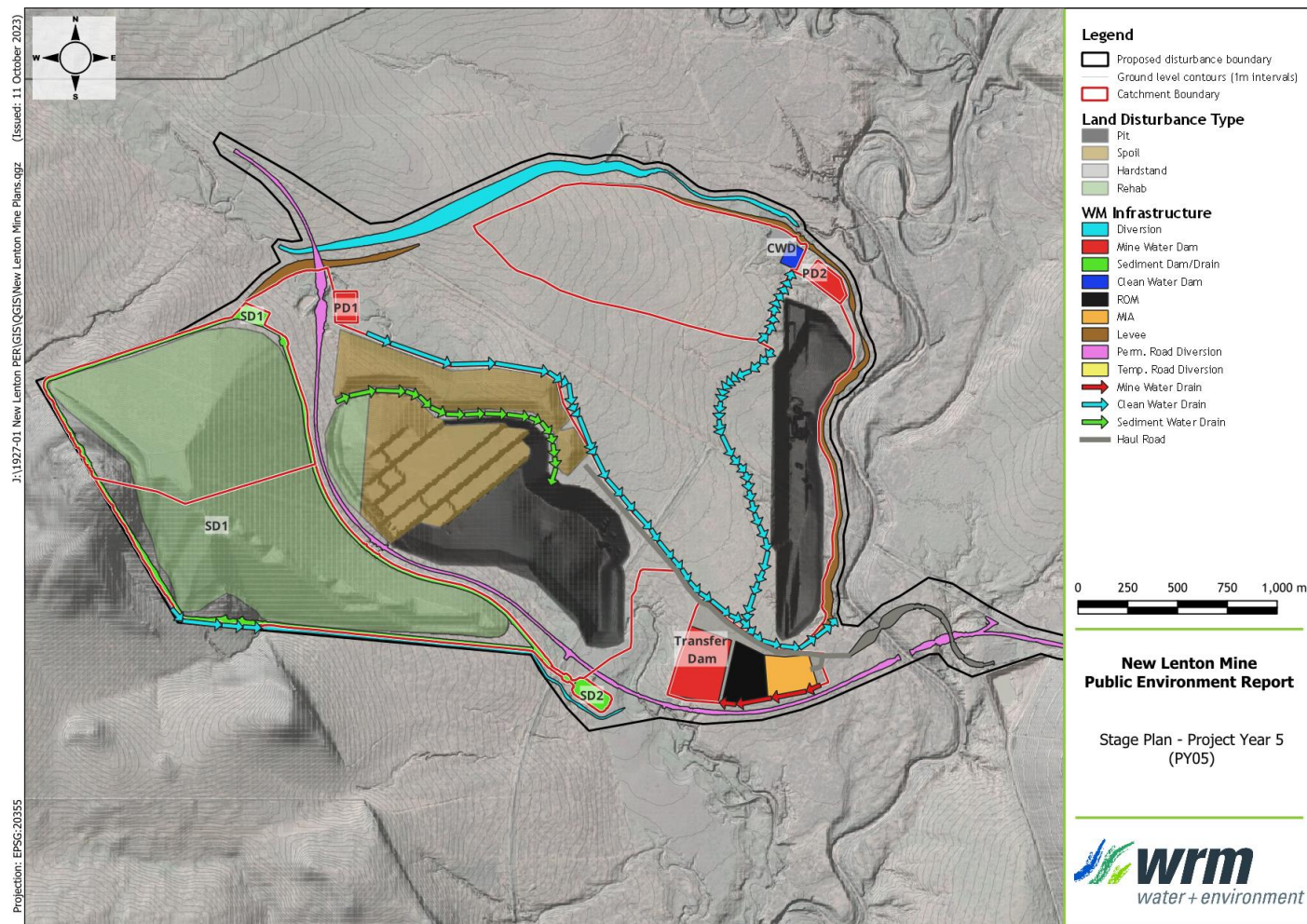


Figure 5.4 Project catchment and land use mapping – Project Year 5 (Phase 2)

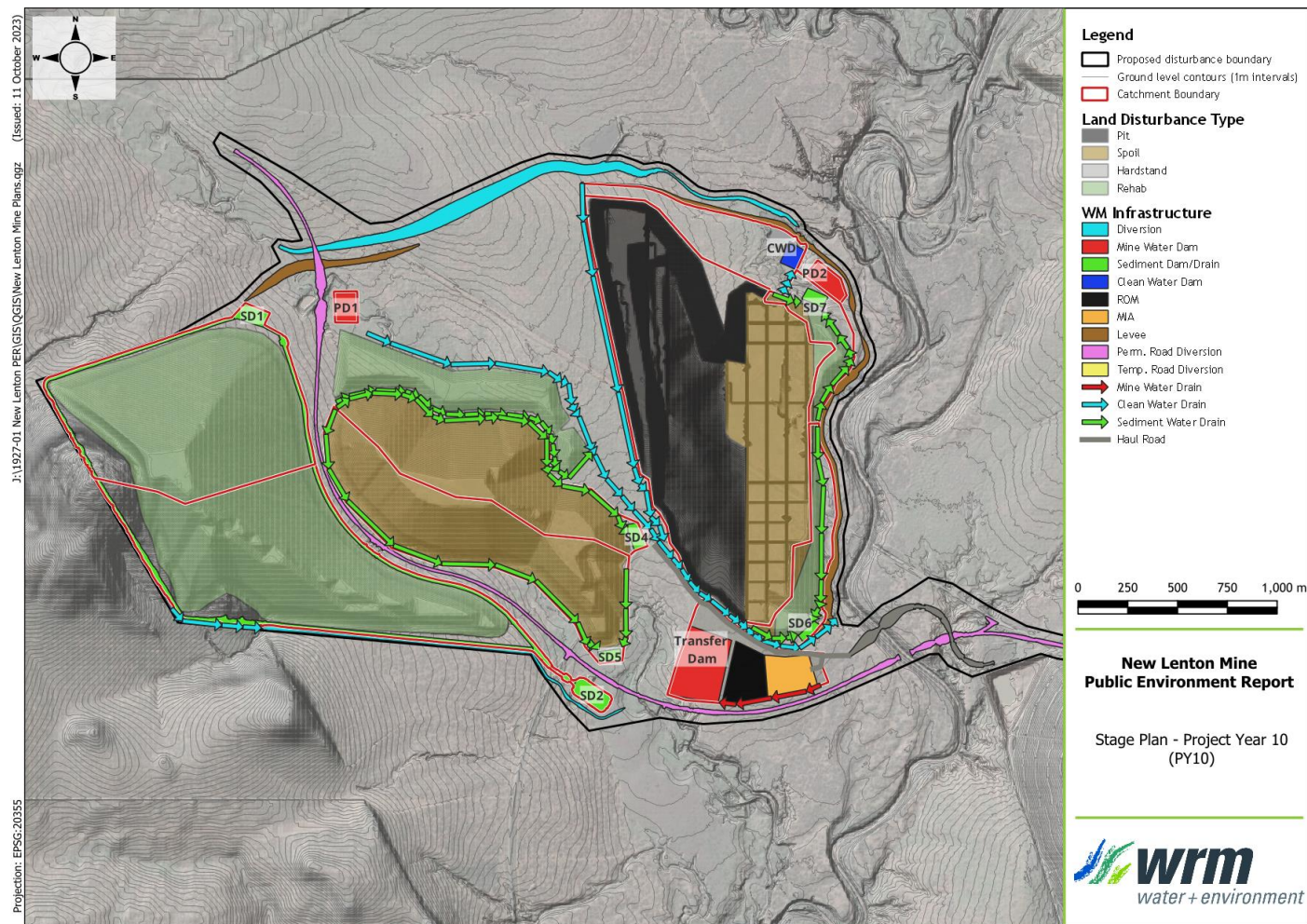


Figure 5.5 Project catchment and land use mapping – Project Year 10 (Phase 3)

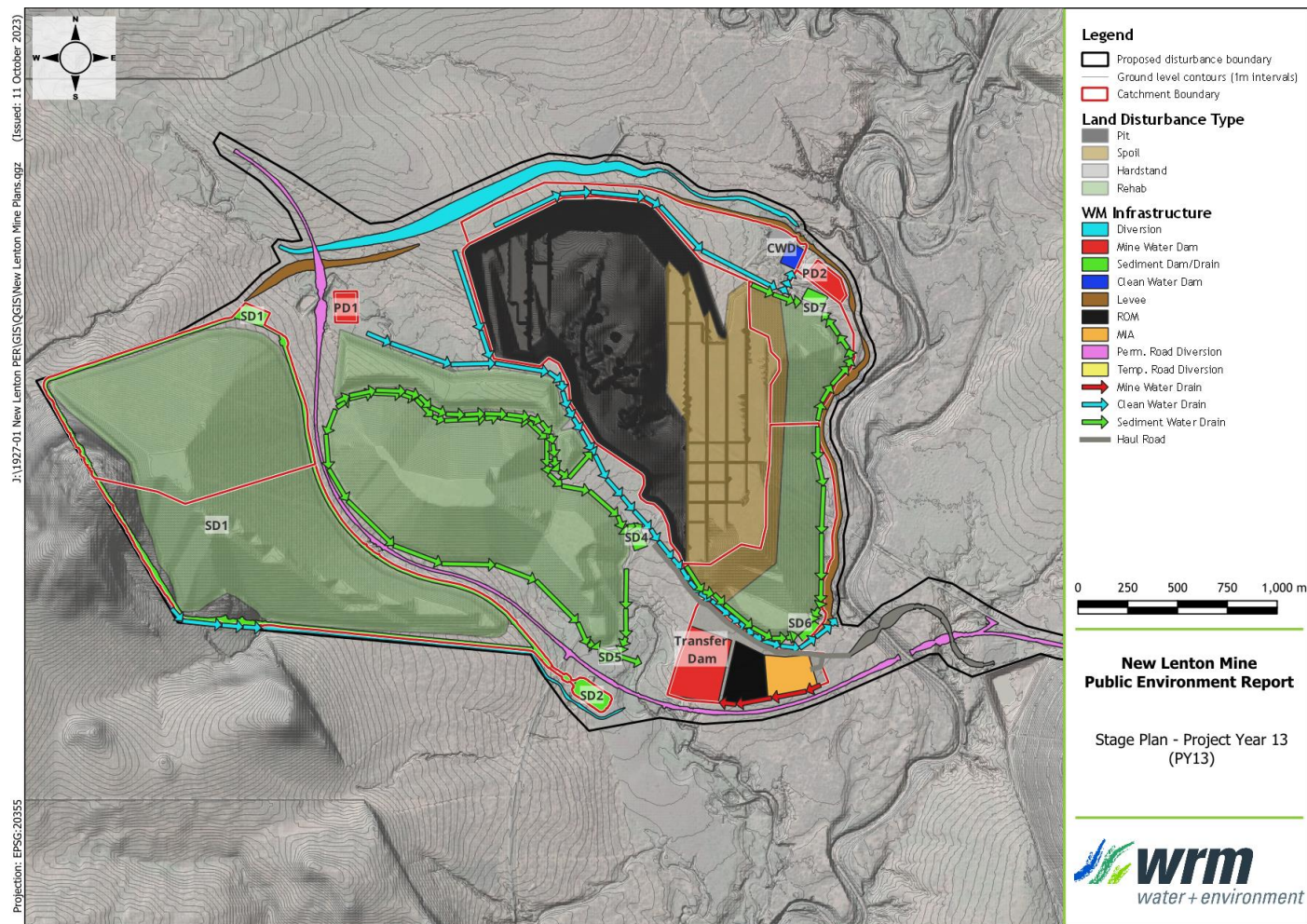


Figure 5.6 Project catchment and land use mapping – Project Year 13 (Phase 4)

5.6 SITE STORAGE CHARACTERISTICS

The Project WMS has been configured to minimise the offsite spill risk from mine water dams and to ensure that all site demands are met. The sediment dams would be operated according to best practice Erosion and Sediment Control (ESC) principals per the IECA (2008) guidelines, which would include dewatering the sediment dams to Transfer Dam following significant rainfall events. The key operating parameters modelled in this assessment to meet these objectives include:

- Dead volume (DV): the volume below which water cannot be accessed by pumping infrastructure.
- Maximum operating volume (MOV): is maximum volume at which a water storage should be operated to prevent spills, and may trigger a water storage to either begin dewatering and/or cease inflows.
- Import Operating Volume (OV): the OV which triggers water importation to begin from an external source, during periods of water shortage onsite.
- Export OV: the OV which triggers water export to begin to an external source, during wet weather conditions.
- Full storage volume (FSV): the total capacity within a storage to the spillway/overflow level.

The key operating parameters for each of the site water storages are summarised in Table 5.4.

Table 5.4 Site water storage characteristics

Storage name	Dead Volume (ML)	Maximum Operating Volume (ML)	Full Storage Volume (ML)
Pit Dam 1	10	90	100
Pit Dam 2	10	90	100
Transfer Dam	10	Burton Import OV: 50 Sediment Water MOV: 200* Burton Export OV: 300 Mine Water MOV: 340^	400
SD1	2	7.9	23.8
SD2	2	9.2	27.6
SD4	2	4.5	13.4
SD5	2	5.4	16.1
SD6	2	4.0	12.1
SD7	2	2.5	7.4
CWD	5	5	100

* Sediment dams would be dewatered to Transfer Dam following significant rainfall events, to restore the capacity for treatment in the sediment dams. Sediment dam dewatering would cease when the Transfer Dam volume exceeds the Sediment Water MOV.

^ Mine Water dams would be dewatered to Transfer Dam to prevent spills from the Mine Water dams. Mine Water dam dewatering would cease when the Transfer Dam volume exceeds the Mine Water MOV.

5.7 CONCEPTUAL WATER MANAGEMENT SYSTEM CONFIGURATION

Based on review of the Project mine plans and discussions with site personnel, representative water management system operating rules have been developed, and are provided in Table 5.5. Schematised plans of the proposed water management system configuration are shown in Figure 5.7.

Table 5.5 Adopted site wide operating rules

Item	Node name	Operating rules
1.0	External water supply/storage	
1.1	Burton Mine	- Water would be transferred from Burton Mine to Transfer Dam, to supplement demands at New Lenton (NL). Transfers (at 50 L/s) would commence when the stored inventory in Transfer Dam falls below the Burton Import OV. - Water would be transferred from Transfer Dam to Burton Mine, for storage in the in-pit water storages when the available capacity at NL is low. Transfers (at 100 L/s) would commence when the stored inventory in Transfer Dam exceeds the Burton Export OV.
2.0	Water demands	
2.1	Haul road dust suppression	Dust suppression demands would be sourced from Transfer Dam.
2.2	CHPP	ROM coal from the Project is transferred to the Burton Mine CHPP for processing. The CHPP demand will be supplied by Burton Mine water storages.
3.0	Mine pits	
3.1	West Pit	- Receives groundwater inflows. - Pumped dewatering (100 L/s) to Pit Dam 1, until Pit Dam 1 reaches its MOV.
3.2	East Pit	- Receives groundwater inflows. - Pumped dewatering (100 L/s) to Pit Dam 2, until Pit Dam 2 reaches its MOV.
4.0	Mine water storages	
4.1	Transfer Dam	- Receives mine water inflows from Pit Dam 1 and Pit Dam 2 up to the mine water MOV (Priority 1) - Receives sediment laden inflows from SD1, SD2, SD4, SD5, SD6 and SD7 up to the sediment water MOV (Priority 2) - Receives mine water inflows from Burton Mine to supplement NL demands, when the Transfer Dam inventory falls below the Burton Import OV (Priority 3). - Supplies haul road dust suppression demands. - Transfers to Burton Mine (100 L/s) when the stored inventory in Transfer Dam exceeds the Burton Export OV.
4.2	Pit Dam 1	- Receives inflows from West Pit. - Pumped dewatering (100 L/s) to Transfer Dam, until Transfer Dam reaches its mine dam MOV. - Overflows to the Isaac River via the clean water drain.

Item	Node name	Operating rules
4.3	Pit Dam 2	- Receives inflows from East Pit. - Pumped dewatering (100 L/s) to Transfer Dam, until Transfer Dam reaches its mine dam MOV. - Overflows to the Isaac River via the clean water drain.
5.0	<i>Sediment dams</i>	
5.1	SD1	- Pumped dewatering (50 L/s) to Transfer Dam, until Transfer Dam reaches its sediment dam MOV. - Overflows to the Isaac River via the Ti-Tree Creek diversion.
5.2	SD2	- Pumped dewatering (50 L/s) to Transfer Dam, until Transfer Dam reaches its sediment dam MOV. - Overflows to remnant Ti-Tree Creek downstream of the Project Disturbance Area.
5.3	SD4	- Pumped dewatering (50 L/s) to Transfer Dam, until Transfer Dam reaches its sediment dam MOV. - Overflows to the Isaac River via the clean water drain.
5.4	SD5	- Pumped dewatering (50 L/s) to Transfer Dam, until Transfer Dam reaches its sediment dam MOV. - Overflows to the Isaac River via the clean water drain.
5.5	SD6	- Pumped dewatering (50 L/s) to Transfer Dam, until Transfer Dam reaches its sediment dam MOV. - Overflows to the Isaac River via the clean water drain.
5.6	SD7	- Pumped dewatering (50 L/s) to Transfer Dam, until Transfer Dam reaches its sediment dam MOV. - Overflows to the Isaac River via the clean water drain.
6.0	<i>Clean water dams</i>	
6.1	CWD	- Captures water from the clean catchment to the north of East Pit. - Pumped releases clean water to the Isaac River via the clean water drain. - Pumped overflows to the Isaac River

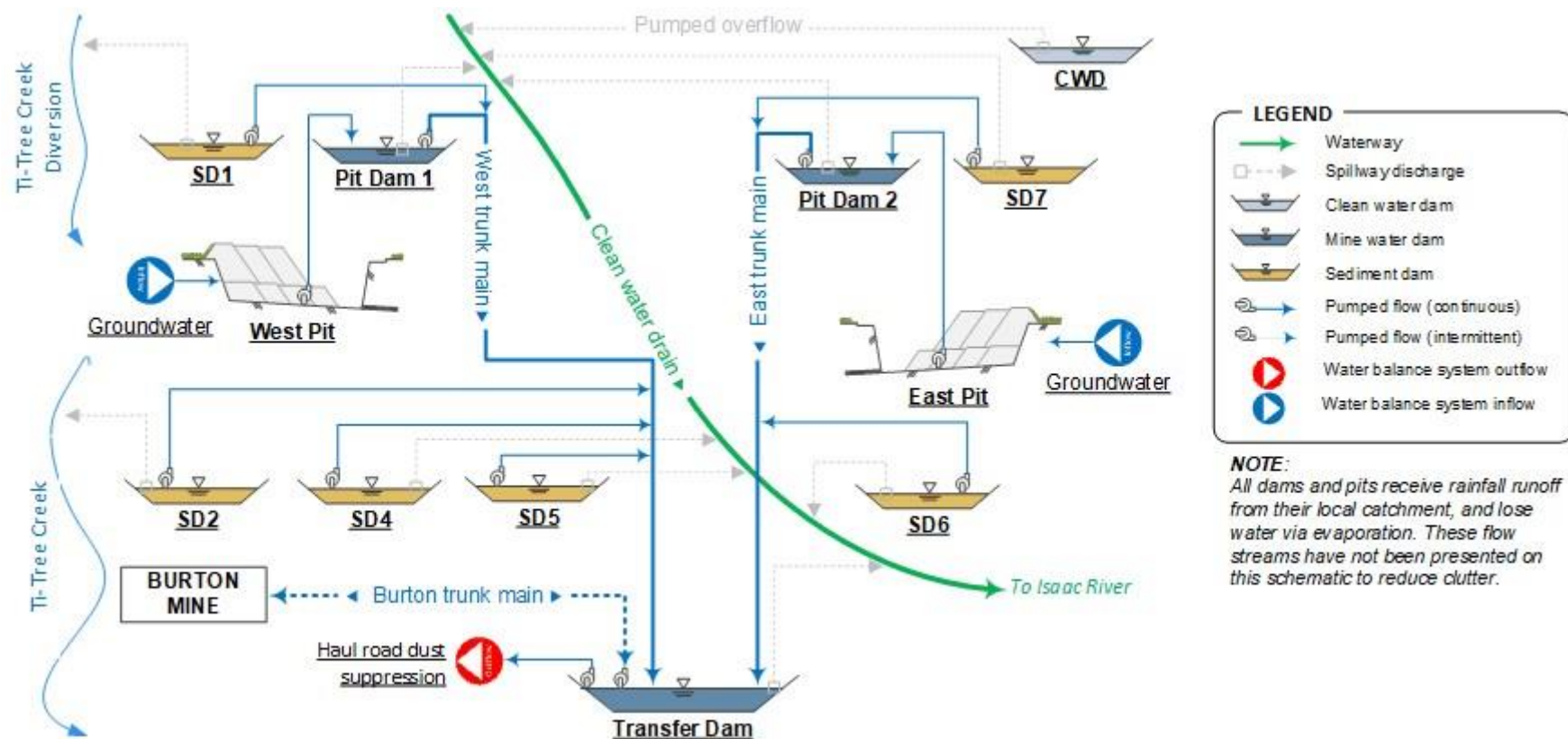


Figure 5.7 Conceptual New Lenton Water Management System schematic

5.8 SITE WATER DEMANDS

5.8.1 Haul road dust suppression

Water for haul road dust suppression at the Project will be sourced from Transfer Dam. Daily haul road dust suppression watering rates were estimated based on haul road surface area and daily rainfall and evaporation rates. The following rules were used to determine the applied dust suppression rate on any given day of the historical rainfall record:

- The assessment used daily evaporation rates sourced from the SILO Datadrill evaporation dataset;
- For a dry day (zero rainfall), the haul road watering rate is equal to the daily evaporation rate;
- For a rain day when rainfall is less than the daily evaporation rate, the watering rate is reduced and is only required to make up the remaining depth to the daily evaporation rate;
- For a rain day when rainfall exceeds the daily evaporation rate, no haul road watering is required; and
- It was assumed that a haul road width of 30 m and length of 12 km (including the connecting road between Burton Mine and New Lenton) would be watered.

The annual average haul road dust suppression rates are shown in Figure 5.8.

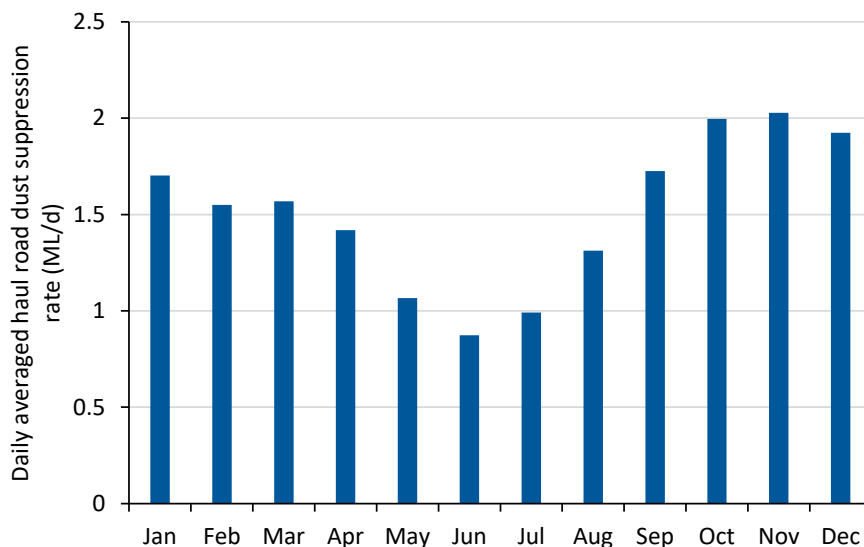


Figure 5.8 Haul road dust suppression rates

5.8.2 Coal handling and processing plant use

ROM coal extracted from the New Lenton mine pits will be transported to Burton Mine via haul roads for processing the Burton CHPP. The CHPP water demands would be supplied by the Burton Mine WMS.

5.9 GROUNDWATER INFLOWS

The net groundwater inflows into the Project Mine Pits are shown in Figure 5.9. The net groundwater inflows were estimated using gross groundwater inflows provided from the numerical groundwater model (SLR, 2023) that were adjusted to account for:

- evaporative losses from the coal face; and

- moisture extracted with the ROM coal (assumed 5% moisture content).

It has been assumed that the groundwater inflows would be evenly distributed between West Pit and East Pit, during periods where both pits are active.

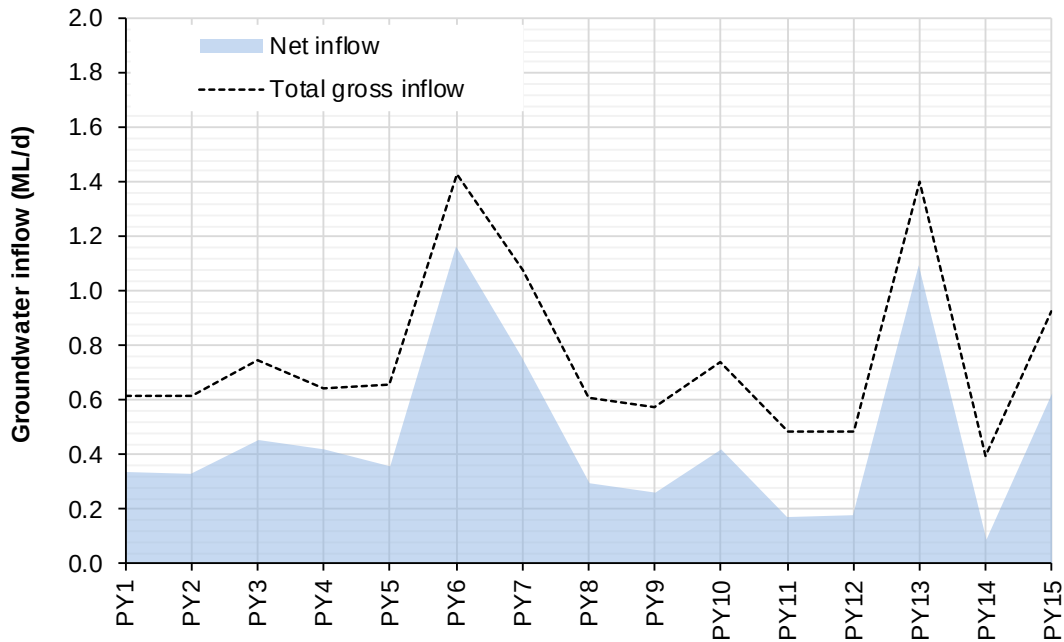


Figure 5.9 Net groundwater inflow rate (SLR, 2023)

5.10 CONTROLLED RELEASES

Whilst the release of mine affected water to receiving waters is permitted under the approved New Lenton Mine EA, the water balance model (see Section 6.3.2) demonstrates that controlled releases are not required as part of the water management strategy due to the balancing of mine affected water with Burton Mine. That is, the water management system does not rely on using controlled releases to manage water inventories.

5.11 INTERACTION WITH BURTON MINE

The Project WMS will have the capability to transfer mine affected water to and from the neighbouring Burton Mine to meet operational needs. Burton Mine is also owned and operated by BCC.

Water from the Project will be transferred to Burton Mine at 100 L/s to manage excess mine water and reduce the risk of pit inundation at the Project. The Project will only transfer to Burton Mine when Transfer Dam exceeds 300 ML.

Water from Burton Mine will be transferred to the Project at 50 L/s to supply mine water demands at the Project.

5.12 SALINITY PARAMETERS

The water balance model has been configured to use electrical conductivity (EC) as an indicator for water quality. Each runoff type has been assigned an EC concentration that has been based on the concentrations applied for the neighbouring Burton Mine water balance model.

The adopted EC concentrations are given in Table 5.6.

Table 5.6 Salinity parameters

Catchment landuse	EC ($\mu\text{S}/\text{cm}$)
Natural runoff	200
Hardstand runoff	1,000
Pit runoff	2,000
Stockpile runoff	500
Spoil runoff	500
Rehab spoil	300
Groundwater	9,921

6 WATER MANAGEMENT SYSTEM ASSESSMENT

6.1 OVERVIEW

Assessment of the Project water management system has been undertaken using the water balance model with the adopted rainfall runoff parameters, against the following key performance indicators:

- Mine affected water inventory;
- Pit inundation characteristics;
- Interaction (transfers to/from) the Burton Mine; and
- Uncontrolled spillway discharges.

An assessment of the overall mine affected water inventory at Burton Mine has also been undertaken. The purpose of this assessment is to confirm that the existing and proposed Burton Mine infrastructure (including dam and pit storages) is able to accommodate the additional water demands, transfers and processing requirements resulting from the Project.

It is important to note that investigation outcomes are dependent on the accuracy of input assumptions. There is inherent uncertainty with respect to some key site characteristics (e.g. catchment yield/rainfall runoff, mining area groundwater inflows). The use of a large number of climate sequences reflecting the full range of historical climatic conditions provides an indication of the system performance variance under very wet, very dry and average climatic conditions.

6.2 INTERPRETATION OF RESULTS

In interpreting the results of the water balance assessment, it should be noted that the results provide a statistical analysis of the water management system's performance over 18 years of New Lenton mining operations, based on 115 realisations with different climatic sequences.

The model results are presented as a probability of exceedance. For example, the 10th percentile represents 10% probability of exceedance and the 90th percentile results represent 90% probability of exceedance. There is an 80% chance that the result will lie between the 10th and 90th percentile traces.

Whether a percentile trace corresponds to wet or dry conditions depends upon the parameter being considered. For site water storage, where the risk is the storage capacity will be exceeded, the lower percentiles correspond to wet conditions. For example, there is only a small chance that the 1 percentile storage volume will be exceeded, which would generally correspond to wet conditions.

For external site water supply volumes (for example), where the risk is that insufficient water will be available, there is only a small chance that more than the 1 percentile water supply volume would be required. This would generally correspond to dry climatic conditions.

It is important to note that a percentile trace shows the likelihood of a particular value on each day and does not represent continuous results from a single model realisation. For example, the 50th percentile trace does not represent the model time series for median climatic conditions.

6.3 WATER BALANCE MODEL RESULTS

6.3.1 Overall water balance

Water balance results for the Project for all of the 115 model realisations are presented in Table 6.1, averaged over each model phase. The results presented are the average of all realisations and will include wet and dry periods distributed throughout the mine life. Rainfall yield for each stage is affected by the variation in climatic conditions within the adopted climate sequence.

Table 6.1 provides an indication of the long-term average annual inflows and outflows. Key outcomes from the overall water balance are as follows:

- Average annual inflows from rainfall runoff are generally consistent between Phase 2 and Phase 4. Rainfall runoff in Phase 1 is generally lower, as the catchment areas reporting to the site storages is significantly less in this phase.
- The spillway overflows from the sediment dams are lowest in Phase 1, and generally increase between Phase 2 and Phase 4.
- The annual import volumes from Burton are, on average, greater than the export volumes from Burton. Hence, the Project is a net importer of water from Burton Mine during average conditions.
- Water requirements from Burton Mine are generally consistent between Phase 1 and Phase 4.
- The total change in inventory is low for all phases, which indicates that the system is generally in balance under “average” climate conditions. It also indicates that the inventory at New Lenton can be successfully managed through the proposed transfers to/from Burton Mine.

It should be recognised that the following items are subject to climatic variability:

- Rainfall runoff;
- Evaporation;
- Transfers to/from Burton Mine;
- Controlled releases;
- Dust suppression demand; and
- Dam overflows.

Whilst it provides an indication of the long-term average annual inflows and outflows, application of the nominated values for other purposes should only be undertaken with due consideration of the suitability of the nominated value and any potential implications.

In particular, the “average” sediment dam overflows do not necessarily mean that discharges occur under median climatic conditions. It means that there was a discharge in at least one of the 115 model realisations. A more detailed analysis of the performance of the various components of the water management system is provided in the following sections.

Table 6.1 Overall water balance results

	Phase 1	Phase 2	Phase 3	Phase 4
Inflows (ML/a)				
Rainfall/runoff	448	717	776	713
Burton Mine import	277	185	238	158
Groundwater	142	208	94	226
TOTAL INFLOW	867	1,109	1,107	1,097
Outflows (ML/a)				
Evaporation	231	255	261	257
Haul road dust suppression	550	553	553	553
Burton Mine export	30	157	98	127
Mine-affected overflows	0	0	0	0
Sediment dam releases	95	129	199	157
TOTAL OUTFLOWS	906	1,095	1,112	1,095
Change in volume (ML/a)				
Change in stored volume	-39	15	-5	2

6.3.2 Mine-affected water inventory

Figure 6.1 shows the modelled Transfer Dam inventory over the 18-year forecast period. Figure 6.2 shows the combined forecast inventory for Transfer Dam, Pit Dam 1 and Pit Dam 2. To prevent uncontrolled discharges from the mine water storages, maximum operating volumes (MOVs) have been set for the out-of-pit mine affected water storages (see Table 5.4).

The out-of-pit mine affected water storages will be decommissioned and rehabilitated following the cessation of mining operations at the Project, unless agreement is reached with a third party landholder for their retention, subject to water quality requirements.

Figure 6.1 shows the following:

- Transfer Dam would be maintained at a minimum inventory of 50 ML via the Burton Mine imports, to supply the site demands.
- The stored inventory in Transfer Dam would exceed the Mine Dam MOV during 5%ile wet climatic conditions. This would limit dewatering from Pit Dam 1 and Pit Dam 2, and potentially increase the inundation risk in the mine pits to prevent controlled or uncontrolled releases.

Figure 6.2 shows the following:

- For the 1%ile results (very wet climatic conditions), the peak inventory in the out-of-pit storages reaches a volume of around 570 ML, which is below the combined capacity of Transfer Dam, Pit Dam 1 and Pit Dam 2.
- The combined mine affected water inventory generally appears to recover following the annual wet seasons, and does not accumulate over consecutive wet seasons.

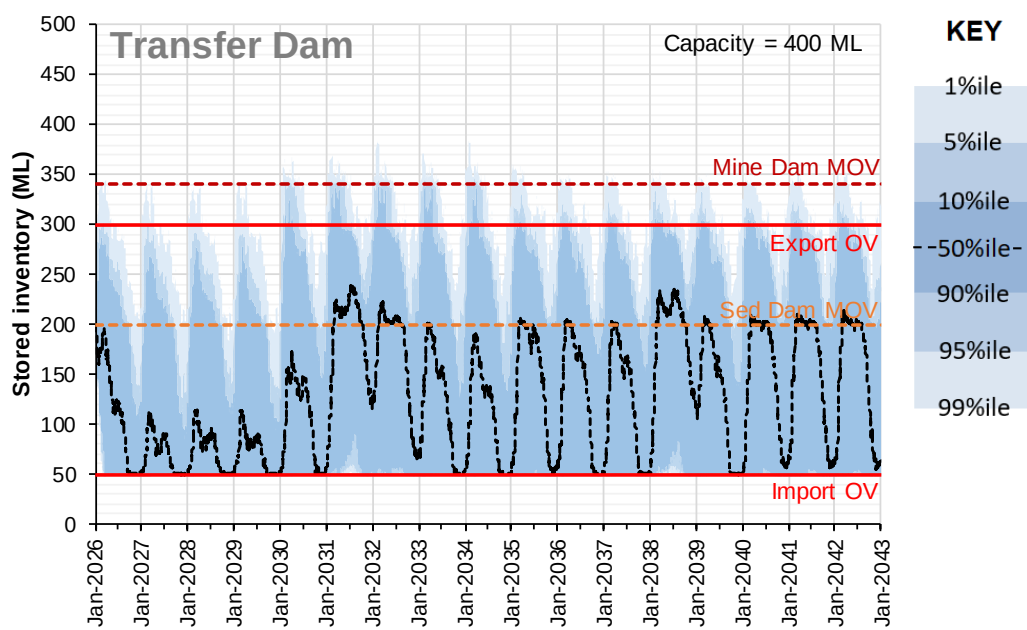


Figure 6.1 Forecast Transfer Dam inventory

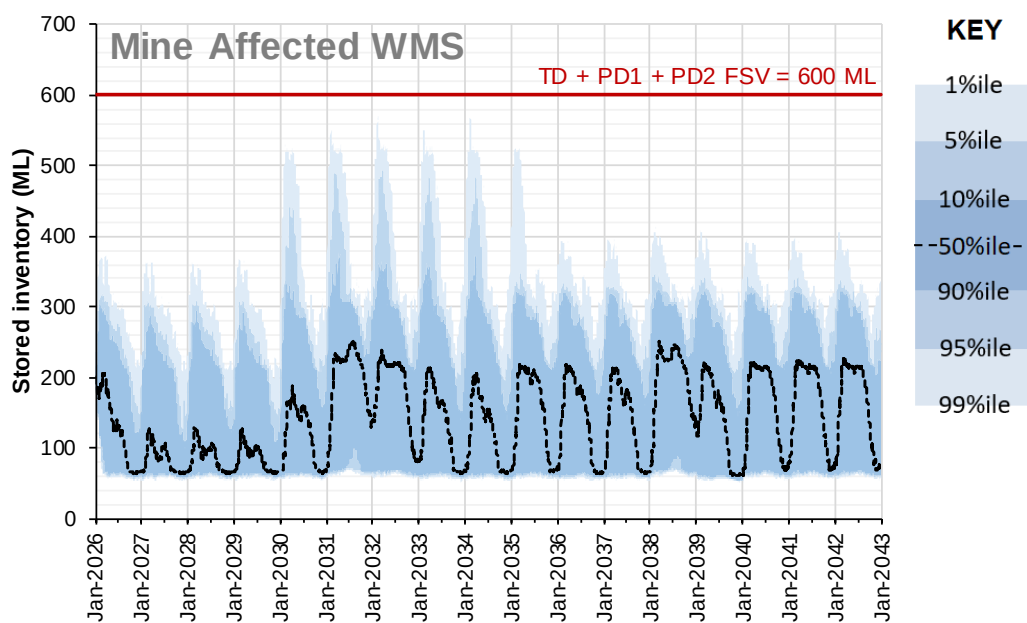


Figure 6.2 Forecast mine affected water inventory (excluding active mine pits)

6.3.3 Pit inundation

Figure 6.3 and Figure 6.4 show the forecast inventory for the West Pit and East Pit, respectively, over the 18-year simulation. Both of the mine pits appear to recover after each wet season while they are operational.

The forecast modelling results for the New Lenton mine pits inventory are summarised as follows for the 18-year simulation:

- When active, West Pit and East Pit would be inundated above the in-pit sump volume (assumed to be 50 ML) during 10%ile wet climatic conditions.
- For the 1%ile results (very wet climatic conditions), the peak inventory in the West Pit reaches a volume of around 600 ML. This represents 3% of the PY1 West Pit capacity, hence the risk of West Pit overflowing during operations is considered negligible.
- For the 1%ile results (very wet climatic conditions), the peak inventory in the East Pit reaches a volume of around 520 ML. This represents 5% of the PY5 East Pit capacity, hence the risk of East Pit overflowing during operations is considered to be negligible.
- The mine pits would not be inundated for climatic conditions drier than the 10%ile wet climatic conditions.

The ability of the New Lenton mine pits to recover after each wet season is largely attributed to the capacity of the New Lenton WMS system to transfer water to Burton Mine when required. The forecasted annual volume of water transferred to Burton Mine is discussed in Section 6.3.4.

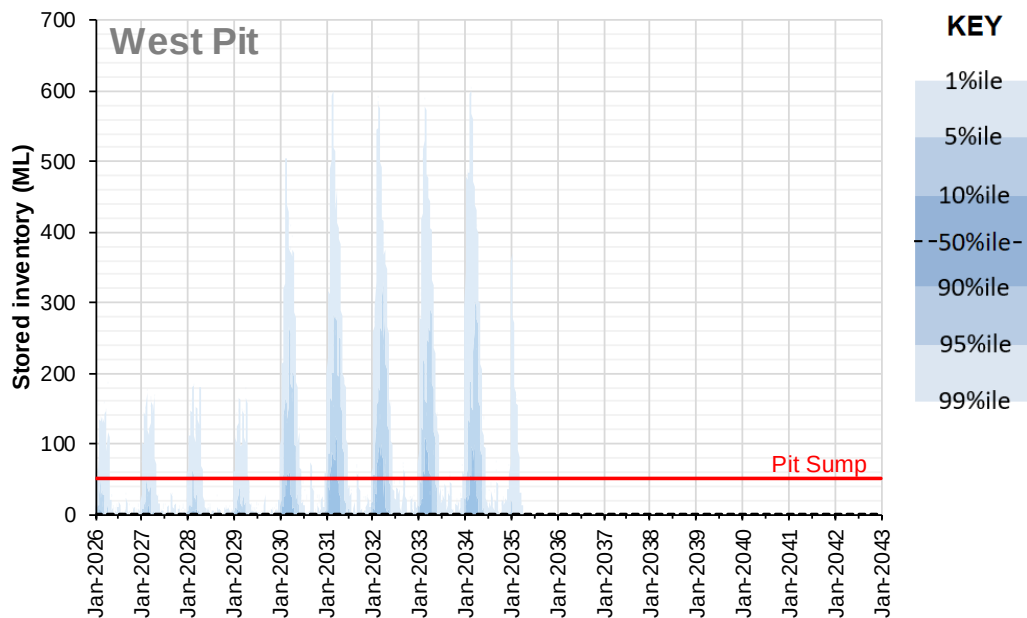


Figure 6.3 Forecast West Pit inventory

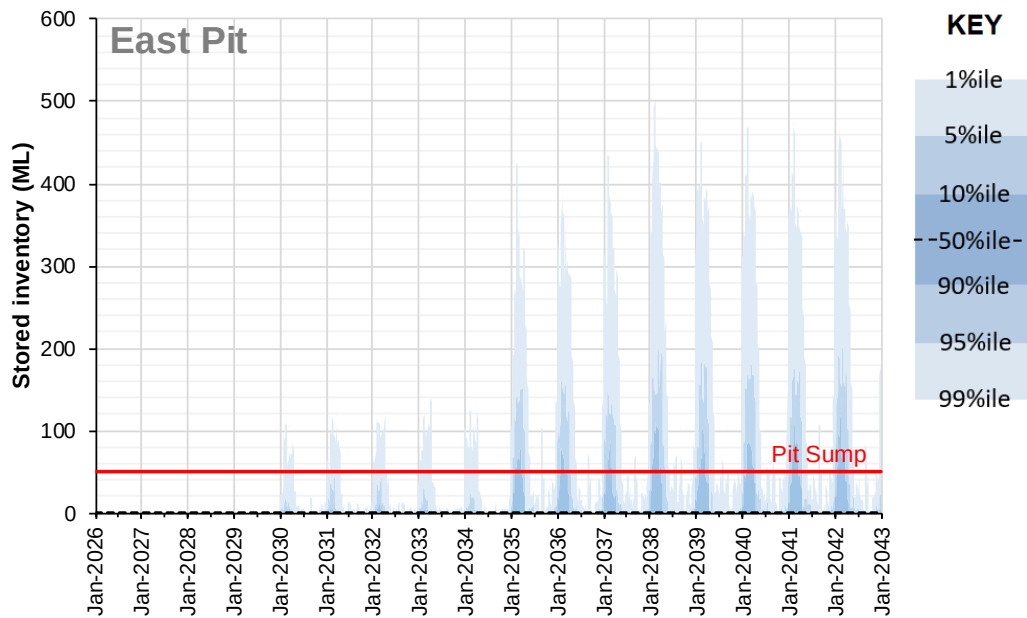


Figure 6.4 Forecast East Pit inventory

6.3.4 Interaction with Burton Mine

Figure 6.5 shows the annual volumes transferred from Transfer Dam at New Lenton to Burton Mine for storage over the 18-year simulation. The following is of note regarding this result:

- Transfer Dam would generally only need to transfer to Burton Mine during climatic conditions wetter than the 50%ile.
- During 1%ile extreme wet climatic conditions, Transfer Dam may transfer an annual volume up to 1,250 ML to Burton Mine in 2031.
- Transfer from New Lenton to Burton Mine would be lowest prior to 2030, when the catchments reporting the New Lenton WMS are the smallest.

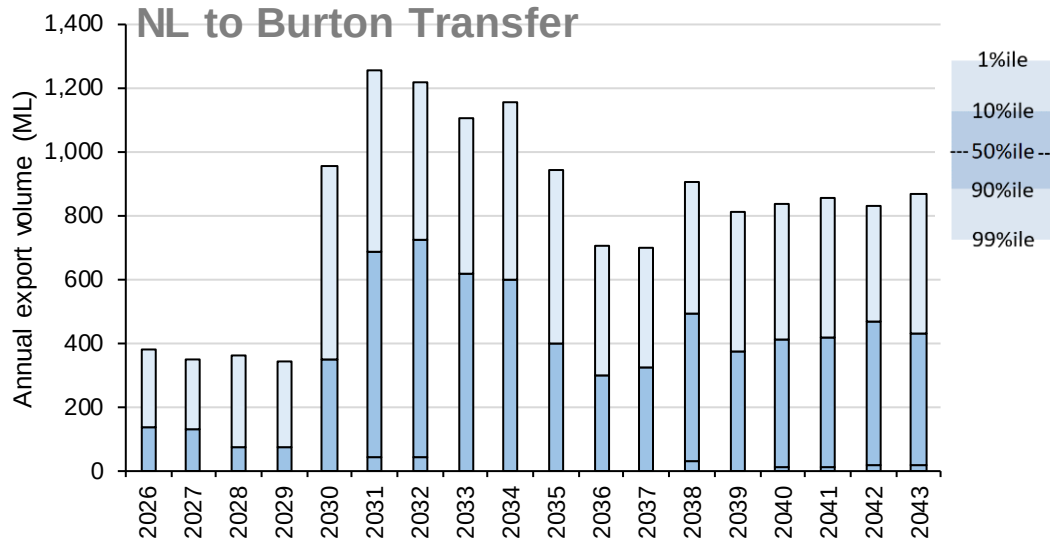


Figure 6.5 Forecast transfer volumes from New Lenton (NL) Transfer Dam to Burton Mine

Figure 6.6 shows the annual volumes transferred from Burton Mine to Transfer Dam to supplement demands at New Lenton over the 18-year simulation. This figure shows that import volume from Burton Mine to New Lenton are consistent over the 18-year simulation, generally ranging between 0 ML/a for 1%ile wet climatic conditions to 700 ML/a in 99%ile dry climatic conditions.

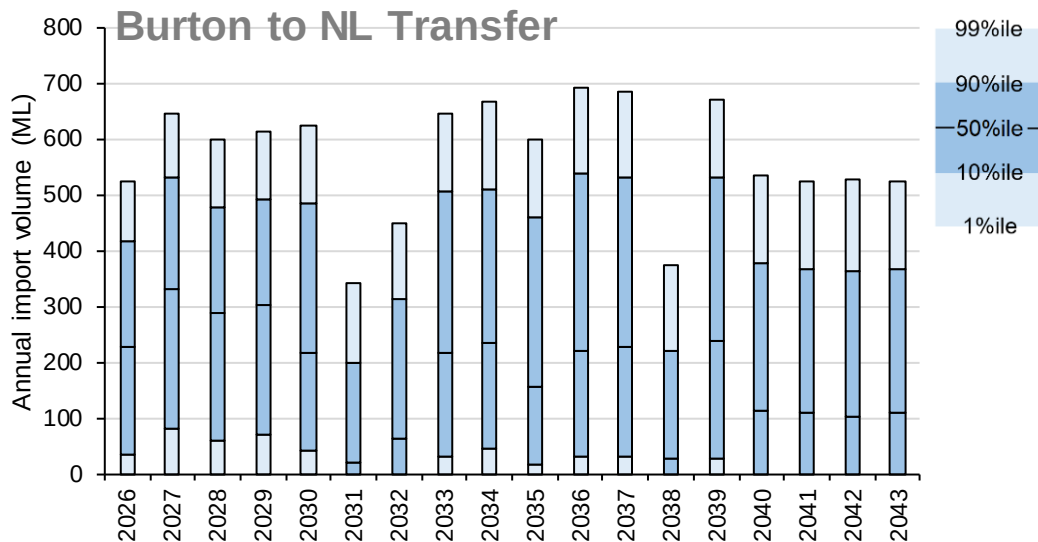


Figure 6.6 Forecast transfer volumes from Burton Mine to New Lenton (NL) Transfer Dam

The import volumes from Burton are typically greater than the export volumes from Burton. Hence, the Project is generally a net importer of water from Burton Mine.

6.3.5 Uncontrolled spillway discharges

6.3.5.1 Mine affected water dams

The water balance model was used to assess the risk of uncontrolled offsite spills from the proposed mine affected water management system. The mine water dams that could potentially overflow directly to the receiving environment if rainfall exceeded the storage design criteria include:

- Transfer Dam (to Isaac River via clean water drain);
- Pit Dam 1 (to Isaac River via clean water drain); and
- Pit Dam 2 (to Isaac River via clean water drain).

There were no modelled overflows from Transfer Dam, Pit Dam 1 or Pit Dam 2 during any of the model realisations over the life of the Project.

6.3.5.2 Sediment dams

Consistent with the IECA design standard, the New Lenton sediment dams do not provide 100% containment for captured runoff. Hence overflows will occur from sediment dams when rainfall exceeds the design standard. The potential for overflows from the proposed sediment dams has been assessed using a forecast assessment simulation.

The predicted annual combined sediment dam overflows under this scenario are provided in Figure 6.7. The results show that:

- During very wet climatic conditions (1%ile) where rainfall events often exceed the dam design standard, modelled sediment dam overflows are between 690 ML/year and 1,420 ML/year.
- During wet climatic conditions (10%ile) where rainfall events sometimes exceed the dam design standard, modelled sediment dam overflows are between 310 ML/year and 620 ML/year.
- During median and dry climatic conditions, there are no modelled sediment dam overflows.

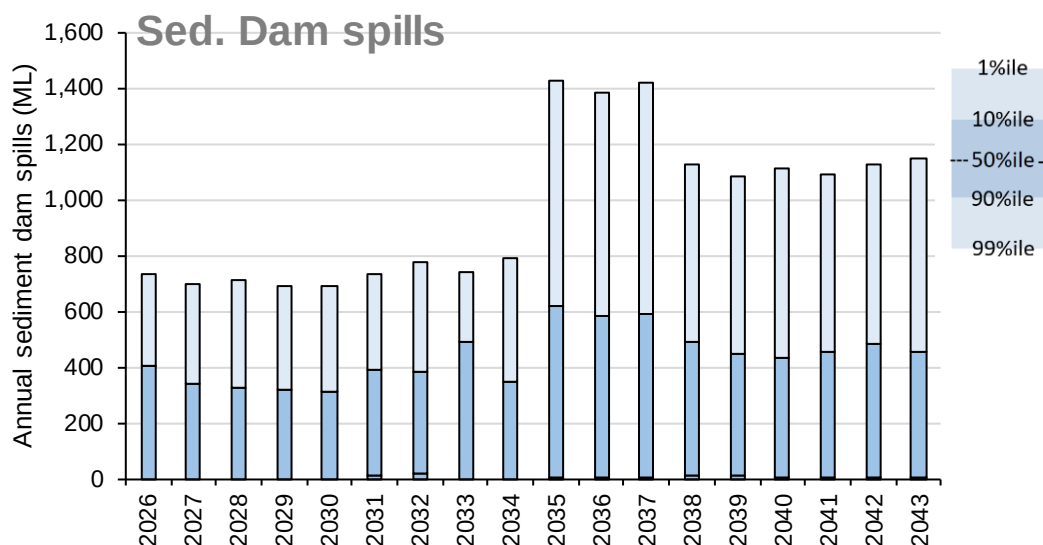


Figure 6.7 Forecast annual sediment dam spill volumes

6.3.5.3 Water quality impacts of sediment dam overflows

An assessment of the predicted salinity of overflows from the sediment dams to the receiving environment has been undertaken. The modelling indicates that salinity of sediment dam overflows will typically be between 300 to 580 $\mu\text{S}/\text{cm}$ (typically during wet or very wet climatic conditions). Figure 6.8 shows the modelled Issac River water quality immediately downstream of the Project on sediment dam spill days. This plot shows that mixed downstream EC would generally be similar to background levels, with 99.3% of the modelled values below the median EC recorded at the Isaac River (Burton Gorge) gauge (458 $\mu\text{S}/\text{cm}$).

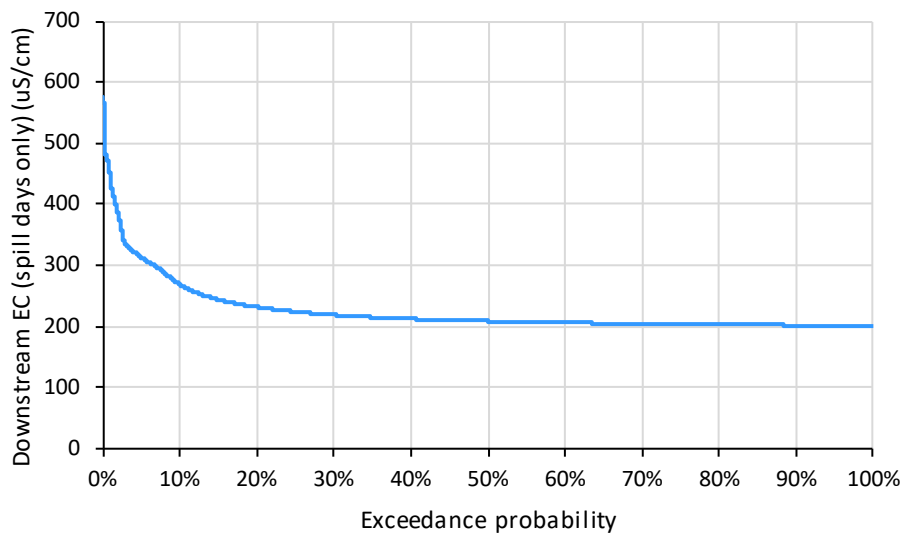


Figure 6.8 Downstream Issac River salinity on sediment dam spill days

6.3.6 Burton Mine inventory

Figure 6.9 presents the forecast inventory in Ellensfield Pit, which is a key mine water storage at Burton Mine. For the purpose of this assessment, it has been assumed that all transfers to and from Burton Mine would be undertaken via Ellensfield Pit. Other, larger pit voids are also available at Burton Mine for water storage should Ellensfield Pit be utilised for other operational purposes at Burton Mine.

This result shows that Ellensfield Pit would have sufficient inventory to manage the excess mine water at New Lenton. Ellensfield Pit reaches a maximum inventory of 14,300 ML over the 18-year mine life in 1%ile wet climatic conditions, which is more than 2,000 ML below the storage capacity.

Ellensfield Pit at Burton Mine would also have sufficient inventory to supplement all site demands at New Lenton. The results show that the Ellensfield pit would not empty during any climatic conditions assessed. Ellensfield Pit may need to source water from Burton Mine's Teviot Dam to make up inventories during dry climatic conditions.

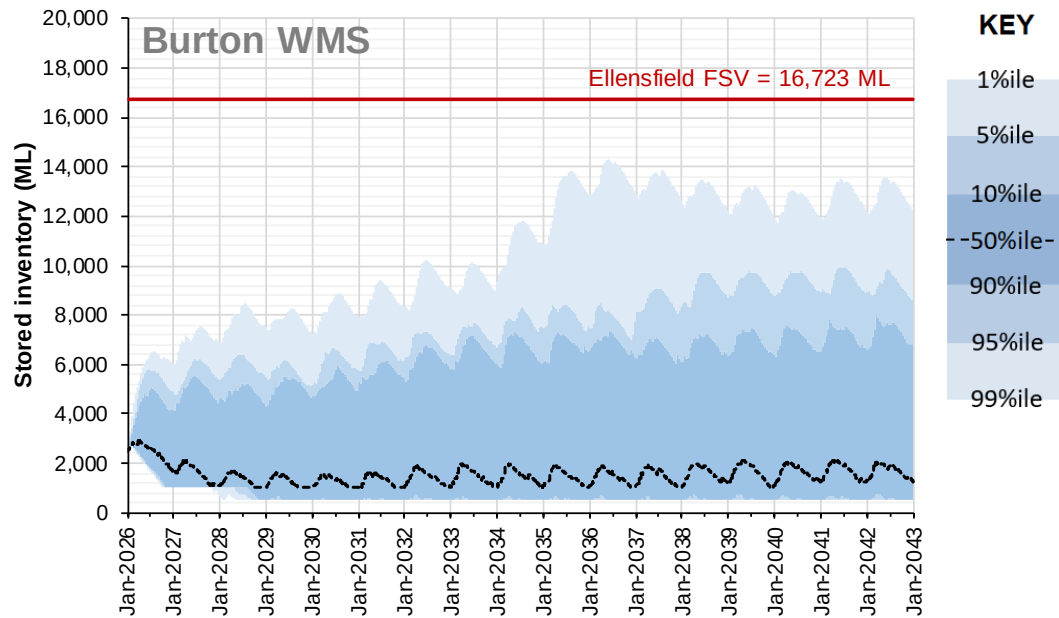


Figure 6.9 Forecast Ellensfield Pit inventory, key Burton Mine water storage

6.4 SALT BALANCE MODEL RESULTS

Figure 6.10 shows a schematic of the salt inputs and outputs for the Project. Sources of salt for the Project includes the groundwater inflows, catchment runoff, direct rainfall, and transfers from Burton Mine. Salt outputs for the Project includes losses through dust suppression, transfer to Burton Mine and discharges from sediment dams from the water management system.

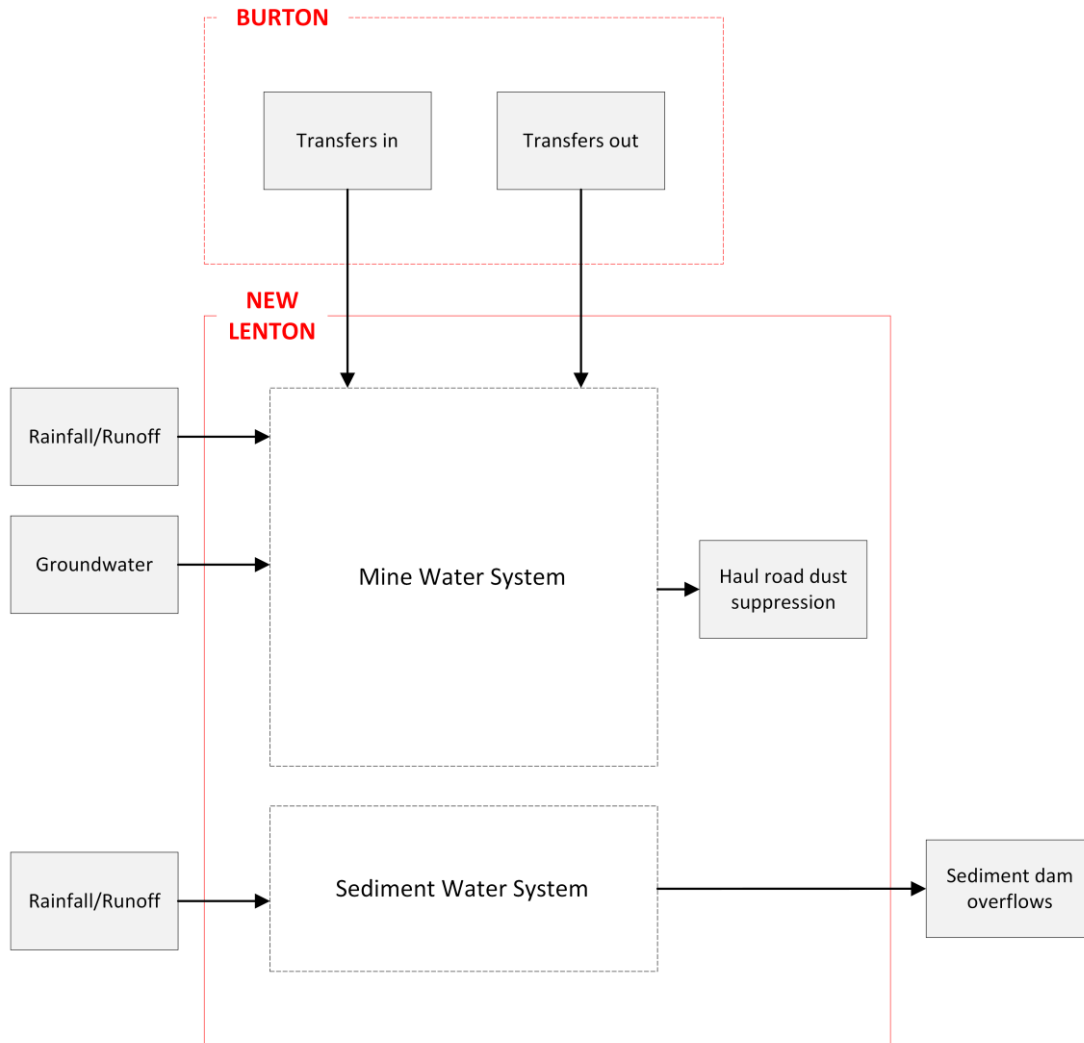


Figure 6.10 Simplified surface water salt balance schematic

Table 6.2 shows the average annual salt balance for the Project, for each phase. The results indicate the following:

- Significant salt loads are transferred to and from the Burton Mine through the pumped transfers between the two operations. Hence, the salt loads associated with the Burton Mine interactions would be considered as net inflows/outflows from the New Lenton WMS only, and would not be lost/gained by the wider New Lenton/Burton Mine interconnected WMS. The salt loads would be managed by the water management infrastructure at New Lenton and Burton Mine. Post-mining, any residual salt loads would be stored indefinitely within the proposed non-polluting final voids at New Lenton (see Section 7) and Burton Mine;
- The largest external contributor to the Project salt load is rainfall runoff from the various surfaces on-site;
- The largest external losses of salt from the Project is through dust suppression and sediment dam overflows; and

- The change in stored salt load is generally low in comparison to the total inputs and outputs, which suggests salt would not accumulate onsite during operations.

Table 6.2 Overall salt balance results

	Phase 1	Phase 2	Phase 3	Phase 4
Inflows (tonnes/a)				
Rainfall/runoff	328	549	611	603
Burton Mine import	985	281	299	196
Groundwater	1,404	2,059	930	2,240
TOTAL INFLOW	2,717	2,888	1,840	3,039
Outflows (tonnes/a)				
Evaporation	0	0	0	0
Haul road dust suppression	2,525	2,506	1,560	2,625
Burton Mine export	53	355	186	334
Mine-affected overflows	0	0	0	0
Sediment dam releases	41	36	75	48
TOTAL OUTFLOWS	2,619	2,897	1,821	3,006
Change in salt mass (tonnes/a)				
Change in stored salt mass	97	-8	19	32

6.5 MODEL SENSITIVITY ASSESSMENT

A sensitivity analysis has been undertaken to assess the potential impact of variations in the rainfall runoff parameters on the performance of the proposed water management system. The sensitivity scenarios that have been assessed are as follows:

- **Scenario 1:** Global increase in AWBM soil capacity by 20%.
- **Scenario 2:** Global decrease in AWBM soil capacity by 20%.

The results from these sensitivity analyses are provided in Appendix C and summarised in Table 6.3.

Table 6.3 Sensitivity assessment summary

Scenario	Description	Mine water containment	Burton Mine transfers	Offsite releases
Scenario 1	Global increase in AWBM soil capacity by 20%	The WMS inventory would be slightly decreased under Scenario 1.	The transfers to/from Burton Mine are generally similar to the base case, however, the Project would tend towards drawing more water from Burton Mine.	No uncontrolled mine affected releases are projected to occur for any of the modelled simulations.
Scenario 2	Global decrease in AWBM soil capacity by 20%	The WMS inventory would be slightly increased under Scenario 2.	The transfers to/from Burton Mine are generally similar to the base case, however, the Project would tend towards sending more water to Burton Mine. The Project would, however remain a net importer of water from Burton Mine.	No uncontrolled mine affected releases are projected to occur for any of the modelled simulations.

6.6 ADAPTIVE MANAGEMENT OF THE WATER MANAGEMENT SYSTEM

The site water balance model results presented above represent the application of the proposed water management system rules over the life of the Project, regardless of climatic conditions. In reality, there are numerous options for adaptive management of the mine water system to respond to climatic conditions and the site water inventory in a way that would reduce the risks of impacts to surface water resources and quality.

A site water balance model would be developed once the mine is operational and would be updated periodically using site monitoring data.

7 RESIDUAL VOID BEHAVIOUR

7.1 OVERVIEW

Following the cessation of mining at the Project, there will be a single residual void, as shown in Figure 7.1. Water levels in the residual void will vary over time, depending on the prevailing climatic conditions, and the balance between evaporation losses and inflows from rainfall, surface runoff, and groundwater.

A separate GoldSim model was developed to assess the likely long-term water level behaviour of the residual void. The historical rainfall and evaporation sequences (134 years) were repeated sequentially 5 times to create an indicative long-term climate record. The volume of water in the void is calculated at each time step as the sum of direct rainfall to the water surface, catchment runoff and groundwater inflows, less evaporation losses.

7.2 RESIDUAL VOID CONFIGURATION

The residual void configuration and contributing catchment areas are shown in Figure 7.1 and Table 7.1. A depth-varying storage evaporation factor has been applied to the void to simulate the expected change in evaporation as residual void water levels vary. The storage evaporation factors are as follows:

- Bottom of void – 0.6.
- 10 m from top of void – 0.9.
- Top of void – 1.0.

Table 7.1 Contributing catchment to residual void

Land use	Contributing catchment area (ha)
Mining pit	53.1
Rehabilitated landform	53.0
TOTAL	106.1

The AWBM parameters present in Table 5.3 have been adopted for the residual void assessment.

7.3 RESIDUAL VOID GEOMETRY

The stage-storage curve for the residual void has been estimated from the final landform terrain model provided by BCC. The geometry of the modelled final void is summarised below:

- Maximum depth – 170 m
- Void overflow level – 321 mAHD
- Void capacity at overflow level – 53.6 GL

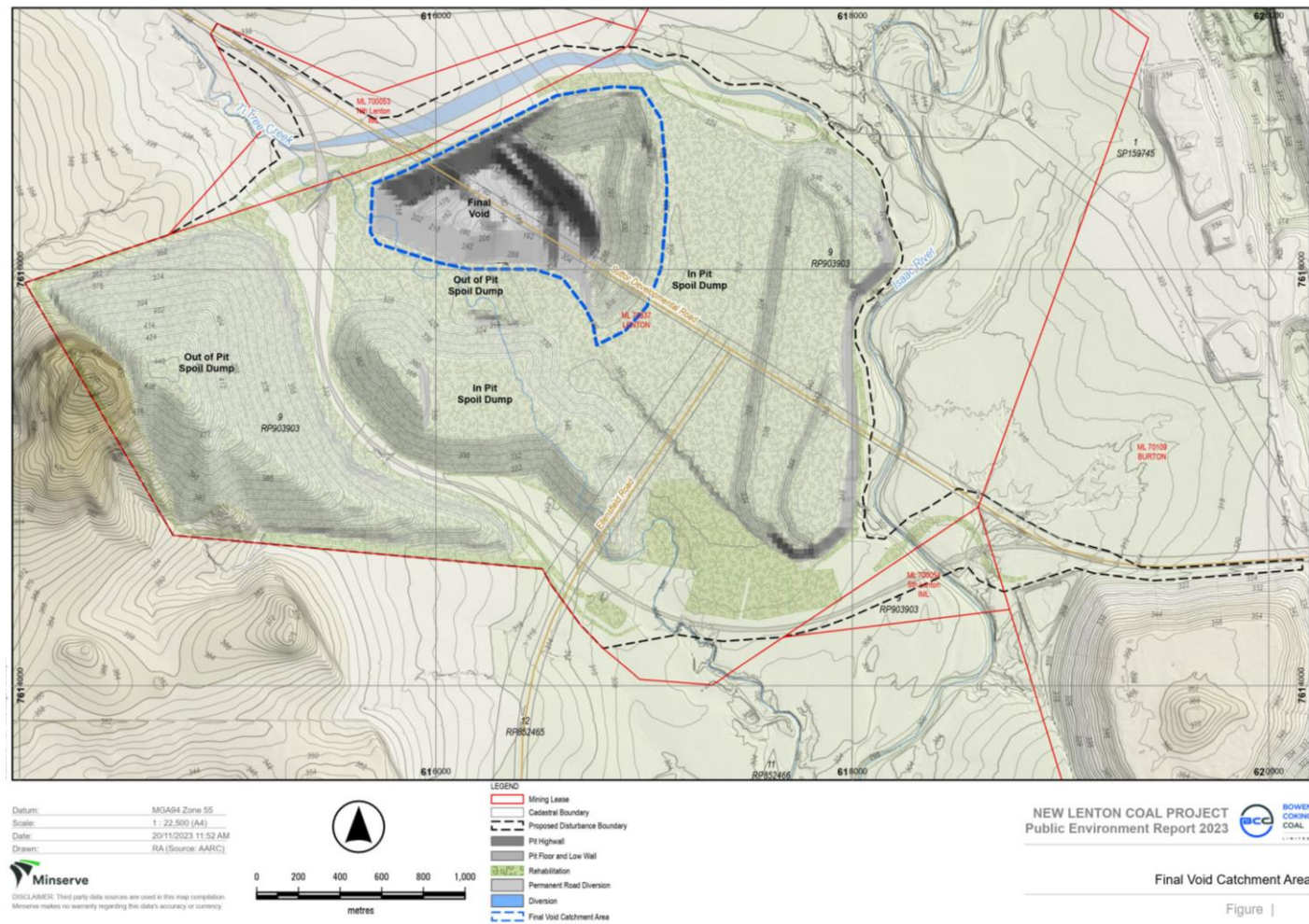


Figure 7.1 Residual void layout and catchment plan

7.4 RUNOFF SALINITY

The adopted salinity concentrations for the final void catchments are as follows:

- Mining pit: 2,000 $\mu\text{S}/\text{cm}$.
- Rehabilitated landform: 300 $\mu\text{S}/\text{cm}$.

The adopted runoff salinity for the final void assessment is applied at a fixed concentration and does not include any allowance for decay in runoff salinity over time.

7.5 GROUNDWATER INFLOW

Groundwater inflows to the final void were provided as a time series by SLR (2023) from the groundwater impact assessment for the Project. Figure 7.2 shows the modelled groundwater inflows over time for the final void.

The salinity of groundwater inflows has been set at 9,921 $\mu\text{S}/\text{cm}$ for consistency with the operational model (refer to Section 5.12).

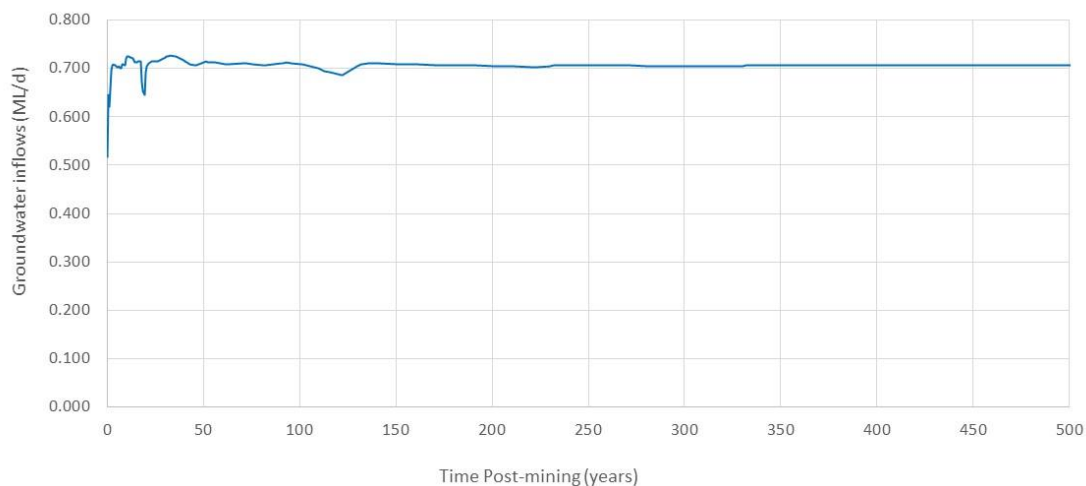


Figure 7.2 Residual final void – annual groundwater inflows

7.6 MODELLED LONG-TERM WATER LEVELS

Figure 7.3 shows the simulated long-term water levels in the residual void, compared against the void overflow level. The model results show the following:

- The water level reaches equilibrium between 270 mAHD and 278 mAHD after approximately 300 years and generally remains at these levels throughout the remainder of the simulation.
- The maximum modelled water level (278.4 mAHD) is around 42 m below the void overflow level (321 mAHD).

The final void water balance modelling results show that the final void at the Project is not at risk of overflowing to the receiving environment.

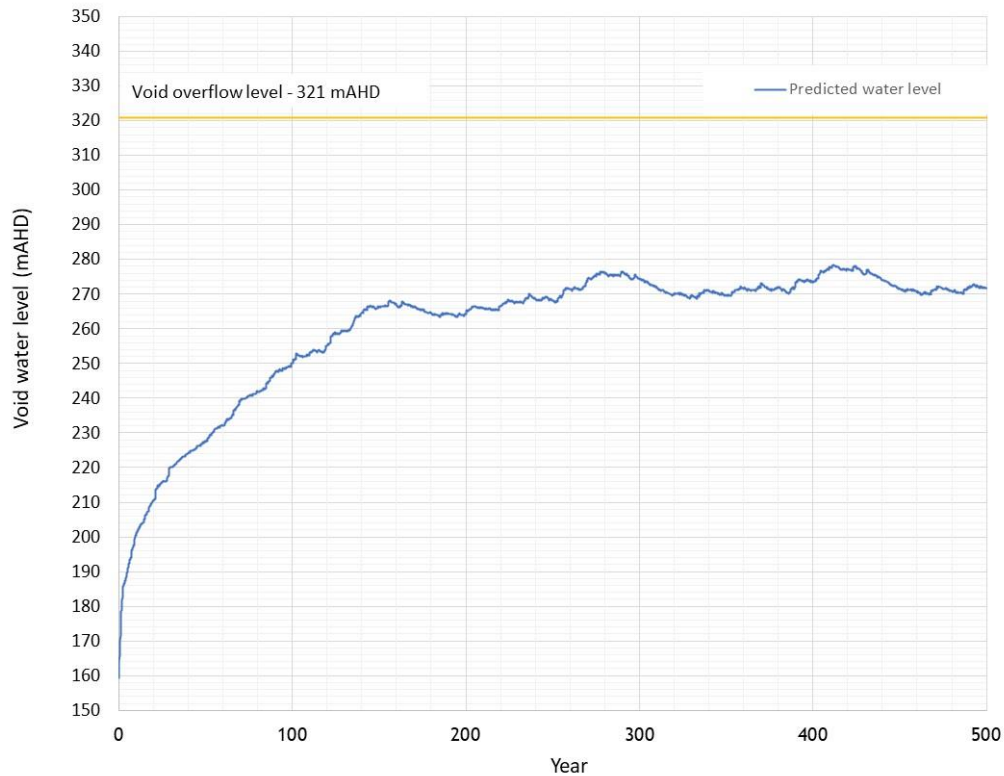


Figure 7.3 Residual void water level behaviour

7.7 MODELLED LONG-TERM SALINITY

Figure 7.4 shows the simulated long-term water salt load and concentrations in the residual void. The model results show the following:

- Salt accumulates within the void at an average rate of around 1,700 tonnes per year.
- The void becomes hyper-saline ($>53,850 \mu\text{s/cm}$) after around 480 years of simulation.

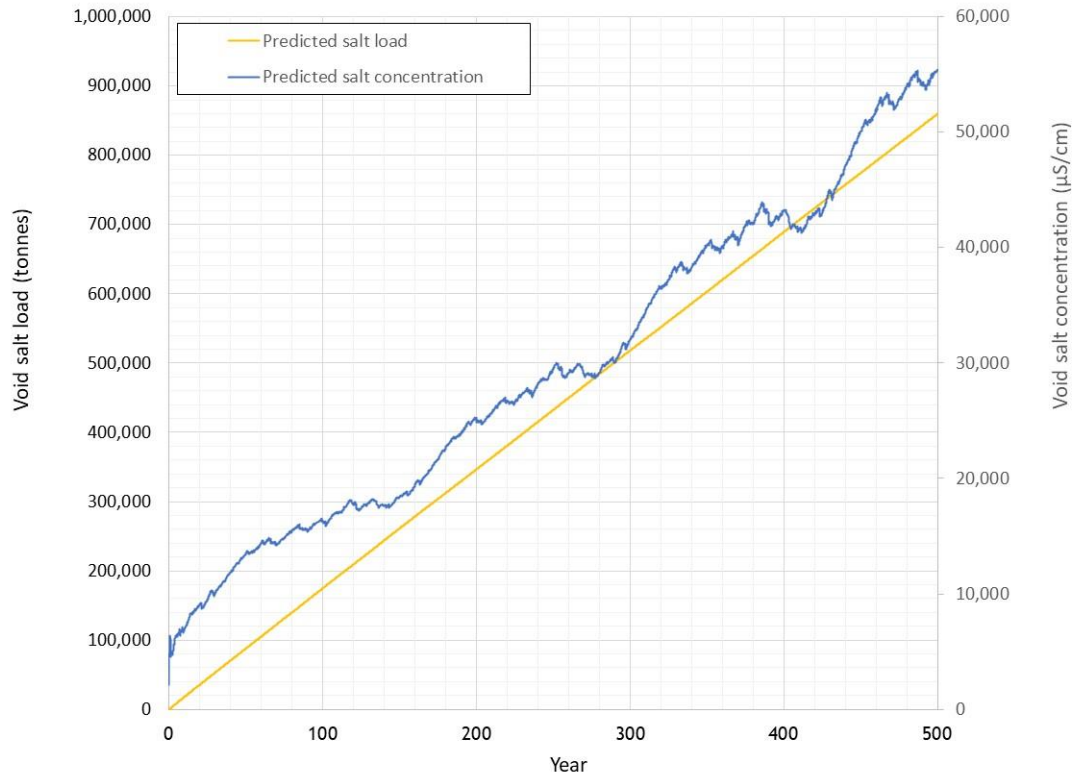


Figure 7.4 Residual void salt load and concentration

7.8 STORM EVENT BEHAVIOUR

7.8.1 Overview

An assessment of the impact of storm events on the water level and volume of water in the final void has been undertaken to determine the probability of overtopping during extreme climate conditions. The potential for discharge has been assessed for the following design rainfall events, using 72-hour (3-day) rainfall depths:

- 1 in 50 AEP;
- 1 in 100 AEP; and
- 1 in 1,000 AEP.

7.8.2 Initial conditions

The peak water level and volume simulated in the base case final void water balance modelling was adopted as the initial conditions for the storm event analysis, as follows:

- initial volume of 26,430 ML; and
- 278.4 mAHd, based on peak modelled water level; and

7.8.3 Design rainfall depths

Design rainfall depths for the 1 in 50 and 1 in 100 AEP and 1 in 1,000 AEP rainfall events were estimated using standard procedures in Australian Rainfall and Runoff (ARR) (Ball et al., 2016).

7.8.4 Storm event behaviour

Runoff volumes were calculated assuming no losses from the total catchment areas adopted in the water balance model. Table 7.2 show the results of the storm event analysis for the proposed final void.

The results show that even during a storm event with a rainfall depth equivalent to the 1 in 1,000 AEP design event, there would be minimal impact on the water level within the final void.

The predicted water level within the void during a concurrent peak water level and 1 in 1,000 AEP design event is around 39 m below the void overflow level (321 mAHD).

Table 7.2 Final void storm event behaviour

Storm event (AEP)	Rainfall depth (mm)	Runoff volume (ML)	Final volume (ML)	Change in water level (m)	Final water level (m)
1 in 50	353	834	27,265	2.0	280.4
1 in 100	410	969	27,400	2.3	280.7
1 in 1000	426	1,480	27,910	3.5	281.9

7.9 CLIMATE CHANGE ASSESSMENT – POST-MINING

7.9.1 Methodology and sensitivity parameters

The potential impacts of climate change on residual void behaviour were assessed using the projections and methodologies given in the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Commonwealth Bureau of Meteorology (BoM) report entitled *Climate Change in Australia Technical Report* (CSIRO, 2015). The CSIRO report provides guidance on the possible projections of future climate for the Australian East Coast based on a current understanding of the climate system, historical trends and model simulations of the climate response to changing greenhouse gas and decreasing aerosol emissions.

Projections are given for a number of climatic variables including (but not limited to) temperature, rainfall, wind speed and potential evapotranspiration. CSIRO (2015) presents a number of possible approaches to quantify risks associated with climate change impacts.

For this assessment, the conservative Representative Concentration Pathway 8.5 (RCP8.5) emissions scenario has been adopted. The year 2090 was selected as the representative year, being approximately 50 years post-mine closure. Potential changes in climate have been obtained using the projection builder tool provided in the Climate Change Australia website. Climate variable inputs for the ‘best case’, ‘maximum consensus’ case and ‘worst case’ as defined by CSIRO (2015) for the RCP8.5 climate change scenarios are provided in Table 7.3. Year 2090 is the current limit of climate change projections as defined by CSIRO (2015).

Rainfall is expected to change by between plus 19.1% and minus 34.0% and evapotranspiration is expected to increase by between 8.3% and 15.2%. The climate variable inputs (rainfall and evaporation) to the water balance model were adjusted to undertake the climate change impact assessment. All three scenarios have been assessed for the proposed residual voids.

Table 7.3 Projections of change to climate – Year 2090 (RCP8.5)

Projection scenario	Climate model	Annual change (%)	
		Rainfall	Evapotranspiration
Best case	GFDL-ESM2M	-34.0%	14.5%
Maximum consensus	ACCESS1-0	-15.4%	15.2%
Worst Case	NorESM1-M	19.1%	8.3%

7.9.2 Potential climate change impacts

7.9.2.1 Overview

Potential climate change impacts to the residual void water balance were assessed by simulating the ‘best’ case, ‘maximum consensus case’ and ‘worst’ case climate scenarios for the Year 2090 climate changes projection. The water balance model climate inputs (rainfall and evaporation) were factored by the values given in Table 7.3.

7.9.2.2 Potential impact on residual void water levels

The water balance modelling results show that the residual void water levels will be lower than under baseline climatic conditions for the ‘best case’ and ‘maximum consensus’ climate scenarios. This is expected given the significant decrease in rainfall and increase in evapotranspiration for these climate scenarios.

For the “worst case” climate scenario, the residual void water levels will be slightly higher than under baseline climatic conditions.

The impact of the potential changes in rainfall and evapotranspiration for the proposed residual void water levels are presented in Figure 7.5. The results show the following (with the baseline results shown for reference):

- For the ‘best case’ climate scenario, the equilibrium and peak water level is around 45 m lower than under baseline climate conditions:
- For the ‘maximum consensus’ case climate scenario, the equilibrium and peak water level is around 30 m lower than under baseline climate conditions.
- For the ‘worst’ case climate scenario, the equilibrium and peak water level is around 4.3 m higher than under baseline climate conditions.

The climate change assessment demonstrates that there is no risk of overflow even under the most conservative climate change scenarios.

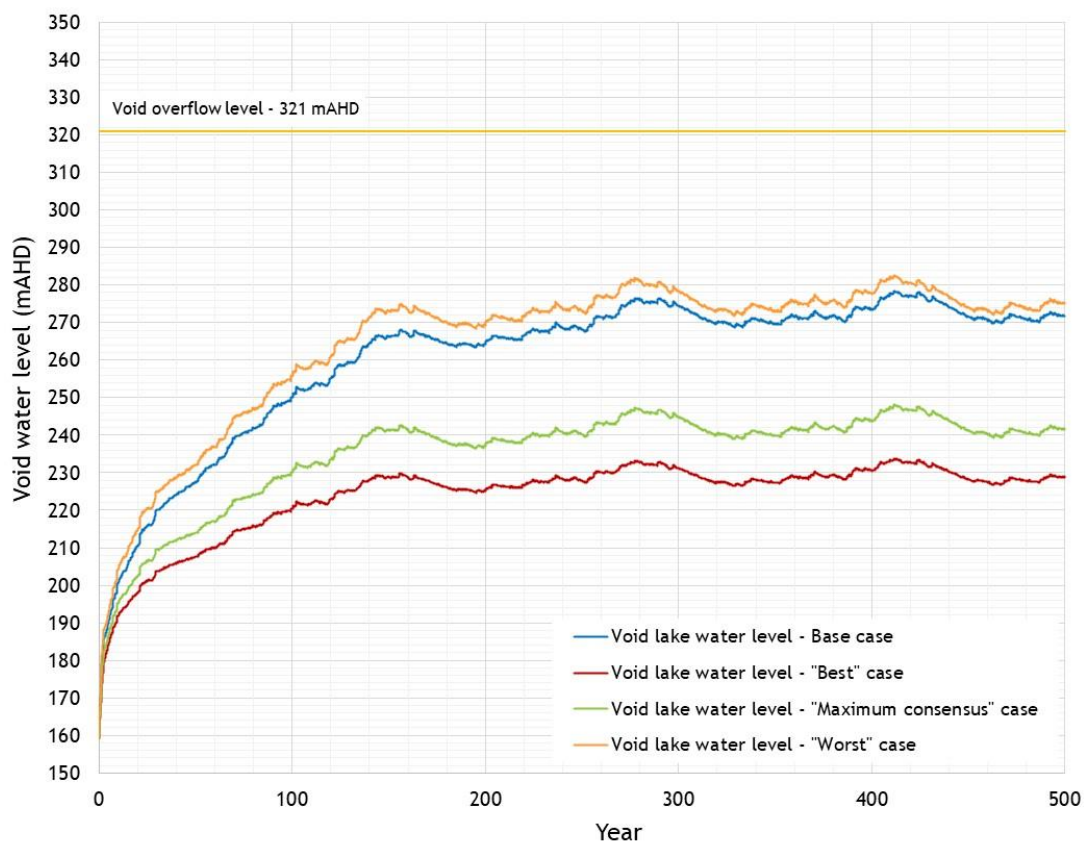


Figure 7.5 Residual void water level – climate change assessment

7.9.2.3 Potential impact on residual void salinity

The water balance modelling results show that the residual void salinity will be higher than under baseline climatic conditions for the ‘best case’ and “maximum consensus” climate scenarios. This is expected given the significant decrease in rainfall and increase in evapotranspiration for these climate scenarios, resulting in lower stored volumes and higher concentrations.

For the “worst case” climate scenario, the residual void salinity will be slightly lower than under baseline climatic conditions.

The impact of the potential changes in rainfall and evapotranspiration for the proposed residual void salt concentrations are presented in Figure 7.6. The results show the following (with the baseline results shown for reference):

- For the 'best case' climate scenario, the salinity is generally around double that of base case climate conditions.
- For the 'maximum consensus' climate scenario, the salinity is generally around 65% higher than under base case climate conditions.
- For the 'worst case' climate scenario, the salinity is generally around 5% lower than under base case climate conditions.

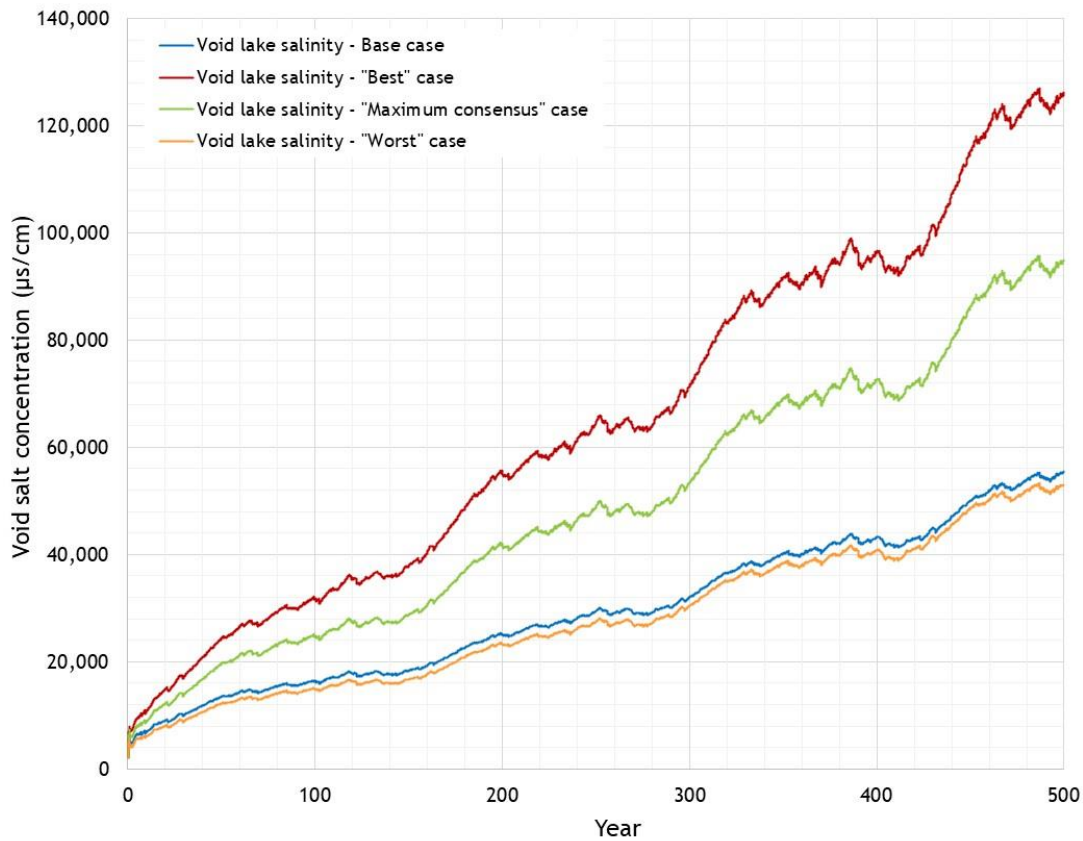


Figure 7.6 Residual void salt concentration – climate change assessment

8 FLOOD MODELLING ASSESSMENT

8.1 OVERVIEW

The TUFLOW hydraulic model described in Appendix B was used to assess the impacts of the Project on flooding over a range of design events. The following development scenario/event combinations were modelled:

- Existing conditions:
 - 50%, 10%, 2%, 1%, and 1 in 1,000 AEP and PMF;
- Developed conditions:
 - 50%, 10%, 2%, 1% and 1 in 1,000 AEP and PMF;
- Post-closure conditions
 - 1 in 1,000 AEP and PMF.

For impact assessment, the modelled existing conditions flood levels and velocities were subtracted from the flood levels and velocities modelled under the developed 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 each development scenario are described in detail in the following sections.

Design flood hydrographs of Ti-Tree Creek and the Isaac River immediately downstream of the Project area for a range of events are shown in Figure 8.1 and Figure 8.2 respectively. The event duration that produces peak flows in Ti-Tree Creek and the Isaac River is less than 24 hours.

8.2 EXISTING CONDITIONS

Modelled 1% AEP and 1 in 1,000 AEP flood depths and extents for the existing conditions scenario are shown in Figure 8.3 and Figure 8.4 respectively. The New Lenton MLs are traversed from north to south on their eastern side by the Isaac River and its tributaries including Hill Creek. The Isaac River has a well-defined channel with flood depths in the main channel in the order of five to eight metres. There are minor flow breakouts in larger events between the tributaries and the Isaac River within the New Lenton MLs.

The New Lenton MLs are traversed in a northwest to southeast direction by Ti-Tree Creek. Ti Creek flows into the Isaac River approximately one kilometre downstream of the New Lenton MLs. Ti-Tree Creek has a relatively shallow channel and in larger events its flow spreads out onto a flat and shallow floodplain. Within the New Lenton MLs, channel depths for Ti-Tree Creek vary from two to four meters. In larger events (2% AEP and greater) there is a flow breakout at the southern end of the New Lenton MLs from Ti-Tree Creek to a small tributary of the Isaac River.

Modelled flood velocities for the existing case conditions for the 1% AEP and 1 in 1,000 AEP events are shown in Figure 8.5 and Figure 8.6 respectively. In the Isaac River, velocities in the main channel in a 1 in 1,000 AEP event typically range from 2.0 to 3.0 m/s and in the 1% AEP event from 1.8 to 2.3 m/s. In Ti-Tree Creek in the 1 in 1,000 AEP event, point channel velocities typically range from 1.5 m/s to 2.6 m/s and in the 1% AEP from 1.3 to 2.5 m/s. Within the New Lenton MLs in both Ti-Tree Creek and the Isaac River there are isolated “hotspots” that experience velocities greater than 3.0 m/s.

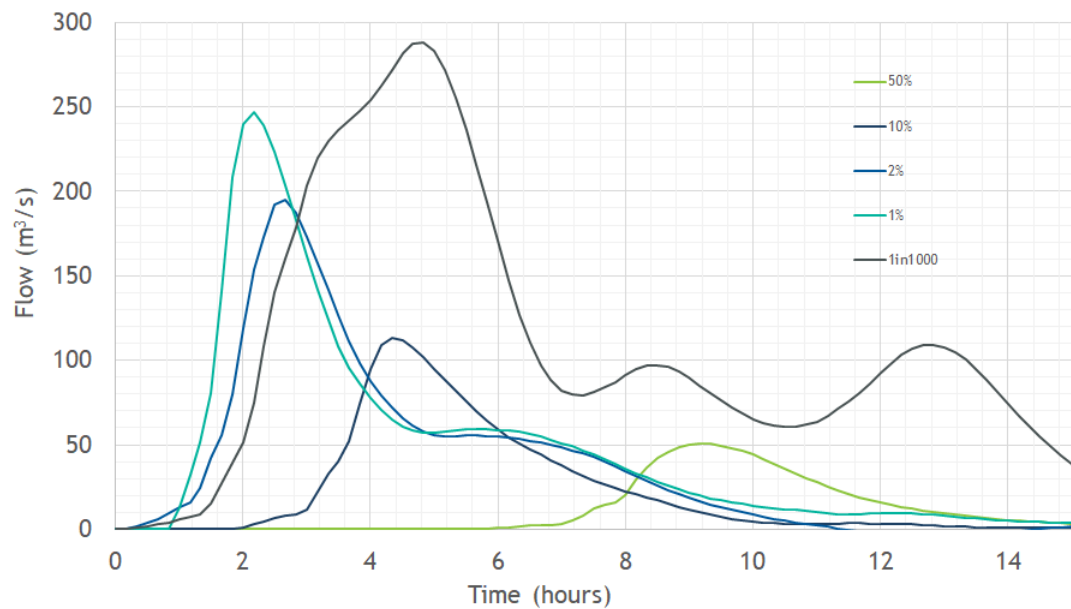


Figure 8.1 Ti-Tree Creek design hydrographs

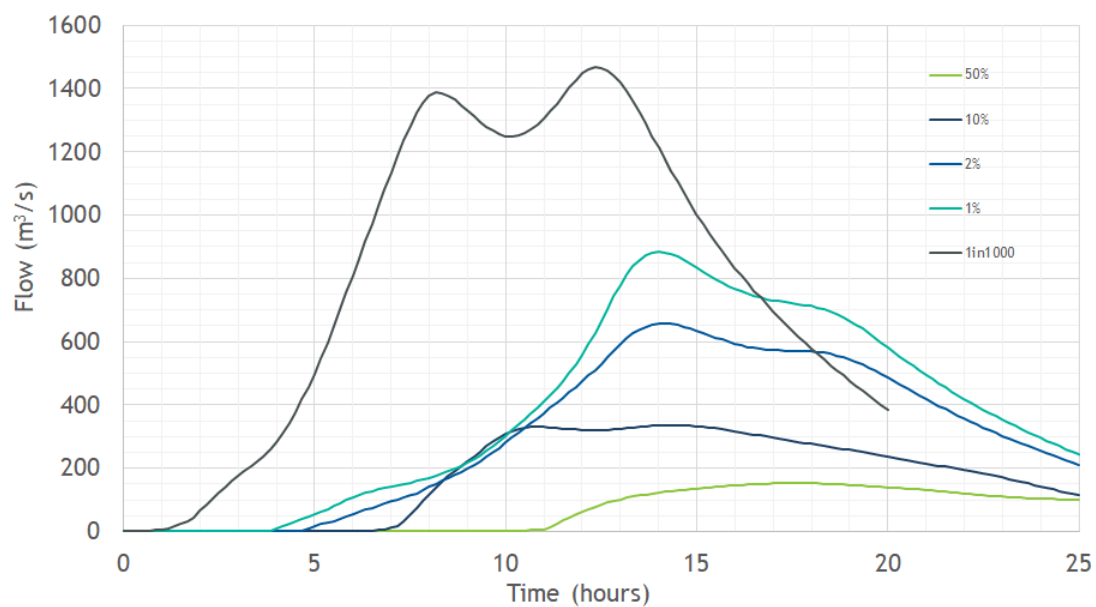


Figure 8.2 Isaac River design hydrographs

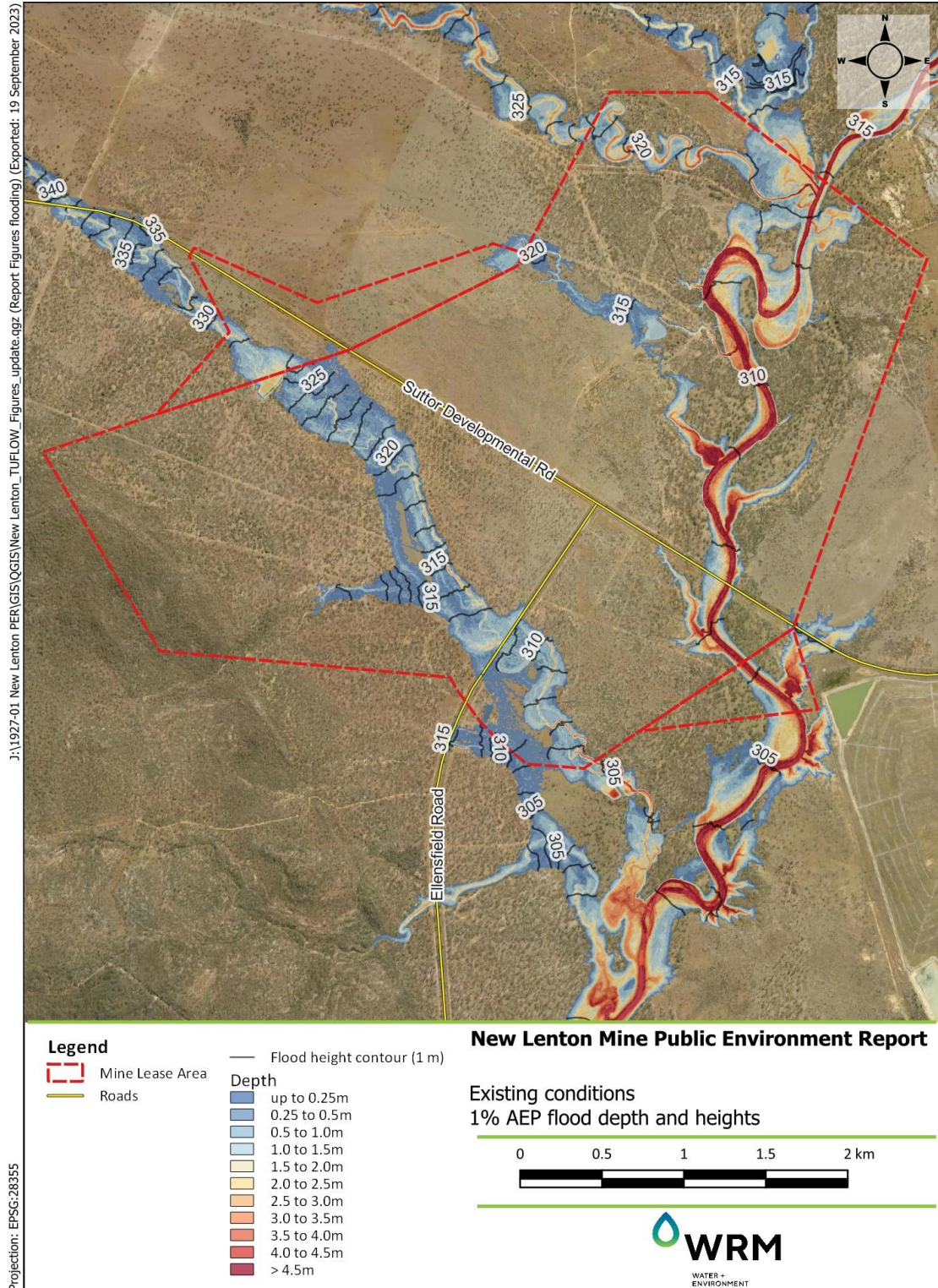


Figure 8.3 Existing conditions 1% AEP flood depths and heights

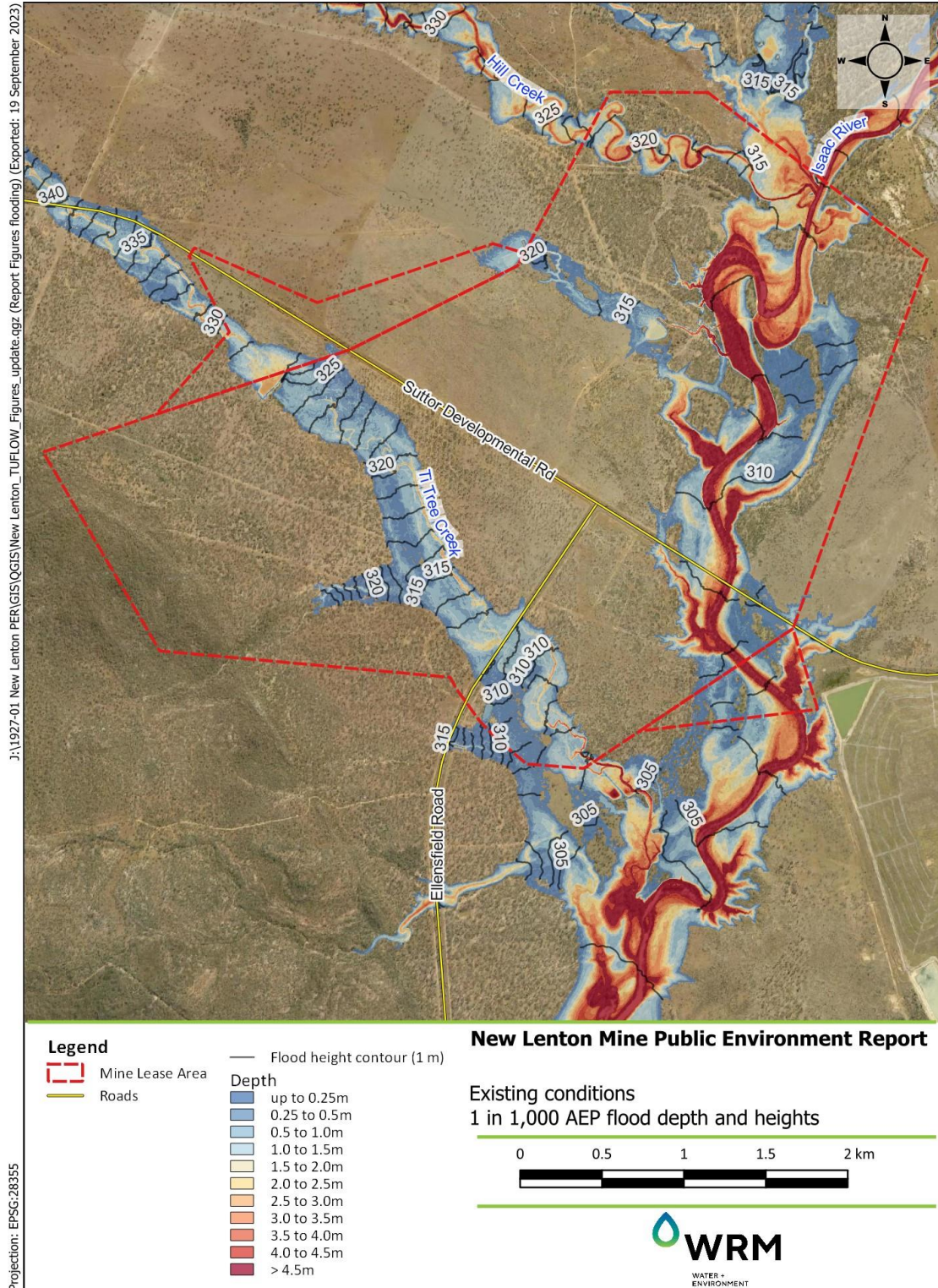


Figure 8.4 Existing conditions 1 in 1,000 AEP flood depth and heights

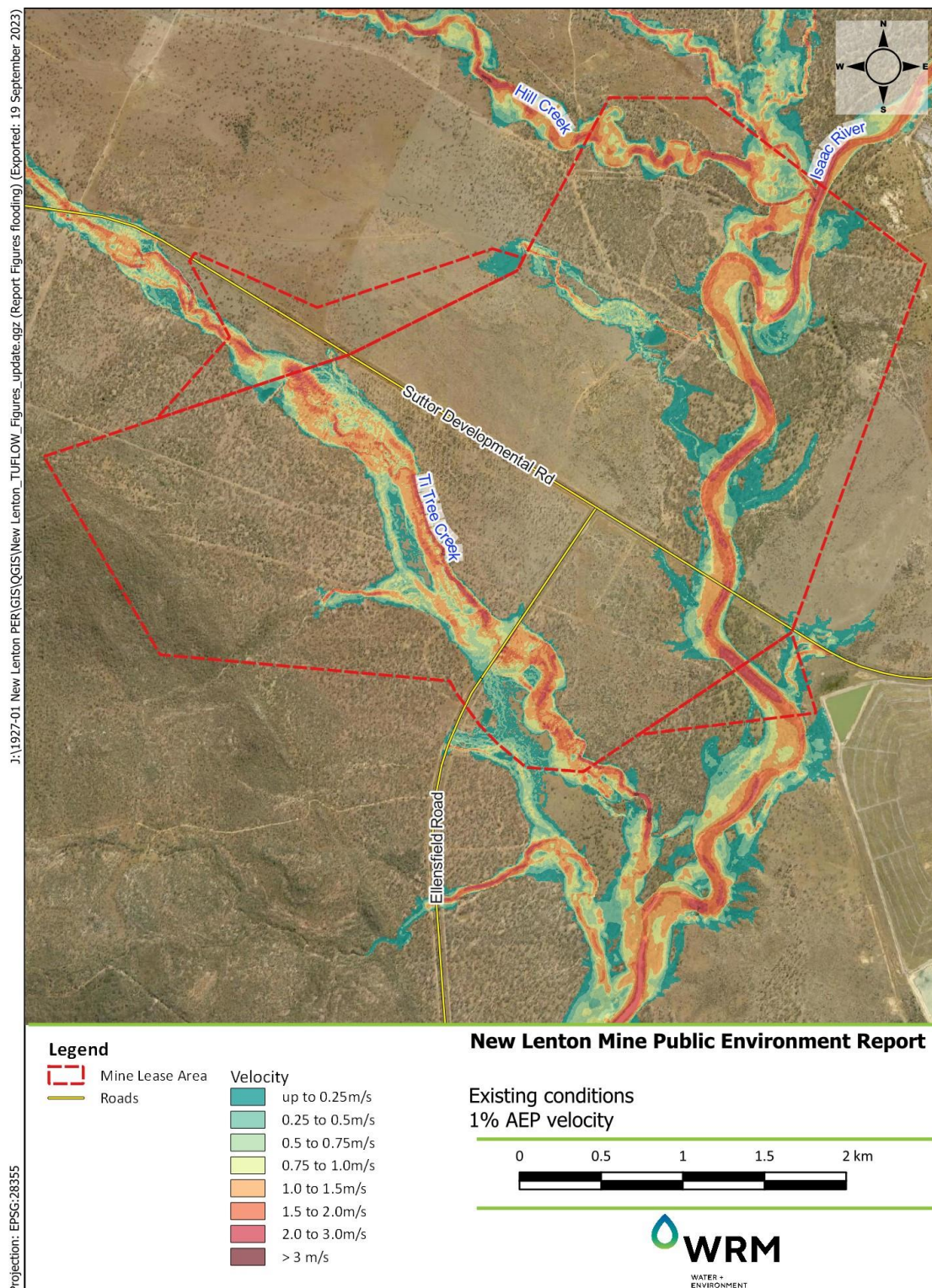


Figure 8.5 Existing conditions 1% AEP velocity

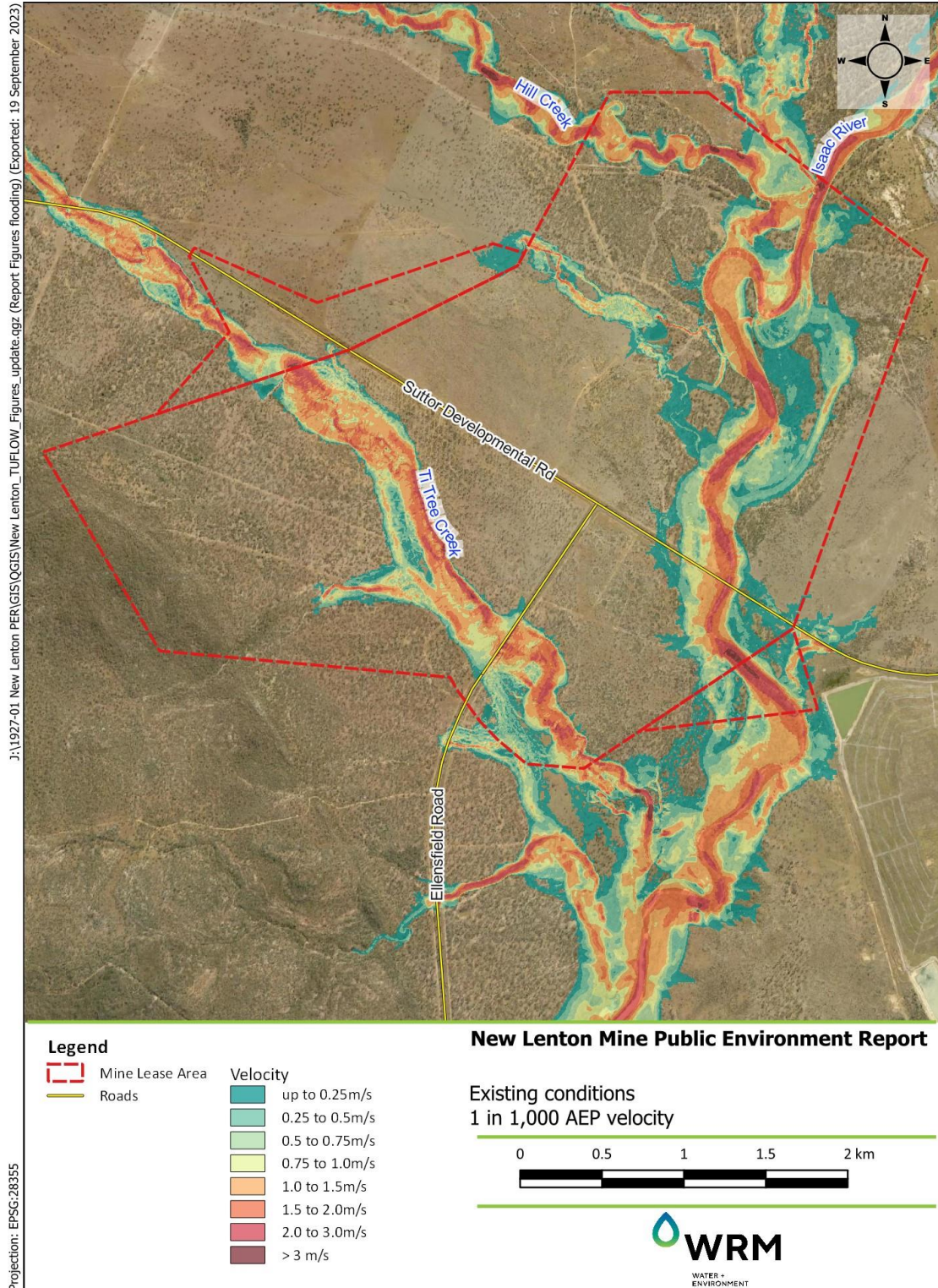


Figure 8.6 Existing conditions 1 in 1,000 AEP velocity

8.3 DEVELOPED CONDITIONS

Full mapping of results of the flood modelling for developed conditions are presented in Appendix E. The results show that the proposed works would alter flood conditions via a number of mechanisms:

- A levee along the western bank of the Isaac River to prevent ingress of floodwaters to the Project Disturbance Area in a 1 in 1,000 AEP event reducing floodplain conveyance and storage. This would have the effect of locally increasing flood levels in the Isaac River.
- A levee intercepting the flowpath of Ti-Tree Creek with flow diverted to a tributary of the Isaac River via a diversion channel. This would have the effect of increasing flood levels in the tributary as well as the Isaac River into which it drains. It would also decrease flood levels in the downstream reach of Ti-Tree Creek because the contributing catchment has been diverted.
- A realignment of the Suttor Developmental Road with a new bridge crossing the Isaac River approximately 700 metres downstream of the existing bridge. Additionally, in the vicinity of the new road crossing there will be a low flow crossing for a ROM haul road. The addition of the bridge and abutments would have the effect of increasing upstream flood levels and decreasing downstream flood levels.

Details of the modelled impacts are summarised in the following sections.

8.3.1 Flood level impacts

Developed conditions modelled flood depths and extents for the 1% AEP and 1 in 1,000 AEP events are shown in Figure 8.7 and Figure 8.8 respectively. The modelled changes in flood level for developed conditions for the 1% AEP and 1 in 1,000 AEP events are shown in Figure 8.9 and Figure 8.10 respectively. This section summaries the impacts in the 10%, 2%, 1% and 1 in 1,000 AEP events. A full set of impact maps for all modelled events is presented in Appendix E.

The flood modelling results show:

- For the Isaac River:
 - For the 10% AEP flood event, level changes are insignificant (< 0.25m), have minimal interaction with the levee and new bridge, and result in an insignificant change in the areas that are subject to flooding
 - For the 1% AEP and 1 in 1,000 AEP events level changes are minor (< 0.5 m to < 1 m) adjacent the levee and upstream of the new bridge, dissipating to insignificant (<0.25 m) upstream and downstream of the levee. There are minor changes in the areas that are subject to flooding.
- For Ti-Tree Creek and Ti-Tree Creek Diversion
 - Upstream of the Ti-Tree Creek diversion and levee, there are increases in flood levels by 2.2 m (10% AEP) to about 3 m (1 in 1,000 AEP), with these impacts dissipating within about 600 m upstream. The diversion and levee are operating in accordance with their conceptual design to channel water around active mining areas and prevent ingress of flood water up to the 1 in 1,000 AEP event.
 - Water levels along the unnamed tributary downstream of the Ti-Tree Creek diversion channel increase by up to about 2.3 m for the range of modelled flood events. These changes dissipate once unnamed tributary joins the Isaac River. There are minor changes in the areas that are subject to flooding around the downstream portion of the unnamed tributary.
 - Water levels are reduced along Ti-Tree Creek downstream of the Project Disturbance Area by 2.8 m to 3.5 m over the range of modelled events due to the

diversion of flow to the unnamed tributary. These changes dissipate once the remaining portion of Ti-Tree Creek enter the Isaac River.

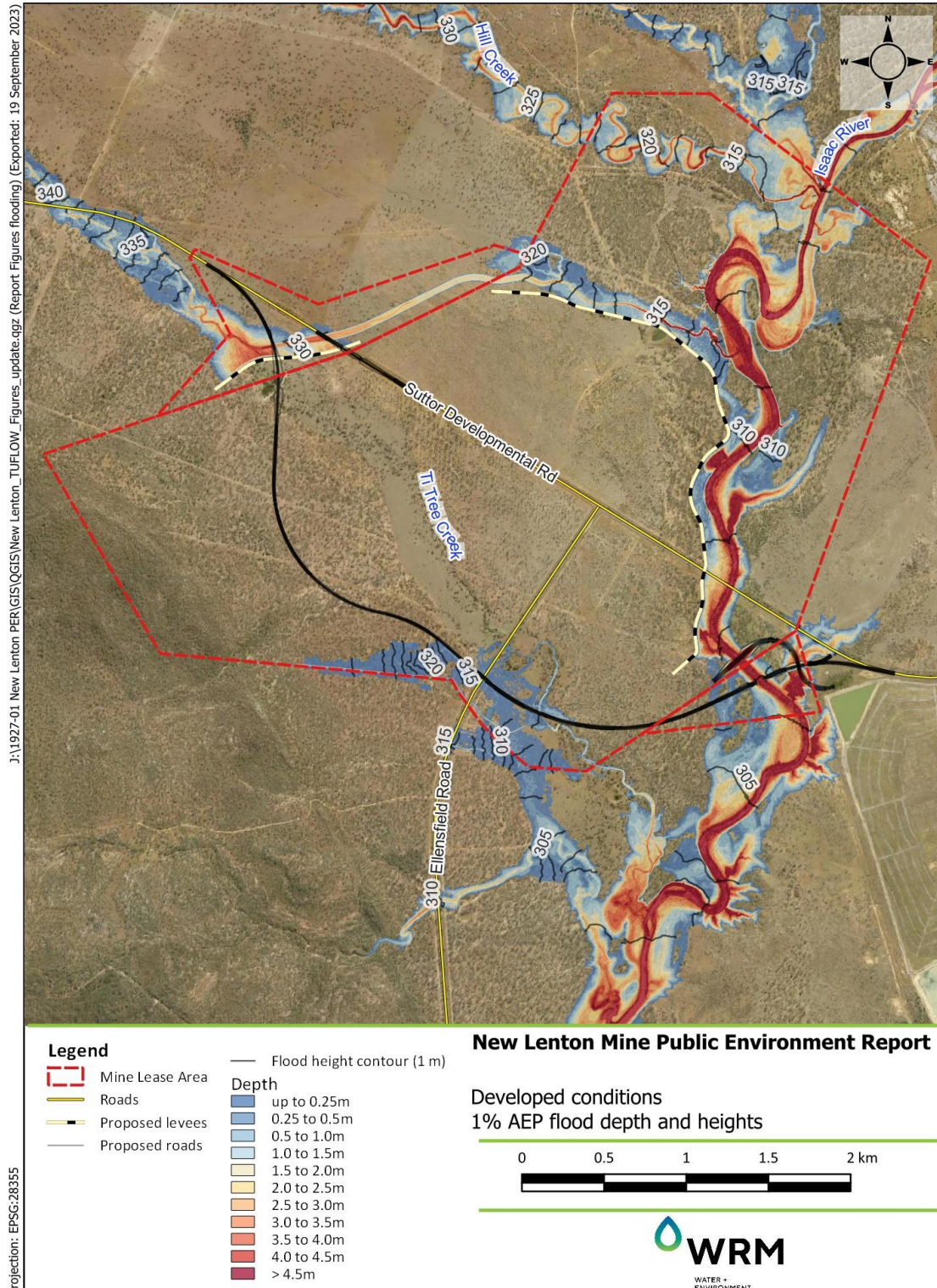


Figure 8.7 Developed conditions 1% AEP flood depths and heights

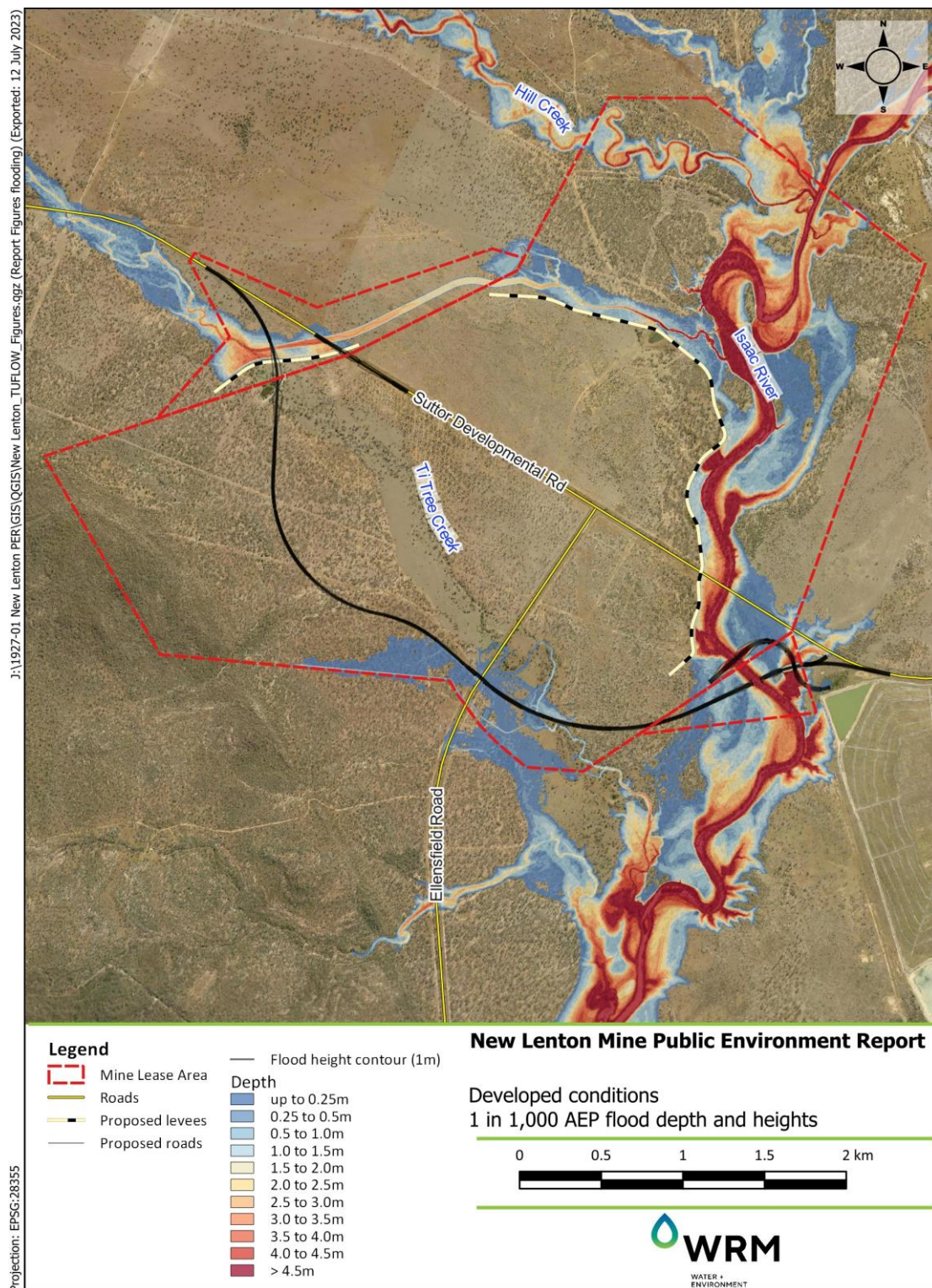


Figure 8.8 Developed conditions 1 in 1,000 AEP flood depths and heights

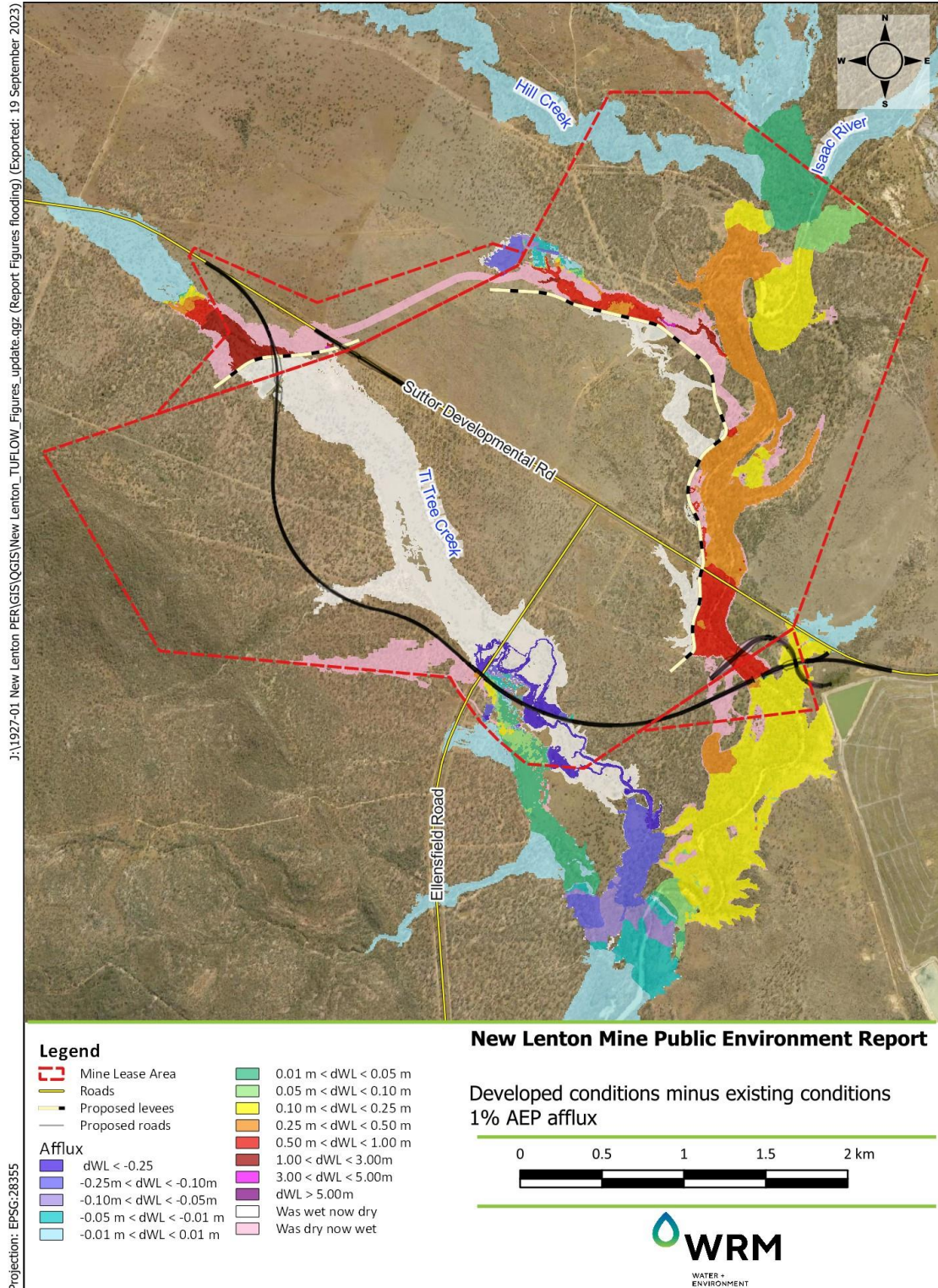


Figure 8.9 Afflux 1% AEP (developed minus existing conditions)

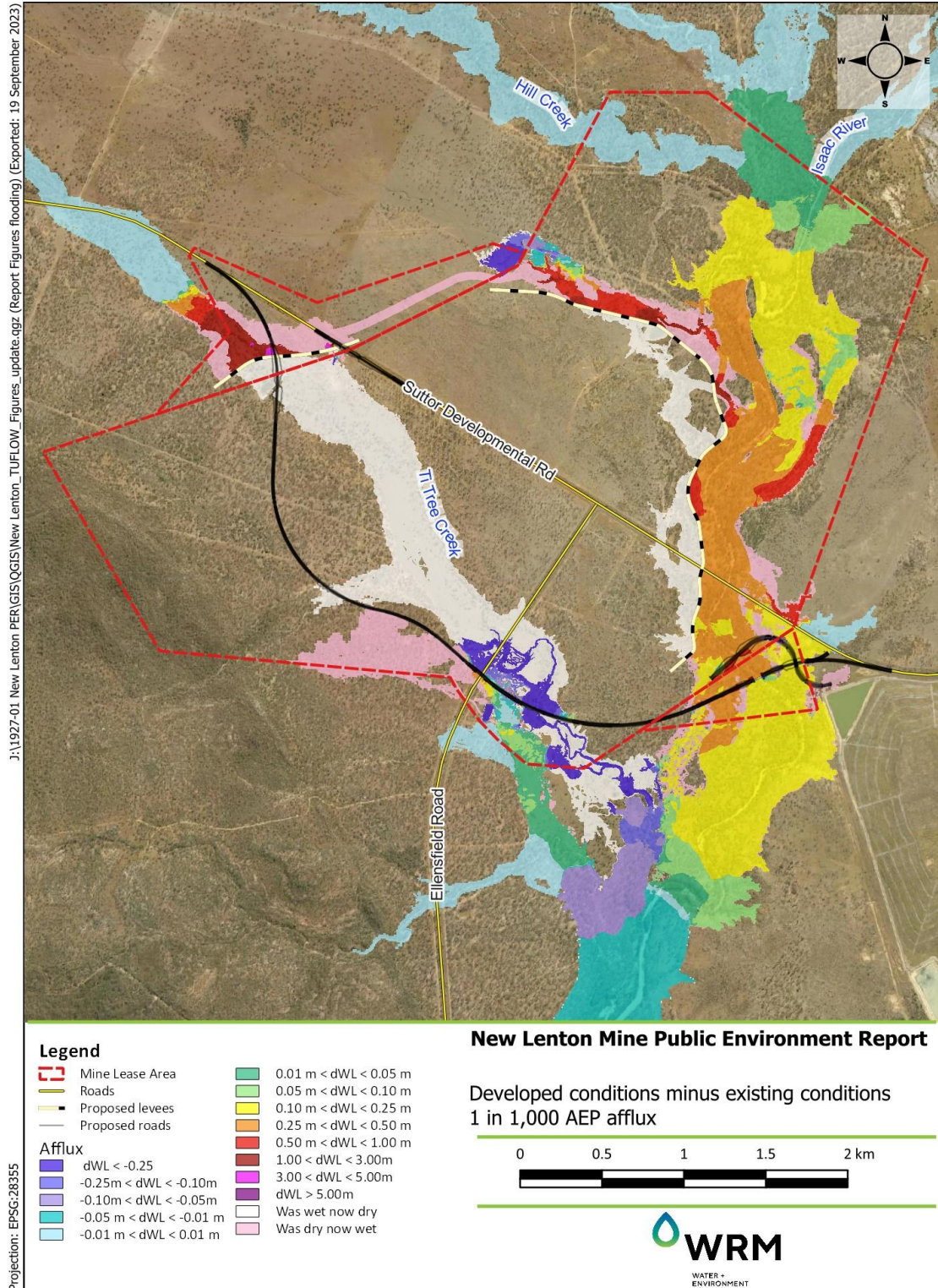


Figure 8.10 Afflux 1 in 1,000 AEP (developed minus existing conditions)

8.3.2 Velocity impacts

Developed conditions modelled flood velocities for the 1% AEP and 1 in 1,000 AEP events are shown in Figure 8.11 and Figure 8.12 respectively. The modelled changes in velocity for developed conditions for the 1% AEP and 1 in 1,000 AEP events are shown in Figure 8.13 and Figure 8.14 respectively. This section summaries the impacts in the 10%, 2%, 1% and 1 in 1000 AEP events. A full set of impact maps for all modelled events are presented in Appendix E.

The flood modelling results show:

- For the Isaac River:
 - For the 10% and 2% AEP flood event there are nil to insignificant velocity changes, with changes confined to very small areas.
 - For the 1% AEP and 1 in 1,000 AEP velocity changes range from nil to minor (< 0.3m/s) with some very localised areas of around 0.5 m/s to 1 m/s near the levee and River crossings. Detailed design of the levees and road embankments will consider appropriate erosion protection measures for locations of potentially higher velocity. Velocity changes dissipate to insignificant (<0.3m/s) upstream of the levee and downstream of confluence with the residual Ti-Tree Creek channel.
- For Ti-Tree Creek and Ti-Tree Creek Diversion
 - Upstream of the Ti-Tree Creek diversion and levee, there are reductions in velocity as the diversion and levee slow the flow of water from Ti-Tree Creek.
 - Velocities along the unnamed tributary downstream of the Ti-Tree Creek diversion channel increase by up to 2.3 m/s for the range of modelled flood events. These changes dissipate once unnamed tributary joins the Isaac River. The potential geomorphological impacts of this change are assessed in Section 9.
 - Velocities are reduced along Ti-Tree Creek downstream of the Project Disturbance Area. These changes dissipate once the remaining portion of Ti-Tree Creek enter the Isaac River.

8.3.3 Impacts of proposed river crossings

Details of the proposed crossings of the Isaac River are summarised in Table 8.1, along with water levels and upstream impacts in the vicinity of the crossings. The new Suttor Developmental Road bridge has flood immunity for the 2% AEP flood and is overtopped in a 1% AEP or larger event. The low flow crossing has low flood immunity and is overtopped by several metres in all flood events. Afflux at the low flow crossing is not caused by the crossing itself, but by the combined effects of increased flow in the river due to the Ti-Tree Creek diversion, the effects of the proposed Isaac River levee, and afflux generated by the new Isaac River bridge downstream.

Table 8.1 River crossing details

Parameter	Haul road crossing	Suttor Developmental Road
Crossing type	Low flow crossing	Bridge
Configuration	Low-level causeway	60 m span, deck width 7.4 m, Soffit level 305.45 mAHD
Minimum road level	299.95 mAHD	306.5 mAHD
AEP	Upstream flood level (mAHD)	
50%	304.12	303.81
10%	305.44	305.00
2%	306.84	306.35
1%	307.60	307.01
1 in 1,000 AEP	308.35	307.72
AEP	Afflux (m)	
50%	- ^a	0.11
10%	- ^a	0.21
2%	- ^a	0.35
1%	- ^a	0.57
1 in 1,000	- ^a	0.45

^a low level crossing does not generate afflux

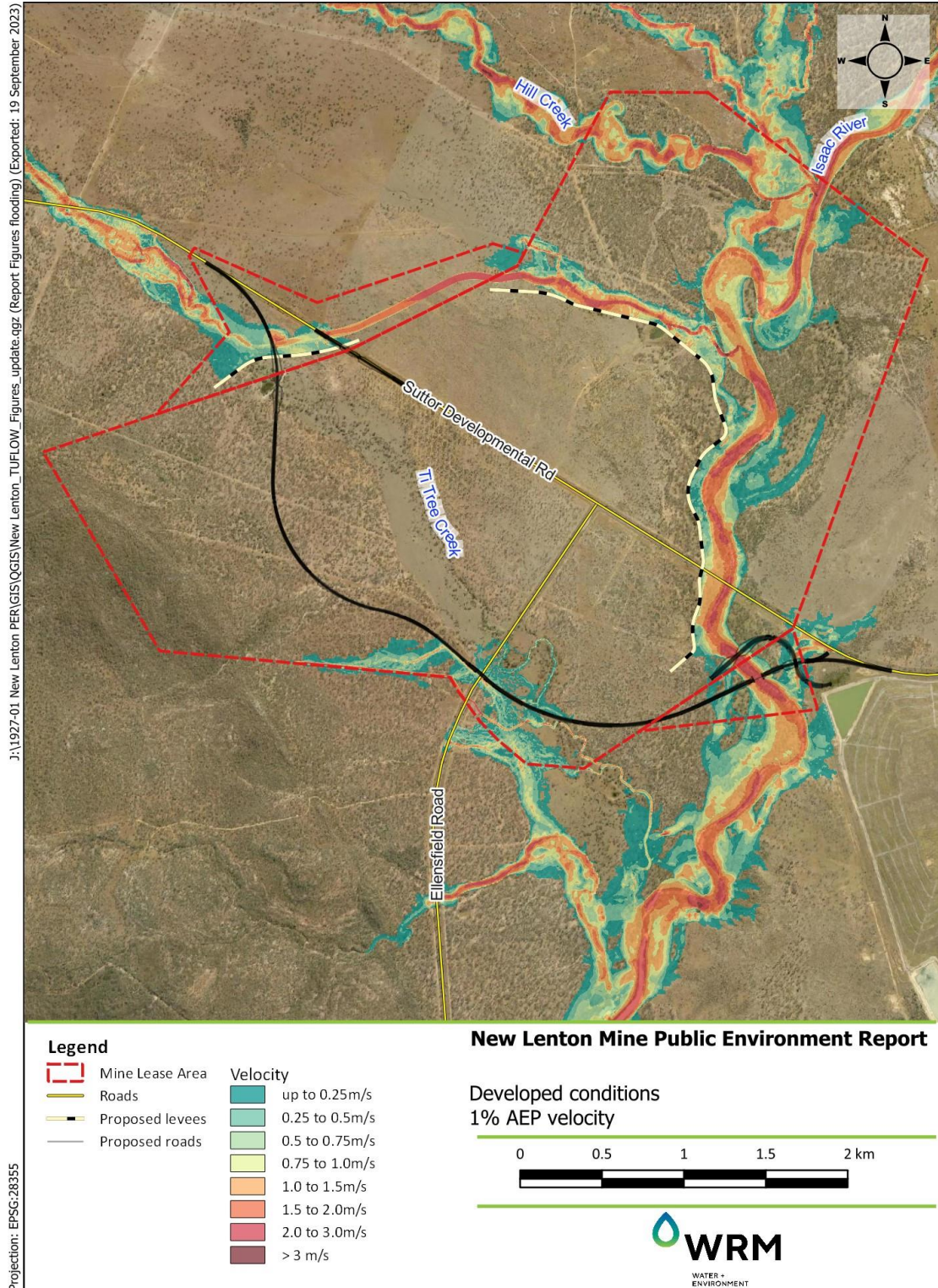


Figure 8.11 Developed conditions 1% AEP velocities

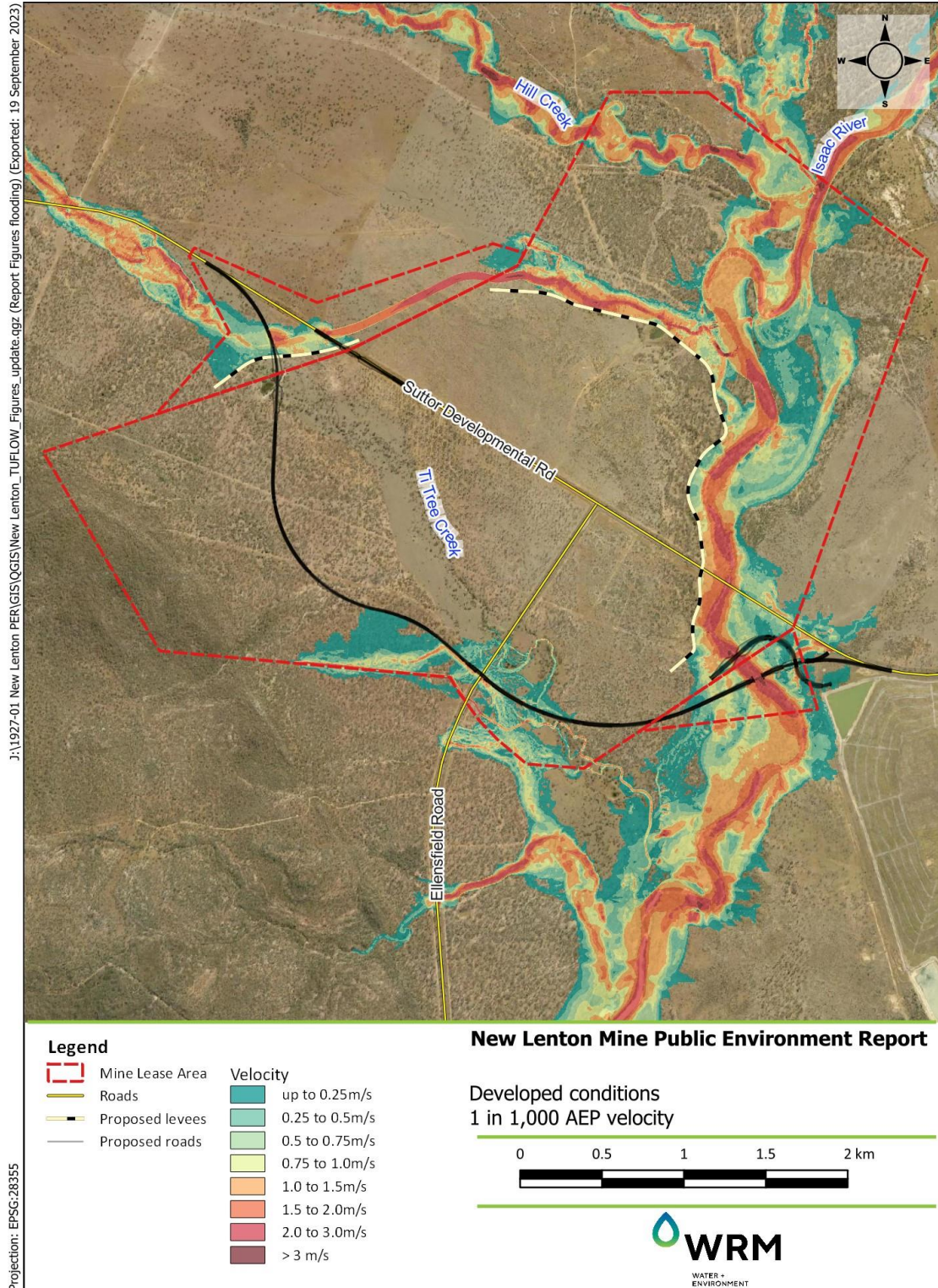


Figure 8.12 Developed conditions 1 in 1,000 AEP velocities

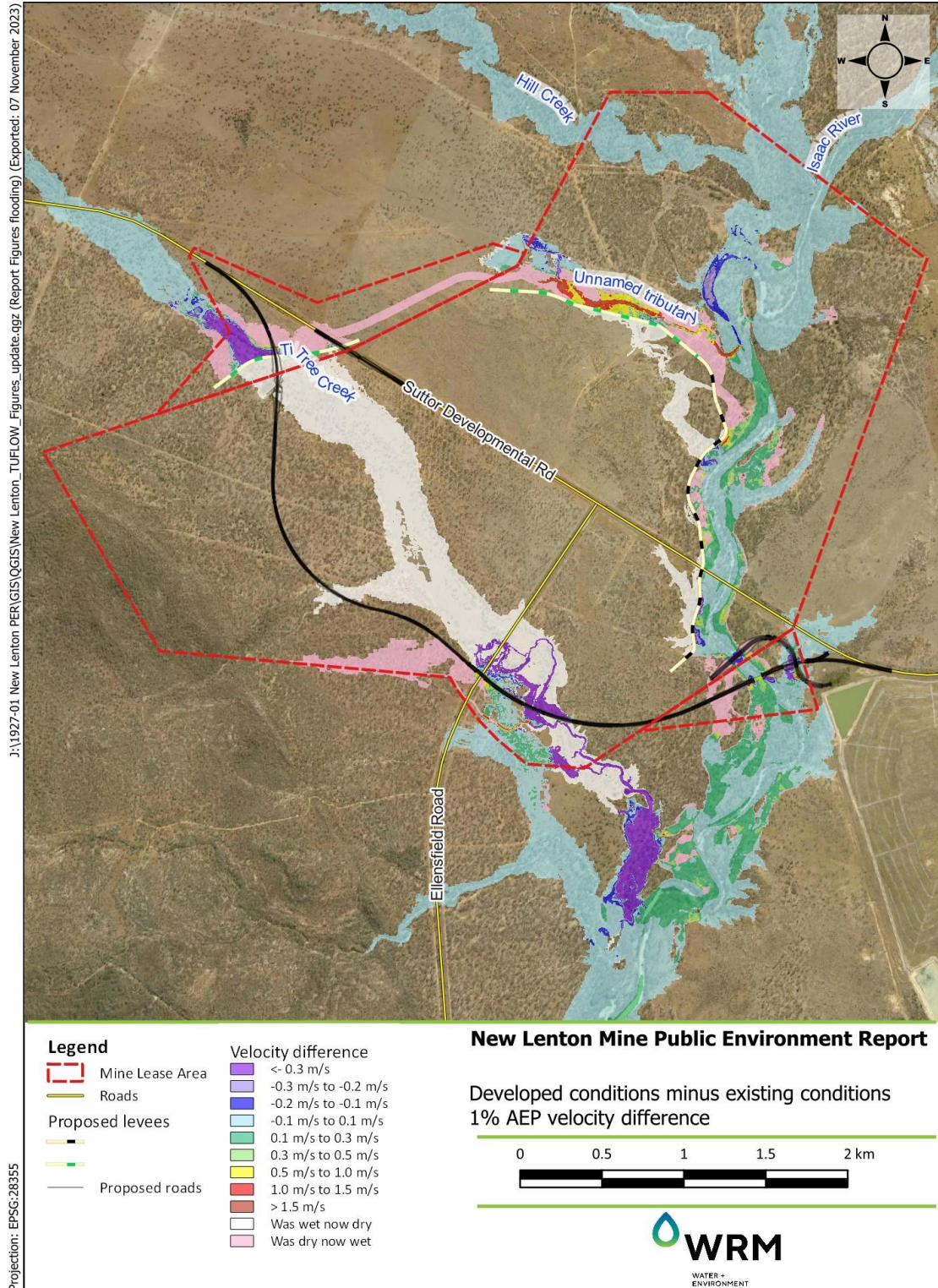


Figure 8.13 Velocity difference 1% AEP (developed minus existing conditions)

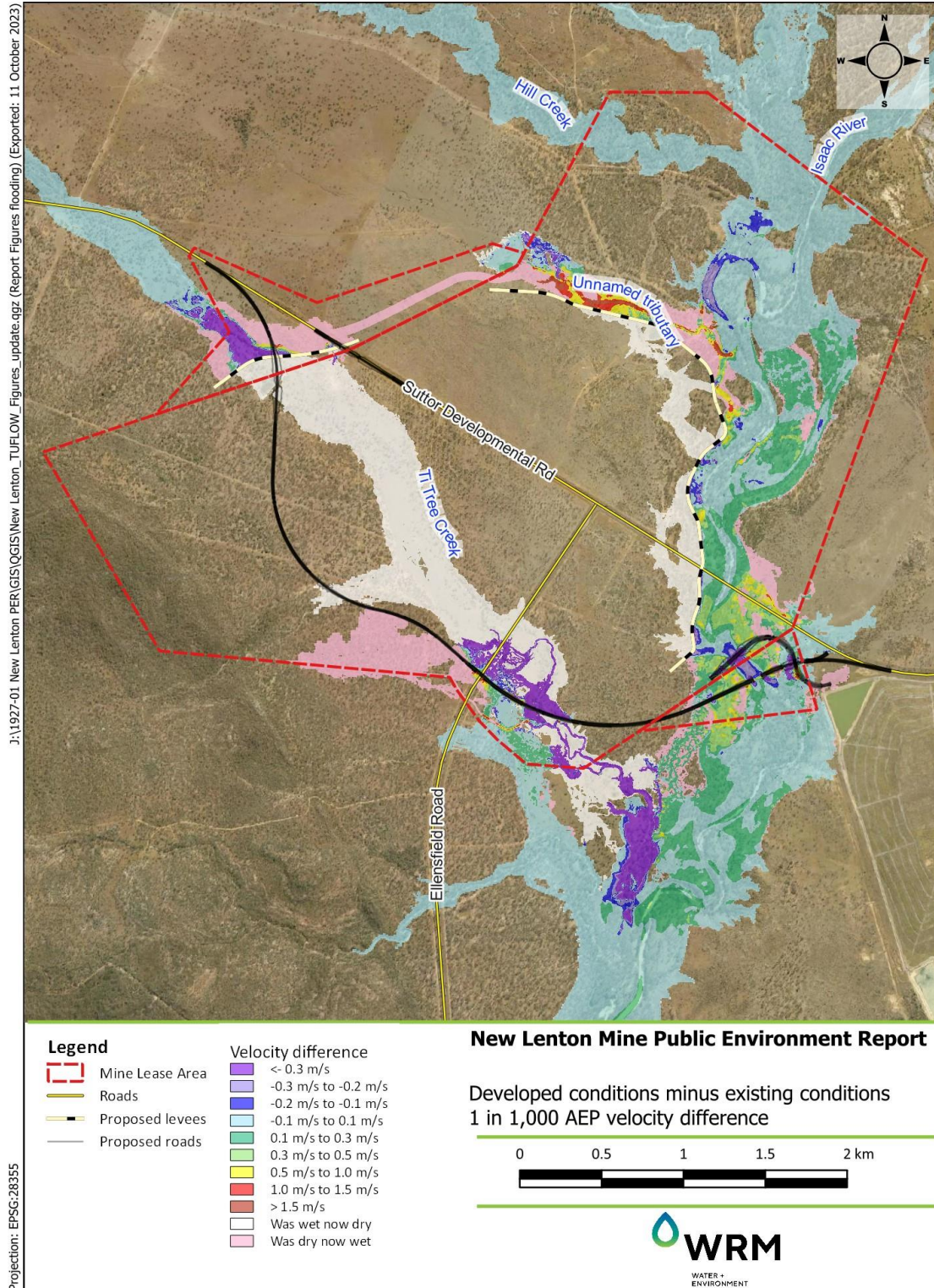


Figure 8.14 Velocity difference 1 in 1,000 AEP (developed minus existing conditions)

8.4 POST-CLOSURE CONDITIONS

The TUFLOW model was used to simulate post-closure conditions for the 1 in 1,000 AEP and PMF flood events. The final landform has been configured to prevent the ingress of floodwaters to the residual void in all events up to the PMF. At the completion of mining, permanent drainage of waste overburden emplacement areas will be installed to minimise capture of surface runoff into the residual void.

The final landform scenario incorporated the following changes:

- Temporary structures have been modified, in particular the flood protection levees, and converted to a final stable, rehabilitated landform shaped to prevent the ingress of floodwaters in a PMF event.
- The realigned Suttor Developmental Road and the Ti-Tree Creek diversion remain in the final landform.
- The final landform surface was incorporated into the model topography including the final overburden emplacement areas.

The model results for the 1 in 1,000 AEP flood event for depth, afflux, velocity and velocity difference are shown in Figure 8.15 to Figure 8.18 respectively. The depth results for the PMF flood event are shown in Figure 8.19. Due to the similarity between the final landform and operational conditions within the floodplains for events of 1% AEP or less, similar changes would be expected for these events for final landform conditions and operational conditions.

The flood level modelling results for the 1:1,000 AEP event show:

- For the Isaac River:
 - Water levels adjacent to the waste rock emplacement areas (i.e. the final stable, rehabilitated landform) along the Isaac River are minor at up to 0.4 m higher than existing conditions.
 - Changes in water level dissipating to insignificant (<0.25 m) upstream and downstream of the levee.
 - There are minor changes in the areas that are subject to flooding compared to pre-mining.
- For Ti-Tree Creek and Ti-Tree Creek Diversion
 - Upstream of the Ti-Tree Creek diversion and levee, there are increases in flood levels by 3 m, with these impacts dissipating within about 600 m upstream. The diversion and levee are operating in accordance with their conceptual design to channel water around active mining areas and prevent ingress of flood water up to the 1 in 1,000 AEP event.
 - Water levels along the unnamed tributary downstream of the Ti-Tree Creek diversion channel increase by up to about 2.0 m. These changes dissipate once the unnamed tributary joins the Isaac River. There are minor changes in the areas that are subject to flooding around the downstream portion of the unnamed tributary.
 - Water levels are reduced along Ti-Tree Creek downstream of the Project Disturbance Area by 3.0 m over the range of modelled events due to the diversion of flow to the unnamed tributary. These changes dissipate once the remaining portion of Ti-Tree Creek enters the Isaac River.

The flood velocity modelling results for the 1:1,000 AEP event show:

- For the Isaac River:
 - Velocity changes range from nil to minor (< 0.3 m/s) with some very localised areas of around 0.5 m/s to 1 m/s near the levee and River crossings. Detailed design of the waste rock emplacement final rehabilitated landform and road embankments will consider appropriate erosion protection measures for locations of potentially higher velocity. Velocity changes dissipate to insignificant (< 0.3 m/s) upstream of the levee and downstream of the confluence with the residual Ti-Tree Creek channel.
- For Ti-Tree Creek and Ti-Tree Creek Diversion
 - Upstream of the Ti-Tree Creek diversion and levee, there are reductions in velocity as the diversion and levee slow the flow of water from Ti-Tree Creek.
 - Velocities along the unnamed tributary downstream of the Ti-Tree Creek diversion channel increase by up to 1.5 m/s with some very localised areas exceeding 1.5 m/s. These changes dissipate once the unnamed tributary joins the Isaac River. The potential geomorphological impacts of this change are assessed in Section 9. Management measures would include minor reshaping of the landform in detailed design and/or erosion protection measures by establishing vegetation cover (noting that vegetation cover is required as part of rehabilitation) to increase erosion resistance.
 - Velocities are reduced along Ti-Tree Creek downstream of the Project Disturbance Area. These changes dissipate once the remaining portion of Ti-Tree Creek enters the Isaac River.

The primary purpose of the PMF assessment, is to demonstrate protection of the void from flooding under the most extreme rainfall conditions. Figure 8.19 shows that the final rehabilitated Project landform protects the final void from flooding even during a PMF event.

Velocities during a PMF event in any natural drainage system are typically extreme and not representative of erosional forces for which management measures are required.

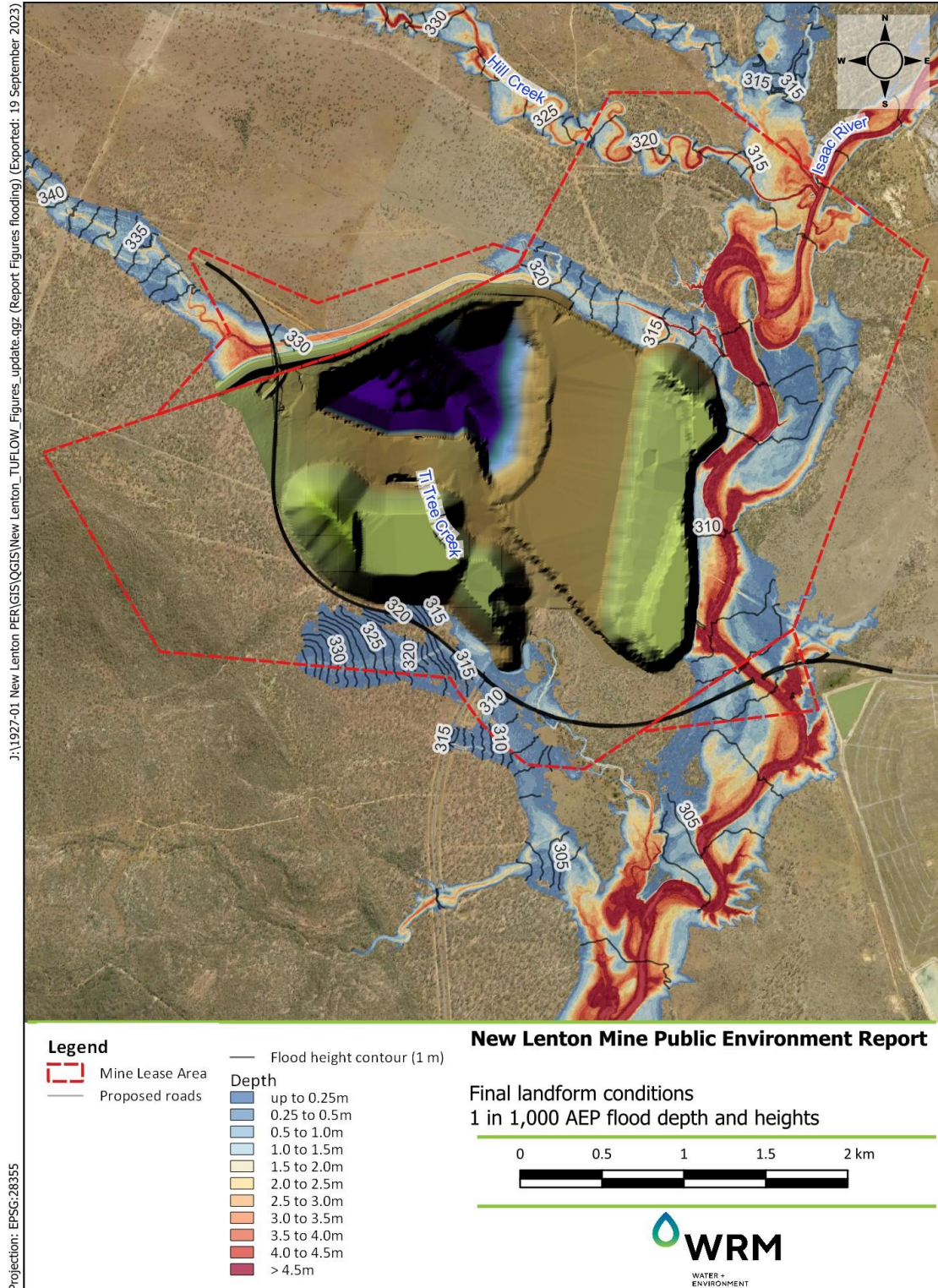


Figure 8.15 Final landform conditions 1 in 1,000 AEP flood depths and heights

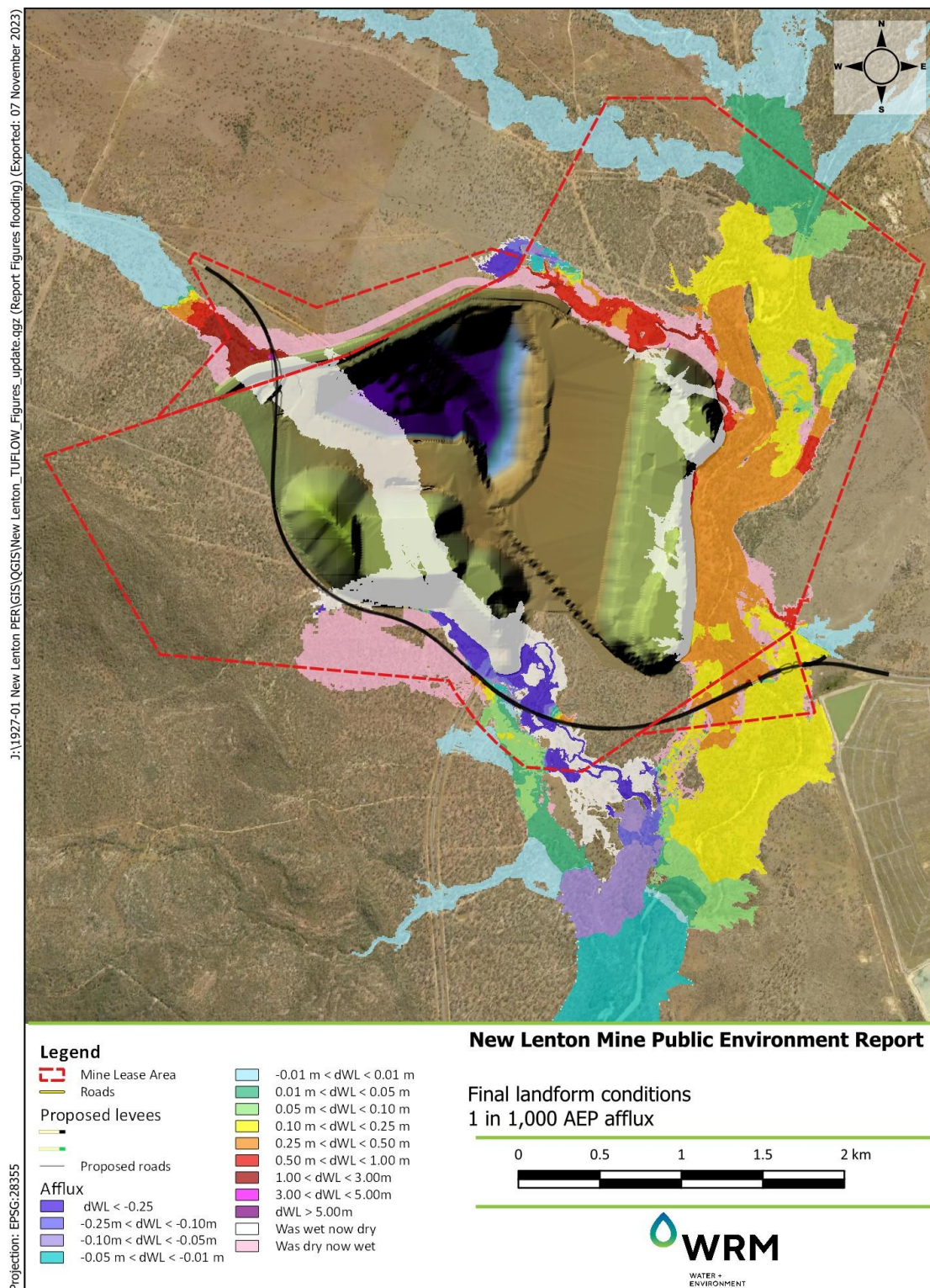


Figure 8.16 Afflux 1 in 1,000 (final landform minus existing conditions)

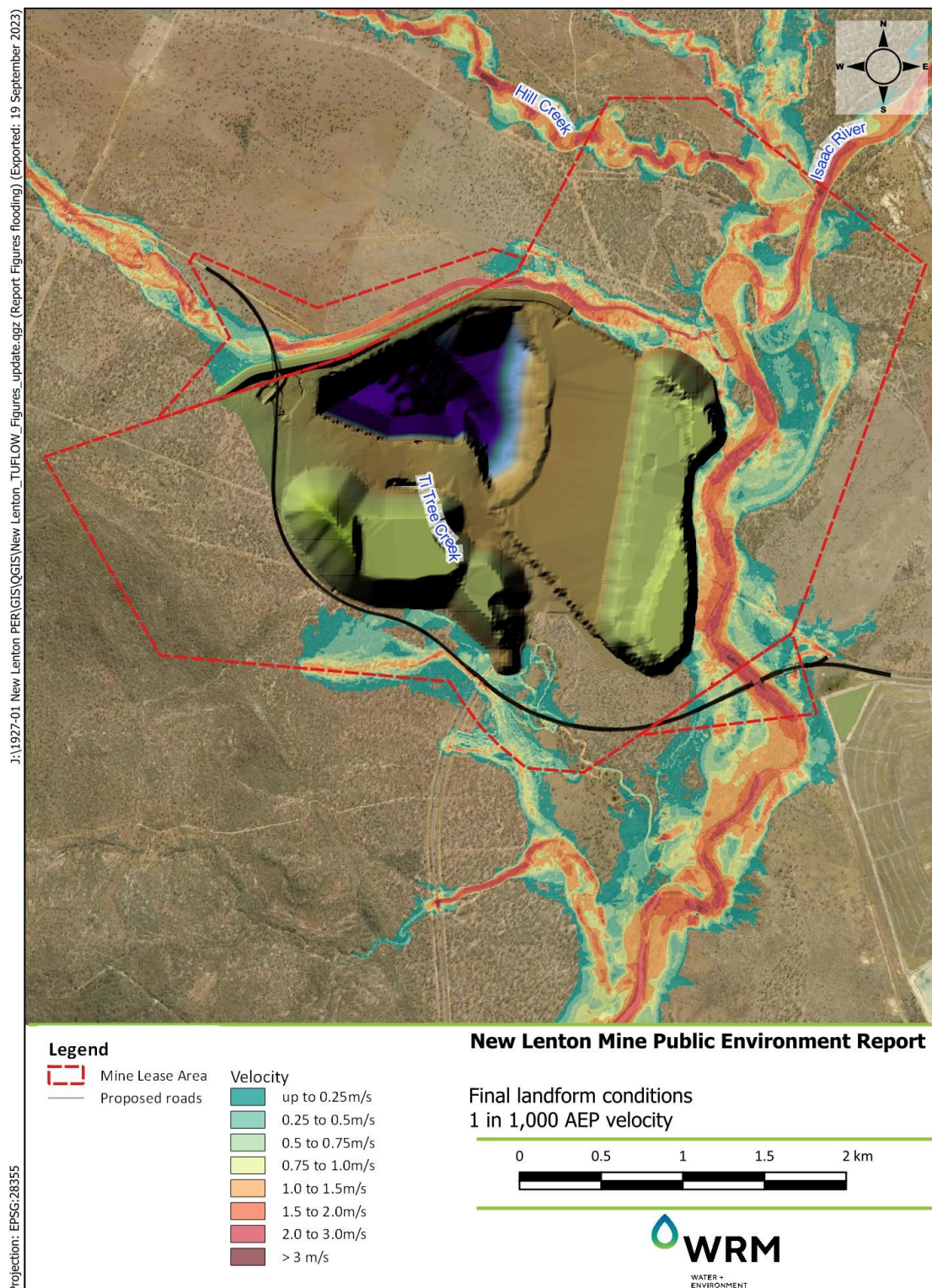


Figure 8.17 Final landform 1 in 1,000 AEP velocity

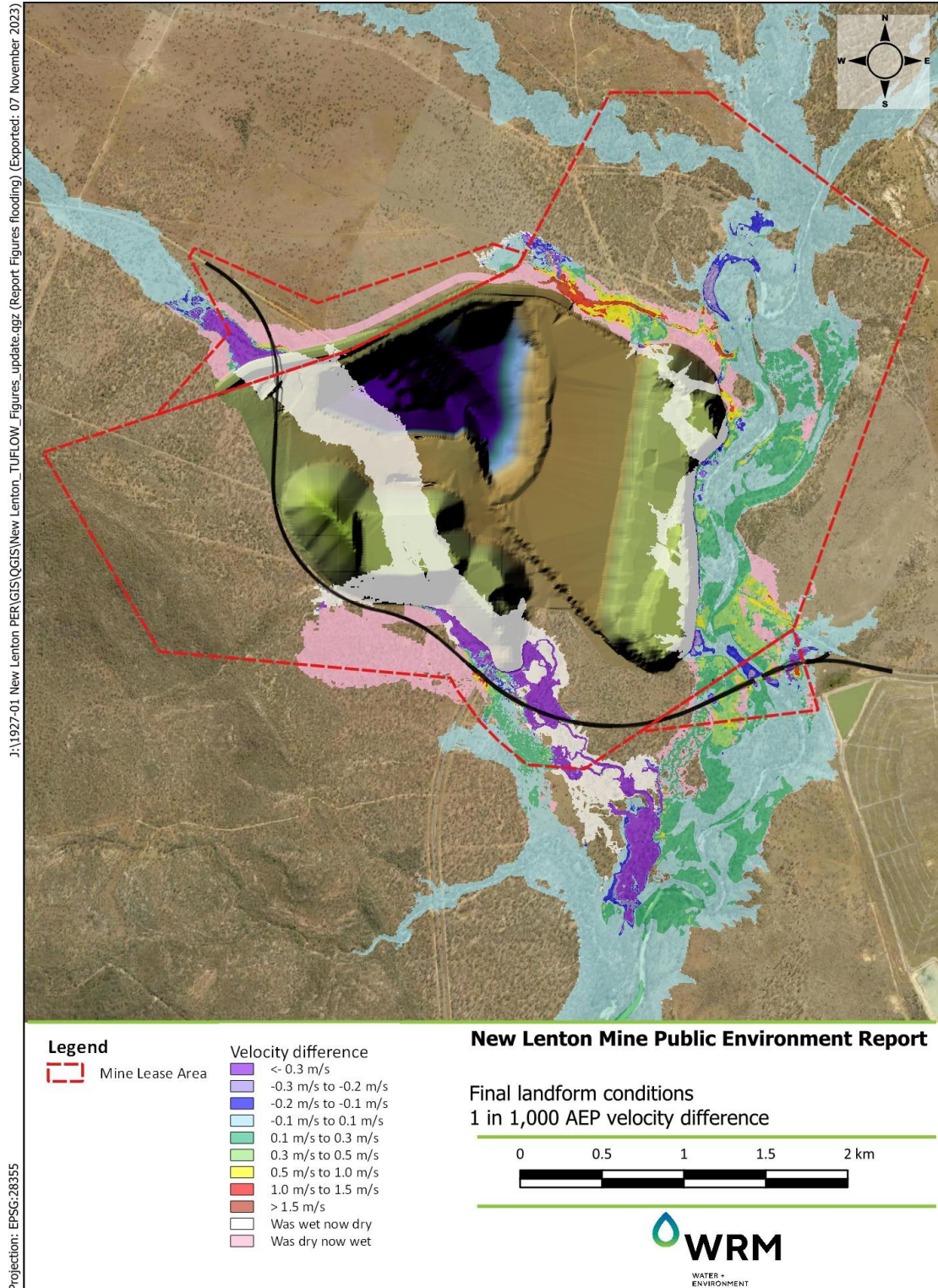


Figure 8.18 Velocity difference 1 in 1,000 AEP (final landform minus existing conditions)

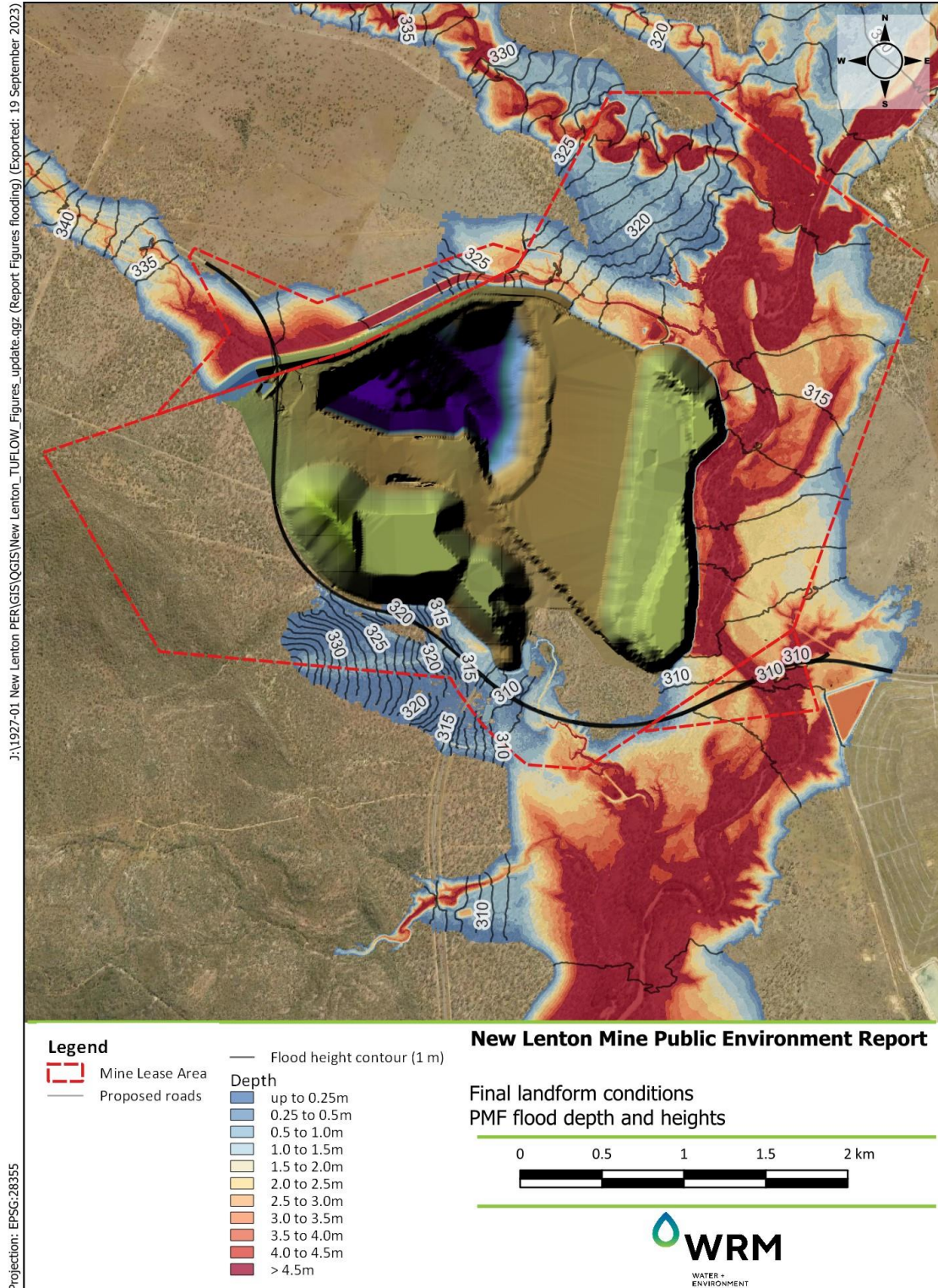


Figure 8.19 Final landform conditions PMF flood depths and heights

9 GEOMORPHOLOGY ASSESSMENT

9.1 OVERVIEW

The development of the Project requires the diversion of a 5.0 km reach of Ti-Tree Creek. A functional design of the Ti-Tree Creek diversion has previously been prepared by GHD (2019). The alignment of the Ti-Tree Creek diversion is shown in Figure 4.6. The design cross-section is based on a trapezoidal excavated channel with bank slopes of 1V:3H.

The design prepared by GHD has been implemented into the TUFLOW model for the development and post closure scenarios. The Ti-Tree Creek diversion diverts flow from Ti-Tree Creek in a west to east direction along the northern side of the mining development to an unnamed tributary of the Isaac River.

As per the GHD design drawings:

- The length of the diversion channel is 2.8 km.
- The diversion has a low flow channel consisting of a 5m base and 1 in 3 side slope batters.
- A larger channel with a 35 m base and 1 in 3 side slope batters.

The purpose of this assessment is to:

- Examine the hydraulic performance of the diversion and the Isaac River tributary in both scenarios against both existing conditions in Ti-Tree Creek and guideline values; and
- Examine what impact, if any, the diversion has on the Isaac River.

The TUFLOW two-dimensional flood model results along the existing watercourses and the Ti-Tree Creek diversion were converted to 1-dimensional section-averaged characteristics along the reaches proposed to be impacted by the Project. The cross sections were located every 25 m along Ti-Tree Creek and the Ti Creek diversion and every 50 m along the Isaac River. Results every 1 m along the section were sampled from the two-dimensional model result grids.

The values of hydraulic parameters were compared against design criteria specified in the Queensland Government *Guideline: Works that interfere with water in a watercourse for a resource activity – watercourse diversions under the Water Act 2000*, (DNRME, 2019). These criteria were developed from research carried out by the Australian Coal Association Research Program (ACARP) Projects (*Project C8030 C9068 – Maintenance of Geomorphic Processes in Bowen Basin River Diversion*). The guideline criteria are summarised in Table 9.1.

Table 9.1 ACARP guideline values

AEP (%)	Velocity (m/s)	Shear Stress (N/m ²)	Stream Power (W/m ²)
50	1.5	40	60
2	2.5	80	220

Although these guidelines are not site-specific, they provide some guidance as to the relative channel velocities, stream power and shear stress that would be expected across the Bowen Basin. These hydraulic parameters and their significance are briefly explained as follows:

- Stream velocity has been used as an indicator of stream impacts, where increases in velocities would suggest some change in the stream characteristics may occur. There is not a 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.

- 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.
- 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 modelling included:
 - An assessment of the 50% AEP design flood to represent the behaviour of the creek channels at bank full flow conditions. The bank full flow is the maximum flow that the channel can carry before it overflows onto the adjacent floodplain. In geomorphologic studies, the bank full flow is often considered to be the stream forming flow, because it often exerts the greatest influence on channel geometry.
 - An assessment of the 2% AEP design flood to represent the behaviour of the creeks and associated floodplains during large floods. It can be used to identify whether the changed out of bank flood behaviour could inadvertently cause an avulsion of the channel.
 - The adopted Manning's 'n' values for both the existing Ti-Tree Creek and the Ti-Tree Creek diversion were:
 - Channel: 'n' = 0.035
 - Banks: 'n' = 0.05

Because the length and alignment of the diversion are different to the existing Ti-Tree Creek, a direct comparison of results on a per chainage basis is not possible. Results have been plotted separately for the existing reach of Ti-Tree Creek and the Ti-Tree Creek diversion. Results for the Isaac River tributary comparing developed conditions to existing conditions have been plotted together. Results for the Isaac River comparing developed conditions to existing conditions have also been plotted together.

9.2 GUIDELINE HYDRAULIC CRITERIA – DEVELOPED VS EXISTING CONDITIONS

9.2.1 50% AEP event

9.2.1.1 Ti-Tree Creek and Ti-Tree Creek Diversion plus Isaac River tributary

The main channel section-averaged results of the hydraulic modelling of the Ti-Tree Creek and Ti-Tree Creek diversion are summarised below.

Figure 9.1 to Figure 9.3 show the results for the existing Ti-Tree Creek for velocity, shear stress and stream power for the 50% AEP event. Figure 9.4 to Figure 9.6 shows the results for the Ti-Tree diversion for velocity, shear stress and stream power for the 50% AEP event. Figure 9.7 to Figure 9.10 show the chainages and depth and velocity maps for the 50% AEP event for Ti-Tree Creek and the Ti-Tree Creek diversion.

Velocity:

- Velocity in existing Ti-Tree Creek varies from 0.3 m/s to 2.8 m/s (i.e. pre-mining conditions are above ACARP guideline value of 1.5 m/s).
- Velocity along the diversion channel varies from 0.3 m/s to 2.25 m/s (i.e. similar to or less than velocities in the existing Ti-Tree Creek).
- Along 2 km of the 2.8 km long diversion channel, velocities are below the guideline value of 1.5 m/s.
- Velocities are in the range of 1.5 m/s to 2.3 m/s along the final portion of the diversion.

- Velocities along the diversion are generally more uniform than Ti-Tree creek and generally lower.
- The maximum velocities along the diversion (2.5 m/s) are less than the maximum velocities in Ti-Tree Creek (2.8 m/s) in existing conditions.
- Velocity in the Isaac River tributary in existing conditions generally ranges from 0.2 to 1.4 m/s. Under existing conditions, there is a localised hotspot with a velocity of approximately 3.0 m/s. This hotspot is removed with the implementation of the diversion channel.
- The velocity in the Isaac River tributary downstream of the diversion in developed conditions generally ranges from 0.7 to 2.4 m/s, with increases of up to 1.0 m/s compared to existing conditions.
- These velocity values are similar too but generally less than the range of velocities in the existing Ti-Tree Creek.
- An erosion monitoring plan will be developed for the Isaac River tributary to assess changes in bed levels and the impact of increased velocities.
- Bank protection measures will be considered if monitoring indicates the increase in erosion is having an identifiable impact on the channel form.

Shear Stress and Stream Power:

- Shear stress and stream power in existing Ti-Tree creek are highly variable with shear stress and stream power peak values up to 130 N/m² and 340 W/m² respectively (i.e. pre-mining conditions are above ACARP guideline values of 40 N/m² and 60 W/m²).
- From chainage 1,200 to 2,800 the Ti-Tree diversion has shear stress values above the guideline value of 40 N/m².
- Between chainage 2,000 and 2,800 there are a couple of localised spikes in stream power that are above the guideline value of 60 W/m².
- However, shear stress and stream power values within the diversion are generally lower than in the existing Ti-Tree Creek and therefore within the bounds of what are typical for local conditions.
- Shear stress and stream power in the Isaac River tributary in existing conditions generally range from 10 to 50 N/m² and from 20 to 70 W/m² respectively.
- There is one localised hotspot with a bed shear value of 245 N/m² and stream power value of 730 W/m². This hotspot is removed with the implementation of the diversion channel.
- Shear stress and stream power in the Isaac River tributary downstream of the diversion in developed conditions generally ranges from 40 to 170 N/m² and 60 to 310 W/m² respectively (i.e. similar to existing Ti-Tree Creek).



Figure 9.1 Ti-Tree Creek longitudinal profile of 50% AEP section-averaged velocity



Figure 9.2 Ti-Tree Creek longitudinal profile of 50% AEP section-averaged shear stress

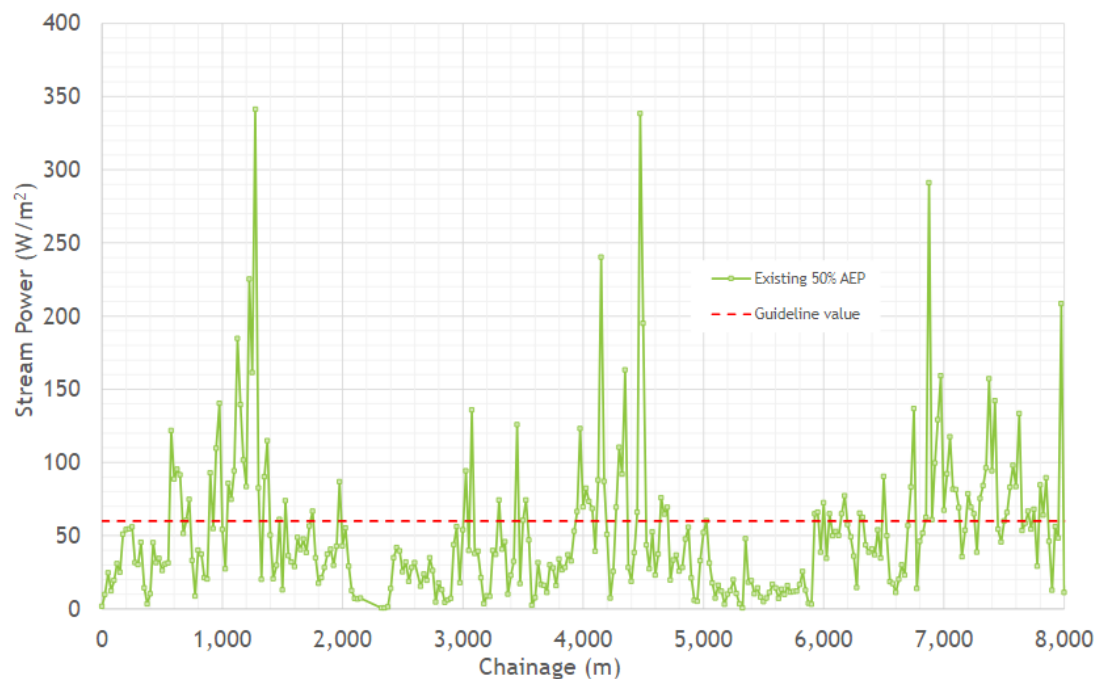


Figure 9.3 Ti-Tree Creek longitudinal profile of 50% AEP section-averaged stream power

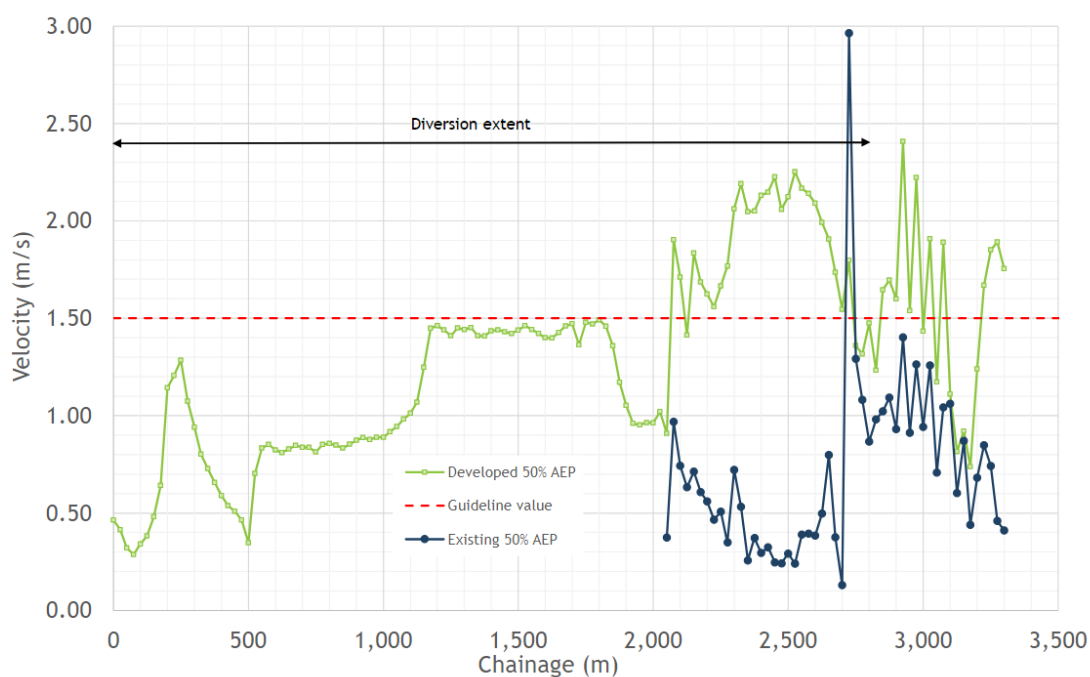


Figure 9.4 Ti-Tree Creek Diversion longitudinal profile of 50% AEP section-averaged velocity

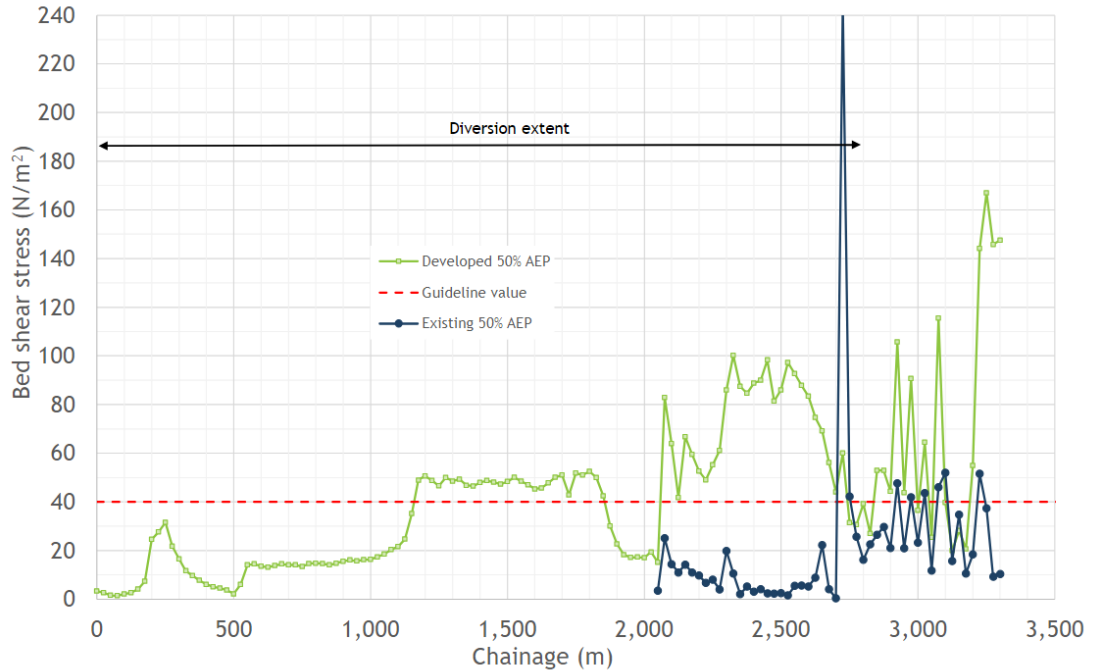


Figure 9.5 Ti-Tree Creek Diversion longitudinal profile of 50% AEP section-averaged shear stress

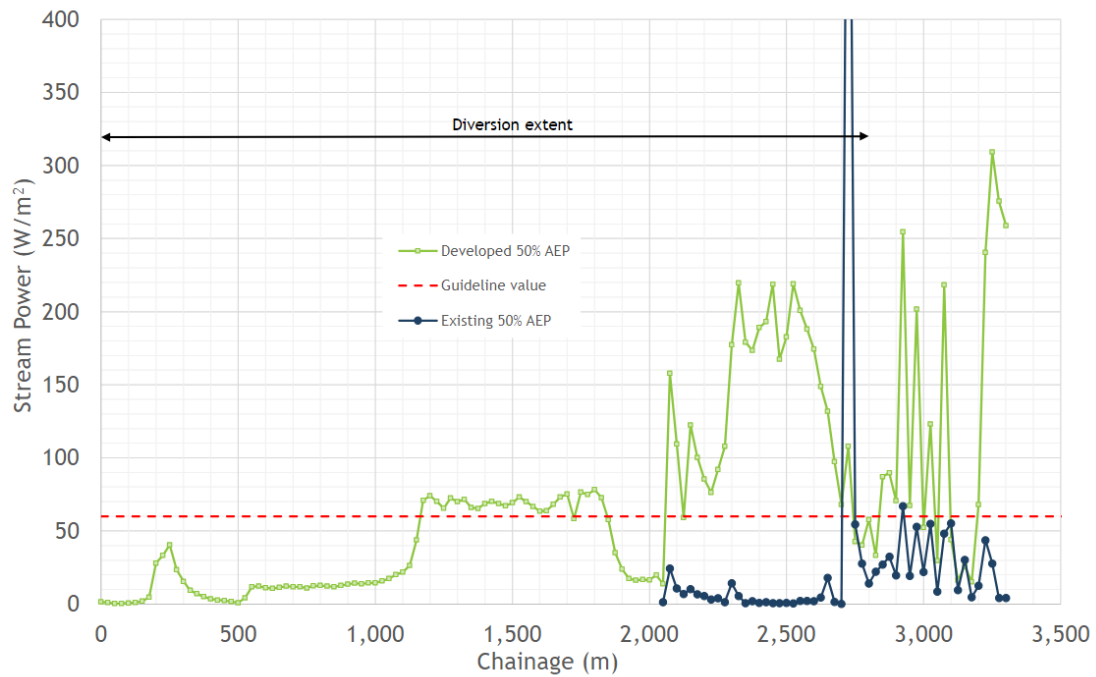


Figure 9.6 Ti-Tree Creek Diversion longitudinal profile of 50% AEP section-averaged stream power

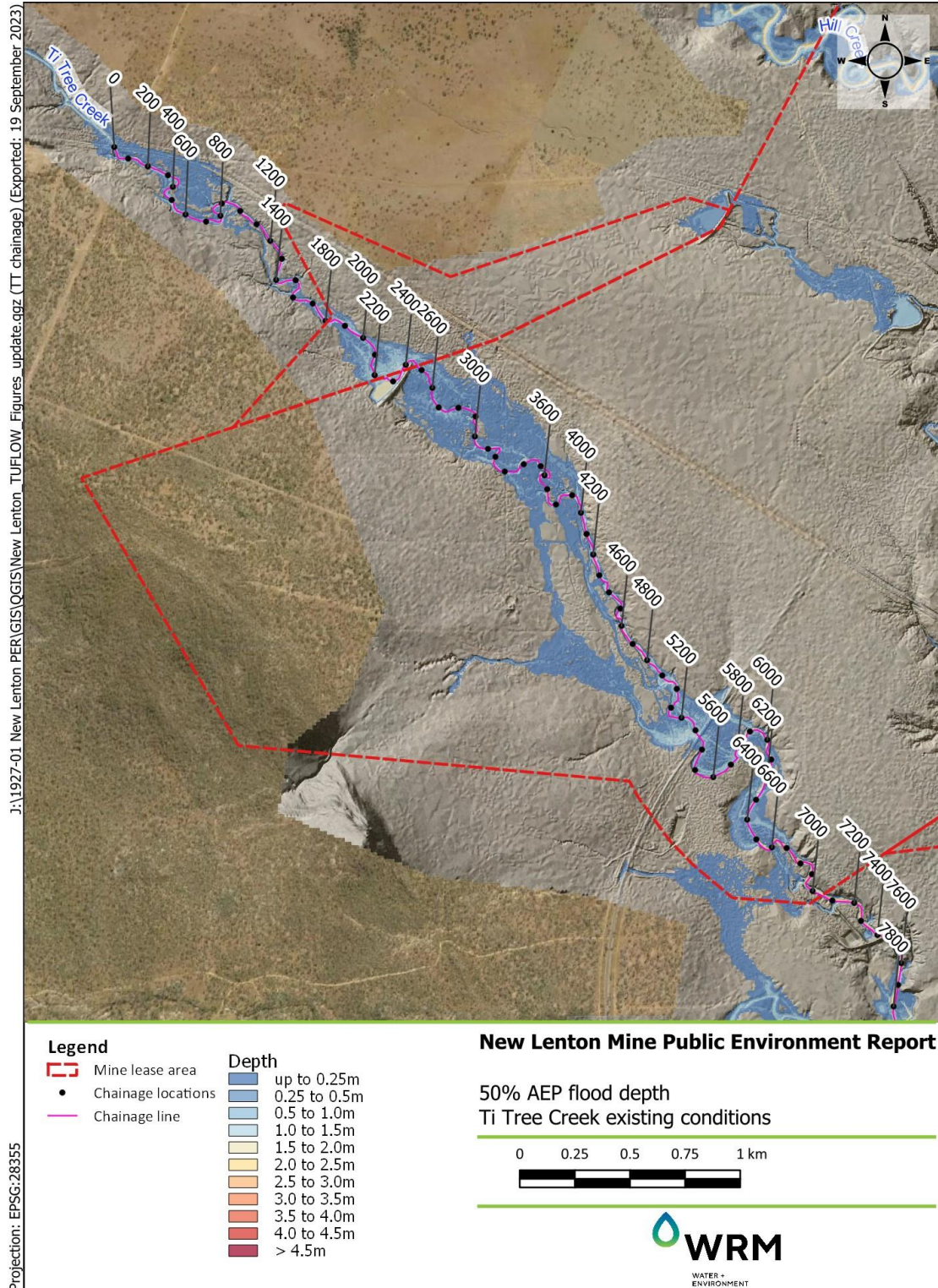


Figure 9.7 Ti-Tree Creek 50% AEP depth existing conditions

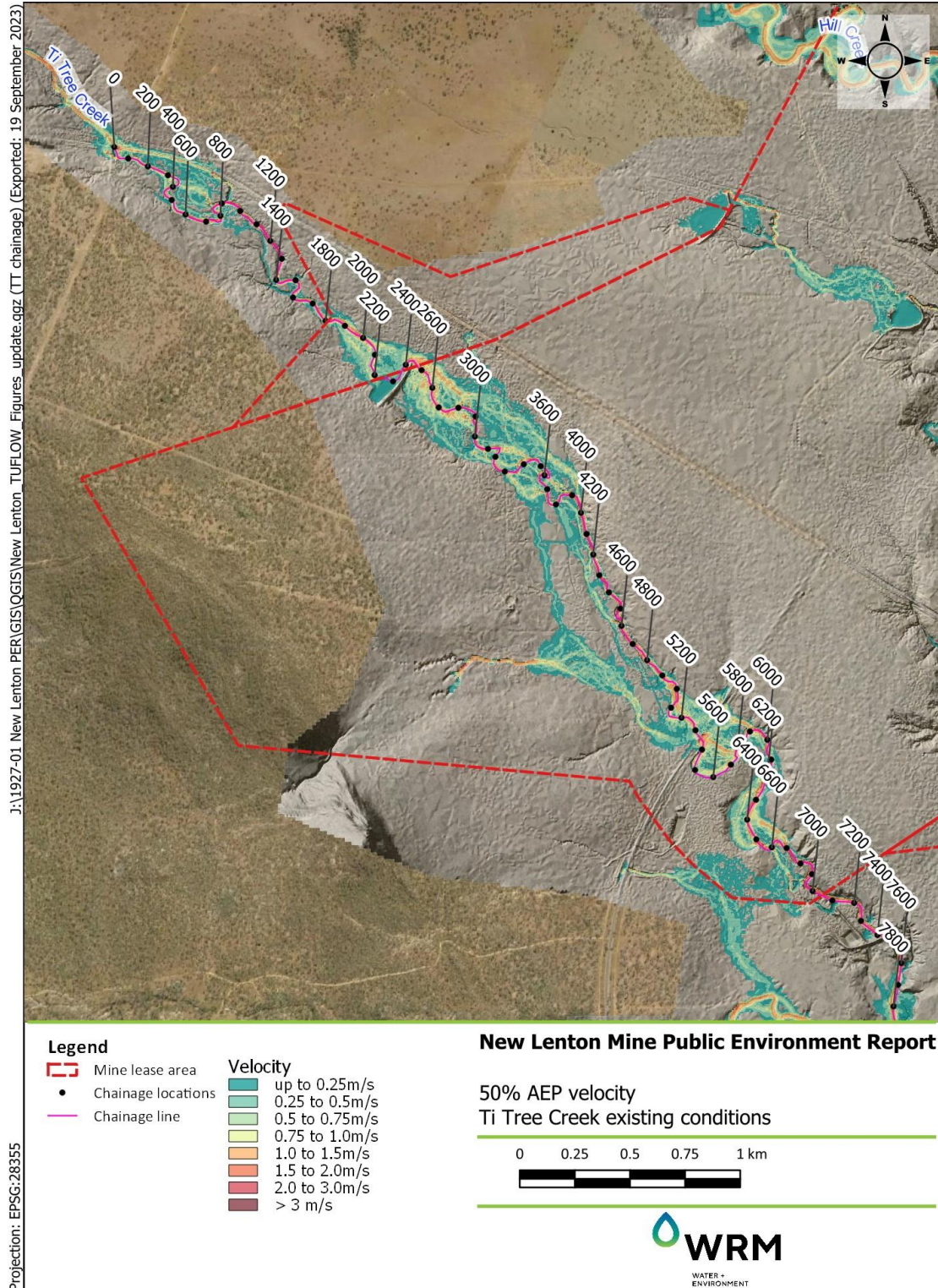


Figure 9.8 Ti-Tree Creek 50% AEP velocity existing conditions

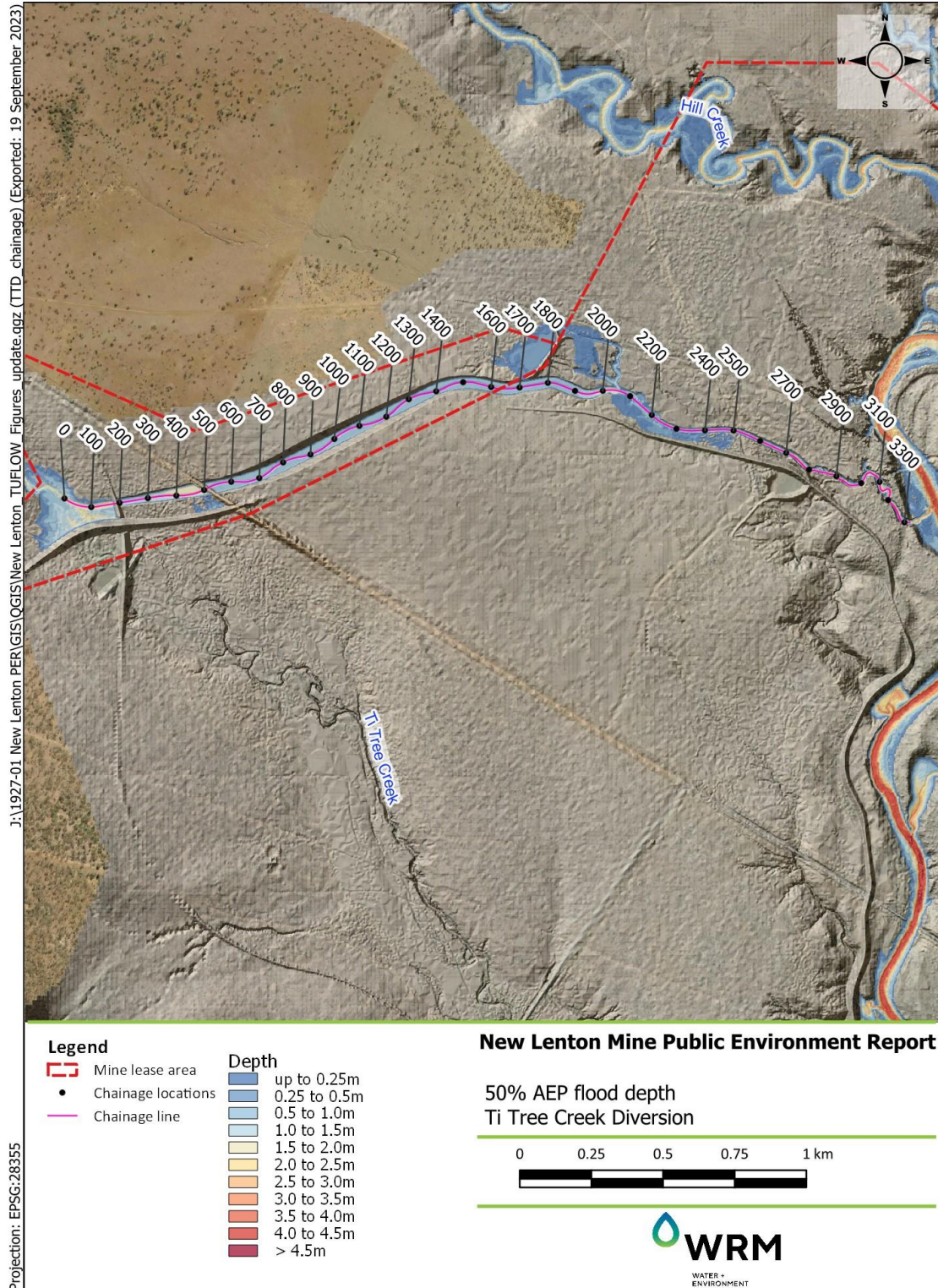


Figure 9.9 Ti-Tree Diversion 50% AEP depth

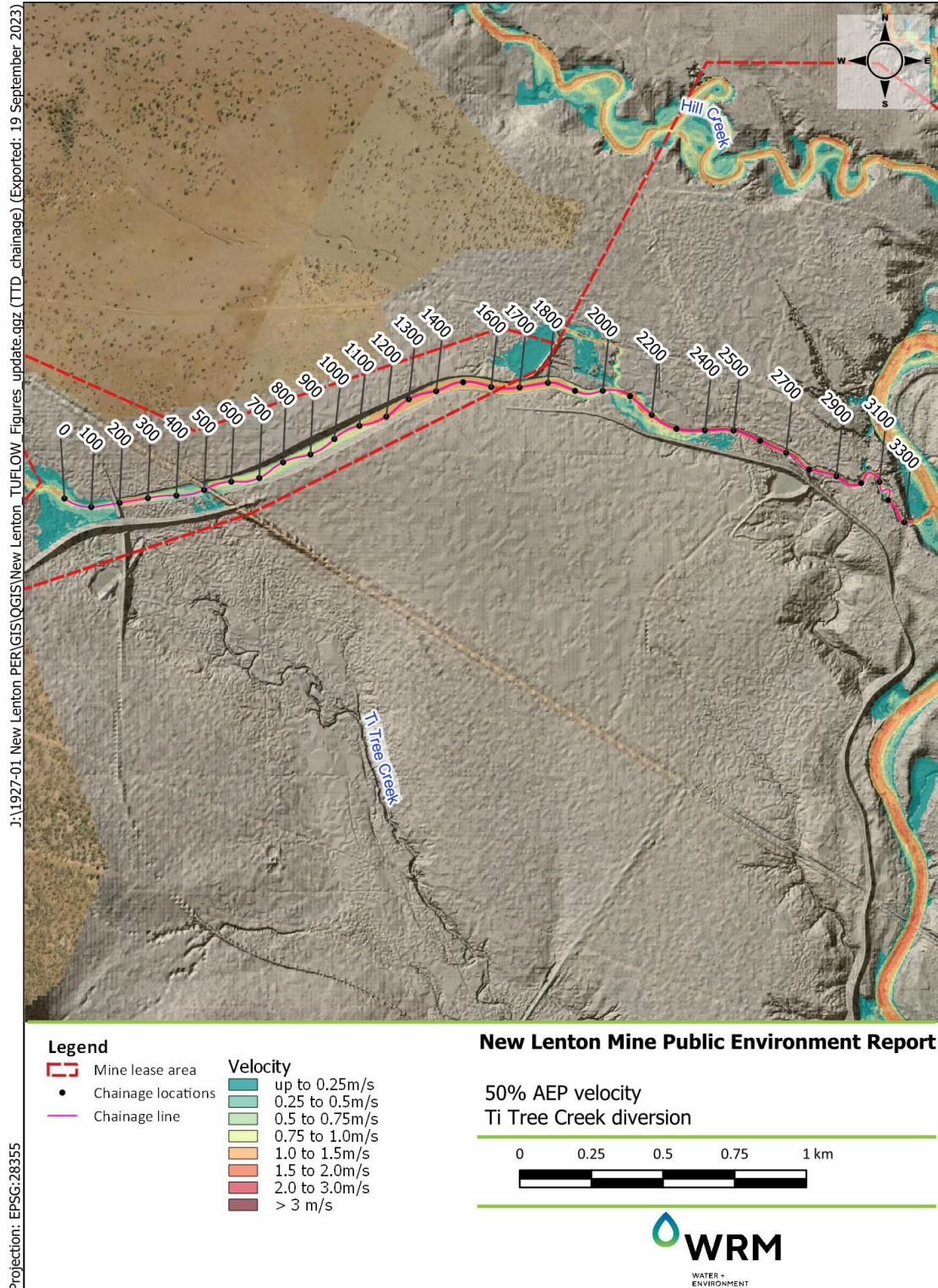


Figure 9.10 **Ti-Tree Diversion 50% AEP velocity**

9.2.1.2 Isaac River

Figure 9.11 to Figure 9.13 show the results for existing and developed scenarios in the Isaac River for velocity, shear stress and stream power. Figure 9.14 to Figure 9.17 show the chainages and depth and velocity maps for the 50% AEP event for the Isaac River for existing and developed scenarios.

The results for velocity, shear stress and stream power show immaterial change between existing and developed conditions in the 50% AEP event.

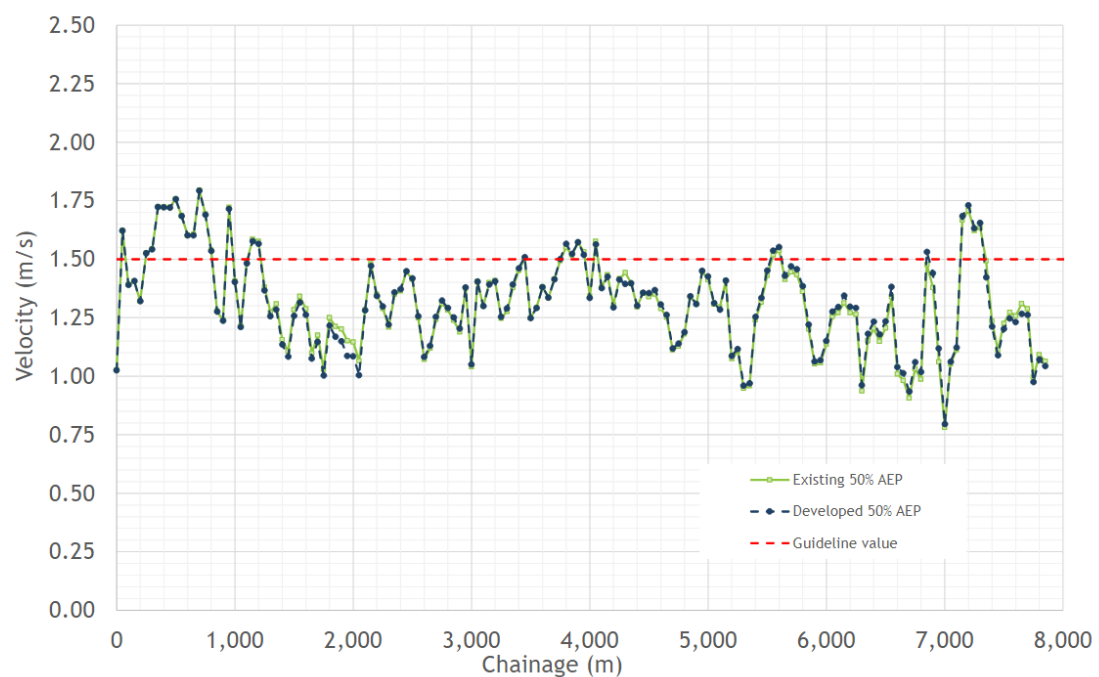


Figure 9.11 Isaac River longitudinal profile of 50% AEP section-averaged velocity

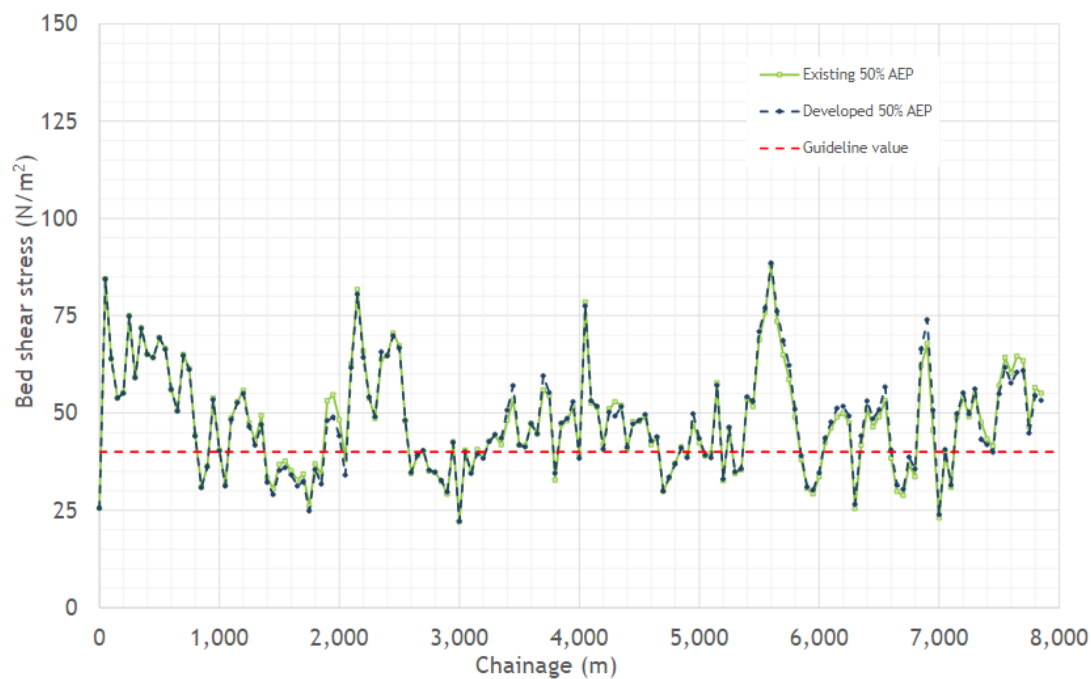


Figure 9.12 Isaac River longitudinal profile of 50% AEP section-averaged shear stress

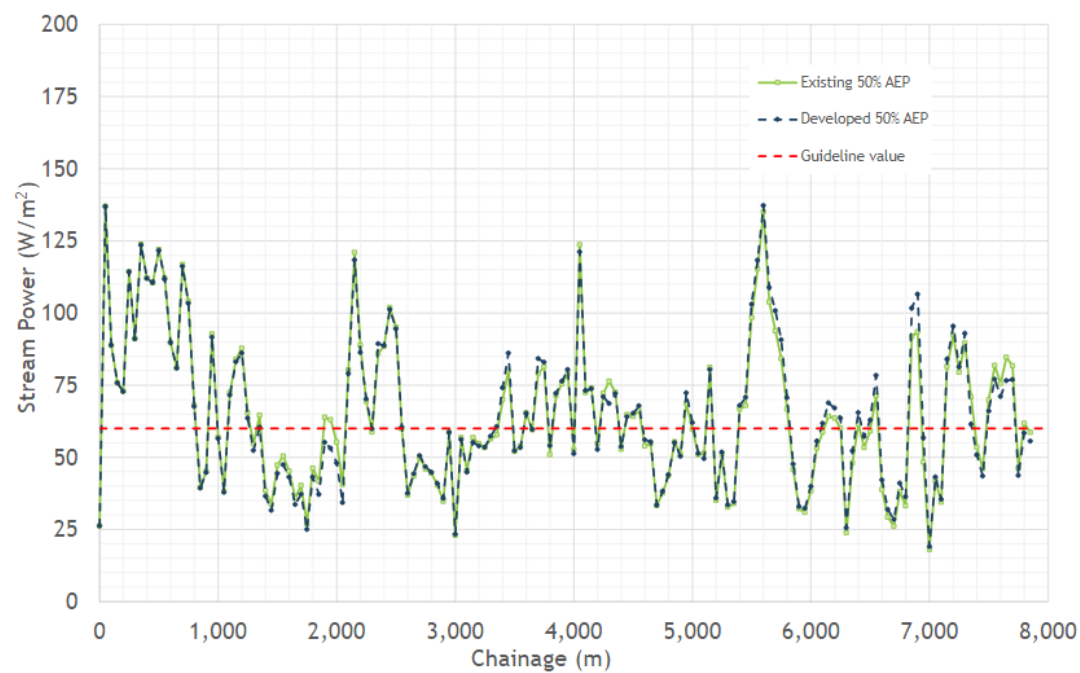


Figure 9.13 Isaac River longitudinal profile of 50% AEP section-averaged stream power

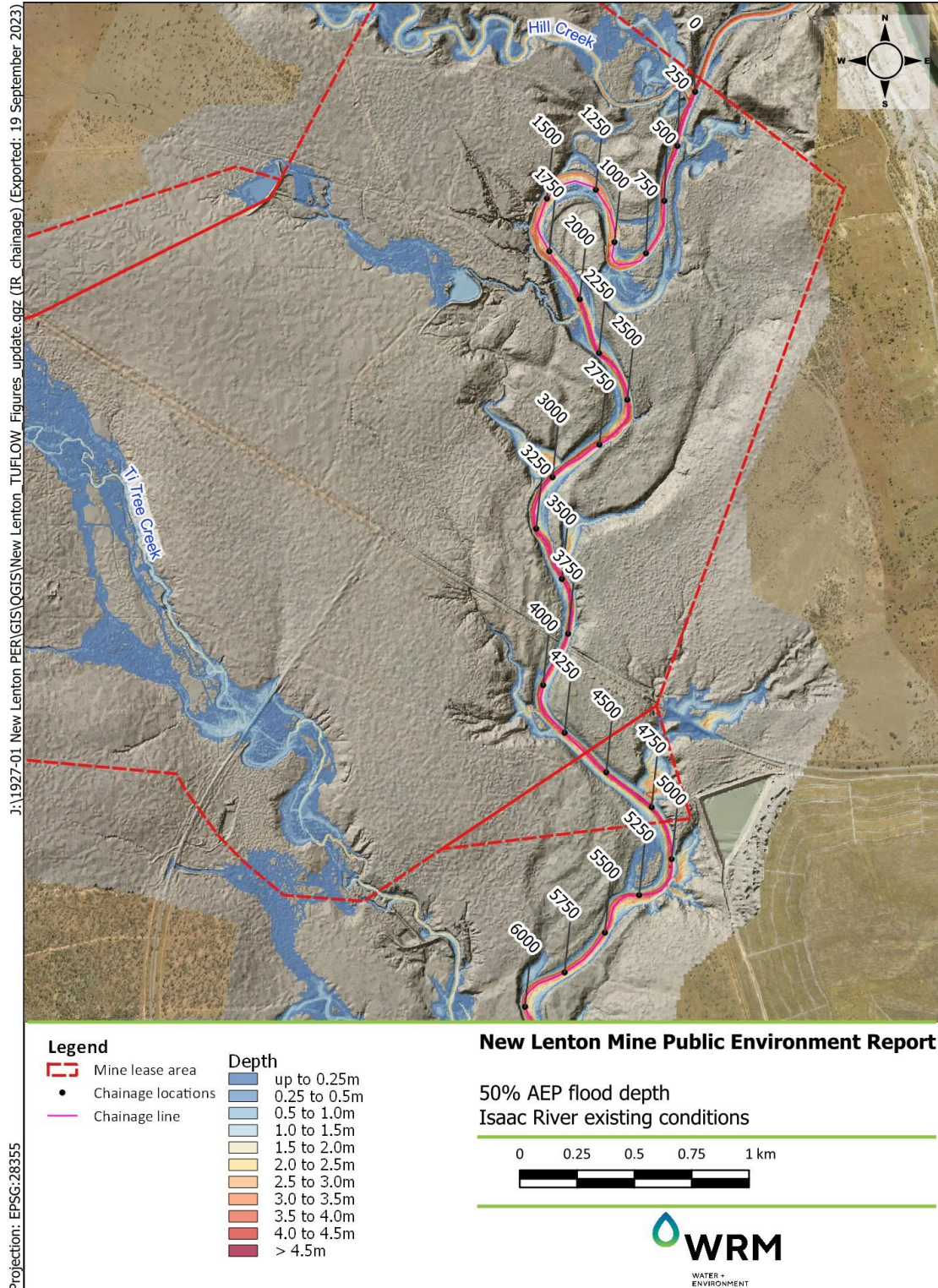


Figure 9.14 Isaac River 50% AEP depth existing conditions

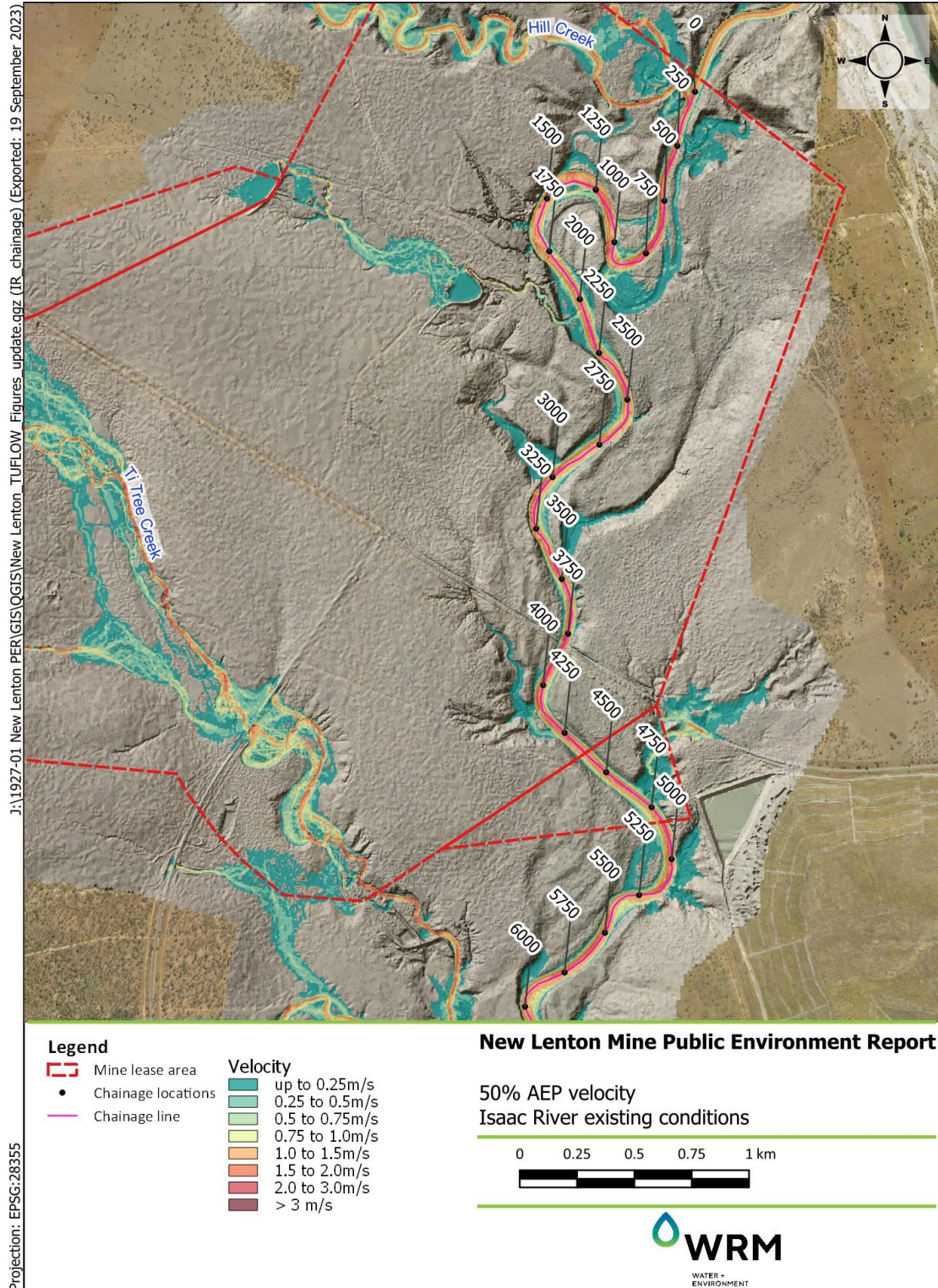


Figure 9.15 Isaac River 50% AEP velocity existing conditions

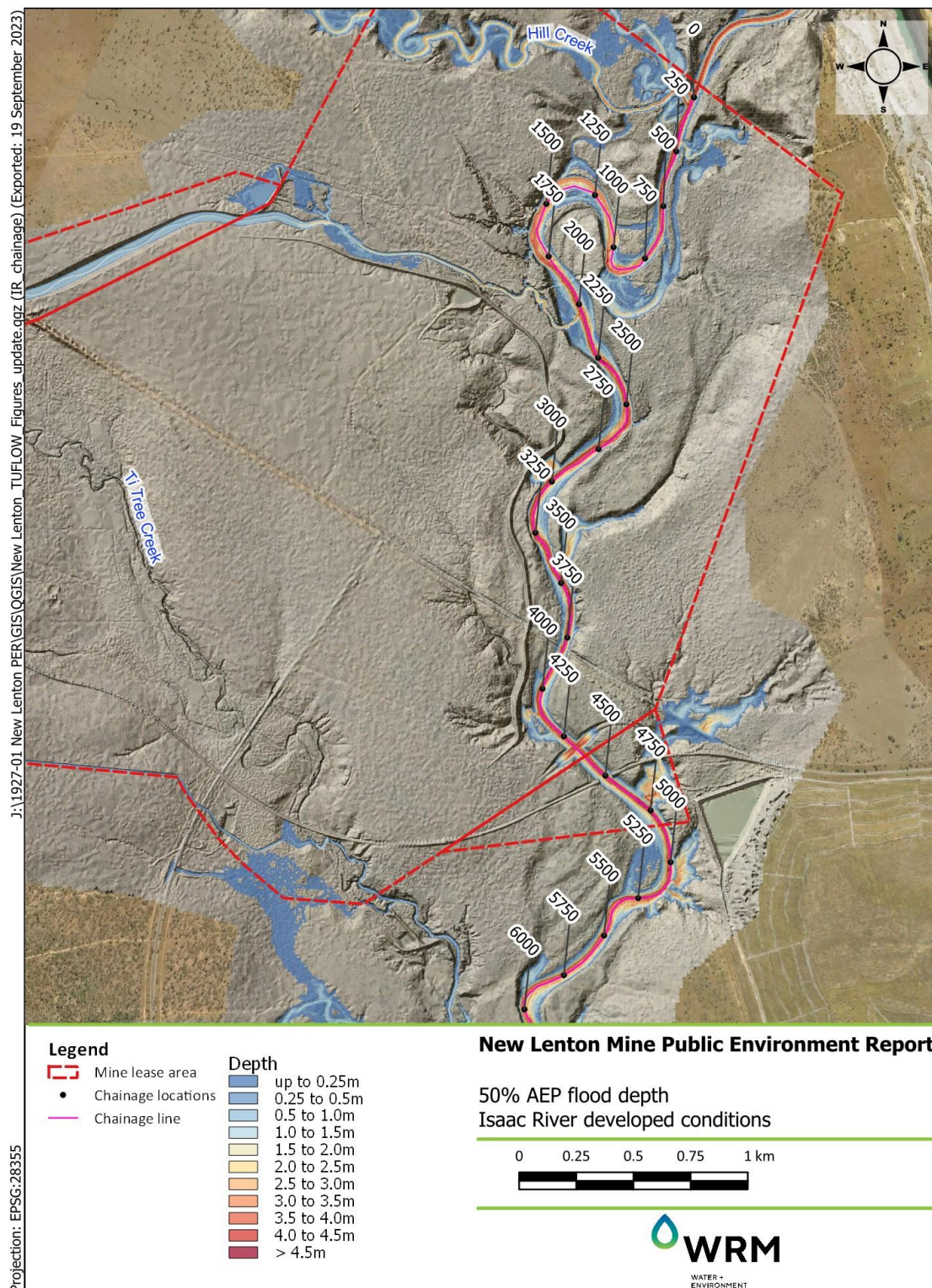


Figure 9.16 Isaac River 50% AEP depth developed conditions

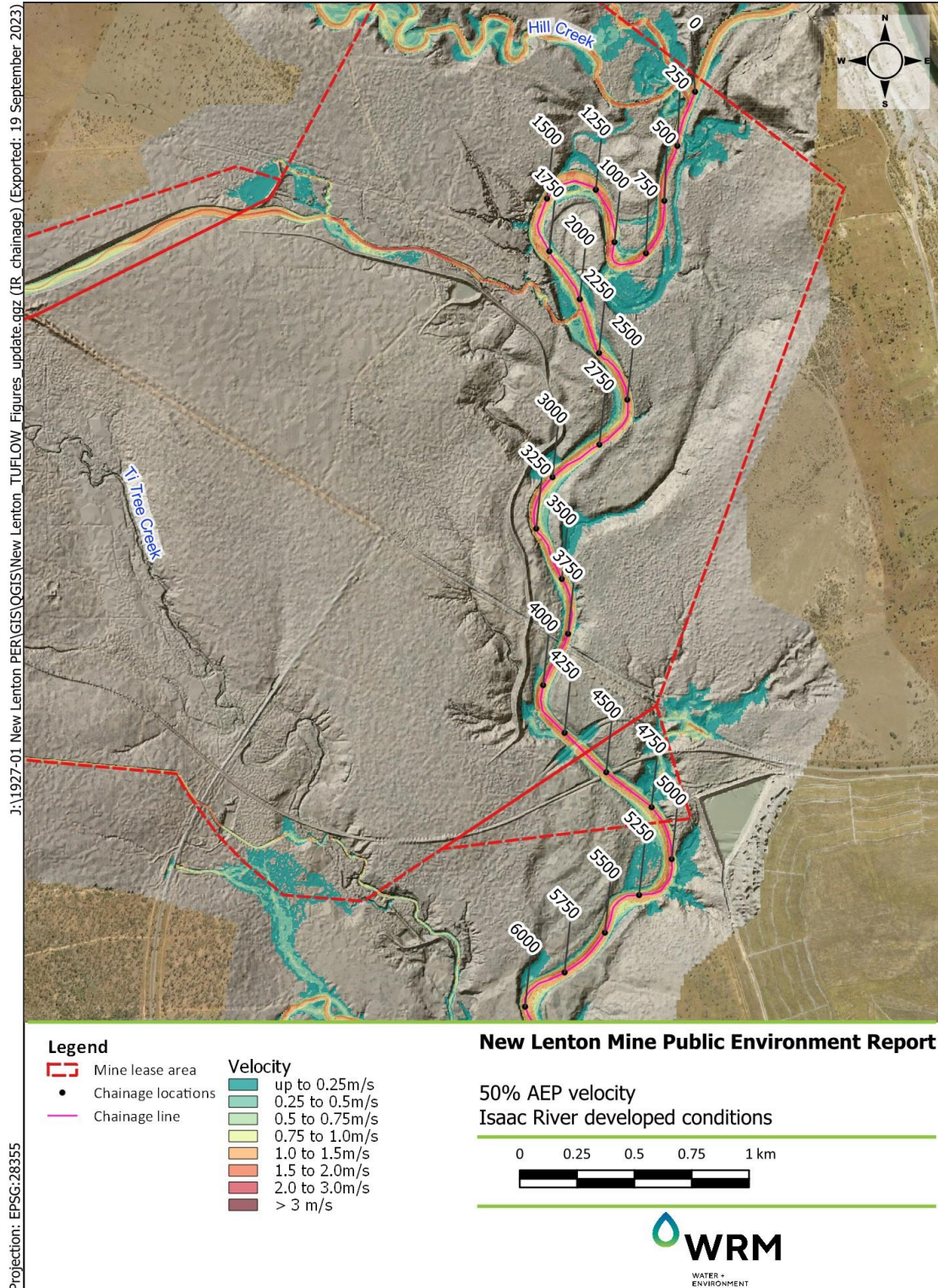


Figure 9.17 Isaac River 50% AEP velocity developed conditions

9.2.2 2% AEP event

9.2.2.1 Ti-Tree Creek and Ti-Tree Creek diversion

The main channel section-averaged results of the hydraulic modelling of the Ti-Tree Creek and Ti-Tree Creek diversion are summarised below.

Figure 9.18 to Figure 9.20 shows results for the existing Ti-Tree Creek for velocity, shear stress and stream power. Figure 9.21 to Figure 9.23 shows the results for the Ti-Tree diversion for velocity, shear stress and stream power. Figure 9.24 to Figure 9.27 show the chainages and depth and velocity maps for the 2% AEP event for Ti-Tree Creek and the Ti-Tree Creek diversion.

Velocity:

- Velocity in existing Ti-Tree Creek is highly variable from near still waters to 3.6 m/s (i.e. pre-mining conditions are above ACARP guideline value of 2.5 m/s).
- Velocity along the diversion channel varies from 0.5 m/s to 2.8 m/s.
- Along 2.3 km of the 2.8 km long diversion channel, velocities are below the guideline value of 2.5 m/s.
- There is a localised peak of 2.8 m/s along the final portion of the diversion but values are otherwise within the guideline value and similar to typical peak values in the existing Ti-Tree Creek.
- Velocities along the diversion are generally more uniform than Ti-Tree Creek.
- The maximum velocity along the diversion (2.8 m/s) is less than the maximum velocities in Ti-Tree Creek (3.6 m/s) in existing conditions.
- Velocity in the Isaac River tributary in existing conditions generally ranges from 0.2 to 2.1 m/s.
- The velocity in the Isaac River tributary downstream of the diversion in developed conditions generally ranges from 0.9 m/s to 2.4 m/s with increases of up to 2.0 m/s compared to existing conditions but under the guideline value of 2.5 m/s.
- As noted previously, an erosion monitoring plan will be developed for the Isaac River tributary to assess changes in bed levels and the impact of increased velocities.
- Bank protection measures will be considered if monitoring indicates the increase in erosion is having an identifiable impact on the channel form.

Shear Stress and Stream Power:

- Shear stress and stream power in existing Ti-Tree Creek are highly variable with peak values for shear stress and stream power up to 240 N/m² and 810 W/m² respectively (i.e. pre-mining conditions are above ACARP guideline values of 80 N/m² and 220 W/m²).
- From chainage 1,200 to 2,350 the Ti-Tree Creek diversion has a shear stress value above the guideline value of 80 N/m².
- Between chainage 2,000 and 2,350 there are a couple of localised spikes in stream power that are above the guideline value of 220 W/m².
- However, shear stress and stream power values within the diversion are generally lower than in the existing Ti-Tree Creek with lower maximum values than are typical in the existing watercourse.

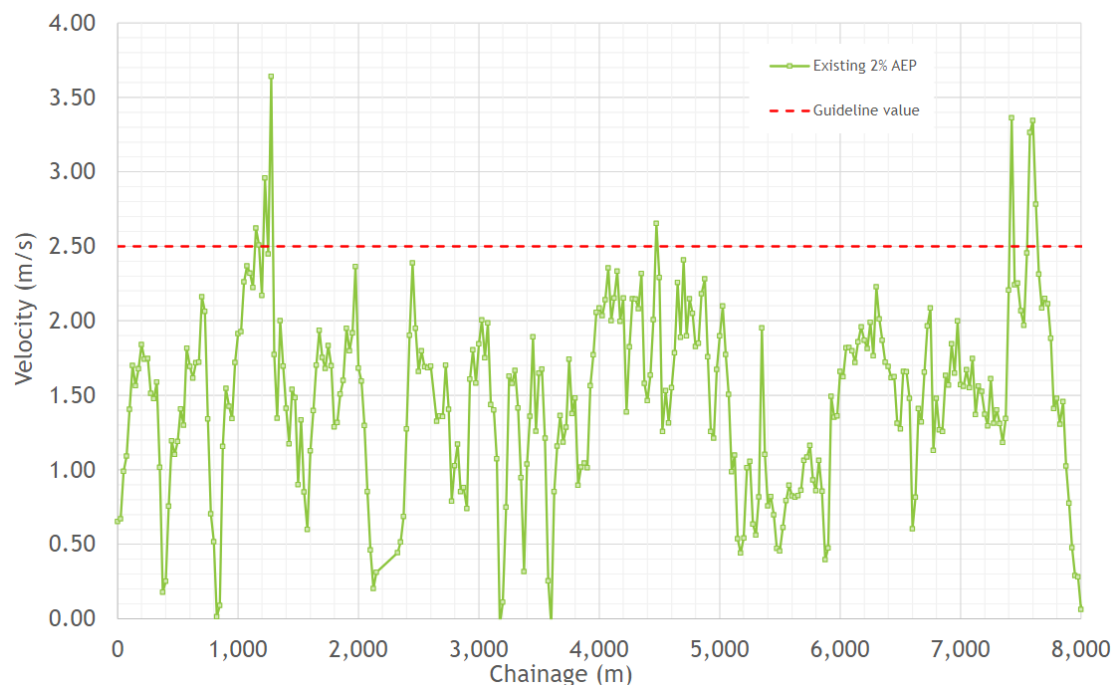


Figure 9.18 Ti-Tree Creek longitudinal profile of 2% AEP section-averaged velocity

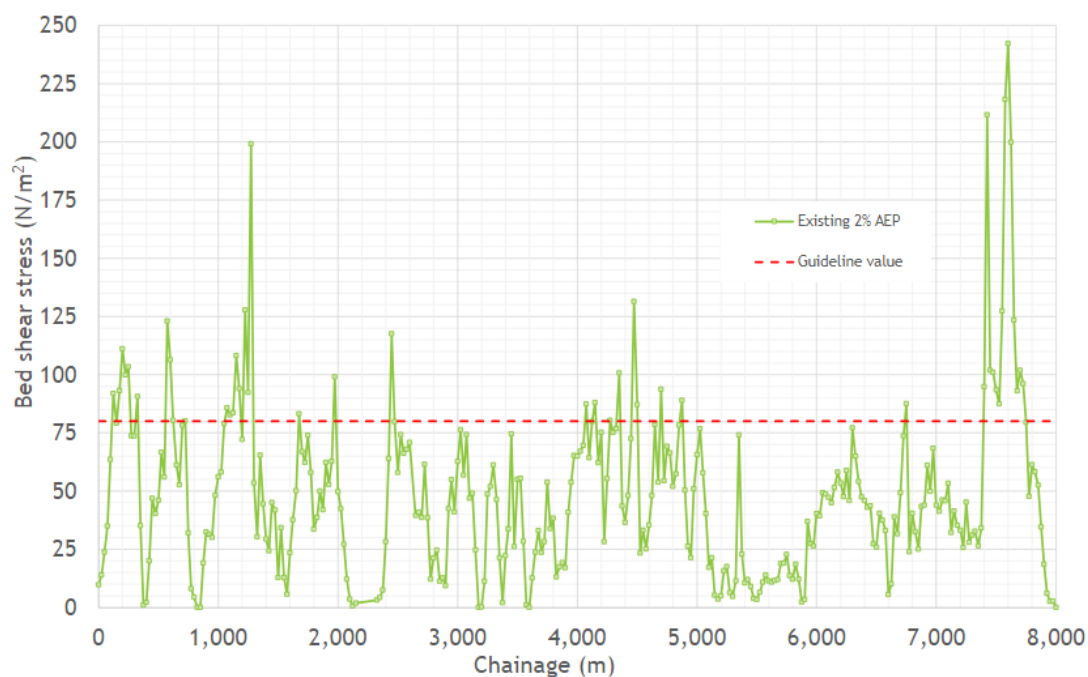


Figure 9.19 Ti-Tree Creek longitudinal profile of 2% AEP section-averaged shear stress

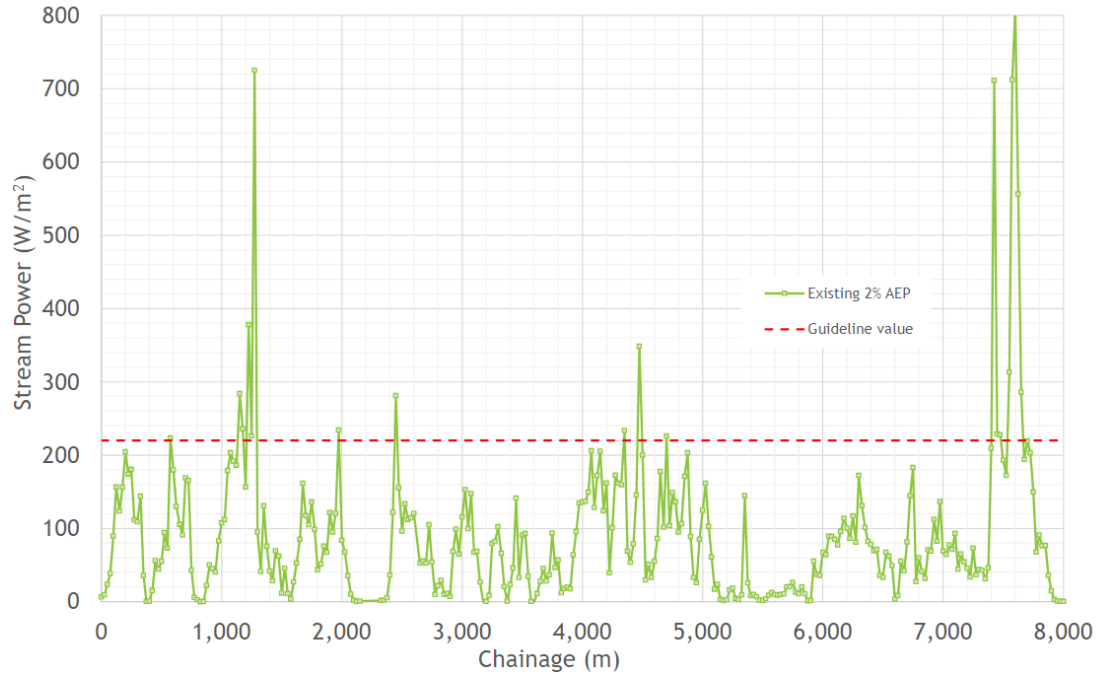


Figure 9.20 Ti-Tree Creek longitudinal profile of 2% AEP section-averaged stream power

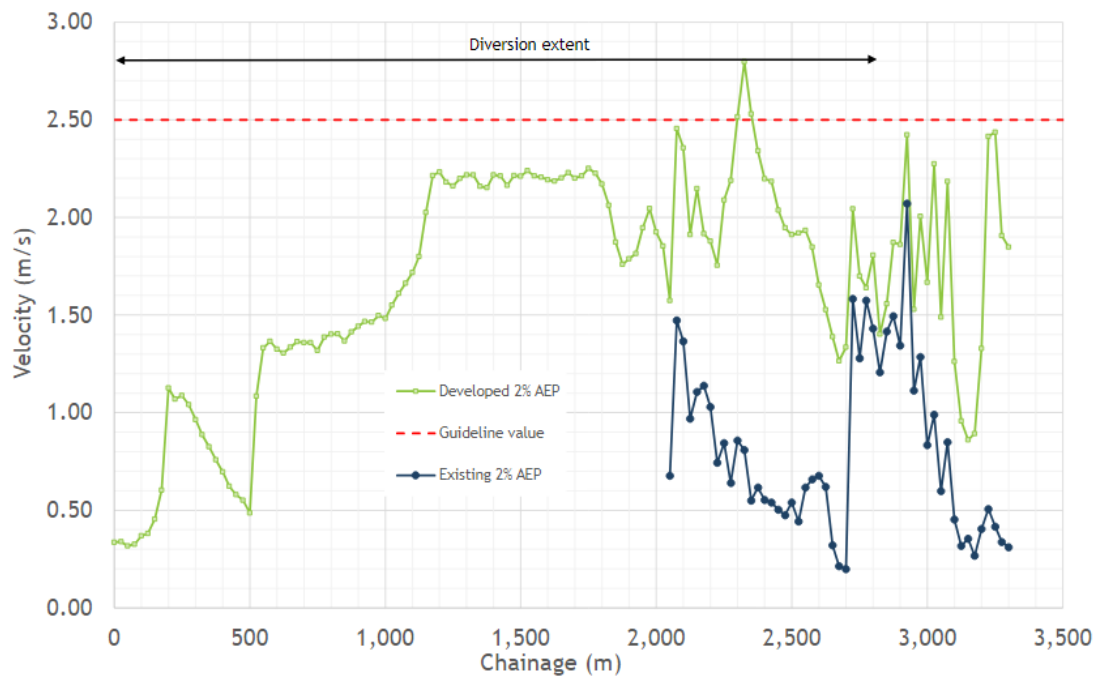


Figure 9.21 Ti-Tree Creek diversion longitudinal profile of 2% AEP section-averaged velocity

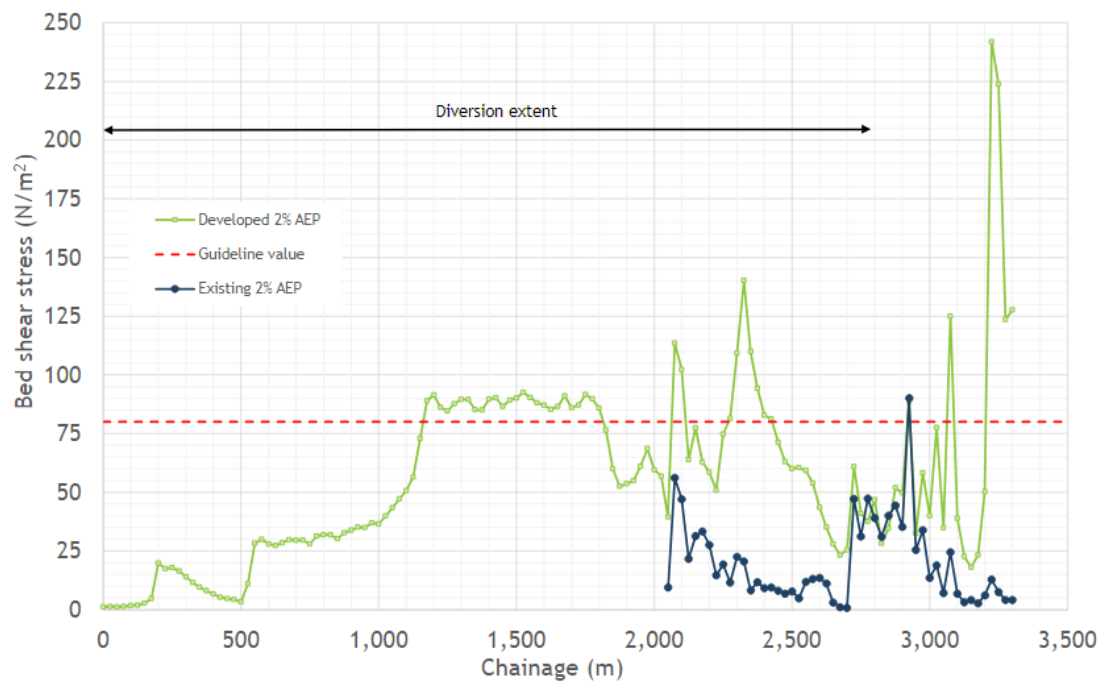


Figure 9.22 Ti-Tree Creek diversion longitudinal profile of 2% AEP section-averaged shear stress

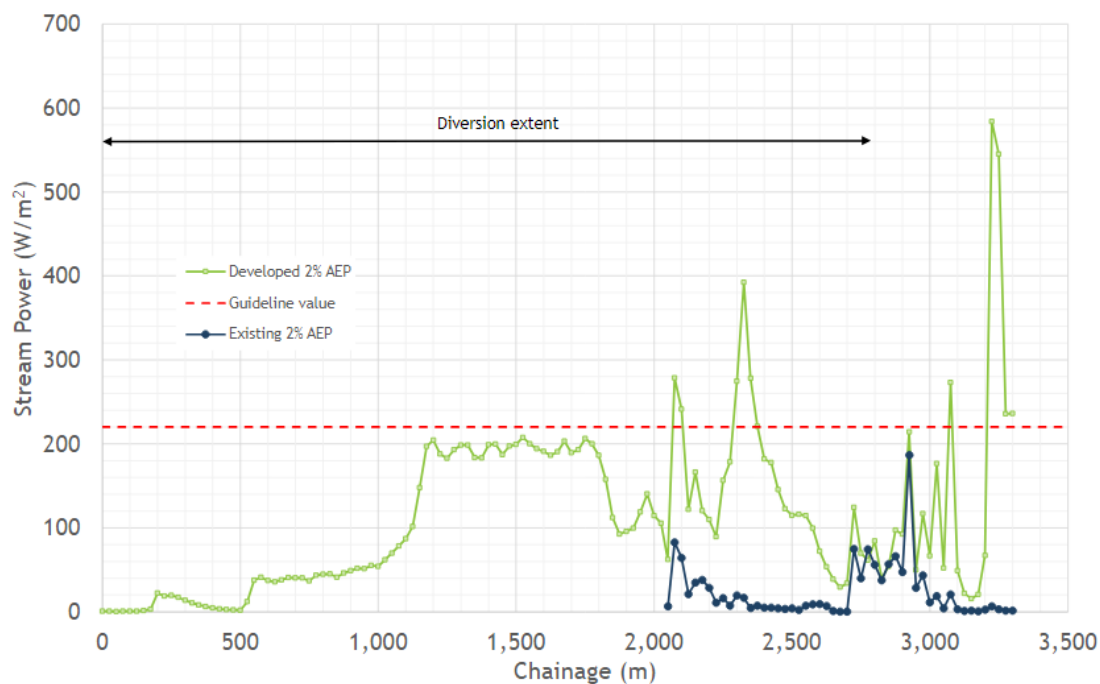


Figure 9.23 Ti-Tree Creek diversion longitudinal profile of 2% AEP section-averaged stream power

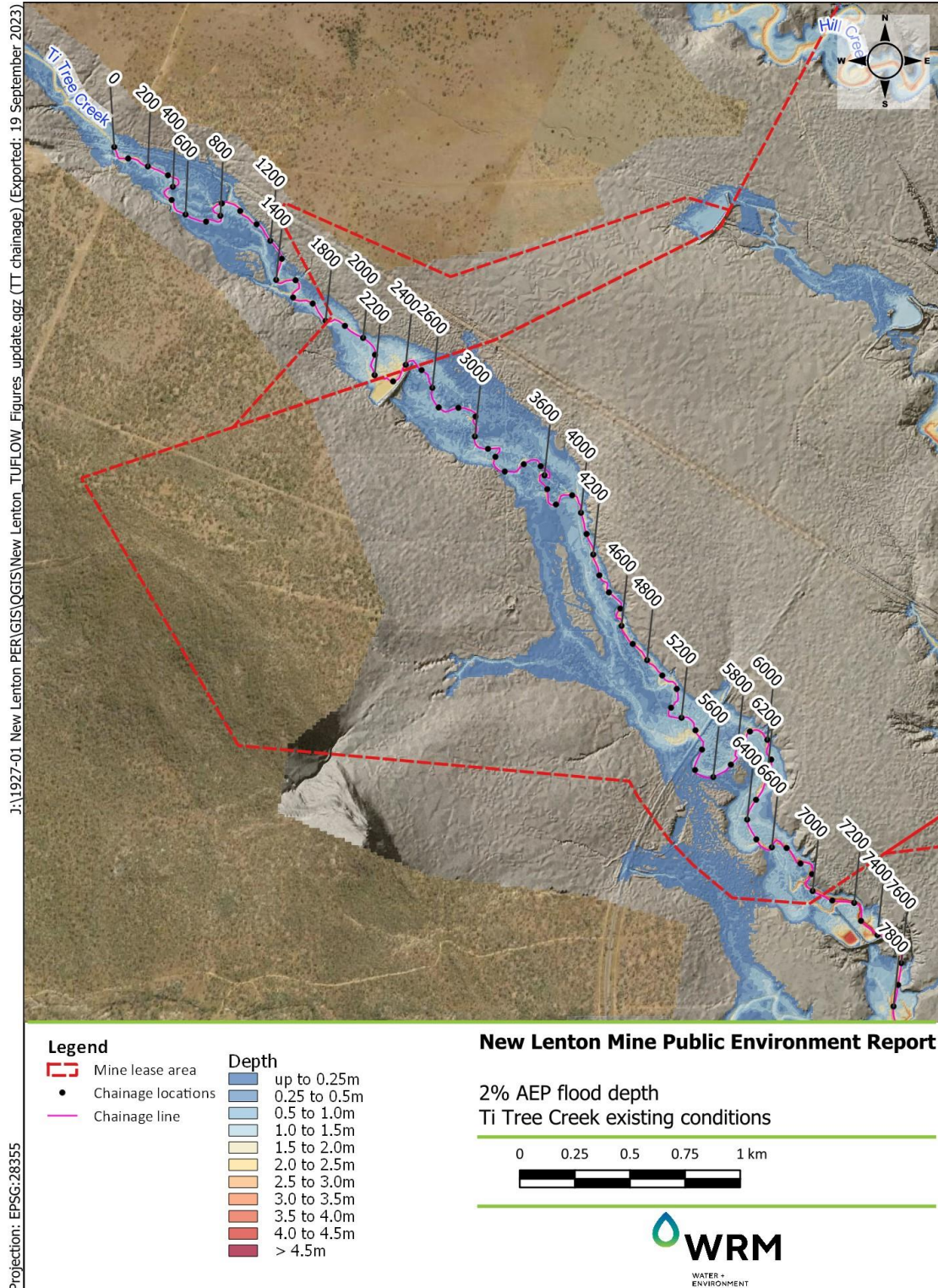


Figure 9.24 Ti-Tree Creek 2% AEP depth existing conditions

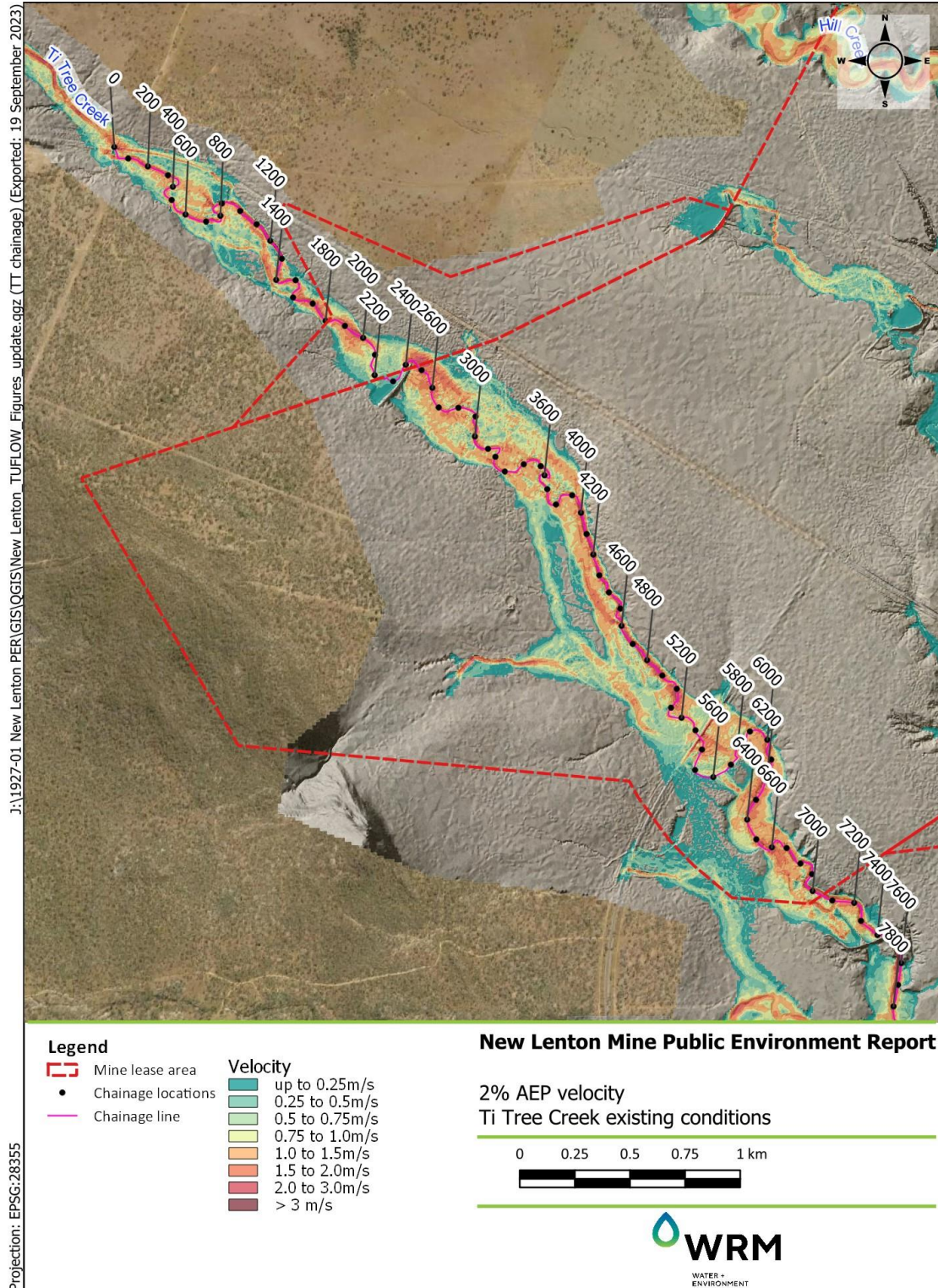


Figure 9.25 Ti-Tree Creek 2% AEP velocity existing conditions

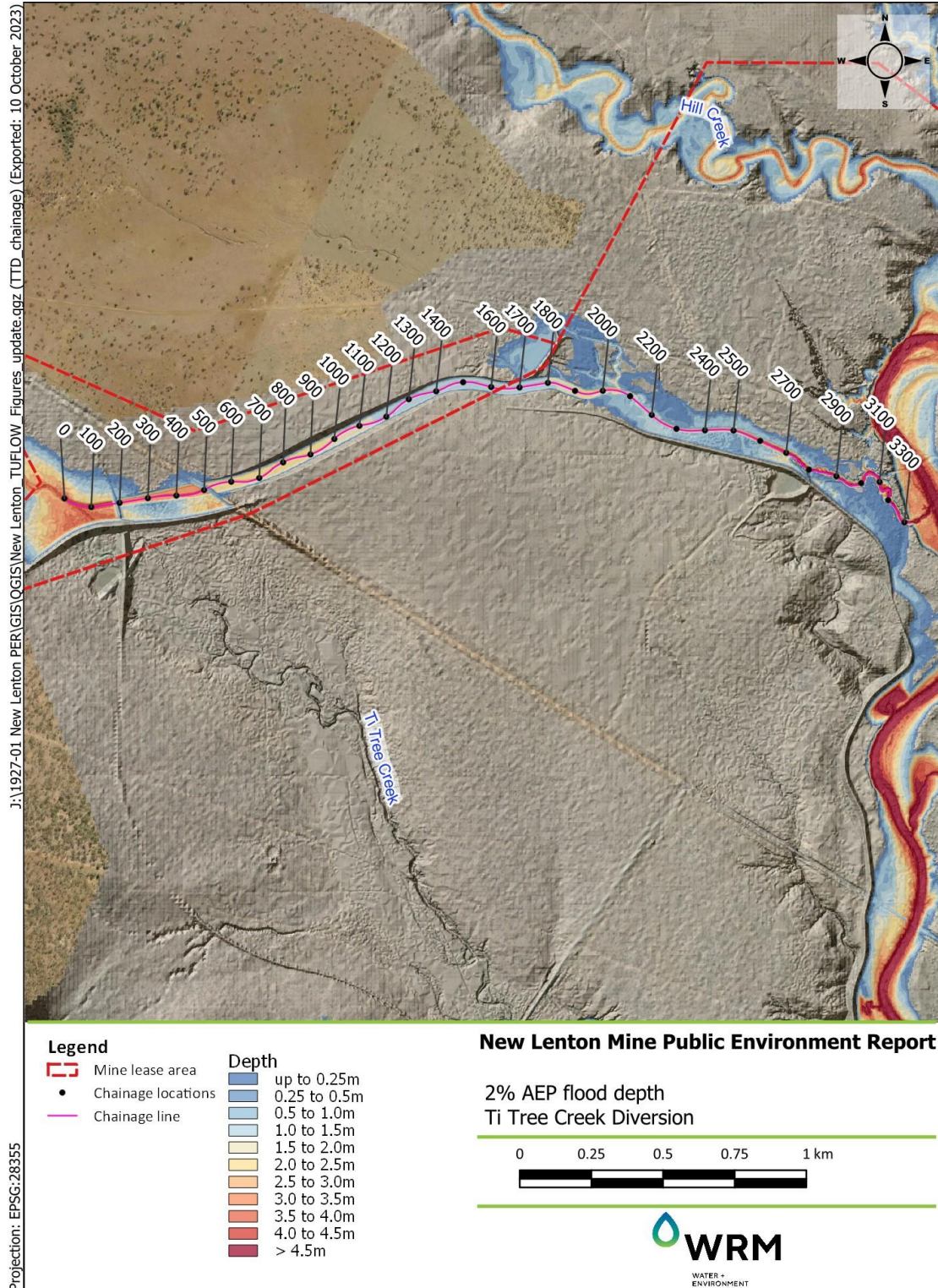


Figure 9.26 Ti-Tree Creek diversion 2% AEP depth

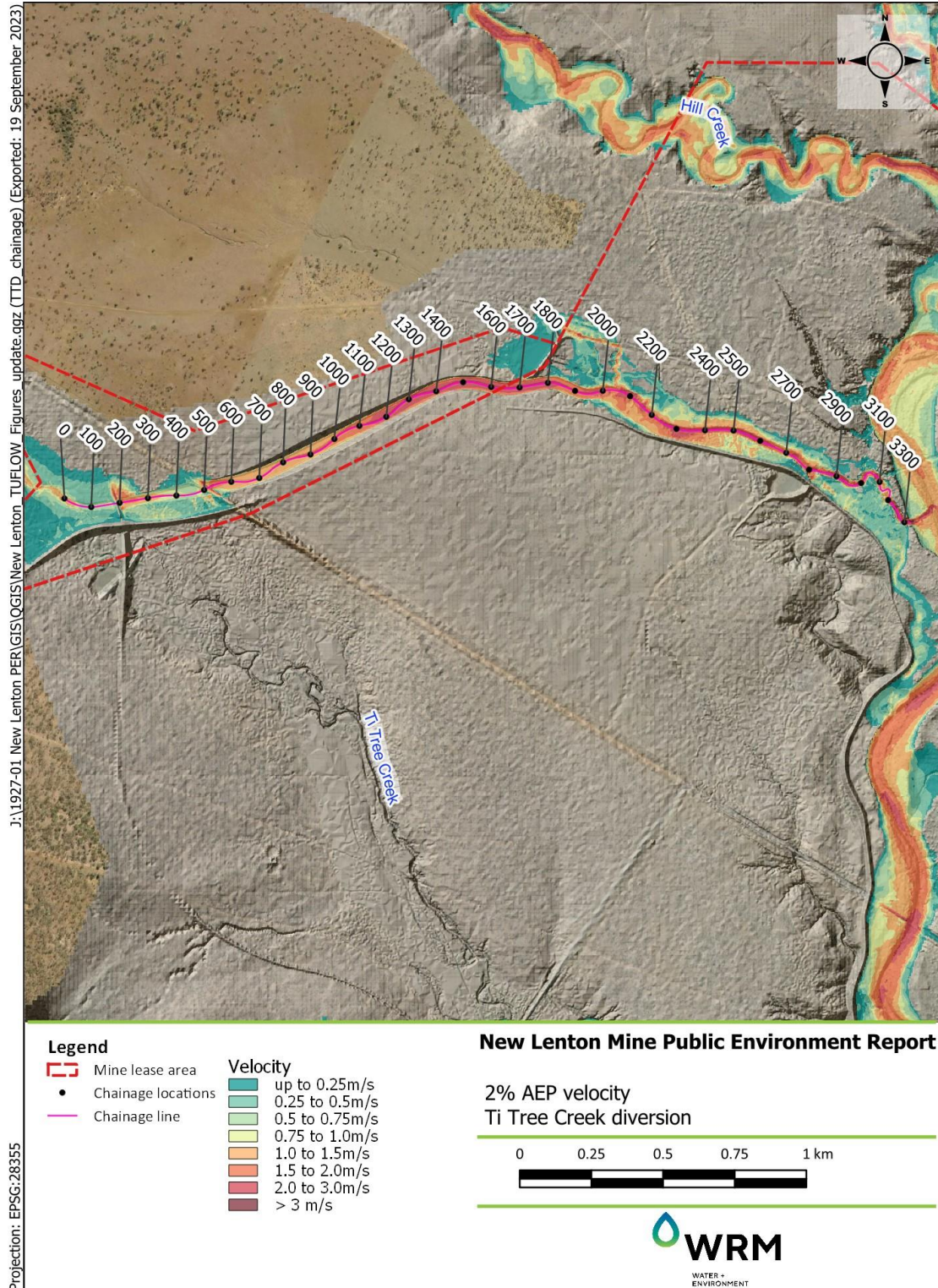


Figure 9.27 Ti-Tree Creek diversion 2% AEP velocity

9.2.2.2 Isaac River

Figure 9.28 to Figure 9.30 show the results for existing and developed scenarios in the Isaac River for velocity, shear stress and stream power. Figure 9.31 to Figure 9.34 show the chainages and depth and velocity maps for the 2% AEP event for the Isaac River for existing and developed scenarios.

The results for velocity, shear stress and stream power show no significant change between existing and developed conditions in the 2% AEP event, with some very minor increases and decreases. On this basis, the Project is not expected to have adverse impacts on the geomorphology of the Isaac River.

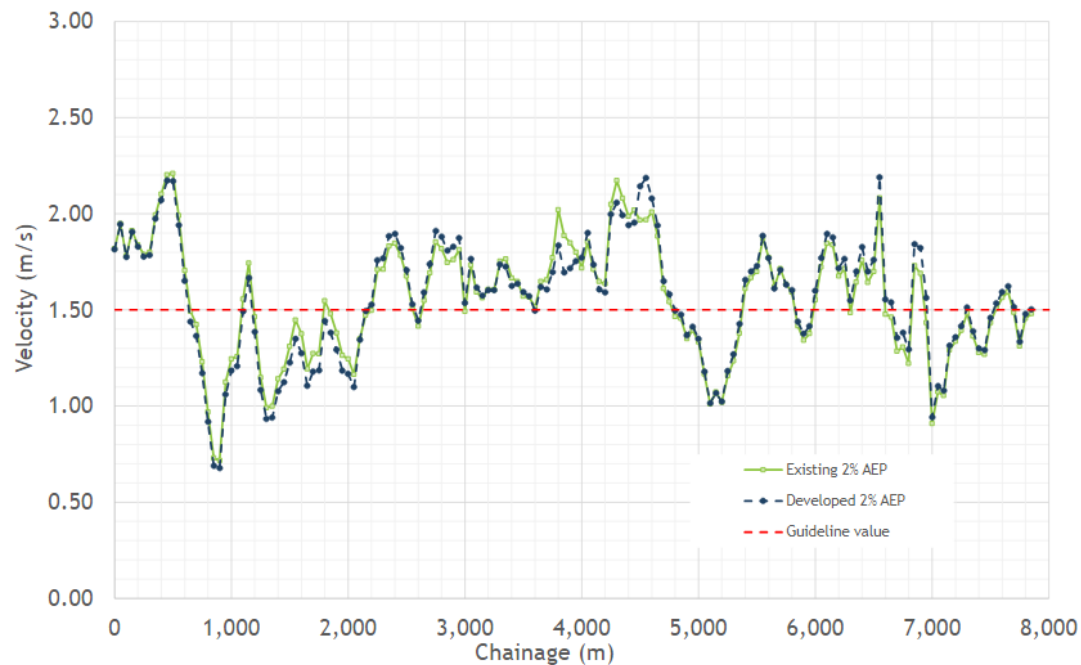


Figure 9.28 Isaac River longitudinal profile of 2% AEP section-averaged velocity

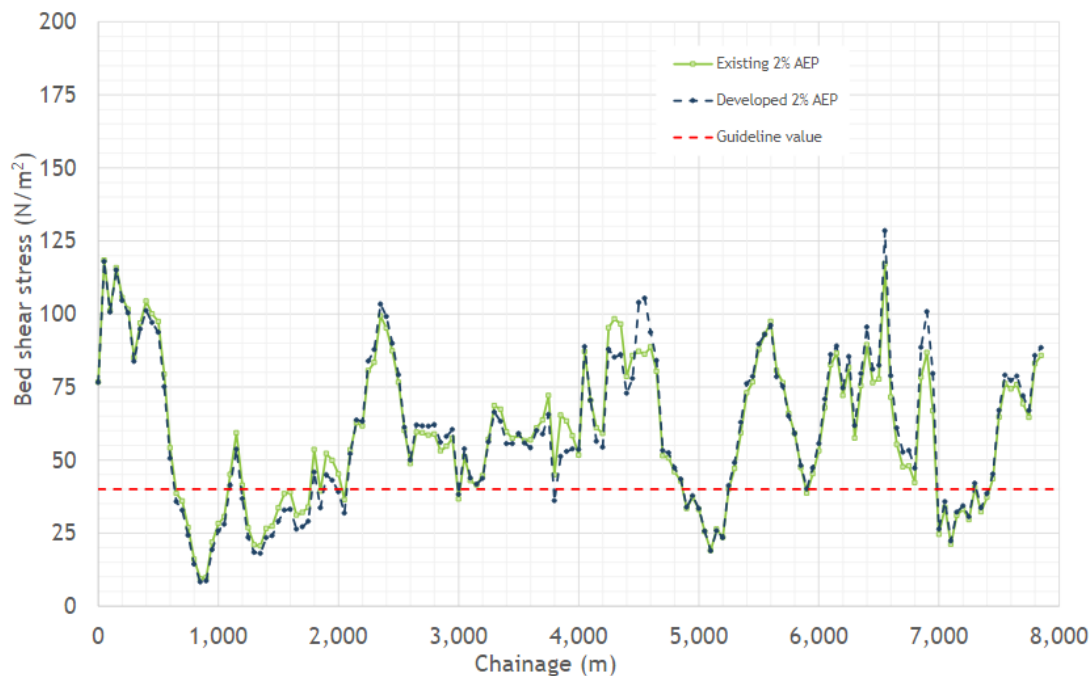


Figure 9.29 Isaac River longitudinal profile of 2% AEP section-averaged shear stress

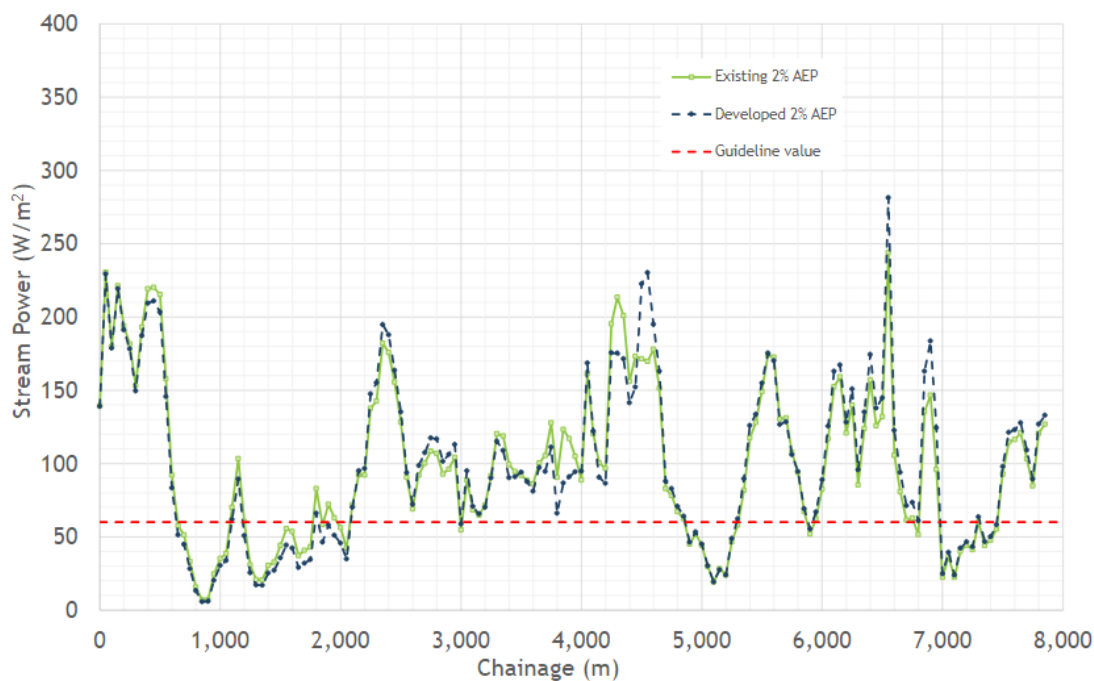


Figure 9.30 Isaac River longitudinal profile of 2% AEP section-averaged stream power

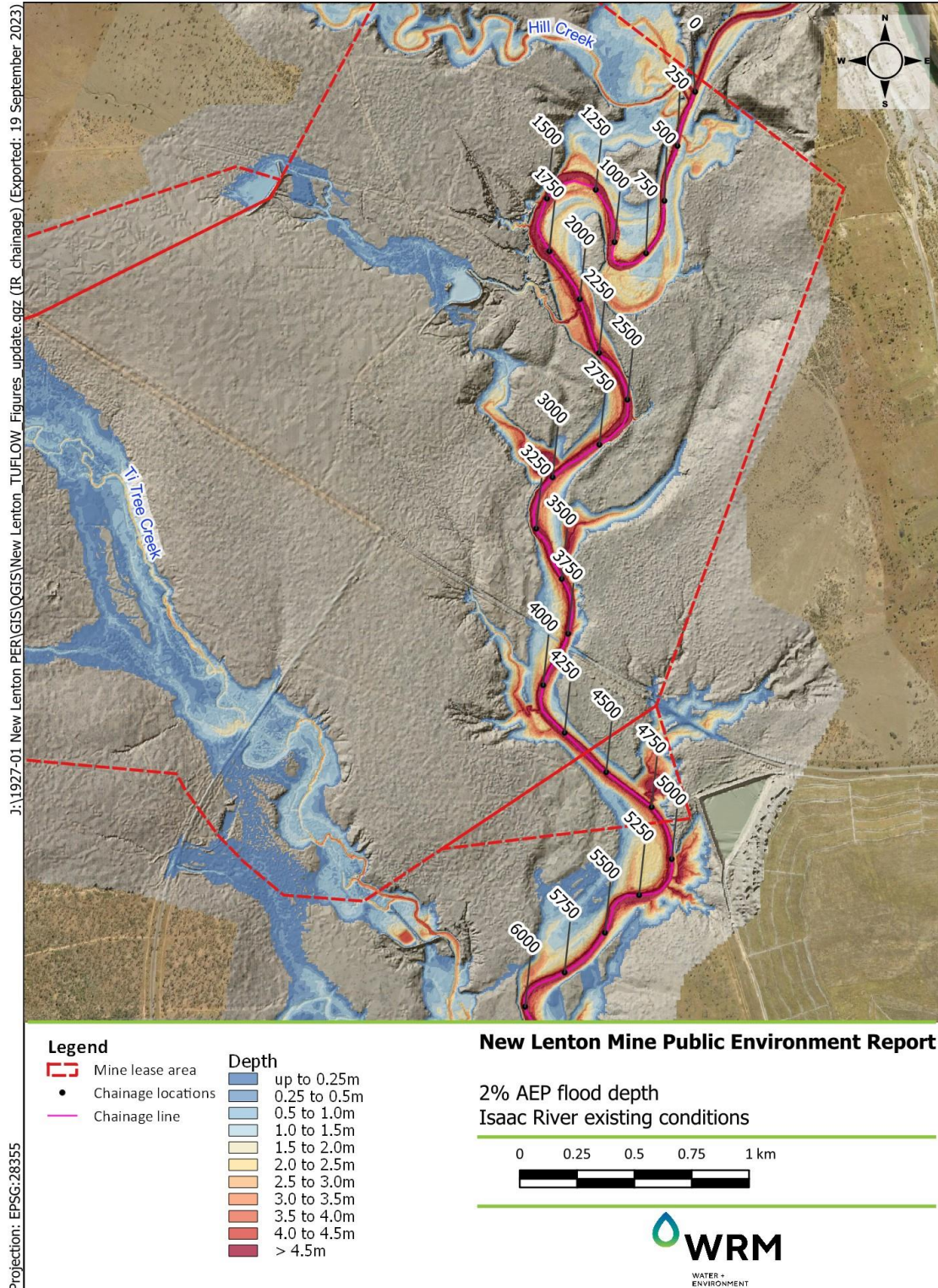


Figure 9.31 Isaac River 2% AEP depth existing conditions

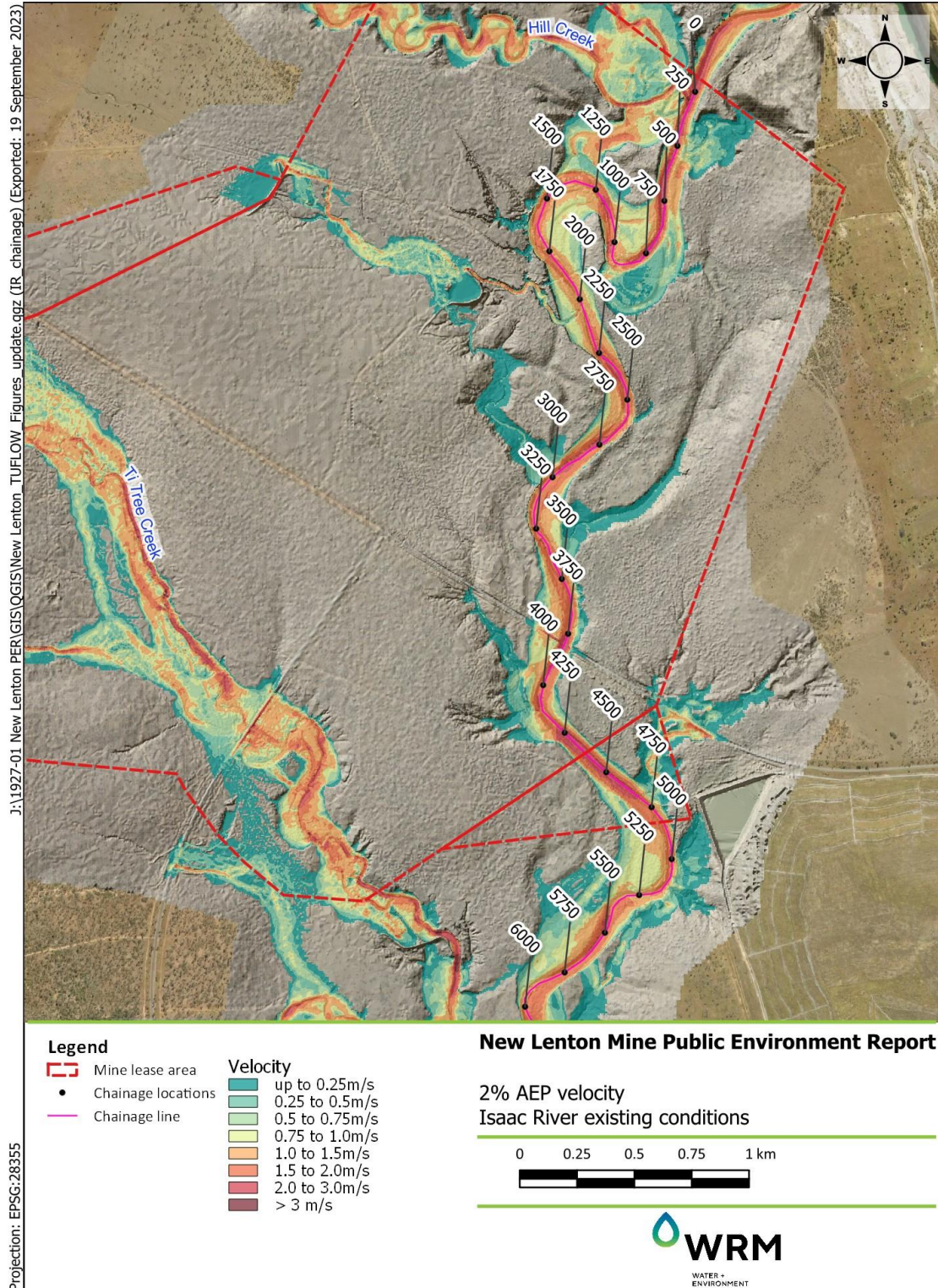


Figure 9.32 Isaac River 2% AEP velocity existing conditions

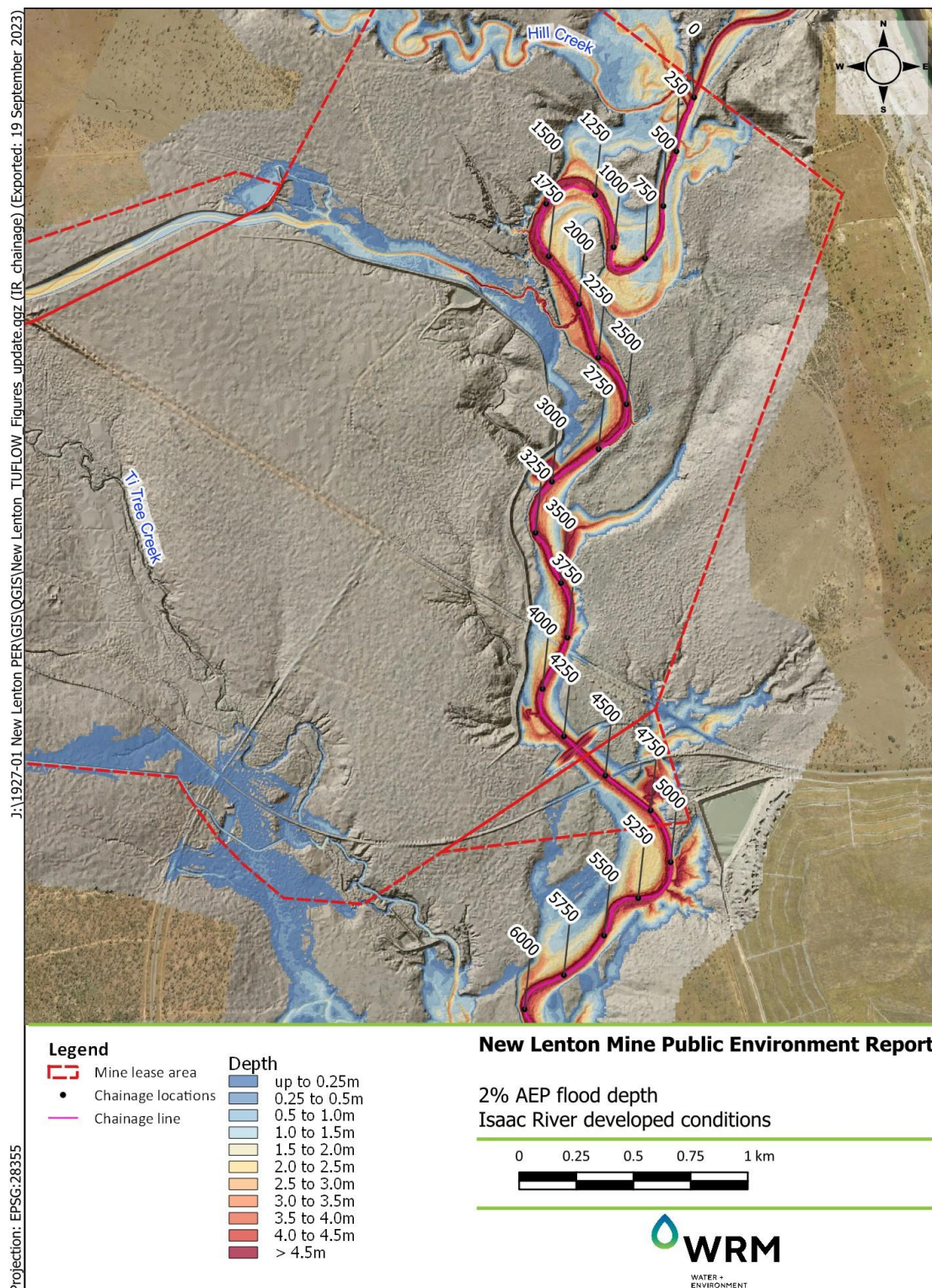


Figure 9.33 Isaac River 2% AEP depth developed conditions

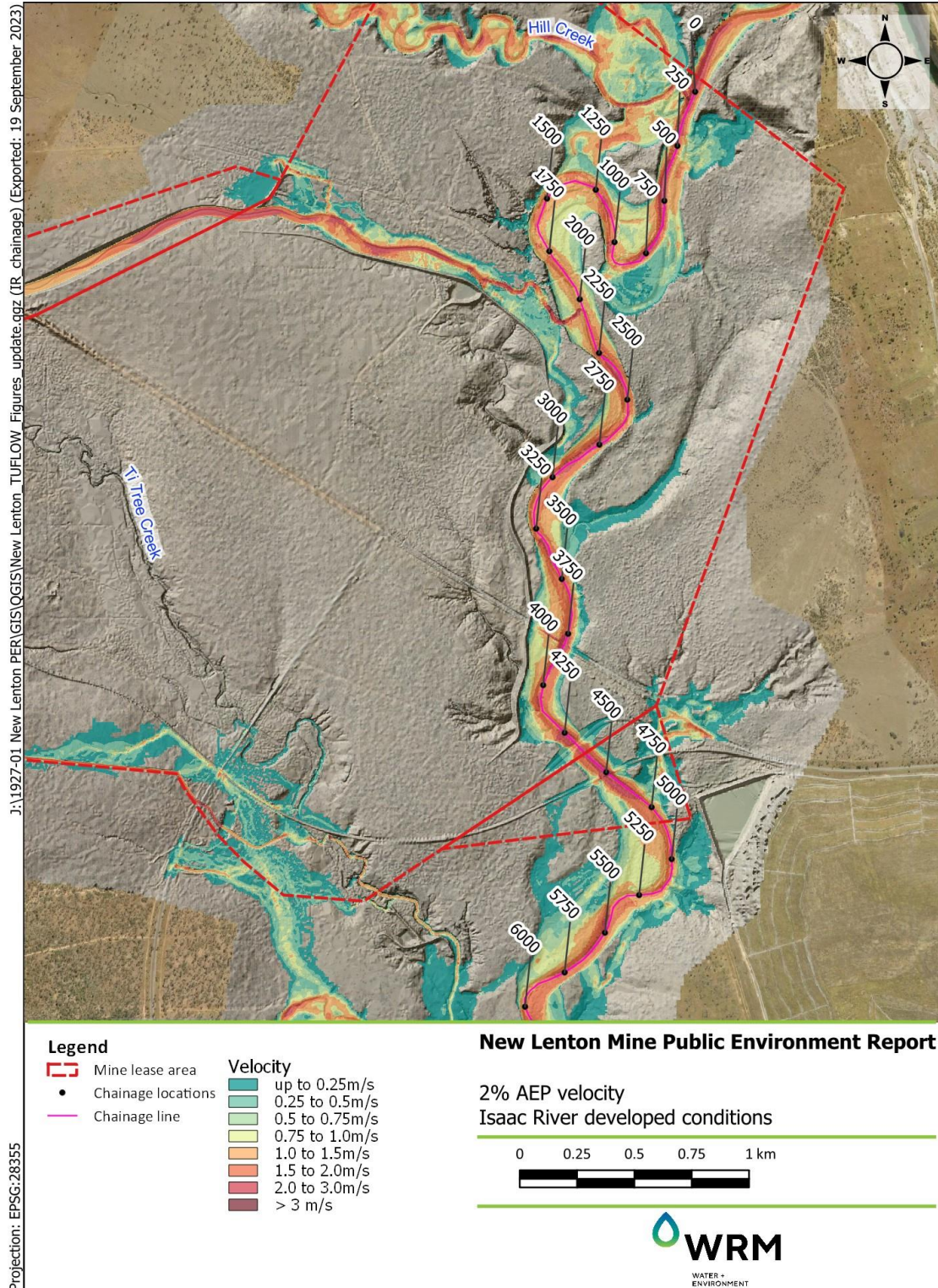


Figure 9.34 Isaac River 2% AEP velocity developed conditions

9.3 POST CLOSURE VS EXISTING CONDITIONS

The proposed Ti-Tree Creek diversion will remain as a permanent feature of the drainage network following the completion of mining operations. The Ti-Tree Creek and Isaac River levees will become part of the post-mining landform. Hence, post-mining drainage and floodplain conditions will be virtually identical to the operational phases of mining. Consequently, geomorphological characteristics for post-mining conditions will be the same as for operational conditions.

10 ASSESSMENT OF IMPACTS, AND MITIGATION AND MANAGEMENT MEASURES

10.1 POTENTIAL IMPACTS

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

- impacts on flows and the flooding regime and erosion in the Isaac River and Ti-Tree Creek due to changes in catchment area and drainage network associated with the Ti-Tree Creek diversion and proposed levees;
- local impacts on flood levels and velocities associated with a proposed new bridge crossing and low-level haul road crossing of the Isaac River;
- impacts on regional water availability due to the need to obtain water from external sources to meet operational water requirements of mining operations;
- impacts on stream flows due to catchment area excision (due to capture of runoff within onsite storages and the open cut pits);
- impact on stream flows due to ingress of floodwater into the residual void (based on model results this is not expected to occur);
- impact on receiving environment due to overtopping of the residual void (based on model results this is not expected to occur);
- adverse impacts on the quality of stormwater runoff draining from the disturbance areas to the various receiving waters surrounding the Project, during both construction and operation of the Project;
- adverse impacts on water quality due to unexpected release of contaminants stored on site, such as hydrocarbons;
- adverse impacts on environmental values in Isaac River and Ti-Tree Creek associated with controlled and uncontrolled releases from the mine water management system (based on model results this is not expected to occur);
- cumulative impacts of all projects in the region on the environmental values of the receiving waters.

An assessment of each of these potential impacts of the Project is provided in the following sections.

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 and deemed to be appropriate for a PER-level assessment. Certain aspects of the Project, such as changes to landforms due to construction of waste rock emplacements, would create changes to the environment that are permanent, although this does not mean that any such change would necessarily be detrimental to the EVs of surface water resources.

10.2 FLOODING IMPACTS – TI-TREE CREEK AND ISAAC RIVER

Potential impacts of the Project on flood levels, velocities and the geomorphic characteristics of the Isaac River and Ti-Tree Creek channels and floodplains (including the Ti-Tree Creek diversion) are addressed in Sections 8 and 9 of this report.

The results of detailed flood modelling show that the impacts of the Project on the hydraulic characteristics (such as velocity, bed shear stress and stream power) of the Isaac River are minimal.

For other key drainage features potentially impacted by the Project, hydraulic parameters are generally within the range of existing values along these drainage features for operational and post-mining conditions. The area of highest risk is the downstream portion of the Ti-Tree Creek diversion.

Ongoing monitoring of the performance of the diversion (see Section 10.10.5) will be undertaken and, if necessary, mitigation measures will be implemented to prevent excessive erosion or sediment deposition. Potential mitigation measures would include minor earthworks, such as filling scour areas, reprofiling banks or removing accumulated sediment, and revegetation of areas subject to erosion.

The hydraulic performance of the Ti-Tree Creek diversion was assessed against the DNRME (2019) guideline values for the 50% and 2% AEP events for both operational and post-closure conditions. The assessment of the diversion found that there were no significant increases in the Isaac River for velocity, shear stress and stream power. Velocity, shear stress and stream power values within the diversion generally performed well against guideline values. Peak modelled values for these parameters within the diversion were less than the peak modelled values within the existing Ti-Tree Creek. Velocity, shear stress and stream power values were greatest within the Isaac River tributary into which the Ti-Tree Creek diversion flows. However, modelled velocity, shear stress and stream power values within this reach of the tributary are less than those modelled in the existing Ti-Tree Creek. On this basis, excessive erosion or deposition of sediment within the Isaac River or the diversion system are not expected to occur. Ongoing monitoring will be undertaken to confirm that the drainage system operates as designed. Remediation measures, such as removal of sediment or reprofiling of channel banks or local erosion protection, will be implemented if necessary to repair and stabilise any areas of local impact.

A monitoring plan will be established to assess any changes to channel levels and channel form resulting from erosion (see Section 10.10.5).

10.3 FLOOD IMPACTS OF PROPOSED RIVER CROSSINGS

Flood impacts of the proposed new low-level (haul road) and bridge crossings of the Isaac River are provided in Section 8.3.3. The new Suttor Developmental Road bridge has flood immunity for the 2% AEP flood and is overtopped in a 1% AEP or larger event. The low flow crossing has low flood immunity and will be overtopped by several metres in all flood events. The crossings are not expected to have a significant adverse impact on Isaac River flooding.

10.4 REGIONAL WATER AVAILABILITY IMPACTS

A significant proportion of mine site water requirements would be sourced from water collected on the site, including rainfall runoff and groundwater inflows to the open cut pits which will be stored in the mine-affected water storages for recycling and reuse. Any shortfall in site water demands will be sourced from Burton Mine.

The results of the water balance modelling (see Sections 6.3.4) indicate between 0 ML/year and 700 ML/year would be required to be supplied via the proposed Burton Mine pipeline connection. Section 6.3.6 of this report shows that the Burton Mine water management system is capable of supplying any potential water deficit for the Project, without detrimentally affecting the performance of the Burton Mine operations.

Based on the results of the impact assessment, the Project will have no impact on regional water availability.

10.5 STREAM FLOW IMPACTS

10.5.1 During active mining operations

During active mining operations, the water management system will capture runoff from areas that would have previously flowed to the receiving waters of Ti-Tree Creek and the Isaac River. The captured catchment area will change as the mine develops. A breakdown of the catchment areas reporting to the mine water management system is provided in Table 10.1.

The total catchment area of Ti-Tree Creek to the confluence of the Isaac River is approximately 22.4 km². The catchment area of the Isaac River to downstream of the Project tenements is approximately 224.7 km².

The maximum captured catchment areas represent:

- Between 9.7% and 18.4% of the Ti-Tree Creek catchment to the confluence of the Isaac River, depending on the stage of mine development.
- Between 1.4% and 2.5% of the Isaac River catchment to downstream of the Project MLs, depending on the Stage.
- The maximum area captured within the pits and mine affected dams occurs during Phase 2. This area (2.2 km²) represents around:
 - 9.9% of the Ti-Tree Creek catchment;
 - 1.0% of the Isaac catchment to downstream of the Project MLs; and
 - 0.2% of the Isaac River catchment at Goonyella (1,214 km²).
- The remaining catchment drains off site through the sediment and clean water management systems.

Table 10.1 Catchment area captured within the whole mine water management system

Catchment	Total catchment area (km ²)	Captured catchment area (km ²)			
		Phase 1	Phase 2	Phase 3	Phase 4
Ti-Tree Creek	22.4	3.2 (14.1%)	4.1 (18.4%)	3.3 (14.6%)	2.2 (9.7%)
Isaac River	224.7	3.2 (1.4%)	5.7 (2.5%)	5.3 (2.4%)	4.9 (2.2%)

* Percentage in brackets represent percentage of total catchment area captured

Given that areas managed under the ESCP would drain from the site, and the sediment dam catchments typically have higher runoff coefficients than under natural conditions, the loss of stream flows would likely be less than the total loss of catchment area (proportionally).

There is likely to be a measurable reduction in flow rates and volumes in the downstream reach of Ti-Tree Creek as a result of the diversion of Ti-Tree Creek. This applies to the approximate 1 km length of the residual portion of Ti-Tree Creek between the Project disturbance area and the Isaac River.

The loss of catchment flows in the Isaac River (<2.5%) would be indiscernible. In addition, any potential impact on flows in the Isaac River would be dissipated by Burton Gorge Dam, the operation of which controls flows in the Isaac River downstream of the Project. The Project Disturbance Area represents about 1% of the total catchment area draining to Burton Gorge Dam (551 km²).

10.5.2 Final landform

At the completion of mining, permanent drainage of waste rock emplacement areas will be installed to minimise capture of surface runoff into the final voids in general accordance with the configuration shown in Figure 7.1.

Following rehabilitation:

- the catchment draining to Ti-Tree Creek (to the confluence with the Isaac River) will reduce by around 2.4 km² (compared to pre-mining conditions), a decrease of less than 11%.
- the catchment draining to the Isaac River (to downstream of the Project MLs) will reduce by around 2.4 km² (compared to pre-mining conditions), a decrease of less than 1.1%.

The loss of catchment flows in the Isaac River (<1.1%) would be indiscernible. In addition, any potential impact on flows in the Isaac River would be dissipated by Burton Gorge Dam, the operation of which controls flows in the Isaac River downstream of the Project.

10.6 INGRESS OF FLOODWATER INTO THE FINAL VOID

The flood modelling assessment in Section 8 shows that the final void lies outside of the 0.1% AEP and PMF flood extent for Ti-Tree Creek and the Isaac River. As such, the Project will have no impact on Ti-Tree Creek or Isaac River flows resulting from ingress of water to the final void.

10.7 OVERTOPPING OF THE RESIDUAL VOID

The residual void water balance assessment in Section 6 shows that the final void equilibrium water level lies well below the void crest level. As such, the Project will have no impact on receiving water quality resulting from overtopping of the final void.

10.8 RECEIVING WATER QUALITY AND ENVIRONMENTAL VALUES

10.8.1 Overview

Section 4 describes the objectives and principles of the water management system, which have been developed to protect water quality and the environmental values of the waterways potentially affected by the Project.

The general principles of the water management system are:

- A catchment runoff water management system that separates clean water from mine affected water and sediment water wherever possible.
- A diversion of Ti-Tree Creek around the mining operations.
- A system of levees to protect mining operations from the 0.1% AEP flood event. Details of the proposed levee infrastructure are provided in Section 4.10.
- An sediment water management system that contains runoff that potentially has high sediment concentrations in sediment dams. Water collected in the sediment dams will be managed in accordance with the ESCP and used for dust suppression or will overflow to receiving watercourses after a period of settling. Details of the sediment water management system are provided in Section 4.7. Proposed measures to manage the sediment in runoff from overburden dumps are described in Section 3.11.1.4
- A mine affected water management system that contains potentially saline runoff from the pit and MIA (including ROM coal stockpile) in mine-affected water dams.. Mine-affected water will be used as a priority in meeting dust suppression demands. Whilst the current EA includes approved releases of mine affected water, the water balance modelling shows that controlled releases of mine-affected water are not required to manage on-site water stores.

10.8.2 Performance of the water management system

10.8.2.1 Mine affected water management system

An assessment of the mine affected water management system is given in Sections 6.3.2 and 6.3.5.1. The results of the water balance modelling indicate that, under the current model assumptions and configuration, the mine-affected water dams will not have uncontrolled releases for any of the climatic sequences assessed.

10.8.2.2 Controlled releases

Whilst controlled release of mine-affected water to the receiving environment is permitted under the approved EA, the water balance model shows that controlled releases are not required to manage mine-affected water storages at the Project, even under extremely wet rainfall conditions.

The proposed mine-affected water management system and Burton Mine pipeline connection is sufficient to manage any potential mine-affected water accumulation, and there is sufficient capacity at Burton Mine to accept any transfers from the Project.

A cumulative impact assessment including mine affected water releases from other mining operations in the upper Isaac River catchment is therefore not required because there is no discharge of mine-affected water from the Project.

10.8.2.3 Sediment water management system

During operations, progressive rehabilitation of the out-of-pit waste rock emplacements would minimise the potential generation of sediment. An ESCP will be developed and implemented throughout construction and operation of the Project. A 'best practice' approach would be adopted that is consistent with the IECA recommendations. The following broad principles will apply:

- Minimise the area of disturbance;
- Where possible, apply local temporary erosion control measures;
- Intercept run-off from undisturbed areas and divert around disturbed areas; and
- Where temporary measures are likely to be ineffective, divert run-off from disturbed areas to sedimentation basins prior to release from the site.

If implemented effectively, environmental risks from disturbed area runoff are expected to be low. In rainfall events below the design standard, runoff from disturbed areas would be intercepted and treated by sediment dams. In larger events that exceed the design standards, these dams would overflow following a period of settlement.

With the implementation of this strategy, the potential impact of sediment dam discharges on the Isaac River water quality would be negligible. Given this, a cumulative impact assessment including sediment water releases from other mining operations in the upper Isaac River catchment is not warranted.

10.8.2.4 Hydrocarbons and other contaminants stored on site

Storage of hydrocarbons (such fuel and oil) or other chemicals on the site will be managed in accordance with relevant industry standards (such as AS1940 – *Storage and Handling of Flammable and Combustible Liquids*). Typical control measures include bunding around fuel or chemical storage tanks to capture leaks or spills and prevent contaminants leaving the site.

10.8.2.5 Monitoring and maintenance

It will be necessary to monitor the site water management systems to ensure that they are operating as designed:

- Continual monitoring of water quality and storage volumes in the mine affected storages will be undertaken to ensure that uncontrolled spills do not occur and cause a downstream impact.
- The pit and dam pumps will be inspected and operated regularly to ensure they will operate when required.
- Sediment dams will be cleaned out on a regular basis to maintain the available sediment storage volume.

- Diversion drains will be monitored regularly to ensure they are operating as designed and do not allow mixing of clean and dirty water.
- Contaminated water sumps and interceptors are to be inspected and cleaned out regularly.

10.9 CUMULATIVE IMPACTS – SURFACE WATER

10.9.1 Overview

The objective of this assessment is to identify the potential for impacts from the Project to have compounding interactions with similar impacts from other projects, including activities proposed, under development or already in operation within a suitable region of influence of the Project.

10.9.2 Existing projects

Projects which are currently operating within the Isaac River catchment upstream of the (now closed) Isaac River at Goonyella gauging station have been included in the cumulative impacts assessment for the Project, are listed in Table 10.2.

With the exception of parts of Burton Mine (also owned by BCC), all other projects are located downstream of the Project.

10.9.3 New or developing projects

Relevant projects that have been considered include:

- Projects within the predicted sphere of influence of the Project, as listed on the Department of State Development, Infrastructure, Local Government and Planning website that are undergoing assessment under the *State Development and Public Works Organisation Act 1971* (SDPWO Act) for which an Initial Advice Statement (IAS) or an EIS are available.
- Projects within the predicted sphere of influence of the Project, which are listed on the website of the Department of Environment and Science (DES) that are undergoing assessment under the *Environmental Protection Act 1994* (EP Act) for which an IAS or an EIS are available.

Projects currently undergoing assessment or having recently completed assessment under these processes and included in the cumulative impact assessment for the Project are listed in Table 10.3.

10.9.4 Cumulative impacts – surface water resources

10.9.4.1 Water quality

The Project is located in the Isaac River catchment, which is a major tributary within the Fitzroy basin. The Fitzroy basin is the largest catchment in Queensland draining into the Pacific Ocean and also the largest catchment that drains to the Great Barrier Reef, although it contributes smaller freshwater flows to the coastal environment when compared to river systems further north.

In 2008, the Queensland Government undertook an investigation into the cumulative effects of coal mining in the Fitzroy River basin on water quality (EPA, 2009). The investigation found that:

- There were inconsistencies in discharge quality limits and operating requirements for coal mine water discharges as imposed through environmental authorities.
- In some cases, discharge limits and operating conditions of coal mines were not adequately protecting downstream environmental values.

These conclusions led to a number of inter-related actions by Queensland Government and other stakeholders:

- Water quality objectives were developed for the Fitzroy Basin and added to Schedule 1 of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (Water)) in October 2011.
- Model water conditions were developed for coal mines in the Fitzroy basin (DERM February 2012). These model water conditions are designed to manage water discharges to meet the water quality objectives set out in the EPP (Water) and to provide consistency between mining operations in the Fitzroy basin.
- Environmental authorities for a number of mining operations were amended to introduce conditions consistent with the model water conditions.
- A number of mining operations entered into Transitional Environmental Programs (TEPs) under the EP Act. These TEPs were focussed on actions that would allow mines to achieve compliance with new environmental authority conditions and upgrade operating conditions.

With these measures in place, a strong strategic and policy framework is now in place for management of cumulative water quality impacts from mining activities. This framework allows for management of individual mining activities in such a way that overarching water quality objectives can be achieved.

The Queensland Government commissioned an assessment of mine-affected water releases in the Fitzroy River basin during the 2012–2013 wet season (known as the Pilot Scheme). The report, prepared by consultants Gilbert and Sutherland (G&S, 2016), concluded that the Fitzroy as a whole is not currently ‘at capacity’ in terms of salt load at a catchment or sub-catchment scale.

The operational policy of the Pilot Scheme aims to manage the cumulative impact of mine affected water releases across the Fitzroy Basin. To achieve this, trigger values have been derived for six monitoring locations across the basin. If in-stream EC triggers are exceeded during times when mine affected water releases are being undertaken upstream, the regulator has the ability to issue a “cease release” notification to all coal mines in the Fitzroy Basin with conditions that authorise the release of mine affected water.

Mine-affected water from the proposed Project will be managed through a mine water management system which is designed to operate in accordance with approved EA conditions that are based on Model Mining Conditions.

The water balance modelling assessment (in Section 6.3) demonstrates that the proposed Project water management system is able to successfully operate without actively discharging mine-affected water to the receiving environment (as approved in the EA). Given this, the proposed management approach for mine water from the Project will have no cumulative impact on surface water quality and associated environmental values.

Table 10.2 Existing projects considered in the cumulative impact assessment

Project	Proponent	Description	Operational status	Relationship to the Project Mining Lease	
				Timing	Location
Burton Mine	Peabody Energy Australia (PEA)	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the Project, although unlikely given the current operational status.	Located 5 km to the southeast (adjacent) of the project area. Located within the upper Isaac River catchment, upstream of Burton Gorge Dam.
North Goonyella / Eaglefield Mine	PEA	Open cut and underground coal mine	Care and maintenance	May have overlapping operational phases with the construction and operations of the Project.	Located 20 km to the southwest (downstream) of the project area. Located within the upper Isaac River catchment, downstream of Burton Gorge Dam.
Plumtree West	PEA	Open cut coal mine	Care and maintenance	Residual void only.	Located 15 km south of the project area. Located in the Sandy Creek/Plumtree Creek catchment, which drains to Burton Gorge Dam.
Goonyella Riverside Mine	BMA	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the Project.	Located 25 km to the southwest (downstream) of the project area. Located within the upper Isaac River catchment, downstream of Burton Gorge Dam.

Table 10.3 Proposed projects considered in the cumulative impact assessment

Project	Proponent	Description	Operational status	Relationship to the Project Mining Lease	
				Timing	Location
Red Hill Mining Project	BMA	Underground coal mine	Approved with conditions	May have overlapping operational phases with the construction and operations of the Project.	Located 20 km to the southwest (downstream) of the project area. Located within the upper Isaac River catchment, downstream of Burton Gorge Dam.

10.9.4.2 Loss of Catchment and Stream Flows in the Isaac River

As detailed in Section 10.5, the Project would result in a loss of catchment to the upper Isaac River catchment during operations and post-mining. The surface runoff volume lost from the catchment would generally be in proportion to the excision of the catchment area. The Project area captured within the water management system is less than 2.5% of the catchment area of the Isaac River to downstream of the Project MLs. Of this, around 50% is managed through the ESCP and then released to the downstream environment following capture and treatment.

The cumulative impact assessment includes mining operations within the Isaac River that are adjacent or downstream of the Project. The catchment of the Isaac River to the Goonyella Gauge confluence is around 1,214 km².

There are approximately 4 existing coal mines adjacent to or downstream of the Project (within the sphere of influence) that also capture runoff from the Isaac River catchment, as shown in Figure 10.1. The total estimated captured area of all these projects (including the Project) combined represents around of 13.0% of the Isaac River catchment to the Goonyella gauge. If the same percentage of ESCP for the Project is applied to the other mines, then the estimated captured catchment areas reduce to around 50% of the total area (around 6.5% of the Isaac River catchment to the Goonyella Gauge).

In addition, these mines have discharge licences which return captured surface water, as well as groundwater collected in underground workings, to the Isaac River catchment, that would reduce the impacts on surface water resources.

A comparison of the captured catchment areas of the existing mining projects considered in the cumulative impact assessment with the Isaac River catchment to the Goonyella gauge is provided in Table 10.4, which indicates the following:

- The combined total catchment area of the existing mines (including the Project) represents around 13% of the total catchment area of the Isaac River to the Goonyella gauge.
- The combined mine-affected catchment area (estimated) represents less than 6.5% of the total Isaac River catchment area to the Isaac River to the Goonyella gauge.

When taking into account potential discharges from the operating mines in accordance with their current release rules, the overall loss of catchment area and associated stream flow is relatively small.

In addition, any potential impact on flows in the Isaac River from the Project or Burton Mine would be somewhat dissipated by Burton Gorge Dam, the operation of which controls flows in the Isaac River downstream of the Project.

Table 10.4 Catchment area of existing projects considered in the cumulative impact assessment

Item	Total catchment area (km ²)	Estimated mine affected catchment area (km ²)	Estimated mine affected catchment area (% of total)
New Lenton Coal Project (the Project)	5.7	3.0	53%
Other mines	152.4	76.2	50%
Combined	158.1	79.2	50%
Isaac River (to Goonyella gauge)	1,214	79.2	6.5%

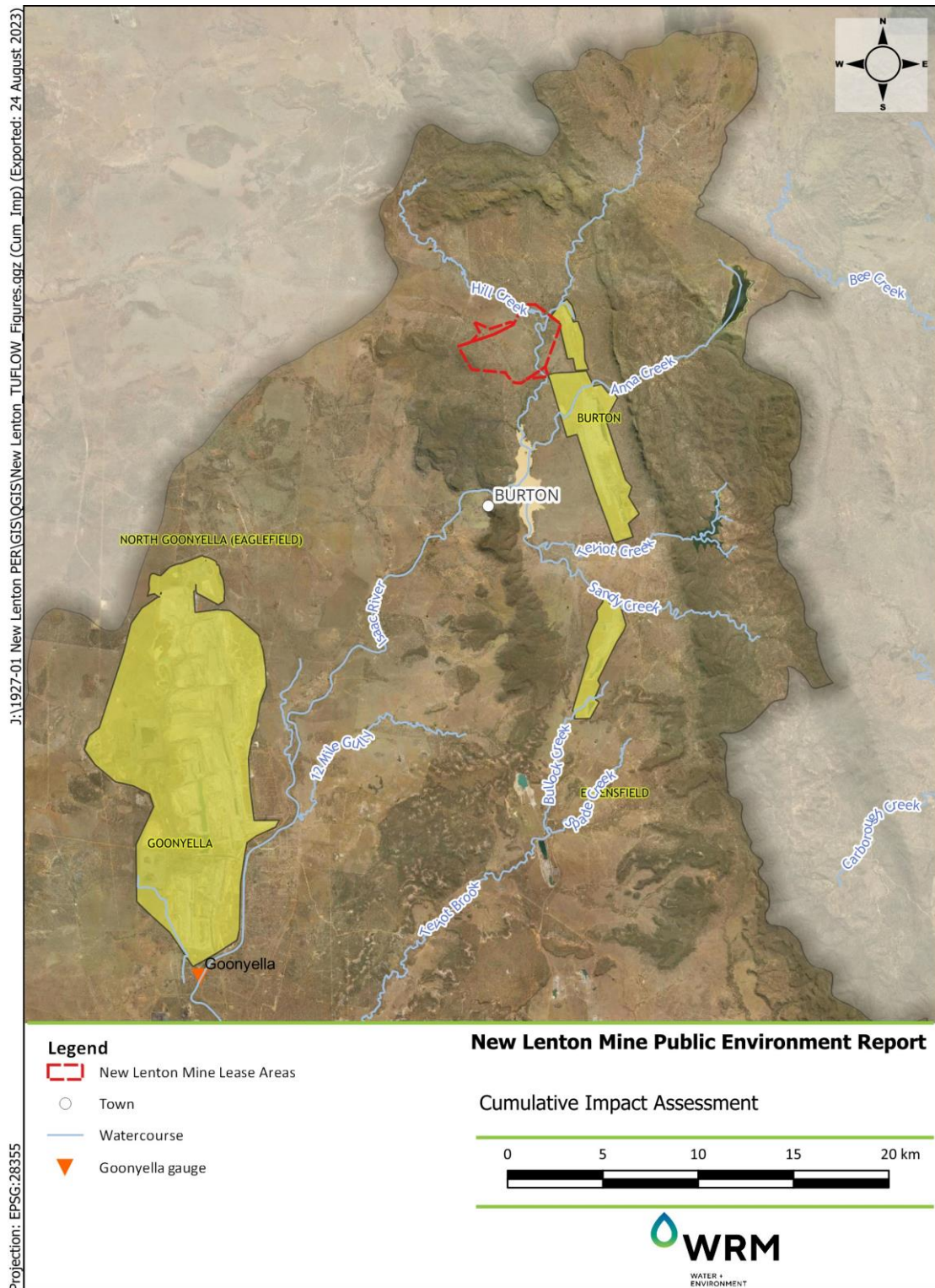


Figure 10.1 Cumulative impact assessment – location of existing mine upstream of the Isaac River at Goonyella gauge

10.10 SURFACE WATER MONITORING PROGRAM

10.10.1 Overview

Monitoring of surface water quality both within and surrounding to the Project area will form a key component of the surface water management system. Monitoring of upstream, on-site and downstream water quality will assist in demonstrating that the site water management system is effective in meeting its objective of minimal impact on receiving water quality and would allow for early detection of any impacts and appropriate corrective action.

The surface water monitoring protocols will:

- ensure compliance with the EA for the Project;
- provide valuable information on the performance of the water management system; and
- facilitate adaptive management of water resources on-site.

10.10.2 Water quality monitoring locations

The proponent has previously monitored a number of surface water locations in the vicinity of the Project (as detailed in Section 3.7). The Surface Water Monitoring Program would include the continued monitoring of a number of these sites to monitor surface water flows and quality upstream and downstream of the Project.

The water quality monitoring program would also include monitoring of dams which contain mine-affected water. This includes the following dams:

- Transfer Dam;
- Pit Dam 1; and
- Pit Dam 2.

Locations of the proposed surface water monitoring locations are shown in Figure 10.2 and summarised in Table 10.5.

Table 10.5 Proposed surface water monitoring program

Monitoring point	Waterway	Location		Parameters
		Latitude (decimal degree, GDA94)	Longitude (decimal degree, GDA94)	
Upstream monitoring points				
MP01	Isaac River 1,000 m upstream of Project disturbance areas	-21.545222	148.145438	Quality only
MP02	Isaac River upstream of nominated mine water release point 1 (RP1) in the EA*	-21.565999	148.142814	Quality only
MP03	Ti-Tree Creek upstream of nominated mine water release point (RP2) in the EA*	-21.549080	148.112127	Quality only
Downstream monitoring points				
MP04	Isaac River downstream of RP1 and RP2	-25.581287	148.137026	Quality only
MP05	Ti-Tree Creek diversion	-21.545931	148.125478	Quality & quantity

* Note that the water balance model presented in this report does not predict that releases of mine affected water will occur.

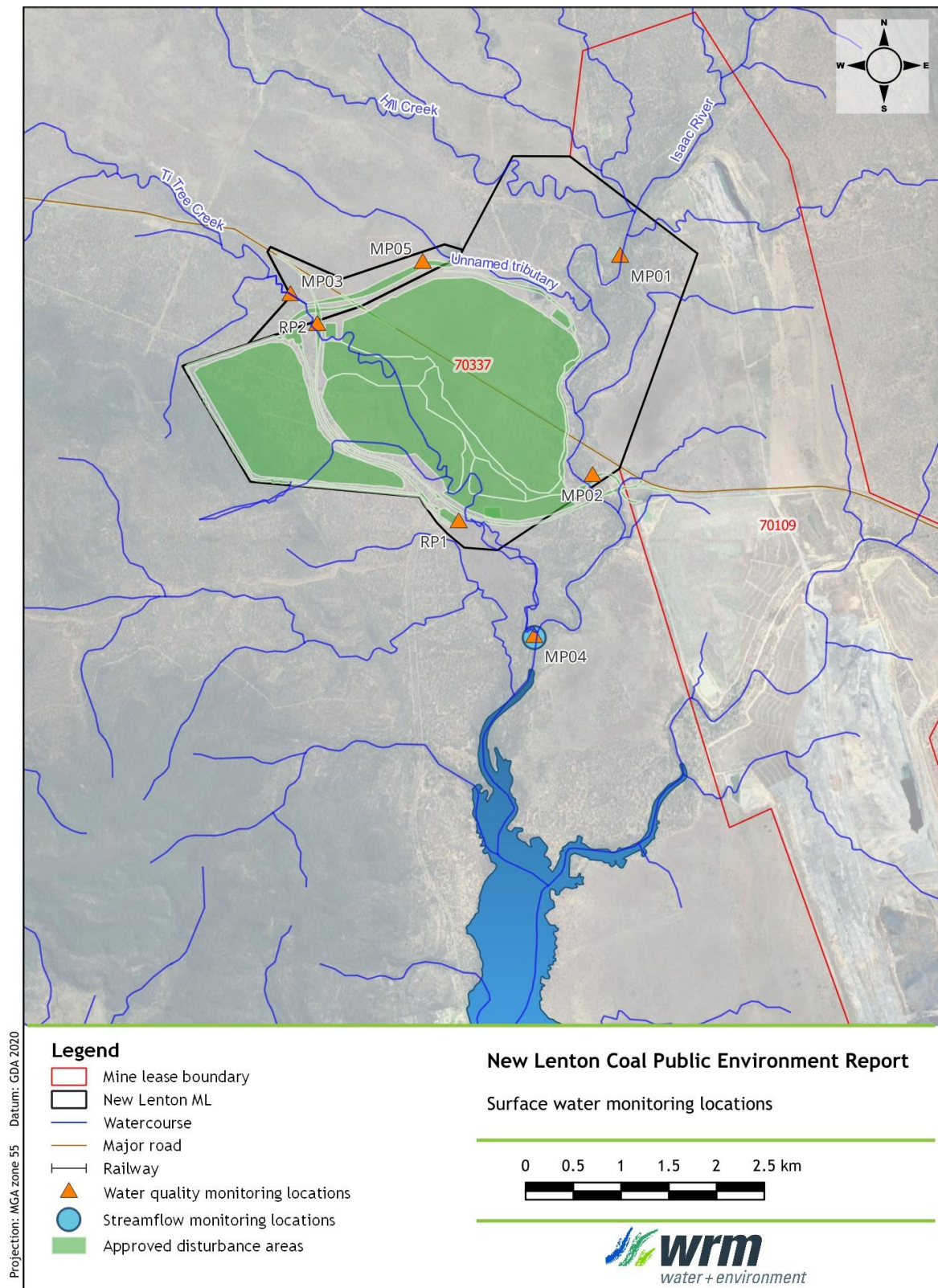


Figure 10.2 Surface water monitoring locations

10.10.3 Water quality monitoring schedule

Table 10.6 and Table 10.7 define the frequency and parameters to be sampled at the authorised release points during the discharge of mine-affected water (as per the approved EA), noting that releases of mine affected water are not predicted to occur.

Table 10.8 defines the frequency and parameters to be sampled across the dams which can discharge to the receiving environment. The proposed water quality monitoring program provides regular monitoring of key mine affected water storages and sediment dams.

The event-based sampling will enable quantification of pollutant loads from the site and their corresponding impact on the water quality of receiving waters. On-site quarterly sampling from the water storages allows for pollutant generation on-site to be identified in advance ensuring appropriate remedial action can be taken.

Table 10.6 Mine affected water release limits (Condition C2 of the approved EA)

Quality characteristic	Units	Release limits	Monitoring frequency	Comment
Electrical conductivity	µS/cm	250	Daily during release (the first sample must be taken within two (2) hours of commencement of release)	Upper Isaac River catchment water quality objective
pH	pH unit	6.5 (minimum) 9.0 (maximum)		
Turbidity	NTU	50		Turbidity is required to assess ecosystems impacts and can provide instantaneous results
Sulphate (SO ₄ ²⁻)	mg/L	25		Upper Isaac River catchment water quality objective

Table 10.7 Release contaminant trigger investigation levels (Condition C3 of the approved EA)

Parameter	Trigger level	Comment on trigger level	Monitoring frequency
Aluminium	55 µg/L	For aquatic ecosystem protection, based on SMD guideline	Commencement of release (within two (2) hours) and thereafter weekly during release
Arsenic	13 µg/L	For aquatic ecosystem protection, based on SMD guideline	
Cadmium	0.2 µg/L	For aquatic ecosystem protection, based on SMD guideline	
Chromium	1 µg/L	For aquatic ecosystem protection, based on SMD guideline	
Copper	1.4 µg/L	For aquatic ecosystem protection, based on SMD guideline	
Iron	300 µg/L	For aquatic ecosystem protection, based on low reliability guideline	
Lead	3.4 µg/L	For aquatic ecosystem protection, based on SMD guideline	
Mercury	0.06 µg/L	For aquatic ecosystem protection, based on SMD guideline	

Parameter	Trigger level	Comment on trigger level	Monitoring frequency
Nickel	11 µg/L	For aquatic ecosystem protection, based on SMD guideline	
Zinc	8 µg/L	For aquatic ecosystem protection, based on SMD guideline	
Boron	370 µg/L	For aquatic ecosystem protection, based on SMD guideline	
Cobalt	1.4 µg/L	For aquatic ecosystem protection, based on SMD guideline	
Manganese	1900 µg/L	For aquatic ecosystem protection, based on SMD guideline	
Molybdenum	34 µg/L	For aquatic ecosystem protection, based on low reliability guideline	
Selenium	5 µg/L	For aquatic ecosystem protection, based on SMD guideline	
Silver	0.5 µg/L	For aquatic ecosystem protection, based on SMD guideline	
Uranium	0.5 µg/L	For aquatic ecosystem protection, based on low reliability guideline	
Vanadium	6 µg/L	For aquatic ecosystem protection, based on low reliability guideline	
Ammonia	900 µg/L	For aquatic ecosystem protection, based on SMD guideline	
Nitrate	1,100 µg/L	For aquatic ecosystem protection, on ambient QLD WQ Guidelines (2006) for TN	
Total recoverable hydrocarbons (C6-C9)	20 mg/L		
Total recoverable hydrocarbons (C10-C36)	100 mg/L		

Notes:

1/ All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metals/metalloids apply to the dissolved fraction.

2/ The quality characteristics required to be monitored as per Table C3 can be reviewed once the results of two years monitoring data is available, or if sufficient data is available to adequately demonstrate negligible environmental risk. It may be determined that a reduced monitoring frequency is appropriate or certain quality characteristics can be removed from Table C3 by amendment.

Table 10.8 Water storage monitoring (Condition C7 of the approved EA)

Water storage	Latitude (decimal degree, GDA94)	Longitude (decimal degree, GDA94)	Monitoring location	Frequency of monitoring	Parameter ¹
Transfer Dam	-21.569	148.134	Spillway	Quarterly	pH, EC, Turbidity, Sulphate, Major Ions, Arsenic ² , Al ³ , Mo ⁶ and Se ⁶
Pit Dam 1	-21.552	148.116			
Pit Dam 2	-21.551	148.140			
SD1	-21.553	148.112			
SD2	-21.570	148.128			
SD4	-21.563	148.130			
SD5	-21.568	148.129			
SD6	-21.567	148.139			
SD7	-21.552	148.139			
CWD	-21.550	148.138			

Notes:

1/ Monitoring against receiving environment limits is for interpretation only to ensure adequate management of water storages to prevent environmental harm.

2/ All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered).

10.10.4 Receiving Environment Monitoring Program

A Receiving Environment Monitoring Program (REMP) will be prepared in accordance with the EA requirements and the relevant guidelines and will specify the proposed monitoring program for the local receiving waters. The REMP will incorporate the proposed monitoring as described in Section 10.10.2 and Section 10.10.3. The main objective of the REMP will be to report against WQOs for local waterways potentially affected by discharge from the Project and would assist in assessing general aquatic ecosystem health.

A set of receiving water contaminant triggers levels have previously been developed within the approved EA. These trigger levels are presented in Table 10.6 and are to be measured at the upstream and downstream monitoring stations. Monitoring at these locations will allow for an accurate evaluation of the impact of any releases from the Project and allow for identification of any upstream influences that are not associated with the Project.

Table 10.9 Receiving water contaminant trigger levels (Condition C6 of the approved EA)

Quality characteristic	Units	Release limits	Monitoring frequency
Electrical conductivity	µS/cm	250	Daily during release
pH	pH unit	6.5 (minimum) 8.5 (maximum)	
Turbidity	NTU	50	
Sulphate (SO ₄ ²⁻)	mg/L	25	

10.10.5 Monitoring of Ti-Tree Creek diversion

Regular monitoring of the Ti-Tree Creek diversion will be undertaken to confirm that the channel form is stable and not subject to excessive erosion or sediment deposition. The monitoring program will be conducted using the process documented by ACARP (2001) which includes:

- Baseline monitoring prior to the construction of the 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 on Ti-Tree Creek upstream of the diversion and a downstream reach on the unnamed tributary will be established. Baseline monitoring will include:
 - Site photography;
 - Aerial photography;
 - Index of Diversion Condition (IDC);
 - Survey;
 - Vegetation characterisation and assessment.
- Operations monitoring will be conducted after construction works have been completed to maintain channel condition and to identify the need for 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; and
 - Post- event monitoring.

Details of the monitoring program will be documented in the site water management plan.

11 SUMMARY OF FINDINGS

11.1 OVERVIEW AND DRAINAGE NETWORK

The proposed New Lenton Coal Project will develop open cut coal mining pits (West Pit and East Pit) on the New Lenton MLs, with supporting infrastructure to mine approximately 30 Mtpa of metallurgical ROM coal over a period of 18 years.

The Project Disturbance Area is located in the upper catchment of the Isaac River, and is drained by the Isaac River and its tributaries Ti-Tree Creek, and an unnamed tributary.

11.2 FLOOD MANAGEMENT INFRASTRUCTURE AND IMPACTS

The eastern edge of the Project Disturbance Area is potentially subject to flooding from the Isaac River. Ti-Tree Creek flows directly through the Project Disturbance Area. Protection of mining operations from flooding requires the diversion of Ti-Tree Creek to the east, on the northern side of East Pit. The diverted Ti-Tree Creek then flows into the Isaac River approximately 4.7 km upstream of the current Ti-Tree Creek and Isaac River confluence.

Key components the proposed flood protection infrastructure are:

- A constructed channel to divert Ti-Tree Creek;
- A levee to protect mine operations from Ti-Tree Creek flooding; and
- A levee to protect mine operations from Isaac River flooding.

Detailed flood modelling of the Ti-Tree Creek diversion and watercourses adjacent the Project Disturbance Area shows that the proposed levees will protect the mine pits from flooding up to the 0.1% (1 in 1,000) AEP event.

The results of detailed flood modelling show that the impacts of the Project on the hydraulic characteristics (such as velocity, bed shear stress and stream power) of the Isaac River are minimal. For other key drainage features potentially impacted by the Project, hydraulic parameters are generally within the range of existing values along these drainage features for operational and post-mining conditions. The area of highest risk is the downstream portion of the Ti-Tree Creek diversion. Ongoing monitoring of the performance of the diversion will be undertaken and, if necessary, mitigation measures will be implemented to prevent excessive erosion or sediment deposition. Potential mitigation measures would include minor earthworks, such as filling scour areas, reprofiling banks or removing accumulated sediment, and revegetation of areas subject to erosion.

11.3 SITE WATER MANAGEMENT

Surface runoff from areas affected by the Project will be managed based on anticipated water quality. Runoff from undisturbed areas (clean water) will be diverted around disturbance areas. Runoff from areas of land disturbance affected by sediment only (sediment water) will be treated in sediment dams prior to reuse or release from the site. Runoff that comes into contact with coal, as well as intercepted groundwater (mine-affected water) will be contained and reused within the Project Disturbance Area for dust suppression.

The mine water management system includes three mine-affected water dams and six sediment dams. The mine water management system includes a connection to existing pit voids at Burton Mine which have capacity to store mine water transferred from the Project. This enables the Project to export water under wet conditions and import water during dry conditions.

The results of detailed water balance modelling of the site water management system, under the full range of historical climatic conditions, show that under extreme wet climatic conditions (1% annual chance of exceedance) the Project may transfer an annual volume of up to 1,250 ML to Burton Mine. Under extreme dry conditions, the Project may import up to 700 ML per year from Burton Mine.

For all climatic conditions, the water balance model results show there will be no discharge of mine-affected water from the site water management system.

11.4 IMPACTS ON RECEIVING WATER QUALITY AND QUANTITY

The maximum total area captured by the site water management system over the life of the Project is about 2.5% of the catchment area of the Isaac River to the Project location. The impact on Isaac River flows of capturing runoff from this small proportion of the catchment would, in practical terms, be undetectable.

The connection of the site water management system to Burton Mine provides the opportunity to manage the inventory of mine-affected water on the site under all climatic conditions. As a result, the Project can be operated with zero discharge of mine-affected water from the site. Therefore, there will be no impact on receiving water quality from mine-affected water. Erosion and sediment control measures, such as collection and treatment of disturbed area runoff in sediment dams, will be implemented on the site to manage the impacts of land disturbance on downstream water quality.

11.5 FINAL LANDFORM

At the completion of mining operations, the Ti-Tree Creek and Isaac River flood levees will be incorporated into the final landform surface that will protect the final void from flooding under all conditions up the Probably Maximum Flood.

Long term water balance modelling of the final void shows that the water level in the void is expected to gradually rise over a period of about 300 years to reach an equilibrium level of about 270 to 278 mAHD. This is about 42 m below the void crest level and therefore no overflows from the void to the receiving environment will occur.

12 REFERENCES

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APPENDIX A HYDROLOGIC MODELLING

A.1 OVERVIEW

The New Lenton MLs are located in the headwaters of the Isaac River catchment. It is crossed by the floodplains of the Isaac River and its tributaries Hill Creek and Ti-Tree Creek. The confluence of Hill Creek and the Isaac River is located in the northeastern corner of the New Lenton MLs. The confluence of Ti-Tree Creek and the Isaac River is located approximately one kilometre to the south of the New Lenton MLs. The Isaac River drains into the Burton Gorge Dam approximately three kilometres downstream of the New Lenton MLs. Burton Gorge Dam also drains Anna Creek, Teviot Creek and Sandy Creek.

This flood impact assessment analysed peak flows in the watercourses draining the New Lenton MLs. An URBS (Unified River Basin System version 6.61) was used to estimate the 50%, 10%, 2%, 1%, and 1 in 1,000 AEP peak design discharges as well as the probable maximum flood (PMF) for a range of durations. Rainfall data (rainfall depths, areal reduction factors and temporal patterns) were applied in accordance with ensemble event procedures in Australian Rainfall & Runoff (ARR) (Ball et al., 2019).

Due to the lack of calibration data in this region of the Isaac River catchment, peak flows in a number of subareas were validated for a range of events against peak flows derived from the Rational Method (QUDM, 2017).

A.2 URBS HYDROLOGICAL MODEL CONFIGURATION

A.2.1 Spatial configuration

Figure A.1 shows the URBS model configuration. The URBS model subcatchments were delineated in greater detail in the tributaries of Hill Creek, Ti-Tree Creek and the upper Isaac River that drain to the New Lenton MLs. Figure A.2 shows the URBS configuration in the vicinity of the New Lenton MLs.

The model extends downstream to the Burton Gorge Dam and includes all tributaries draining to the Burton Gorge Dam including the Anna, Teviot and Sandy creek catchments. The model has a total catchment area of 541 km² and includes 72 subcatchments ranging in size from 0.3 km² to 40 km².

A.2.2 Subcatchment parameters

URBS now includes the Laurenson's 10 equal subarea method (the 'Aitken' method) of sub catchment routing, meaning that output from a single URBS sub catchment is routed similarly to a single sub catchment in XP-RAFTS. Previously an URBS model needed a minimum of five subareas upstream of any hydraulic model inflow to ensure adequate routing. The Aitken method has been adopted in this study.

Model parameters for each subcatchment were determined as follows:

- A percentage impervious of zero was adopted for all subcatchments;
- Catchment slopes were determined based on available topographic data;
- A PERN 'n' value of 0.07 was adopted for all catchments;
- A channel routing or alpha value of 0.5 was adopted based on model validation.
- The selection of initial and continuing losses for design events is described in Section A.2.5.

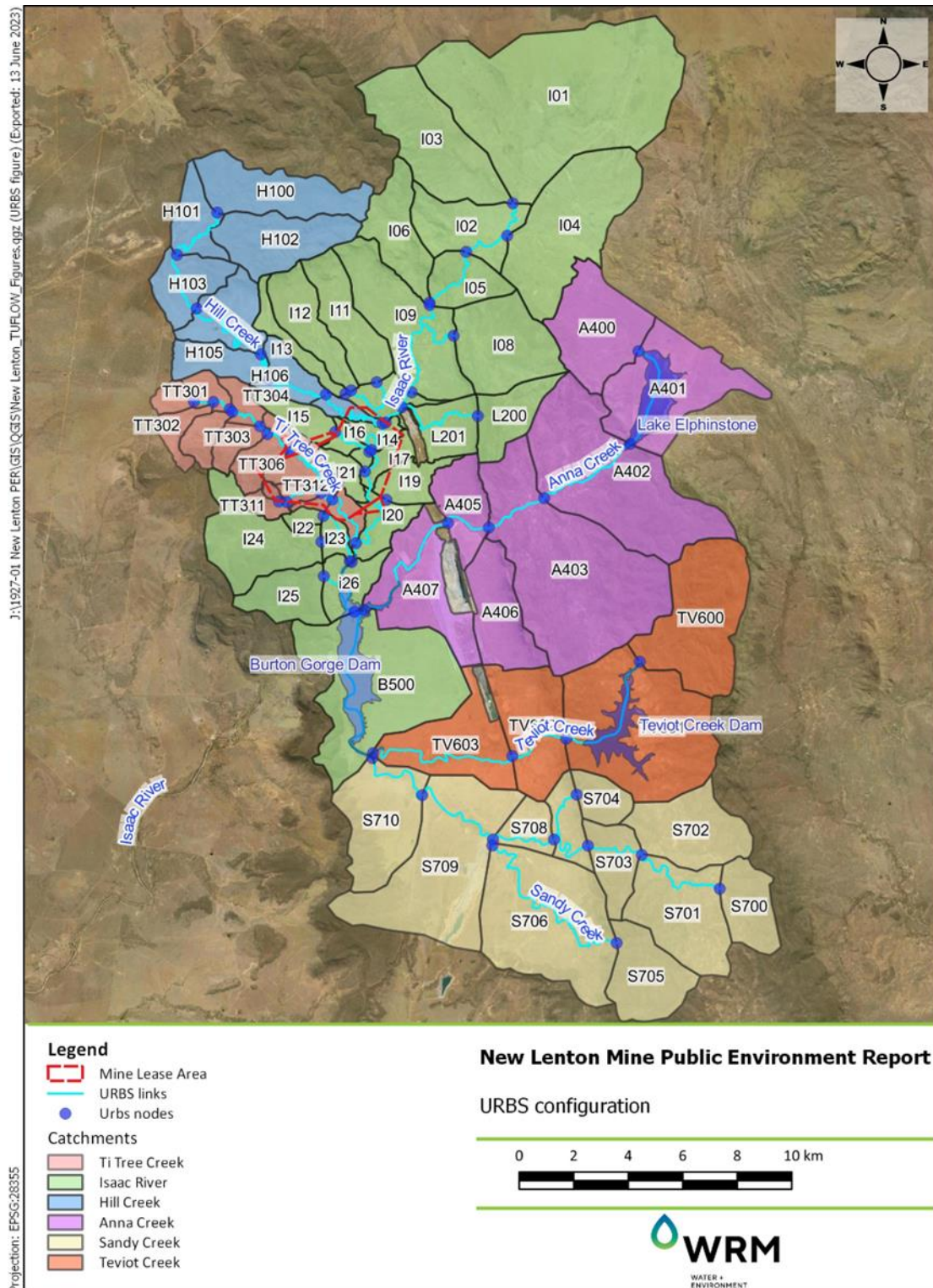


Figure A.1 URBS hydrological model configuration

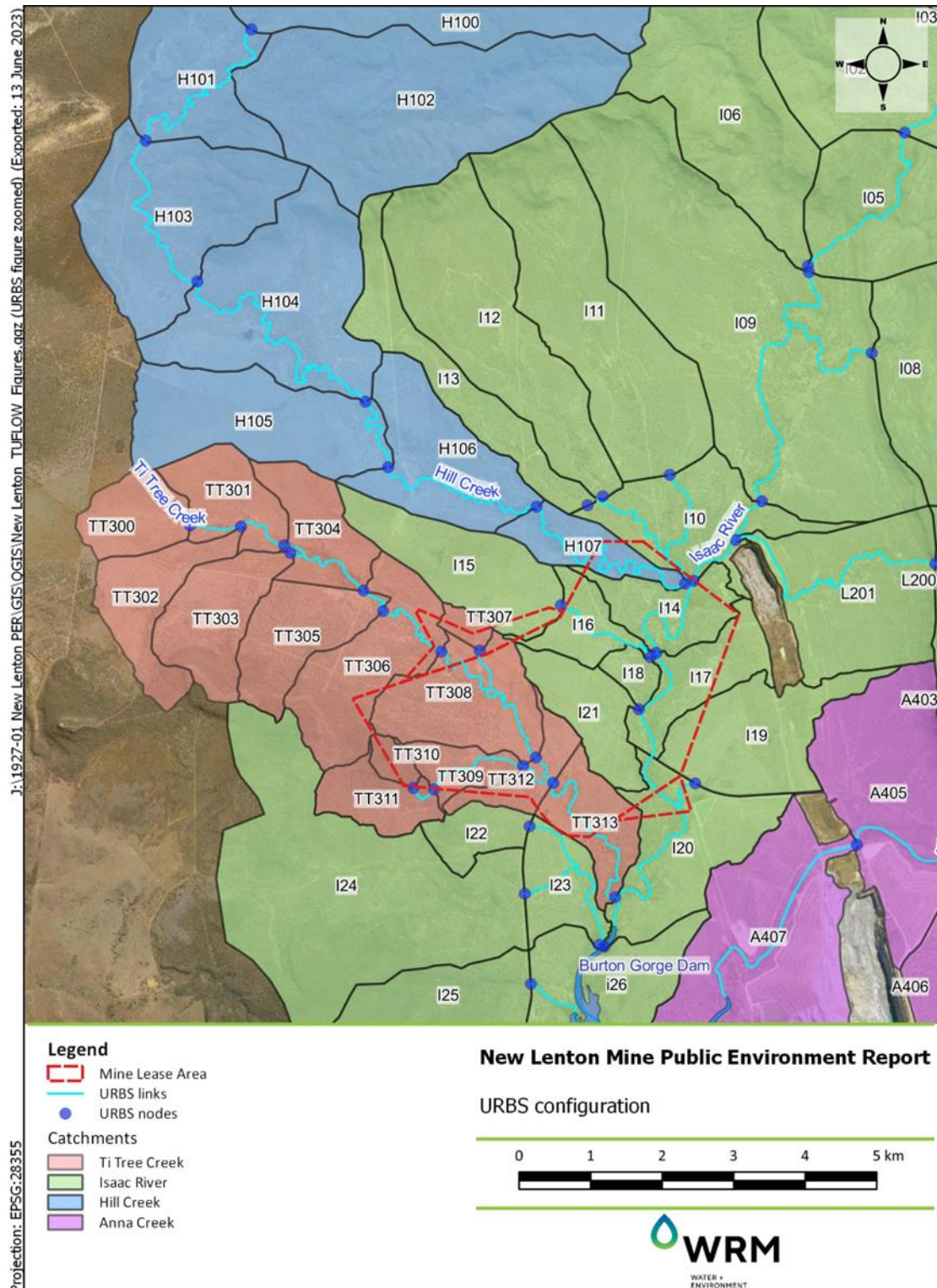


Figure A.2 URBS configuration in vicinity of New Lenton MLs

A summary of URBS model parameters and methodology is provided in Table A.1. Adopted subcatchment characteristics are summarised in Table A.2

Table A.1 URBS parameters

URBS Parameter	Value/Type	Comment
Model type	Aitken	
alpha	0.5	
beta	1.0	Mandatory value for Aitken method
m	0.715	Mandatory value for Aitken method
Pern 'n'	0.07	
USES	L, CS	Length and average catchment slope

Table A.2 URBS subcatchment parameters

Subcatchment ID	Catchment Area (km ²)	Catchment slope (%)	Catchment PERN n
A400	11.13	7.02	0.07
A401	14.76	6.33	0.07
A402	24.28	14.25	0.07
A403	30.54	12.12	0.07
A405	5.66	12.38	0.07
A406	8.25	14.06	0.07
A407	11.33	12.02	0.07
B500	23.31	6.47	0.07
H100	9.65	17.77	0.07
H101	4.21	10.95	0.07
H102	8.69	19.18	0.07
H103	5.32	11.27	0.07
H104	5.90	10.84	0.07
H105	4.18	4.28	0.07
H106	3.34	4.86	0.07
H107	1.31	6.44	0.07
I01	40.07	5.40	0.07
I02	7.83	15.90	0.07

Subcatchment ID	Catchment Area (km ²)	Catchment slope (%)	Catchment PERN n
I03	13.96	13.98	0.07
I04	17.36	6.87	0.07
I05	4.67	21.29	0.07
I06	6.91	23.15	0.07
I08	10.72	12.53	0.07
I09	13.70	11.60	0.07
I10	3.00	6.10	0.07
I11	7.07	8.91	0.07
I12	6.12	9.71	0.07
I13	2.69	6.46	0.07
I14	1.60	8.45	0.07
I15	2.97	3.16	0.07
I16	1.10	4.14	0.07
I17	1.75	7.10	0.07
I18	0.44	6.52	0.07
I19	3.08	5.86	0.07
I20	3.33	10.93	0.07
I21	1.69	3.97	0.07
I22	0.94	6.22	0.07
I23	1.46	4.24	0.07
I24	10.20	8.13	0.07
I25	5.21	10.92	0.07
I26	3.92	4.17	0.07
L200	5.19	13.35	0.07
L201	4.45	10.11	0.07
S700	5.63	9.80	0.07
S701	11.91	6.91	0.07
S702	9.65	8.36	0.07
S703	4.81	17.40	0.07
S704	3.19	15.72	0.07
S705	8.17	14.61	0.07
S706	21.27	9.24	0.07
S707	3.54	17.38	0.07
S708	3.12	5.68	0.07
S709	21.75	6.80	0.07
S710	11.37	11.53	0.07
TT300	1.43	3.73	0.07
TT301	1.69	4.30	0.07

Subcatchment ID	Catchment Area (km ²)	Catchment slope (%)	Catchment PERN n
TT302	2.01	6.76	0.07
TT303	2.22	10.93	0.07
TT304	1.77	4.06	0.07
TT305	2.16	7.62	0.07
TT306	3.12	9.11	0.07
TT307	0.28	3.36	0.07
TT308	2.83	5.84	0.07
TT309	0.84	7.34	0.07
TT310	0.33	16.51	0.07
TT311	1.23	7.96	0.07
TT312	0.93	4.27	0.07
TT313	1.58	5.10	0.07
TV600	15.90	17.42	0.07
TV601	23.55	11.57	0.07
TV602	10.40	12.40	0.07
TV603	10.50	6.18	0.07

A.2.3 Spatial and areal variability

A comparison of the design rainfall intensities revealed variations in design rainfalls of up to 20% within the catchment area draining to the Burton Gorge Dam. Differences in rainfall were generally more pronounced in the upstream areas of the Hill Creek and the Isaac River catchments with the upper reaches experiencing higher rainfall intensities.

Design rainfalls within the catchments of Anna, Teviot and Sandy creeks vary less than 3% and were therefore assigned only a single rainfall gauge. A similar degree of variation was observed between Ti-Tree creek and the downstream extent of the Isaac River.

Design rainfall intensity-frequency-duration (IFD) relationships were determined at five representative gauge locations throughout the URBS model. These IFD gauges were assigned to subcatchments based on the nearest subcatchment centroid location. Table A.3 shows the locations of the IFD data selected for the study. Table A.4 summarises the 1% AEP rainfall intensities for a range of durations for each IFD location. Figure A.3 shows the location of the IFD gauges taken from the Bureau of Meteorology (BOM) and their assignment to the model subcatchments.

Areal reduction factors (ARF) were applied to the three main flowpaths draining to the New Lenton MLs from Ti-Tree Creek, Hill Creek and the Isaac River as well as a tributary of the Isaac River immediately downstream of the New Lenton MLs. Inflows entering the Burton Gorge Dam from Anna and Teviot creeks were determined based on an ARF applied to the entire catchment area to the Burton Gorge Dam (541 km²).

No ARF was adopted for the PMP rainfall as the catchment area is already incorporated into the PMP rainfall estimates. The spatial variation of rainfall for the Probable Maximum Flood is discussed in section A2.6.

Table A.3 Location of BOM IFD data

IFD name	Latitude	Longitude
Upper Isaac	-21.4875	148.1875
Hill	-21.4875	148.0875
Ti-Tree	-21.5375	148.0875
Isaac	-21.5875	148.1375
Teviot Creek	-21.6375	148.2375

Table A.4 1% AEP rainfall depths for BOM gauge locations

Event Duration (hours)	1% AEP rainfall intensity (mm/hr)				
	Upper Isaac	Hill	Ti-Tree	Isaac	Teviot Creek
0.5 (30 min)	123	123	124	125	124
0.75 (45 min)	96.5	95.9	97	98.0	97.2
1	80.5	79.8	80.7	81.8	81.1
1.5	62.0	61.2	61.8	62.6	62.3
2	51.6	50.7	51.0	51.7	51.6
3	40.0	39.2	39.1	39.5	39.8
4.5	31.4	30.7	30.2	30.3	30.9
6	26.7	26.0	25.3	25.3	26.0
9	21.5	20.8	19.9	19.7	20.7
12	18.5	17.9	16.9	16.6	17.7
18	15.0	14.5	13.5	13.1	14.2
24	12.9	12.5	11.5	11.1	12.2
30	11.5	11.0	10.1	9.75	10.8
36	10.3	9.94	9.06	8.73	9.72
48	8.71	8.35	7.58	7.29	8.19
72	6.64	6.36	5.75	5.54	6.27
96	5.35	5.12	4.63	4.46	5.07
120	4.46	4.27	3.86	3.72	4.22

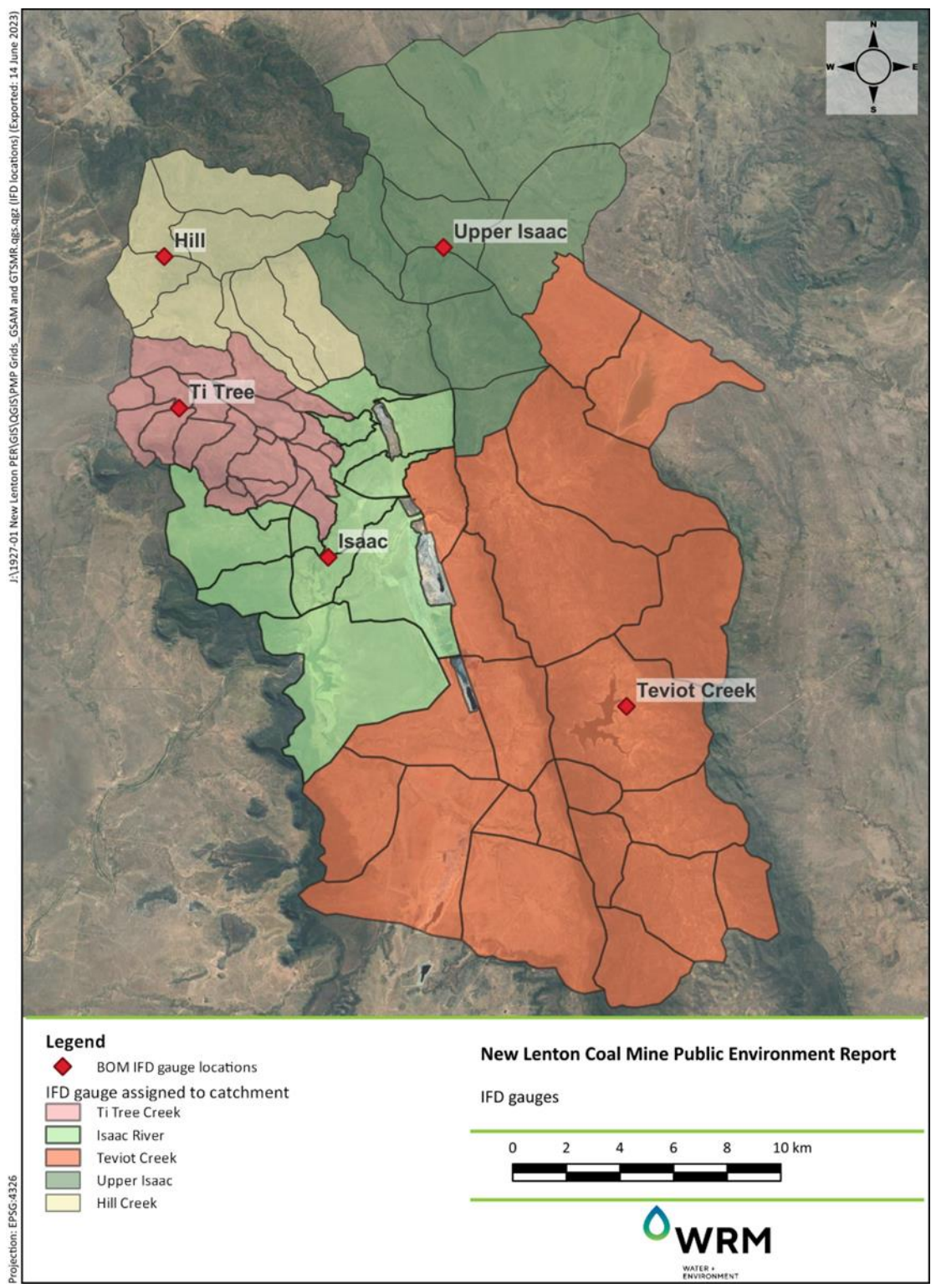


Figure A.3 IFD gauges

A.2.4 Temporal patterns

The East Coast North temporal patterns from ARR Data Hub (Geoscience Australia, 2019) were used for design events up to the 1% AEP event.

For the 1 in 1,000 AEP, ARR recommends using temporal patterns for storm duration applied to the Probable Maximum Precipitation (PMP) rainfall. For durations up to 6 hours an ensemble of ten temporal patterns developed by Jordan et al. (Jordan, 2005) can be applied to PMP rainfall. For durations of 24 hours and greater the ensemble of GTSMR temporal patterns for the standard area 100 (for catchment areas between 1 and 300 km²) was used. Durations between 6 hrs and 24 hrs were assessed by applying both sets of temporal patterns in accordance with the recommendation given in ARR 2019.

A.2.5 Design rainfall losses

The design losses were selected based on the data from the ARR Datahub (Geoscience Australia, 2019). No changes to the ARR Datahub losses were required when flows from the hydrological model were validated against the Rational Method. The Datahub losses applied to the design events from the 50% AEP to the 1% AEP were a 36 mm initial loss and 2.7 mm/hr continuing loss. The validation of the model is discussed in section A.2.8.

Conservative losses of zero initial loss and 1 mm/hr continuing loss were applied to the 1 in 1,000 AEP event and the PMF event.

A.2.6 PMP storm

The PMP design rainfall depths were determined separately for a range of storm events for Ti-Tree Creek, Hill Creek and the Isaac River. Rainfall depths for a range of storm durations were estimated using the methodology provided by the Commonwealth Bureau of Meteorology (BoM) (BOM, 2003 & BoM 2006).

Each catchment required an assessment using the Generalised Short Duration Method (GSDM) (BOM, 2003) (for catchments <1,000 km² and durations up to 6 hours) and the Generalised Tropical Storm Method Revised (GTSMR) (BoM, 2006) for durations of 24 hours and longer. Rainfall values were interpolated using the results of both methods for durations falling between 6 hours and 24 hours. Values for the 4.5 hr storm were also interpolated from the 4 hour and 5 hour GSDM storms.

The following parameters were adopted for the calculation of the GSDM PMP depths for all the catchments:

- Elevation Adjustment Factor of 1.0;
- Moisture Adjustment Factor of 0.87; and
- 100% of the catchment was considered rough due to the proximity of rough terrain throughout the catchment areas.

GTSMR rainfall values for the coastal zone were calculated and applied in accordance with BOM 2006 methodology. The parameters adopted for the calculation of GTSMR rainfall depths for each catchment are summarised in Table A.5.

Table A.5 PMP GTSMR rainfall factors

Catchment	Topological Adjustment Factor (TAF)	Decay Amplitude Factor (DAF)	Extreme Precipitable Water (EPW)	Annual Moisture Adjustment Factor (EPW/120)
Isaac River	1.0	1.0	94.3	0.79
Hill Creek	1.0	1.0	94.2	0.79
Ti-Tree Creek	1.0	1.0	93.6	0.78

For the GSDM, the ensemble of ten temporal patterns developed by Jordan et al. were used (Jordan, 2005). For the GTSMR, the ensemble of coastal storm patterns for the standard area 100 (for catchment areas between 1 and 300 km²) was used. Durations between 6 hours and 24 hours were assessed by applying both sets of temporal patterns in accordance with the recommendation given in ARR 2019.

The PMP rainfall for GSDM rainfall depths was spatially varied using the method of ellipses. The ellipses were centred over the entire catchment. Spatial distribution of rainfall was then applied based on the ellipse that each subcatchment centroid was located within. The spatial distributions of GSDM rainfalls within the Ti-Tree Creek, Hill Creek and Isaac River catchments are shown in Figure A.4, Figure A.5 and Figure A.6 respectively.

Because the TAF for the entire catchment was uniform the GTSMR design rainfall depths (24 hours to 120 hours) were not varied spatially.

Spatially distributed rainfall depths for durations between 12 to 18 hours were interpolated between the spatially distributed 6 hour rainfall depths and the 24 hour rainfall depths derived from the GTSMR method.

Table A.6, Table A.7 and Table A.8 show the adopted PMP rainfall depths in each ellipse for the Ti-Tree Creek, Hill Creek and Isaac River catchments respectively.

Table A.6 Spatially distributed PMP depth estimates for Ti-Tree Creek catchment

Event Duration (hours)	Rainfall Depth (mm)*			
	Ti-Tree A	Ti-Tree B	Ti-Tree C	Ti-Tree D
1	429	397	381	380
1.5	553	507	487	486
2	647	592	569	568
3	784	713	686	685
4.5	943	860	824	823
6	1044	956	918	917
9*	1049	985	957	957
12*	1052	1007	986	986
18*	1057	1038	1029	1029

Event Duration (hours)	Rainfall Depth (mm)*			
	Ti-Tree A	Ti-Tree B	Ti-Tree C	Ti-Tree D
24	1060	1060	1060	1060
36	1260	1260	1260	1260
48	1480	1480	1480	1480
72	1850	1850	1850	1850
96	2080	2080	2080	2080
120	2180	2180	2180	2180

*Rainfall depths interpolated between GSDM and GTSMR

Table A.7 Spatially distributed PMP rainfall depth estimates for Hill Creek catchment

Event Duration (hours)	Rainfall Depth (mm)*			
	Hill A	Hill C	Hill C	Hill D
1	431	381	365	360
1.5	557	488	470	463
2	650	570	545	537
3	789	686	659	650
4.5	951	827	795	775
6	1048	918	965	865
9*	1052	957	992	918
12*	1054	986	1011	957
18*	1058	1029	1040	1016
24	1060	1060	1060	1060
36	1260	1260	1260	1260
48	1480	1480	1480	1480
72	1850	1850	1850	1850
96	2080	2080	2080	2080
120	2180	2180	2180	2180

*Rainfall depths interpolated between GSDM and GTSMR

Table A.8 Spatially distributed PMP rainfall depth estimates for Isaac River Creek catchment to Burton Gorge Dam

Event Duration (hours)	Rainfall Depth (mm)*					
	Isaac A	Isaac B	Isaac C	Isaac D	Isaac E	Isaac F
1	429	391	348	324	316	313
1.5	553	500	449	418	407	405
2	647	585	519	479	468	465
3	784	705	633	586	574	572
4.5	943	847	748	692	678	671
6	1044	943	835	772	754	746
9*	1043	970	891	842	829	822
12*	1042	990	932	896	886	881
18*	1041	1019	994	978	973	971
24	1040	1040	1040	1040	1040	1040
36	1260	1260	1260	1260	1260	1260
48	1480	1480	1480	1480	1480	1480
72	1850	1850	1850	1850	1850	1850
96	2080	2080	2080	2080	2080	2080
120	2180	2180	2180	2180	2180	2180

*Rainfall depths interpolated between GSDM and GTSMR

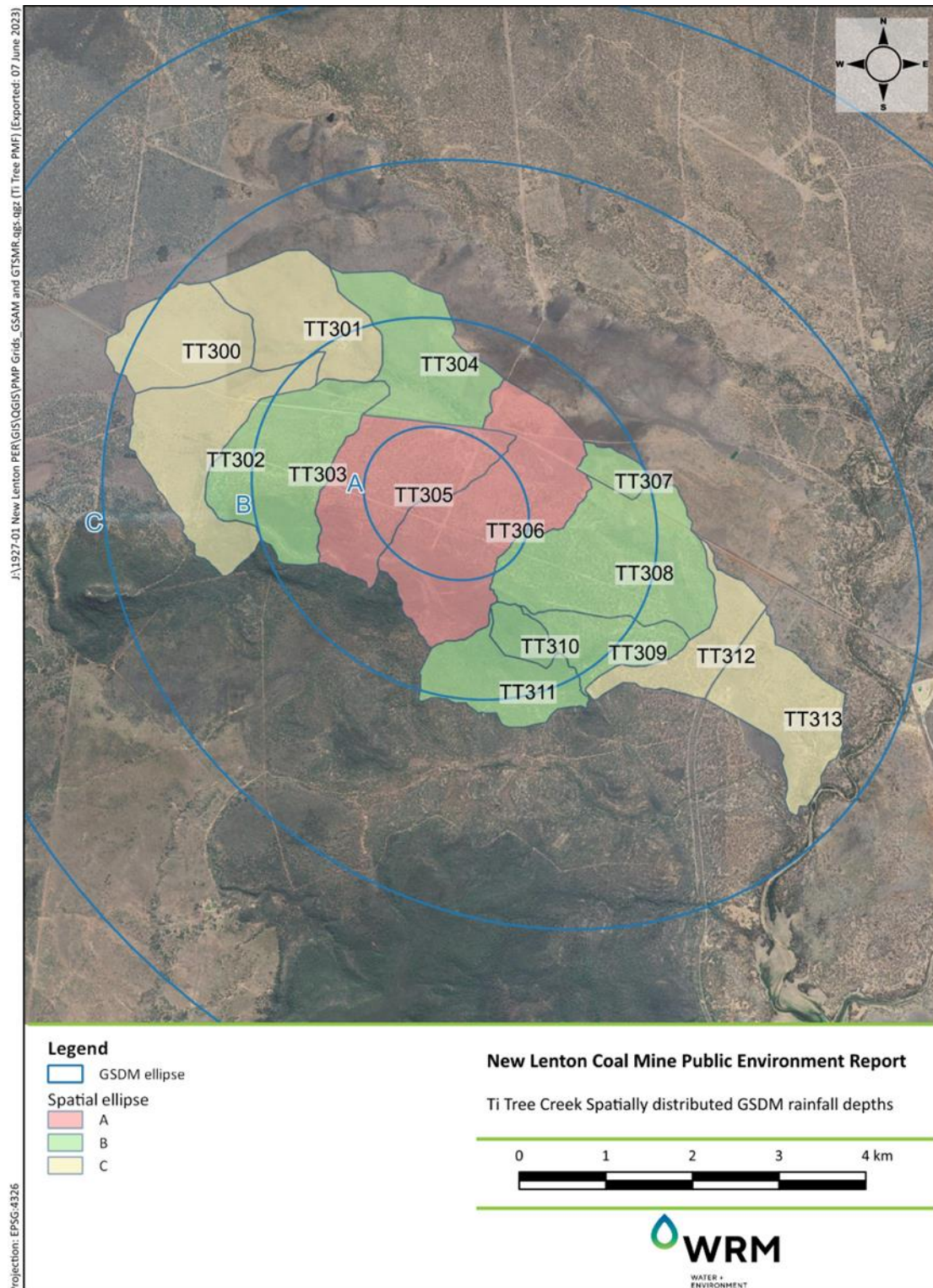


Figure A.4 Ti-Tree Creek spatial distribution of GSDM rainfall depths

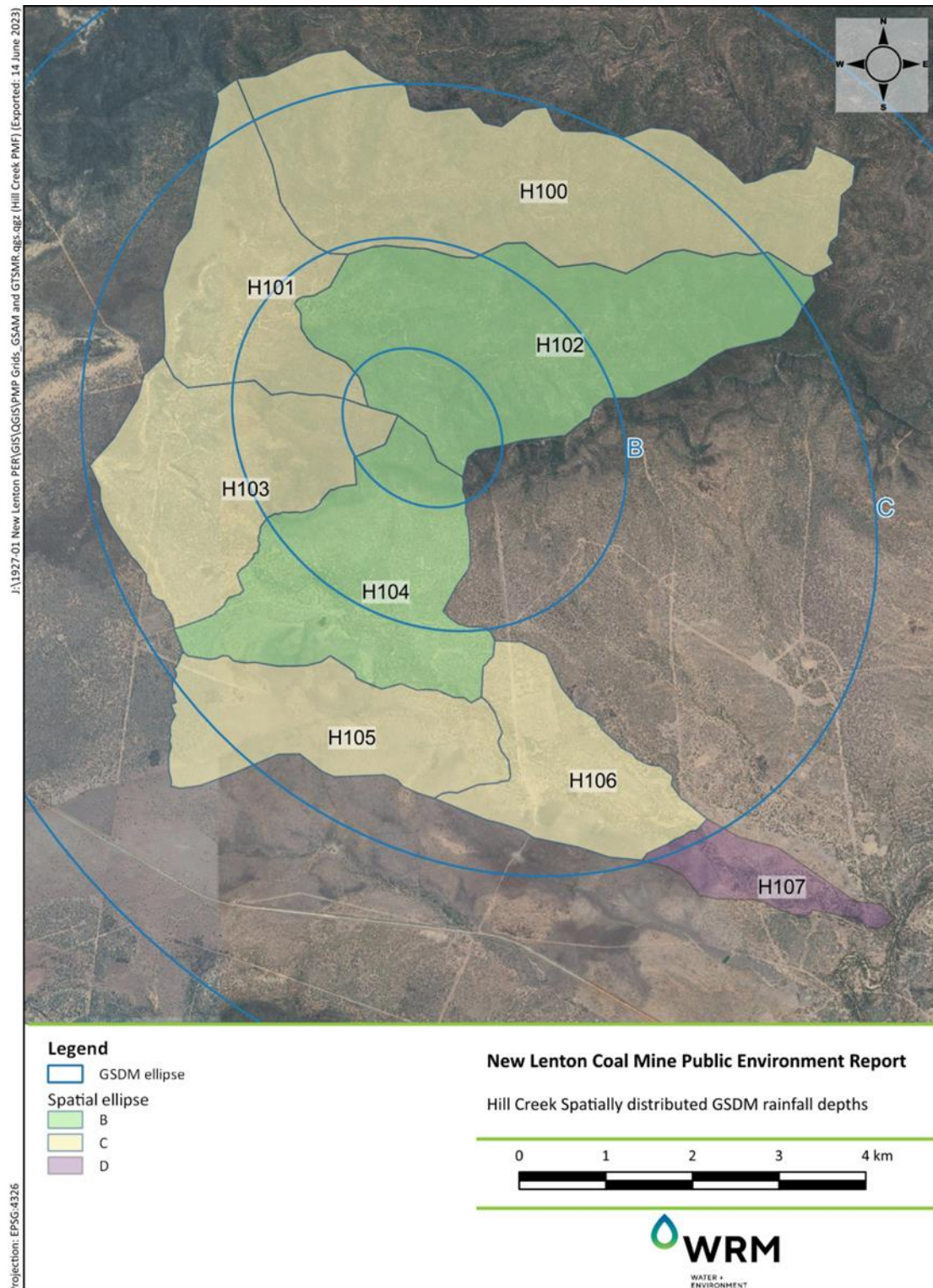


Figure A.5 Hill Creek spatial distribution of GSDM rainfall depths

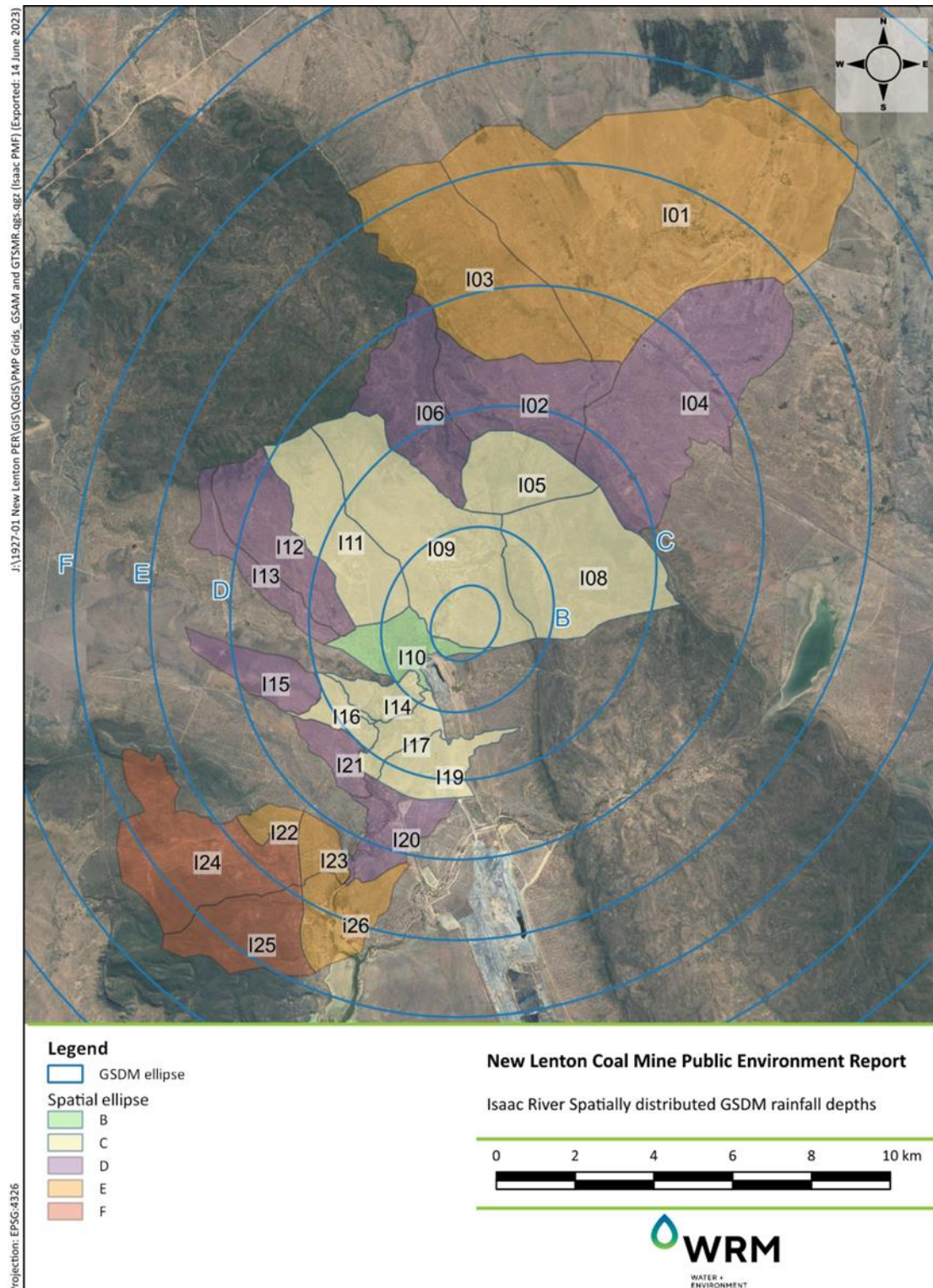


Figure A.6 Isaac River spatial distribution of GSDM rainfall depths

A.2.7 Storages

The catchment area includes three storages including the Burton Gorge Dam, Teviot Creek Dam and the naturally occurring Lake Elphinstone. The Burton Gorge Dam was not included in the hydrologic model as it is explicitly included in the hydraulic model developed for this study. It also constitutes the downstream boundary of both the hydrologic and hydraulic models and therefore it was not necessary to route flows through the dam.

A stage storage curve for the Teviot Creek Dam (see Figure A.7) was developed using available one metre LiDAR data from ELVIS captured in 2014.

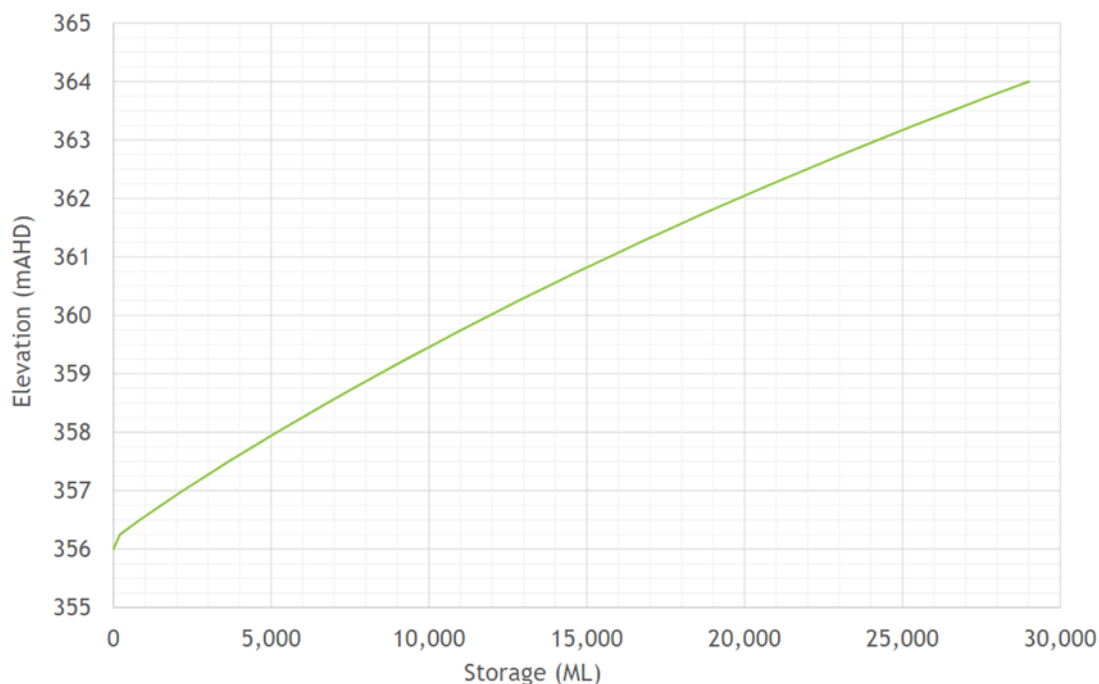


Figure A.7 Teviot Creek Dam Stage Storage Relationship

The structural details of the Teviot Creek Dam were derived from the URS Baseline Hydrology Technical Report (URS, 2013) that in turn derived these details from the Alluvium Consulting study (2008).

The initial water level for the Teviot Dam was set to the spillway crest elevation level of 356 mAHD. The dam has a broad crested weir with a 30 m spillway length. A weir coefficient of 1.45 was adopted as in previous studies to model flow over the spillway using the weir equation. The depth discharge relationship for flows over the spillway was incorporated into the hydrologic model.

Lake Elphinstone is a naturally occurring lake and the impact of this storage on the study area would be minor. However, WRM has derived a depth-discharge relationship for this storage assuming that the lake is full. This relationship was derived from a separate hydraulic TUFLOW model developed to assess the hydraulic behaviour of the dam. This model explicitly modelled the storage relationship in the dam using 1 m 2014 LiDAR data. The depth-discharge relationship for the natural spillway that was derived from the hydraulic modelling was incorporated into the hydrological model as the hydraulic model developed for this study does not include the Lake Elphinstone area.

A.2.8 Model validation

As there are no gauges in the catchment in the vicinity of the Project the model could not be calibrated. Instead, peak flows from the outlet of Ti-Tree Creek (22 km²) as well as subcatchment I21 (1.69 km²) located within the New Lenton MLs were validated against the Rational Method (QUDM, 2013) for events ranging from 50% to the 1% AEP. The Rational Method technique adopted was the Bransby Williams Equation for rural catchments less than 25 km². The inputs to the Rational Method calculations for Ti-Tree Creek and subcatchment I21 are shown in Figure A.8 and Figure A.9 respectively.

Table A.9 and compare the URBS estimated discharges for the Ti-Tree Creek and I21 catchments against the peak discharges derived from the Rational Method. URBS peak discharges are within 10% of flows derived from the rational method for all AEPs for both catchments that were assessed and is therefore an acceptable validation.

Table A.9 URBS Model peak discharge validation for Ti-Tree Creek

Design Storm Event (AEP)	Rational Method (m ³ /s)	URBS (m ³ /s)	Difference (%)
50%	25.4	26.0	3
10%	51.3	50.0	-3
2%	81.9	83.0	2
1%	96.1	98.0	2

Table A.10 URBS Model peak discharge validation for I21 subcatchment

Design Storm Event (AEP)	Rational Method (m ³ /s)	URBS (m ³ /s)	Difference (%)
50%	5.0	4.7	7
10%	9.4	9.9	5
2%	14.2	15.4	8
1%	16.2	18.1	10

Catchment:	Ti Tree Creek
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Catchment area and coefficient of runoff	
Catchment Area (ha)	2200.00
C ₁₀	0.53

Time of concentration	
<i>Bransby-Williams' Equ</i>	
Channel length (m)	12947
Channel slope (m/m)	0.005
t _c (mins)	393.44

Design Discharges						
ARI (years)	AEP (%)	Frequency Factor F _y	C _y	t _c ^b (mins)	Rainfall Intensity (mm/h)	Peak Discharge (m ³ /s)
1	63	0.80	0.42	393.4	9.2	23.9
1.44	50	0.85	0.45	393.4	9.2	25.4
4.48	20	0.95	0.50	393.4	13.1	40.3
10	10	1.00	0.53	393.4	15.8	51.3
20	5	1.05	0.56	393.4	18.4	62.7
50	2	1.15	0.61	393.4	22.0	81.9
100	1	1.20	0.64	393.4	24.7	96.1

Figure A.8 Rational Method Calculations for Ti-Tree Creek

Catchment:	I21					
Catchment area and coefficient of runoff						
Catchment Area (ha)	168.70					
C ₁₀	0.53					
Time of concentration						
<u>Bransby-Williams' Equ</u>						
Channel length (m)	3120					
Channel slope (m/m)	0.009					
t _c (mins)	111.42					
Design Discharges						
ARI (years)	AEP (%)	Frequency Factor F _y	C _y	t _c ^b (mins)	Rainfall Intensity (mm/h)	Peak Discharge (m ³ /s)
1	63	0.80	0.42	111.4	23.8	4.72
1.44	50	0.85	0.45	111.4	23.8	5.02
4.48	20	0.95	0.50	111.4	32.4	7.64
10	10	1.00	0.53	111.4	37.8	9.39
20	5	1.05	0.56	111.4	43.0	11.2
50	2	1.15	0.61	111.4	49.5	14.1
100	1	1.20	0.64	111.4	54.2	16.1

Figure A.9 Rational Method Calculations for subcatchment I21

A.2.9 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 are summarised in Table A.11 For each AEP event a single representative critical duration and temporal pattern was selected.

Peak discharges were calculated at six focal points in the hydrological model. The name and location of these points is shown in Figure A.10.

Flows for a range of durations for all the focal points of interest for each AEP are presented as boxplots in Figure A11 to Figure A.46.

Table A.11 Peak design storm discharges, critical storm duration and temporal pattern

Key location	Event (AEP)	URBS design peak discharge (m ³ /s)	Critical storm duration (hours)	Temporal pattern
ISAAC10ML	50%	120	18	4
	10%	238	18	8
	2%	413	18	5
	1%	494	18	5
	1 in 1,000	866	12	8 (GSDM)
	PMF	2,750	9	3 (GSDM)
TiTree306	50%	28	9	10
	10%	50	6	1
	2%	82	6	8
	1%	101	6	8
	1 in 1,000	166	4.5	4 (GSDM)
	PMF	875	3	7 (GSDM)
Hill107	50%	38	24	10
	10%	67	24	6
	2%	113	12	3
	1%	148	12	10
	1 in 1,000	278	12	9 (GSDM)
	PMF	925	6	3 (GSDM)
Isaac024	50%	23	9	7
	10%	52	3	4
	2%	98	6	8
	1%	118	6	7
	1 in 1,000	203	1.5	7 (GSDM)
	PMF	840	2	3 (GSDM)
Anna407	50%	81	24	5

Key location	Event (AEP)	URBS design peak discharge (m ³ /s)	Critical storm duration (hours)	Temporal pattern
	10%	158	24	5
	2%	280	24	5
	1%	338	24	5
	1 in 1,000	596	12	2 (GSDM)
	PMF	2,120	6	8 (GSDM)
	50%	138	24	10
ST500	10%	268	24	5
	2%	471	24	8
	1%	591	24	5
	1 in 1,000	978	12	7 (GSDM)
	PMF	3,385	6	7 (GSDM)

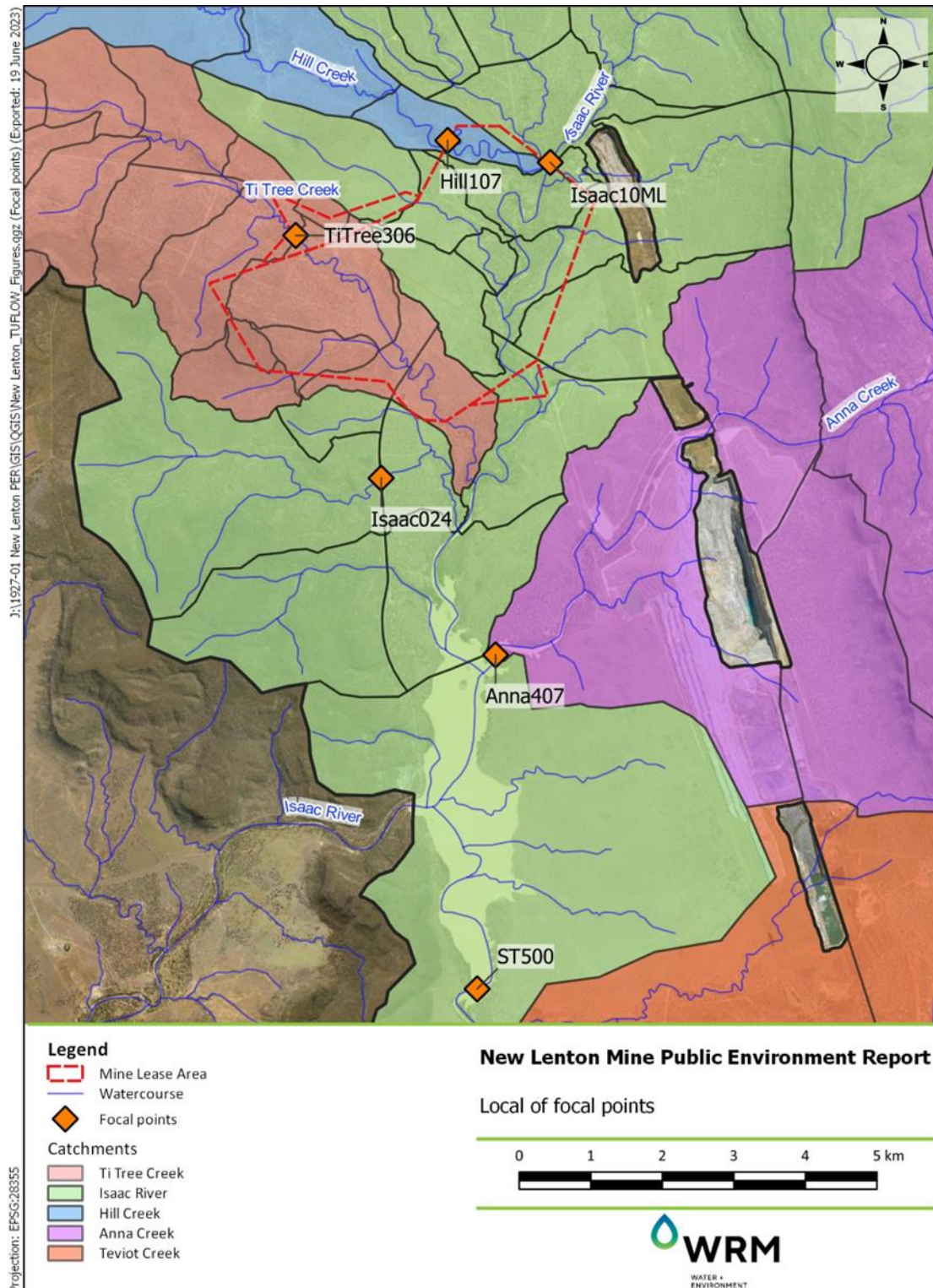


Figure A.10 Focal points used for deriving peak design discharges

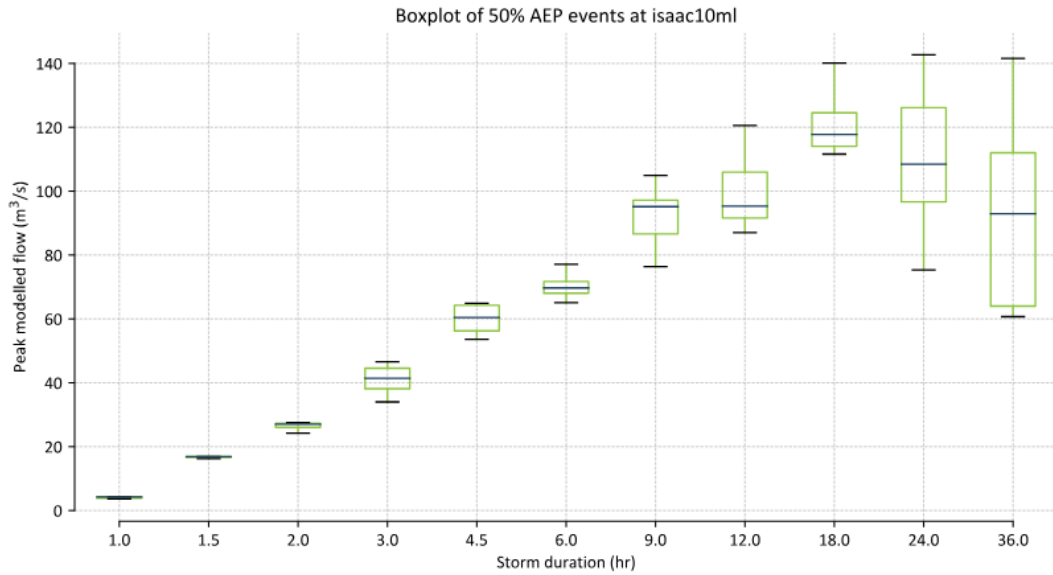


Figure A.11 **50% AEP at Isaac10ML**

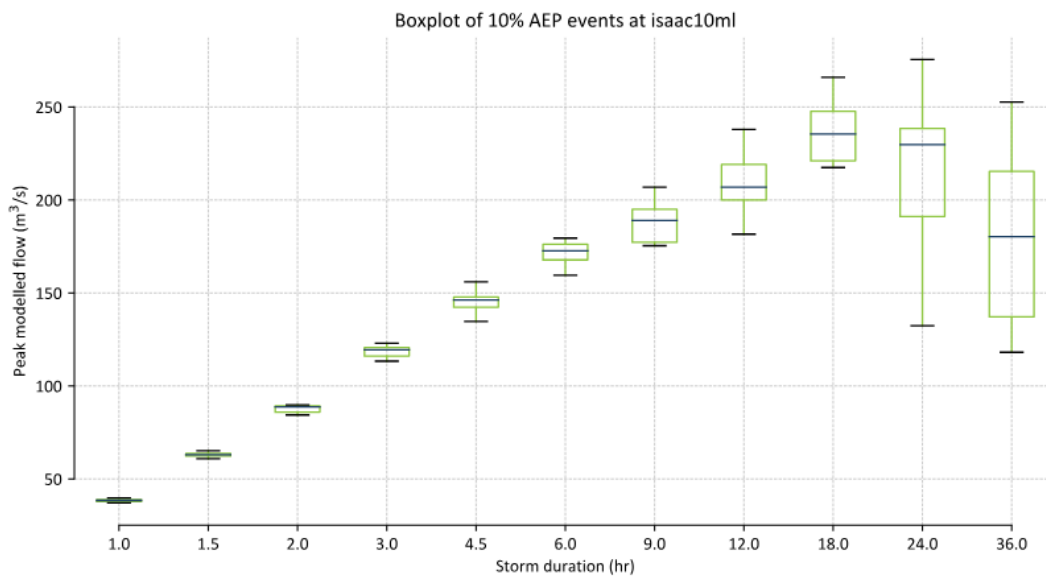


Figure A.12 **10% AEP at Isaac10ML**

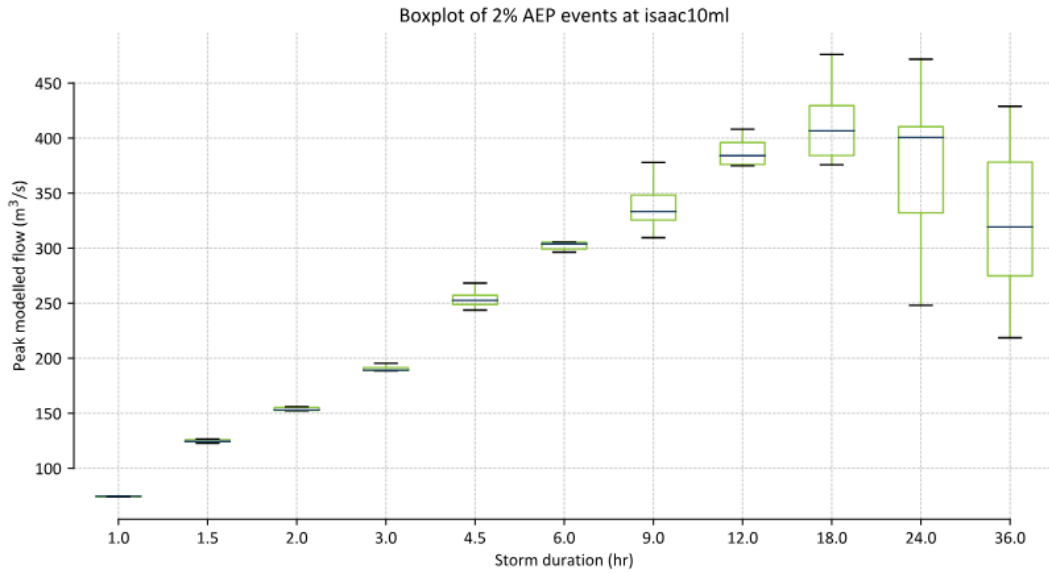


Figure A.13 **2% AEP at Isaac10ML**

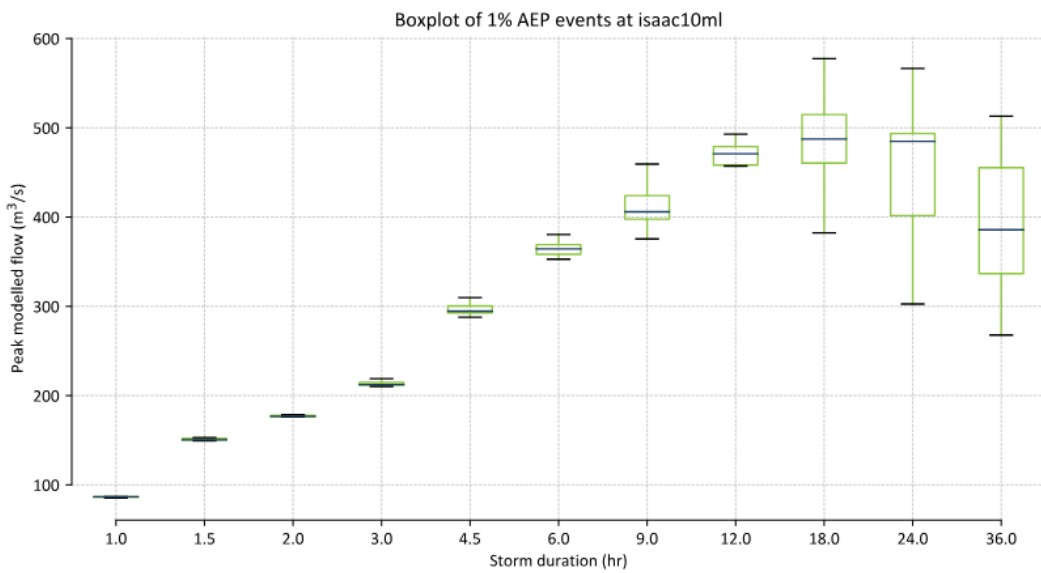


Figure A.14 **1% AEP at Isaac10ML**

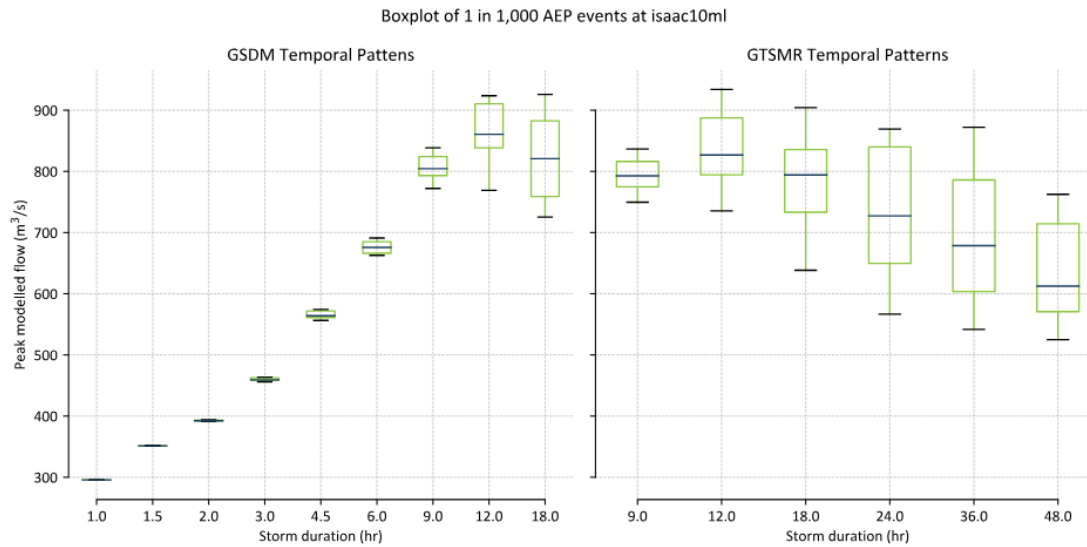


Figure A.15 1 in 1,000 AEP at Isaac10ML

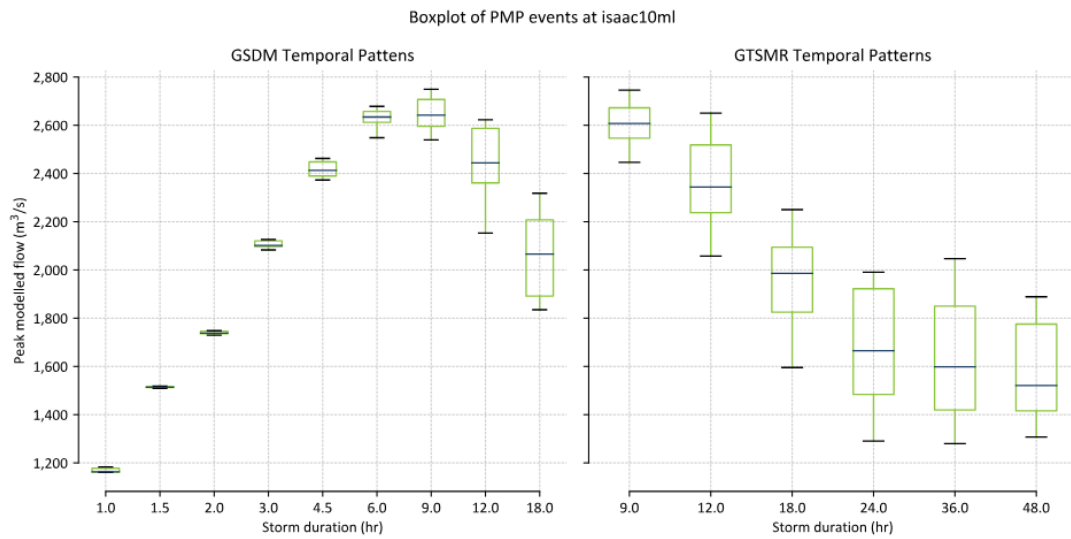


Figure A.16 PMF at Isaac10ML

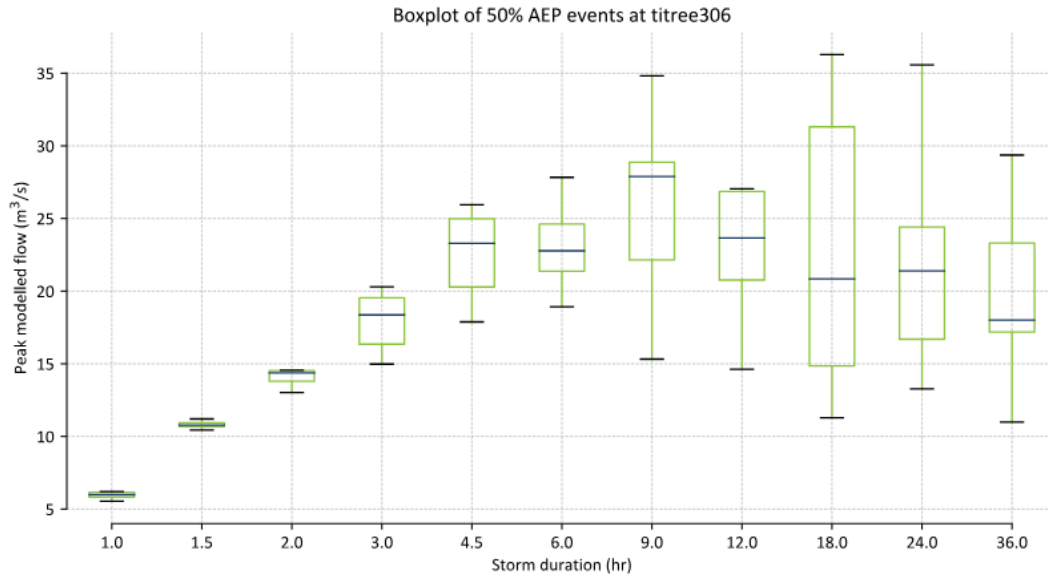


Figure A.17 **50% at TiTree306**

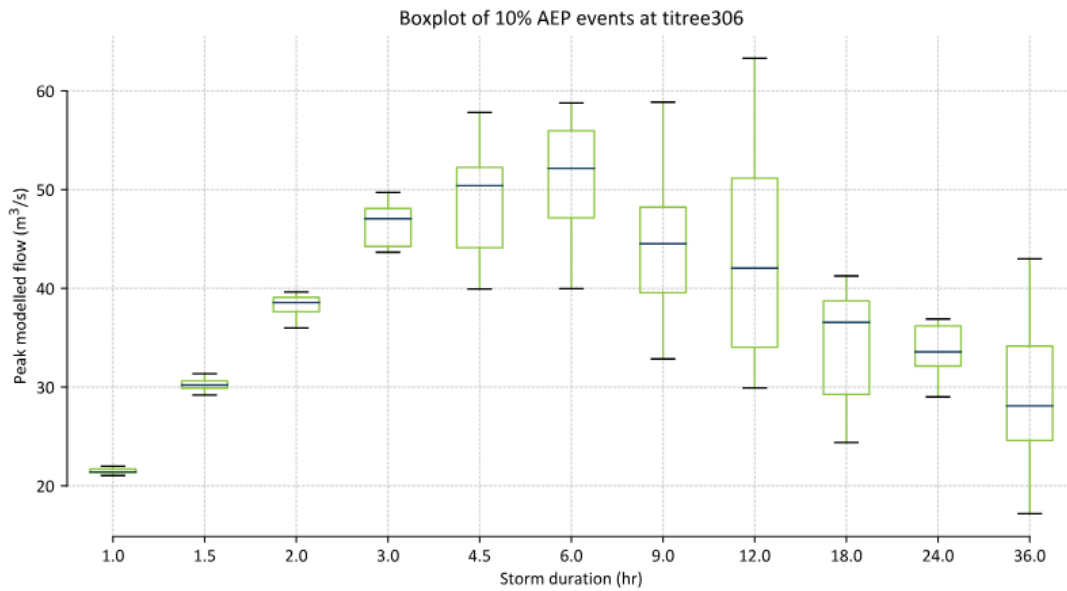


Figure A.18 **10% at TiTree306**

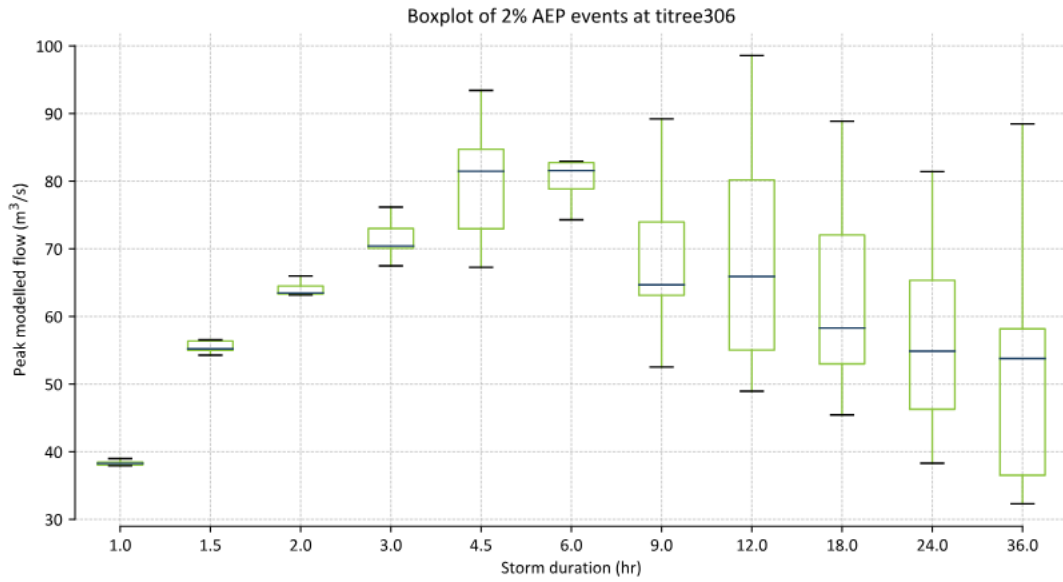


Figure A.19 **2% at TiTree306**

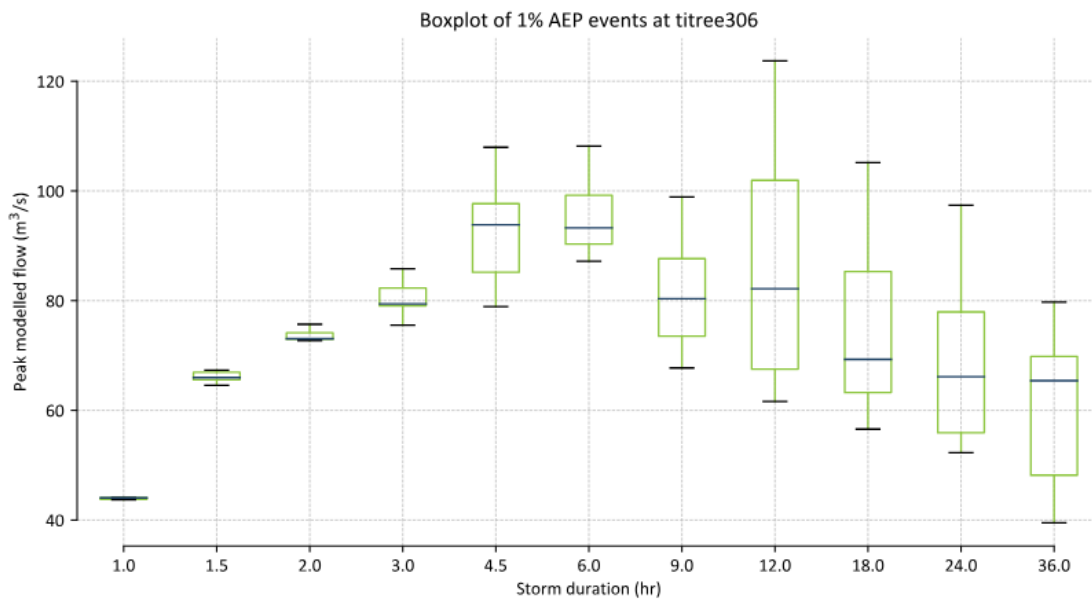


Figure A.20 **1% at TiTree306**

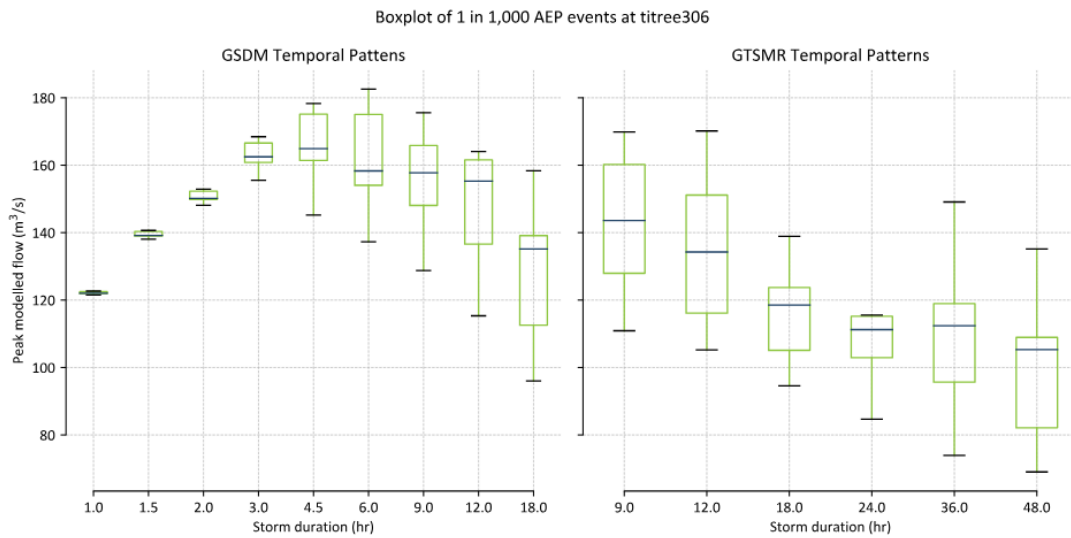


Figure A.21 1 in 1,000 at TiTree306

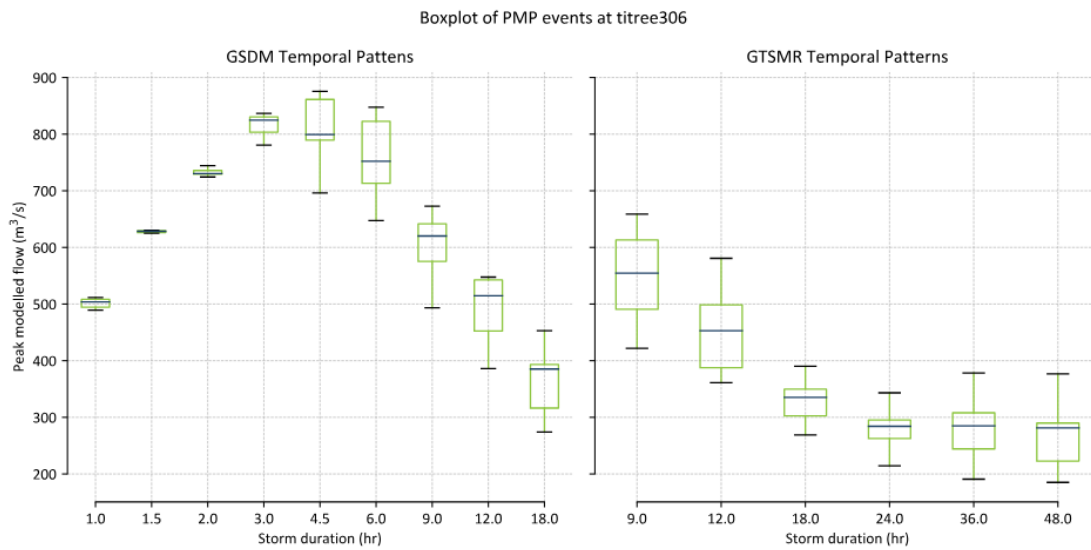


Figure A.22 PMF at TiTree306

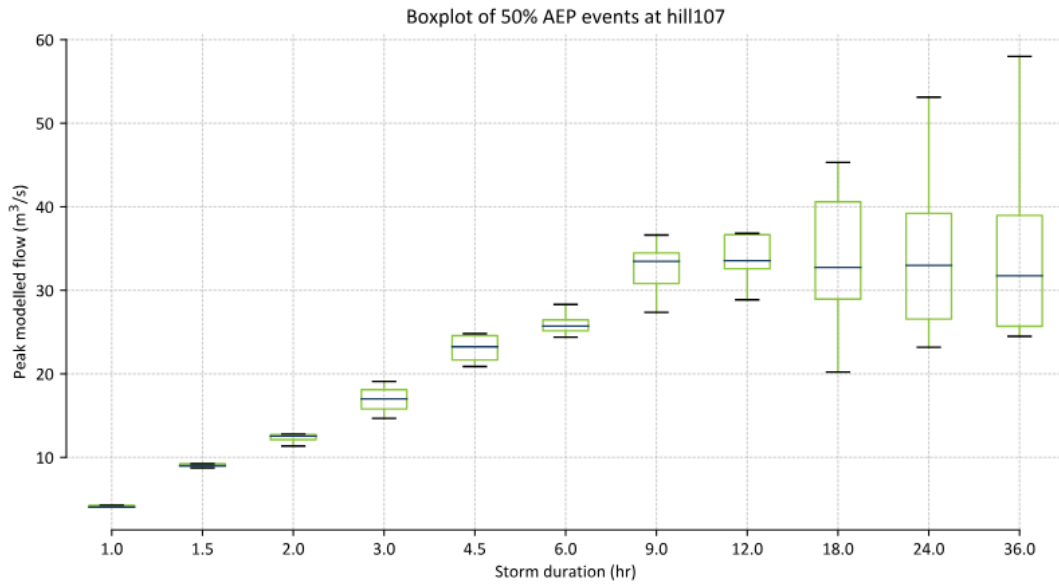


Figure A.23 **50% AEP at Hill107**

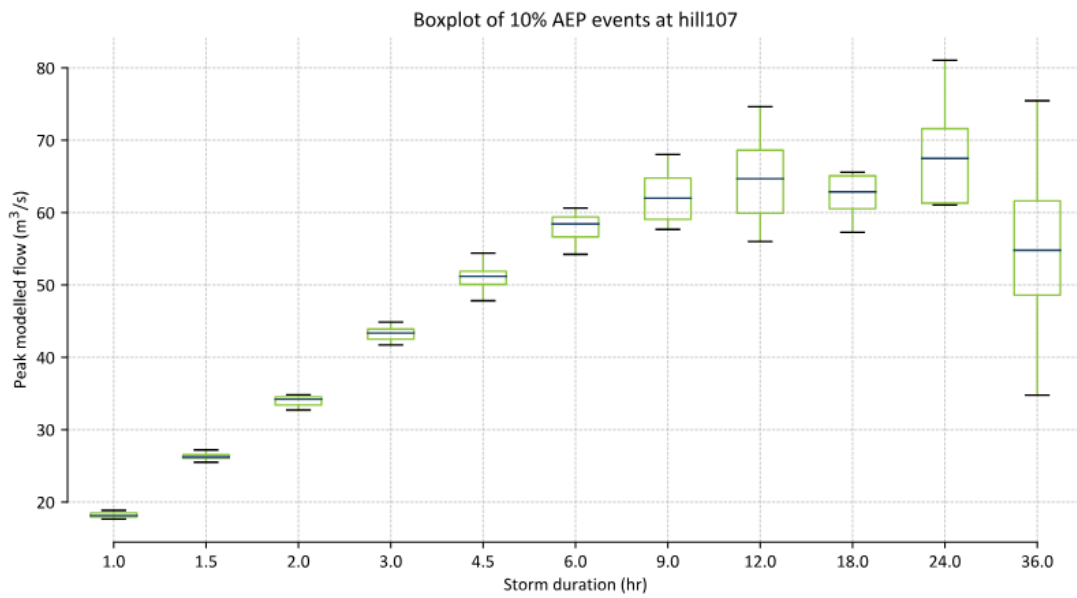


Figure A.24 **10% AEP at Hill107**

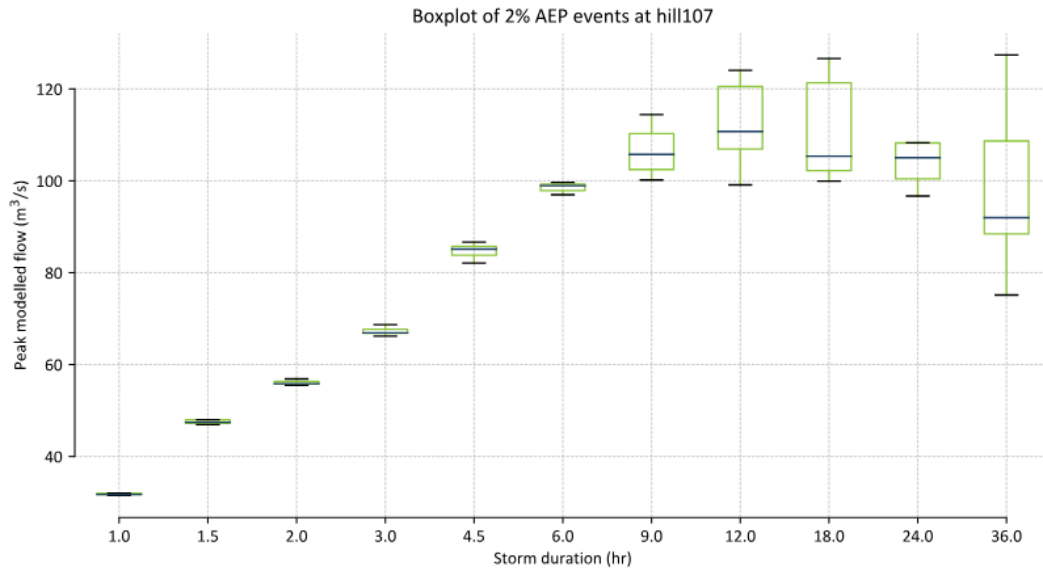


Figure A.25 **2% AEP at Hill107**

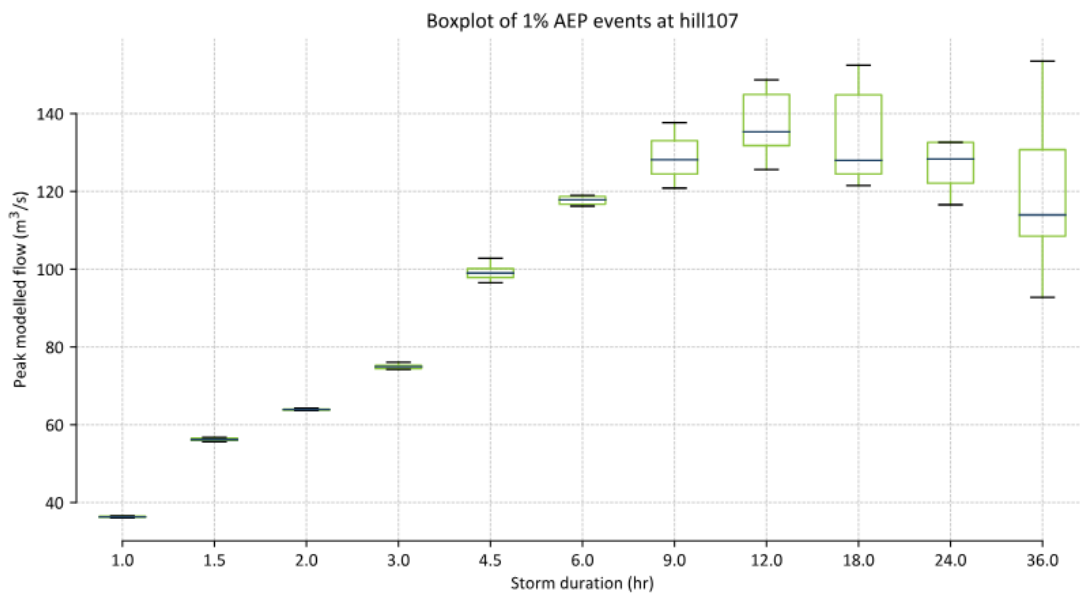


Figure A.26 **1% AEP at Hill107**

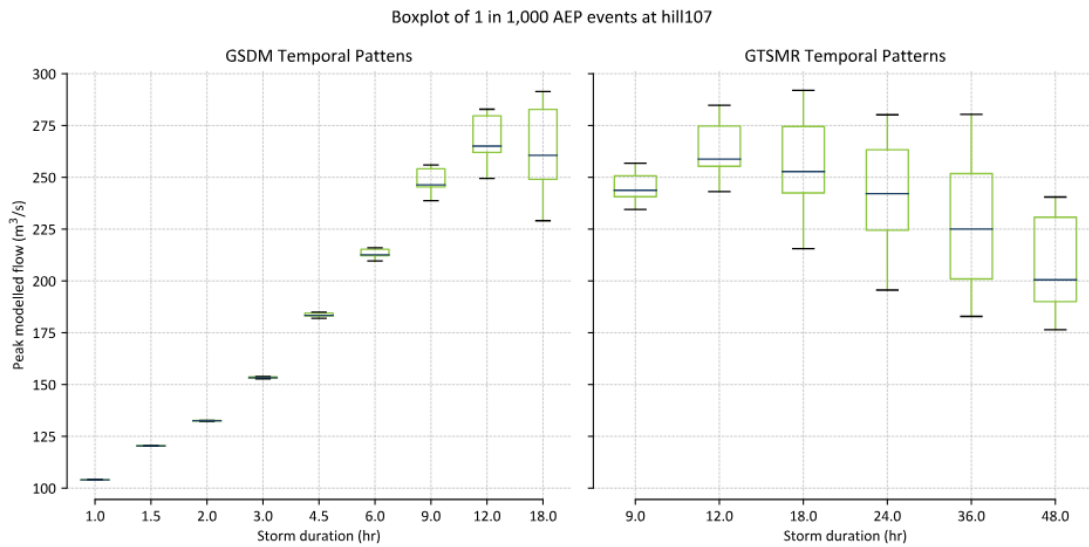


Figure A.27 1 in 1,000 AEP at Hill107

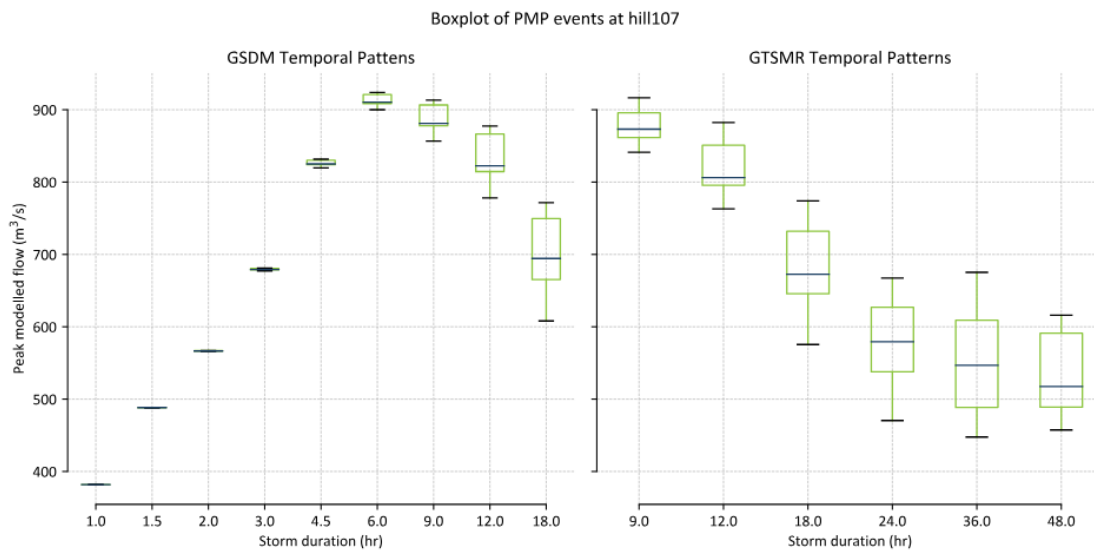


Figure A.28 PMF at Hill107

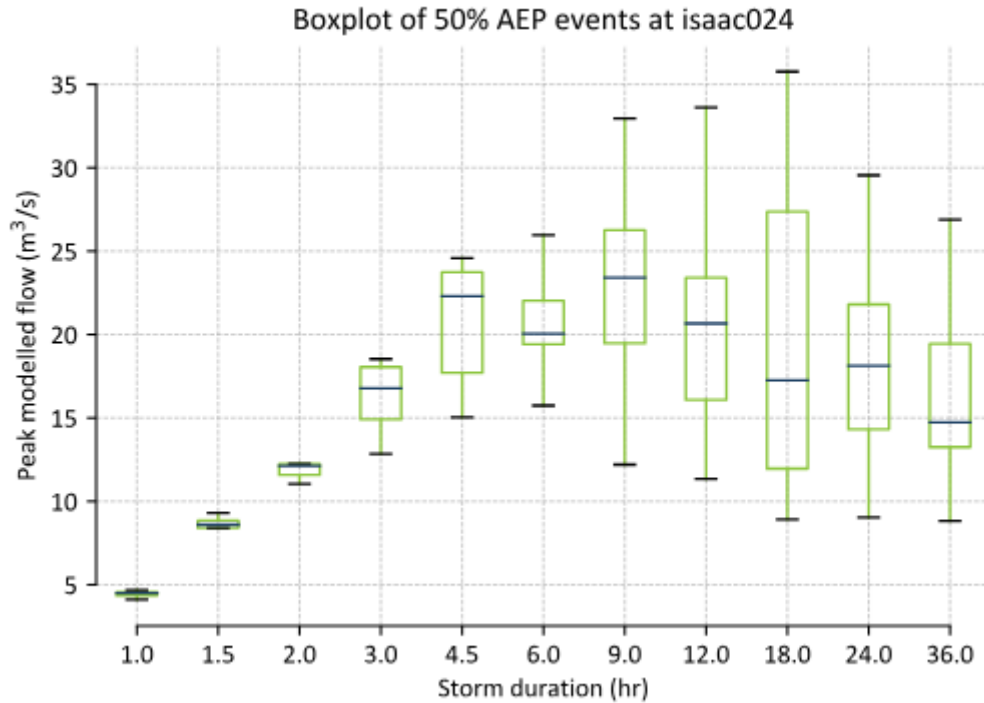


Figure A.29 50% AEP at Isaac024

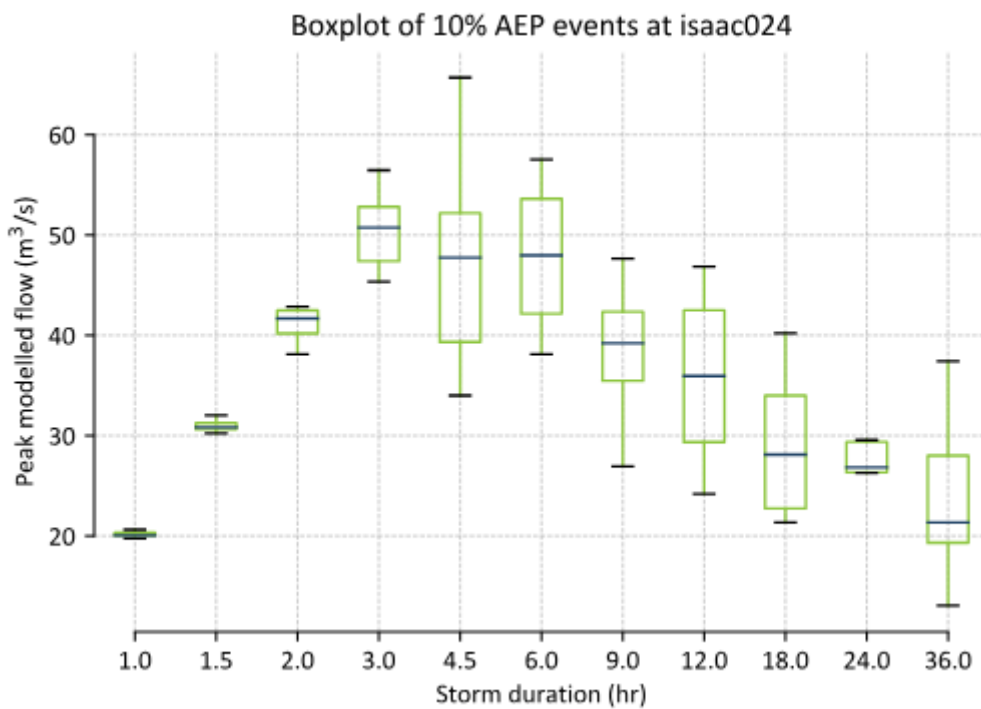


Figure A.30 10% AEP at Isaac024

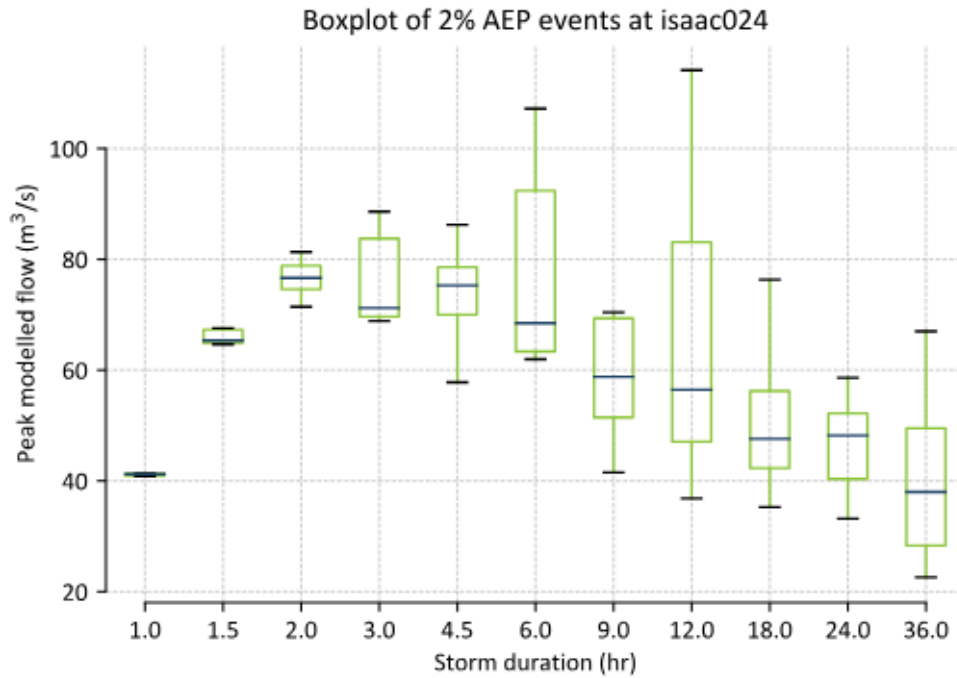


Figure A.31 2% AEP at Isaac024

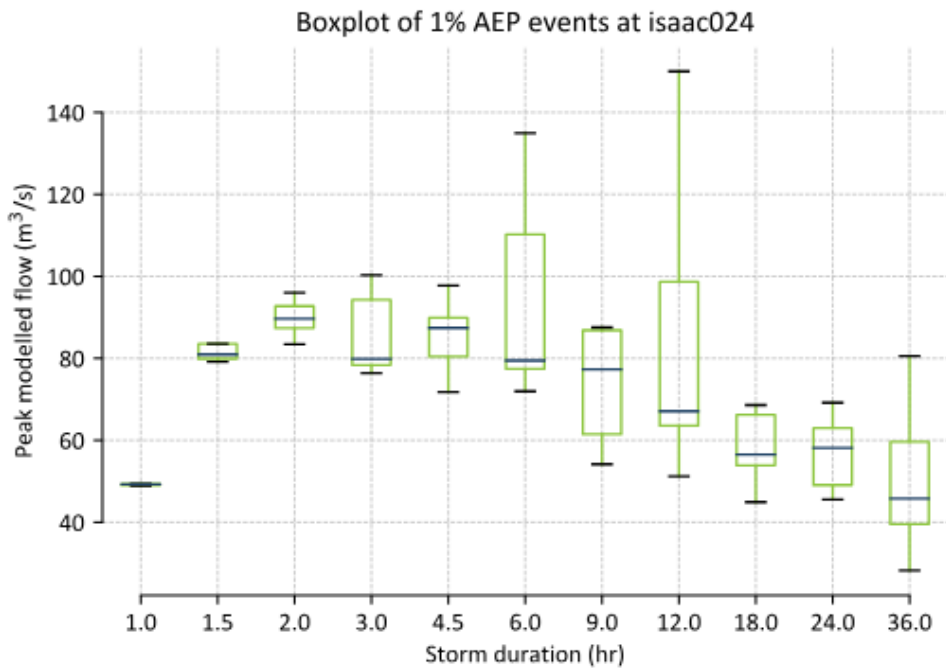


Figure A.32 1% AEP at Isaac024

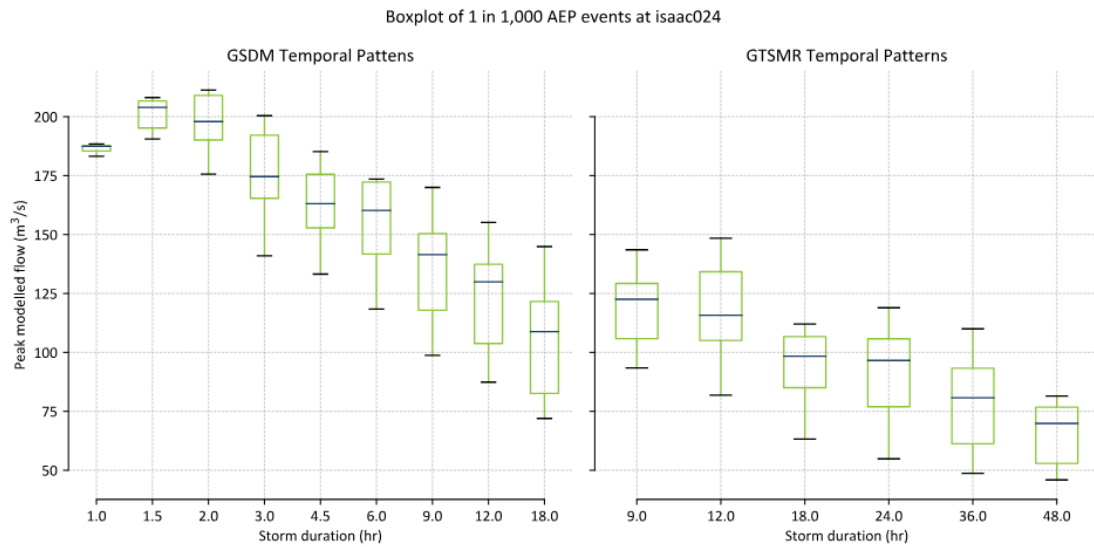


Figure A.33 1 in 1,000 AEP at Isaac024

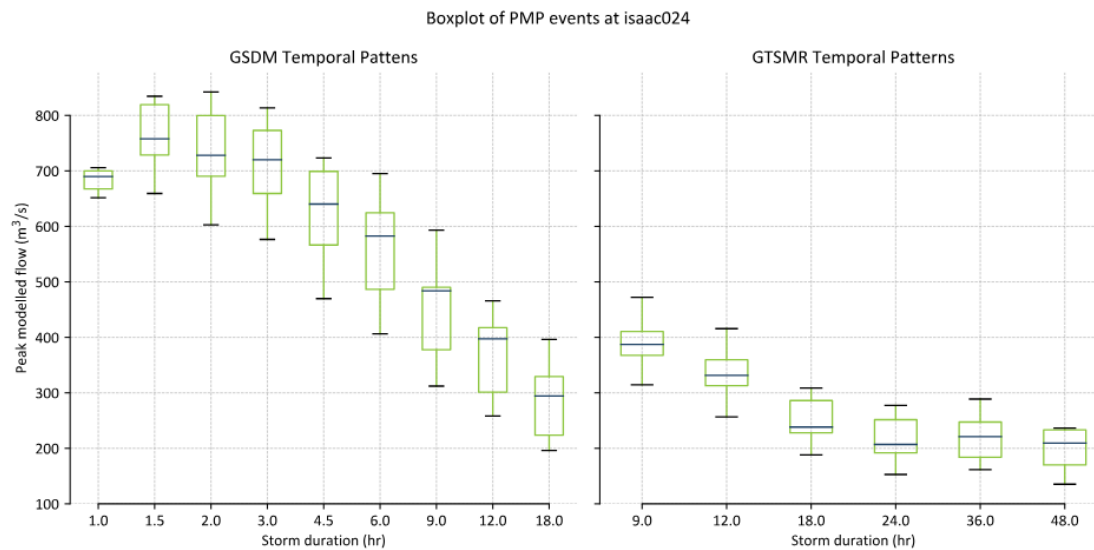


Figure A.34 PMF at Isaac024

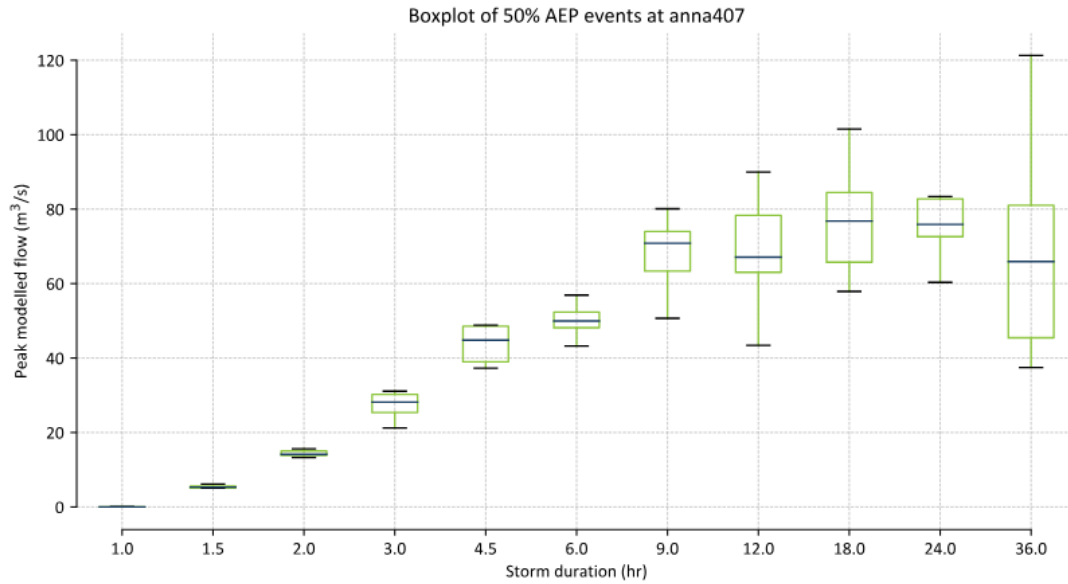


Figure A.35 **50% AEP at Ann407**

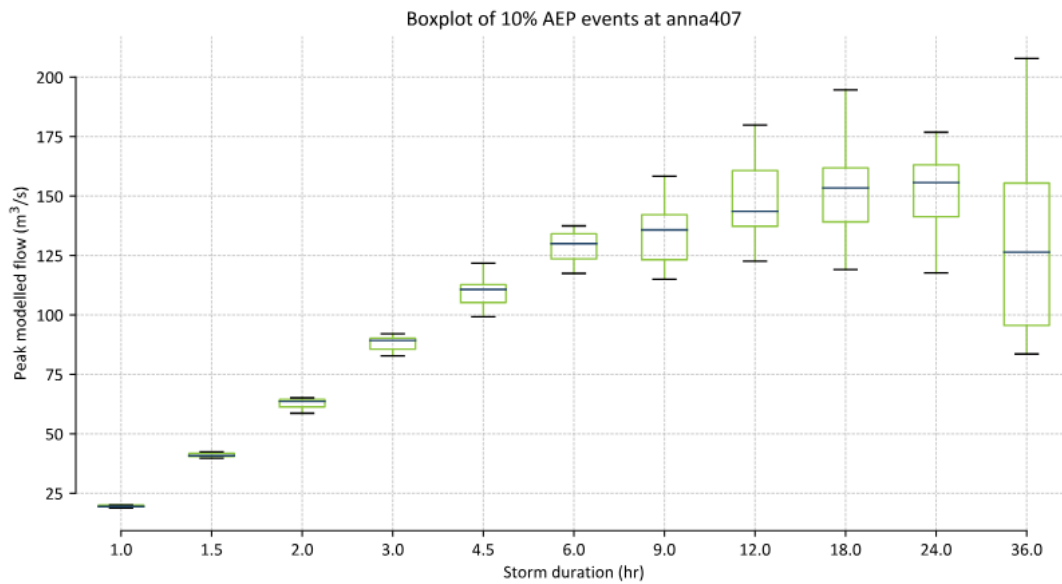


Figure A.36 **10% AEP at Ann407**

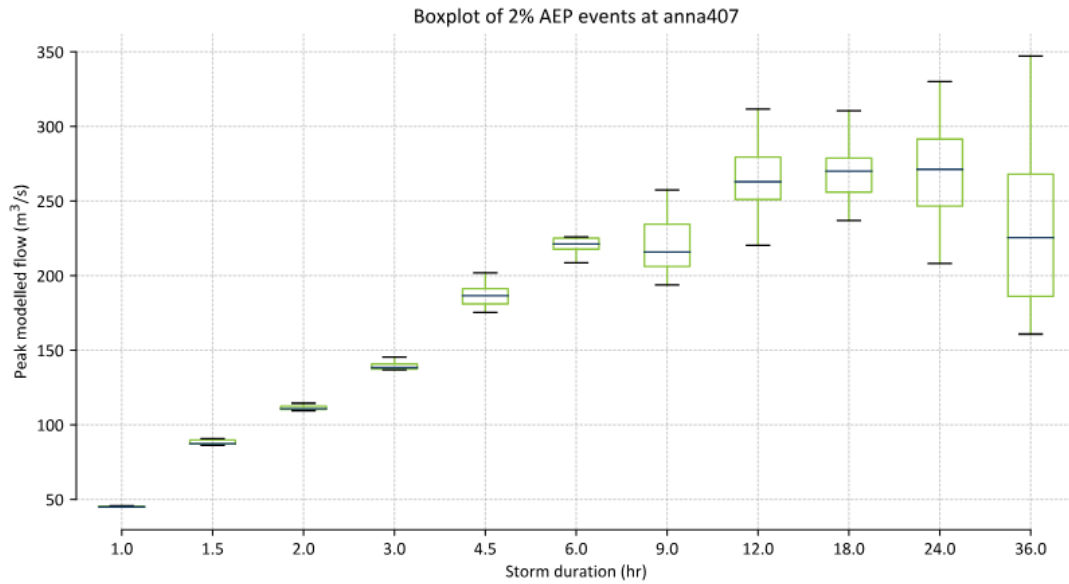


Figure A.37 **2% AEP at Ann407**

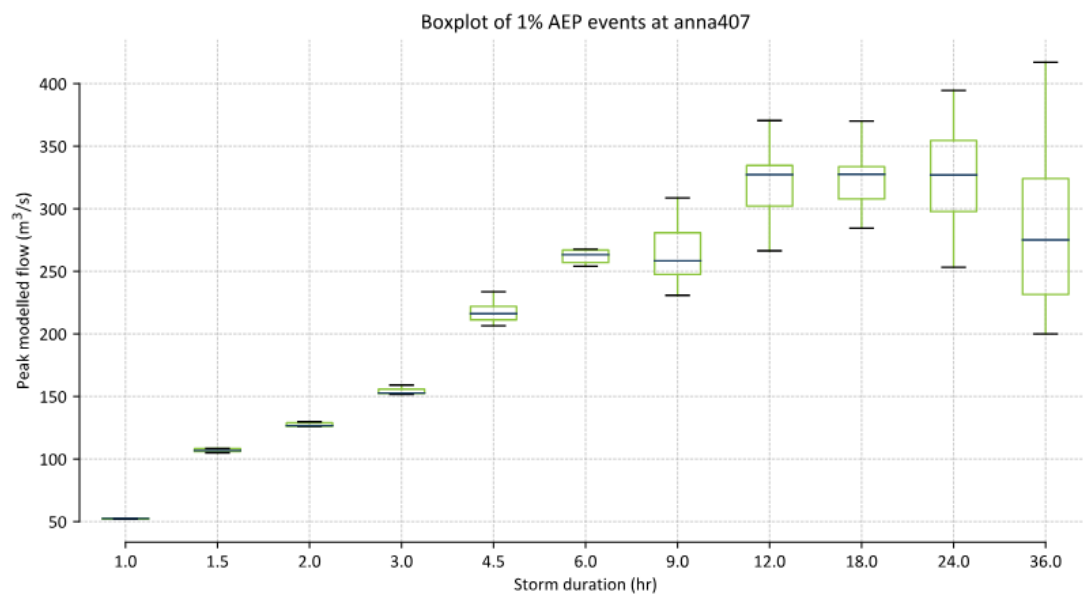


Figure A.38 **1% AEP at Ann407**

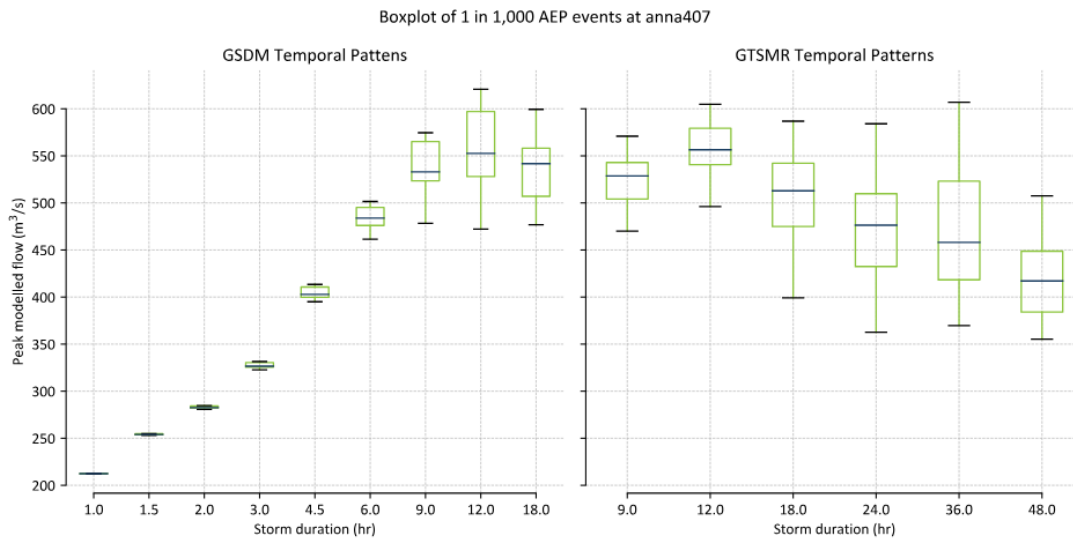


Figure A.39 1 in 1,000 AEP at Ann407

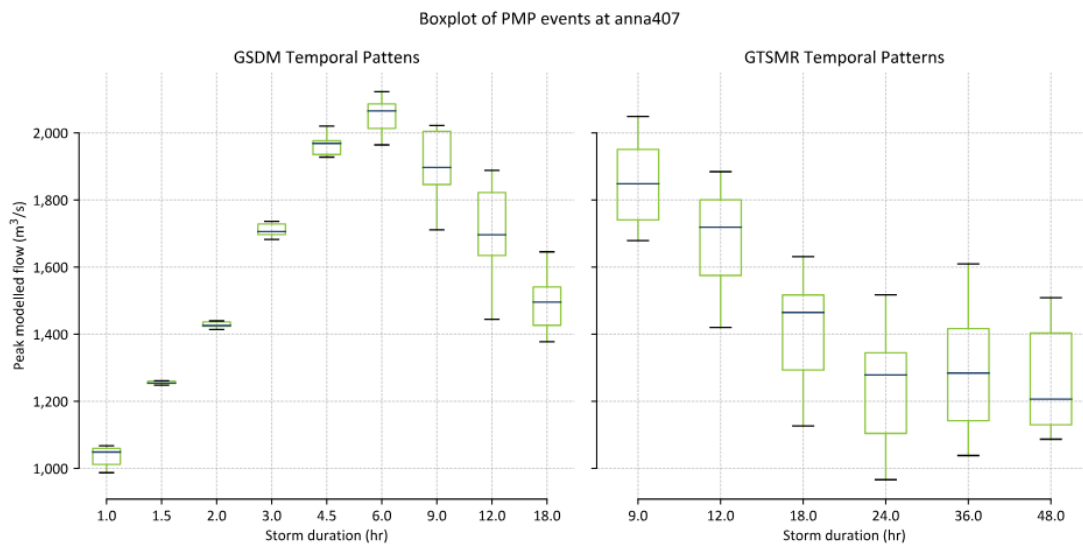


Figure A.40 PMF at Ann407

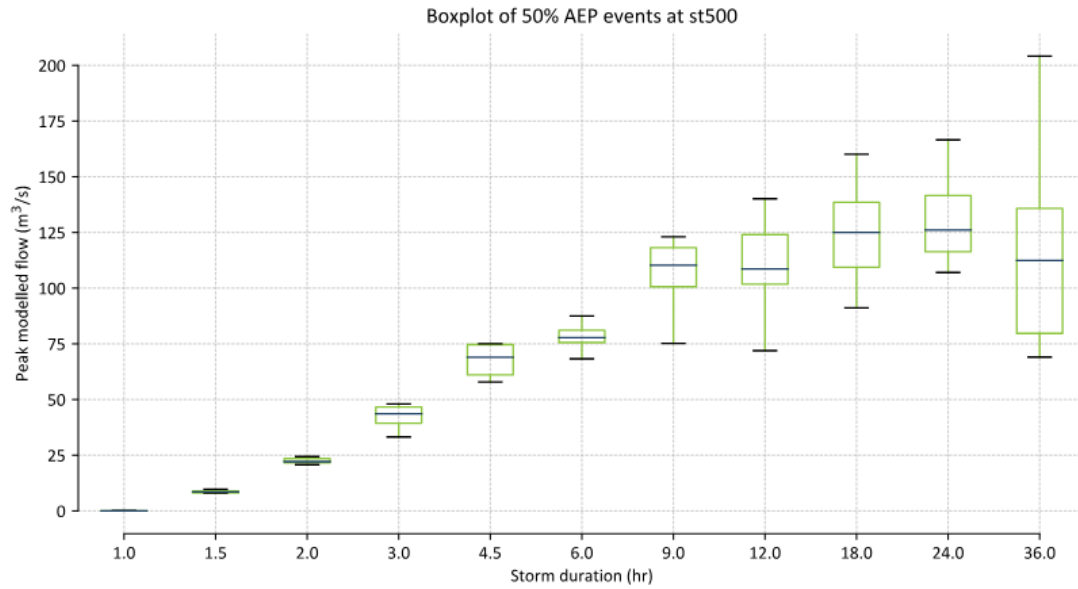


Figure A.41 **50% AEP at ST500**

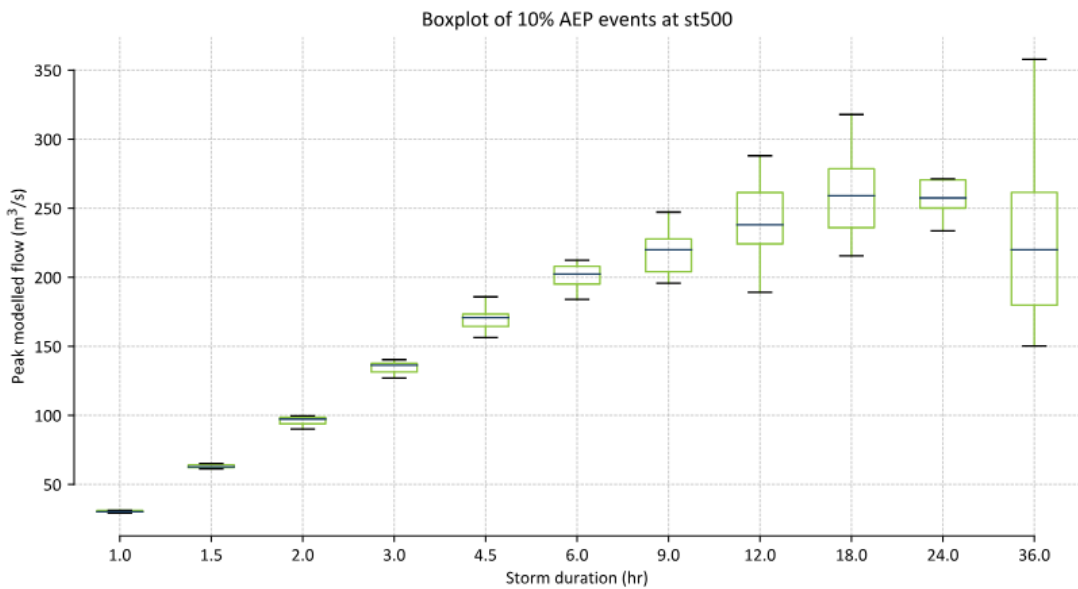


Figure A.42 **10% AEP at ST500**

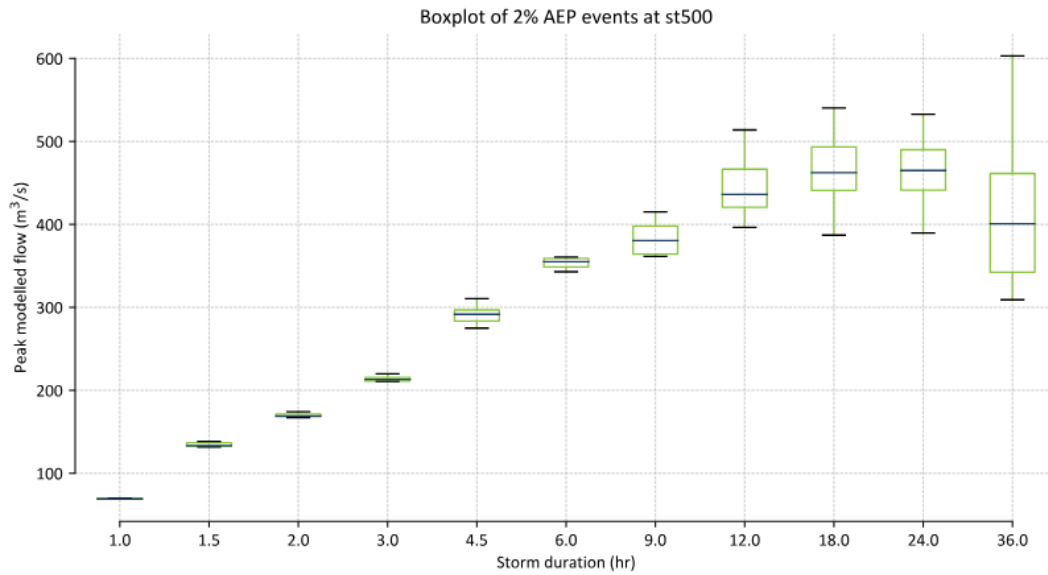


Figure A.43 **2% AEP at ST500**

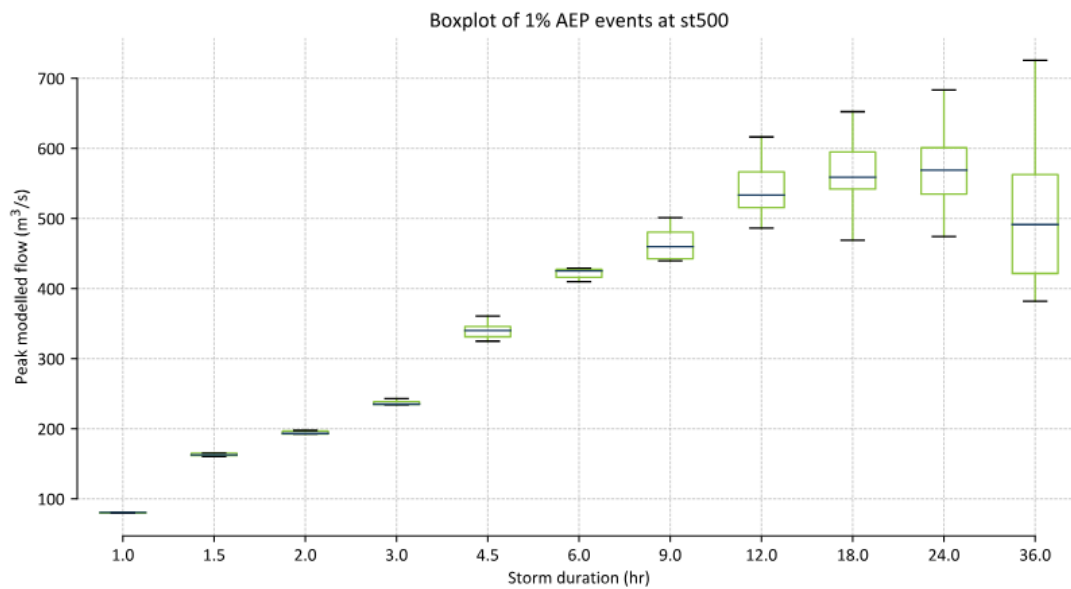


Figure A.44 **1% AEP at ST500**

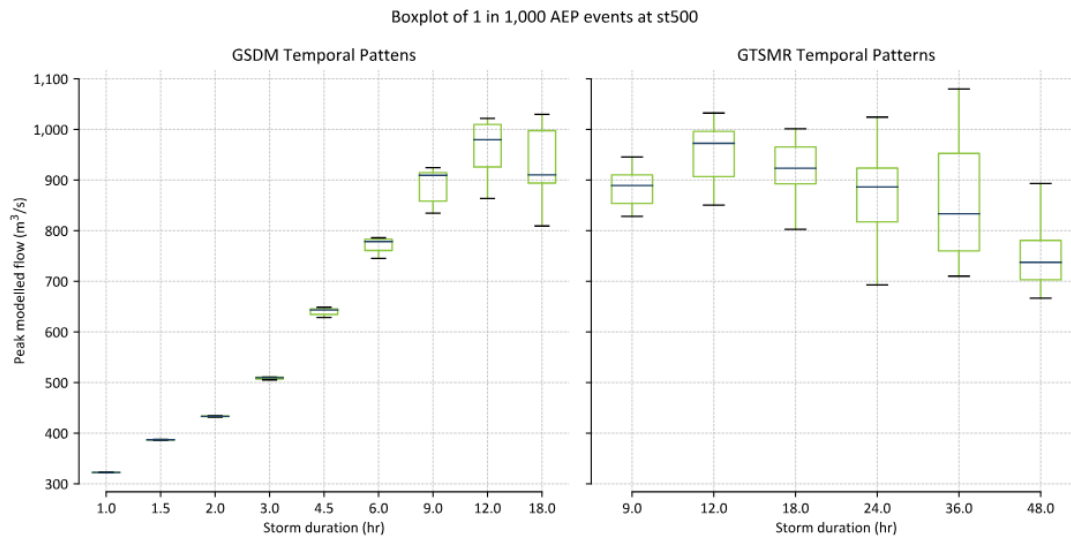


Figure A.45 1 in 1,000 AEP at ST500

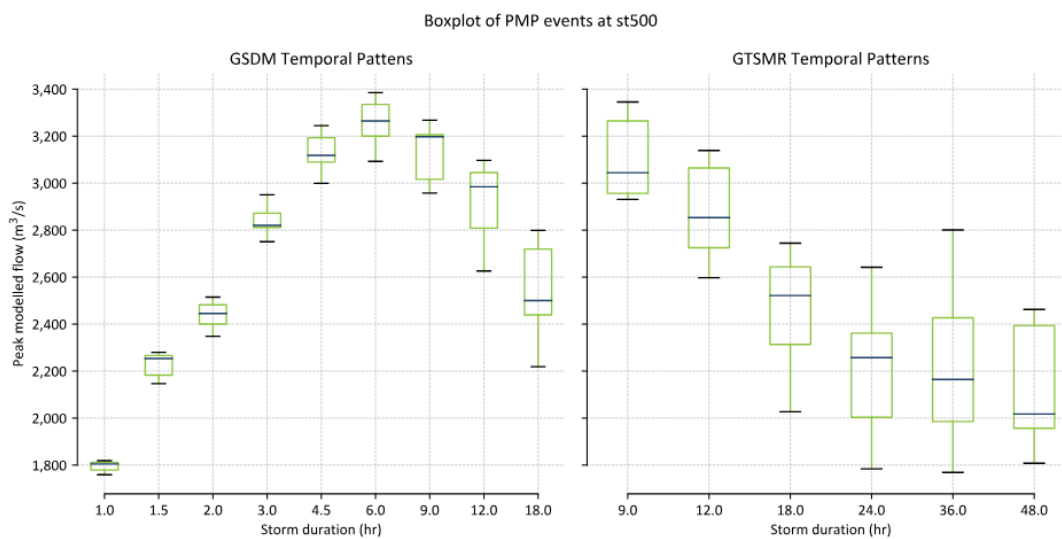


Figure A.46 PMF at ST500

APPENDIX B HYDRAULIC MODELLING

B.1 OVERVIEW

The two-dimensional TUFLOW hydrodynamic model (BMT, 2018) was used to simulate the flow behaviour of the Isaac River, Ti-Tree Creek and Hill Creek in the vicinity of the Project including flood extents, depths and velocities.

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, 2018). The model automatically calculates breakout points and flow directions within the model area. The most recent version of the TUFLOW software (Build 2023-03-AB) was used for this study.

The TUFLOW model was run using the Heavily Parallelised Compute (HPC) GPU solver which uses adaptive time stepping. The Maximum Courant Number was limited to 0.8 to improve model stability in the sections of the Isaac River where the water depth exceeded 10 m for the extreme events.

Hydraulic models were prepared for the following scenarios:

- **Pre-mining existing conditions.** The site has no significant current development other than Suttor Developmental Road and Ellensfield Road with cross drainage structures. Suttor Developmental Road also has a bridge crossing over the Isaac River within the New Lenton MLs. There are also several small farm dams.
- Developed conditions with:
 - A levee on the right hand bank of the Isaac River designed for 1 in 1,000 AEP flood immunity;
 - A levee running through Ti-Tree Creek that cuts off the natural flow path and also designed with 1 in 1,000 AEP flood immunity;
 - A stream diversion to direct flow from Ti-Tree Creek along the northern boundary of the New Lenton MLs and into a natural tributary of the Isaac River.
 - Realignment of the Suttor Developmental Road including a new bridge crossing of the Isaac River
 - A low-flow crossing of the Isaac River for the ROM coal haul road.
- **Post mining conditions** with the incorporation of the final landform leaving the final in-pit emplacement area and the rehabilitated overburden stockpiles. The final landform leaves the realigned Suttor Developmental Road. The landform has been shaped to prevent ingress of floodwaters into the remaining void in a PMF flood event. The realigned Suttor Developmental Road and the Ti-Tree diversion have been left in place.

B.2 TUFLOW MODEL CONFIGURATION – EXISTING CONDITIONS

B.2.1 Topographic data

The TUFLOW model uses several sources of Light Detecting and Ranging (LiDAR) topographic data. Bowen Coking Coal supplied 1 m resolution Lidar data in April/May 2022 that covers the New Lenton Mine area. Further 1 m LiDAR was supplied in July 2022 by Bowen Coking Coal. Both of these data sources have been used in the TUFLOW model. The remainder of the model uses freely available 1 m LiDAR captured in 2014 and covering the area of the Burton Gorge Dam. Figure B.1 shows the sources and extent of the various LiDAR sources used in the TUFLOW model.

B.2.2 Model extent and resolution

Figure B.2 shows the configuration of the existing conditions TUFLOW model. The hydraulic model includes all the main drainage paths upstream of the New Lenton MLs. The upstream extents of the

model are approximately 3 km upstream of the crossing of the Isaac River and the New Lenton MLs, approximately 7 km upstream of the crossing of Hill creek and the New Lenton MLs and approximately 4 km upstream of the crossing of Ti-Tree creek and the New Lenton MLs boundary. The model extends downstream to incorporate the entire storage area of the Burton Gorge Dam so that levels in the dam could be modelled explicitly in the hydraulic model. The Burton Gorge Dam includes inflows from Anna, Teviot and Sandy creeks.

The grid size was varied throughout the model using a quadtree mesh. Complex areas within the Project area were modelled using a fine mesh, while floodplain areas of less importance to the impact assessment were modelled using a coarse mesh.

The quadtree configuration is shown in Figure B.3. An 8 m cell size was adopted for the Burton Gorge Dam and upper Isaac and Hill Creek flow paths. Major flow paths through the New Lenton MLs and Ti-Tree Creek that were subject to detailed geomorphological assessment were modelled using a 2 m cell size with 4 m used for out of bank flows. A 16 m cell size was only adopted in dry areas of the model.

The method of sub-grid sampling, which stores and uses elevation curves of the underlying topography data has been incorporated into the model. Sub-grid sampling (SGS) was enabled so that each 2d cell face was represented by multiple elevation values. The number and spacing of SGS sampling points varies with cell size. The implementation of sub-grid sampling provides the model with a better representation of flow conveyance and capacity. This feature is particularly useful when modelling narrow channels.

B.2.3 Inflow and outflow boundaries

Figure B.2 shows the locations of the 2D inflow and outflow boundaries used in the TUFLOW model. The discharge hydrographs estimated using the URBS runoff-routing model were adopted as inflows to the TUFLOW model. The URBS inflows for all watercourses were applied concurrently.

Inflows from the hydrological model draining to the upstream extents of the hydraulic model were applied as total hydrograph inflows at these locations. The positions of these inflow boundaries were chosen so that flows were as confined as possible at their point of entry into the hydraulic model, with minimum flow break out. The flows from the subcatchments within the hydraulic model were applied as local source area inflows. These source areas apply the flow to the lowest cells within the source area polygons.

The outflow boundary is located at the Burton Gorge Dam spillway, approximately 6 km downstream of the New Lenton MLs. The spillway uses a rating curve based on the weir equation for an ogee crested weir with a weir coefficient of 2.15 and a spillway width of 160 metres.

The initial water level in the Burton Gorge Dam for all events was set to the spillway height of 297.55 mAHD.

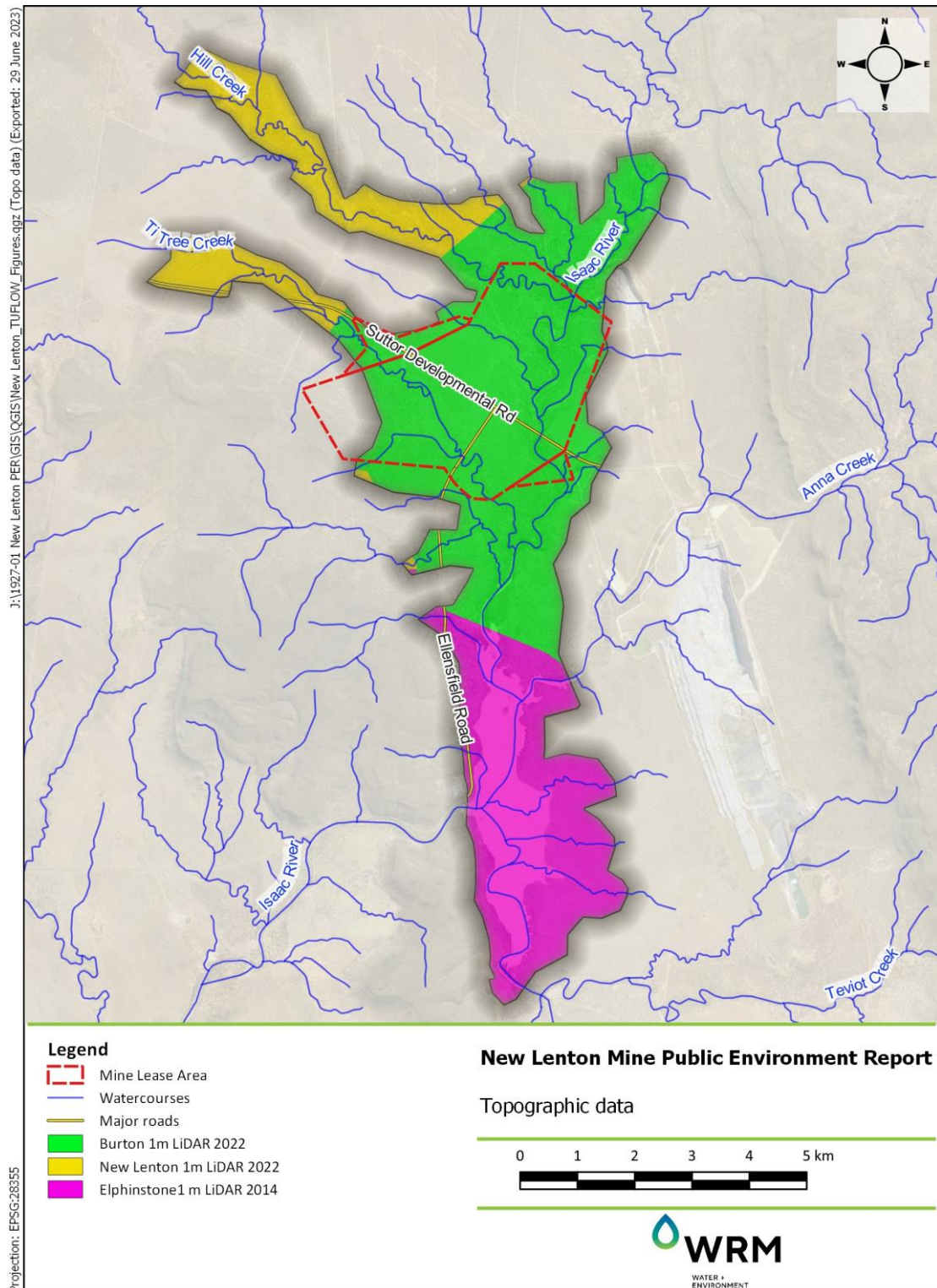


Figure B.1 Topographic data sources

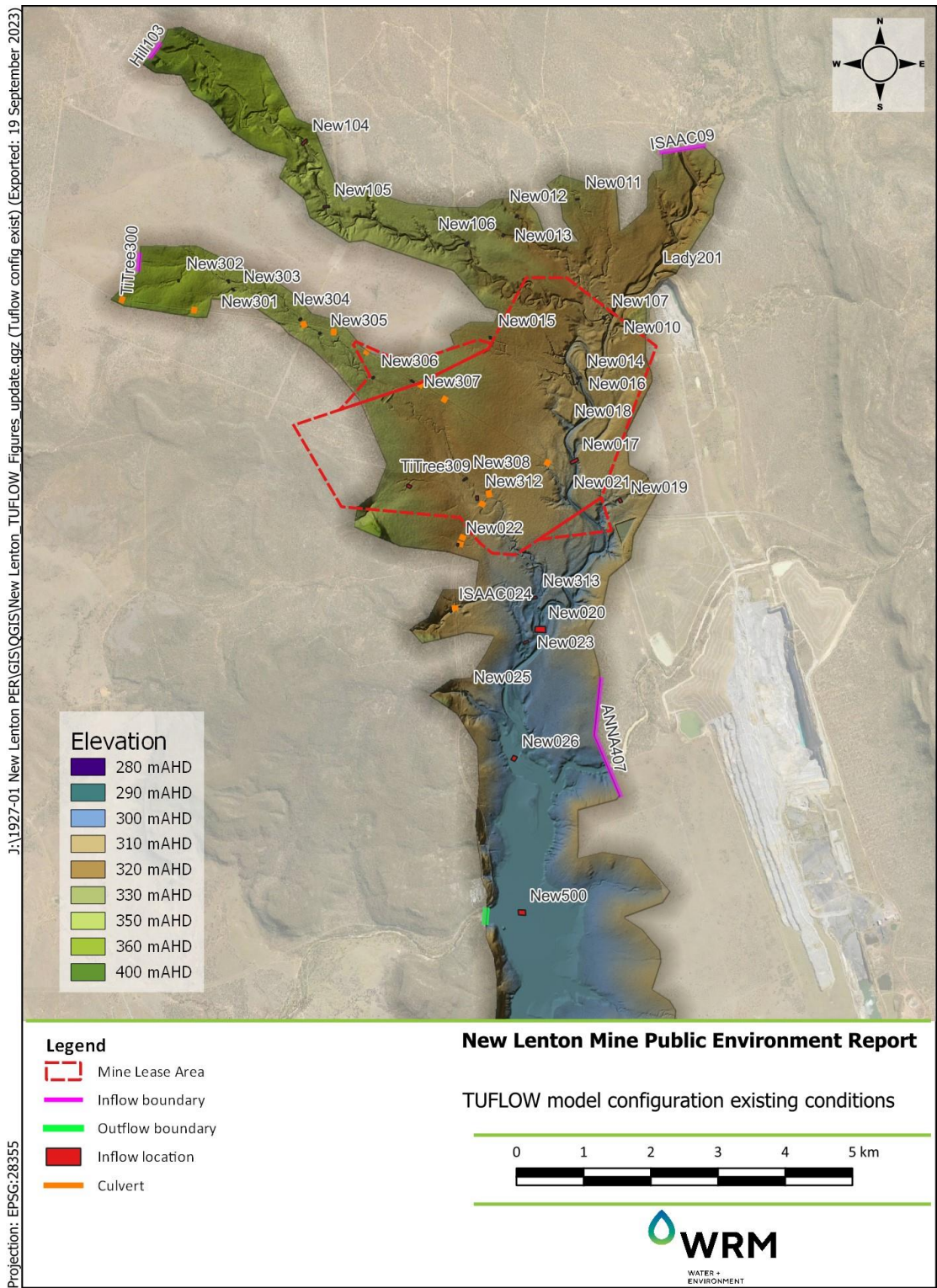


Figure B.2 TUFLOW existing model configuration

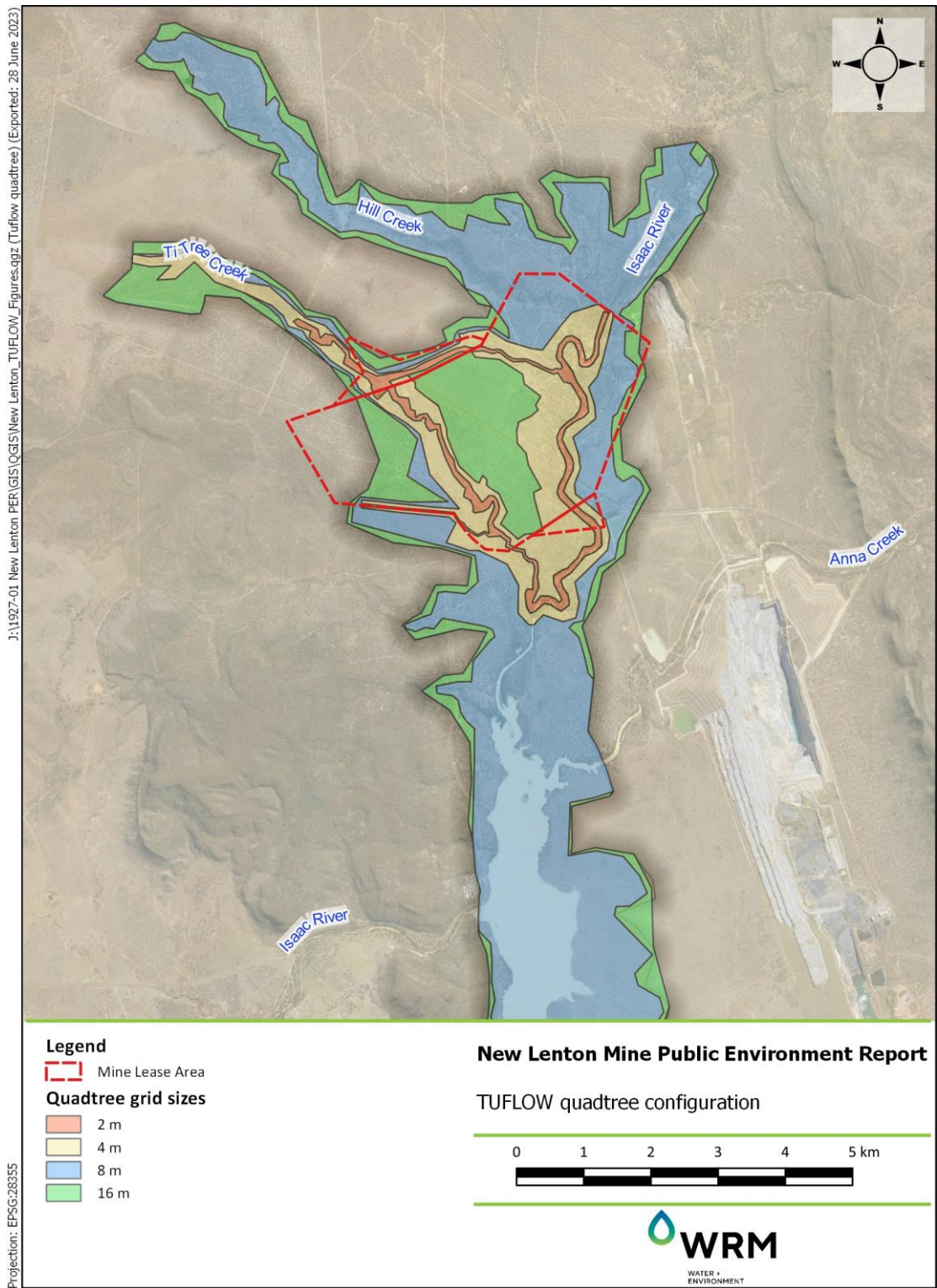


Figure B.3 TUFLOW quadtree configuration

B.2.4 Adopted Mannings 'n' roughness

The TUFLOW model uses Manning's 'n' values to represent hydraulic resistance. Manning's 'n' values were adopted based on typical published values (for example those of Chow, 1959) and consistent with Manning's 'n' values adopted in nearby flood studies which were calibrated to recorded water level hydrographs at Deverill gauging station for the March 2017 event.

Table B.1 shows the adopted Mannings 'n' values for the TUFLOW model and Figure B.4 shows the location of each landuse.

Table B.1 Adopted Mannings 'n' values

Land use	Mannings 'n'
Channel bed	0.035
Dense vegetation	0.08
Medium vegetation	0.06
Light vegetation	0.045
Roads	0.02
Water body/dam	0.02

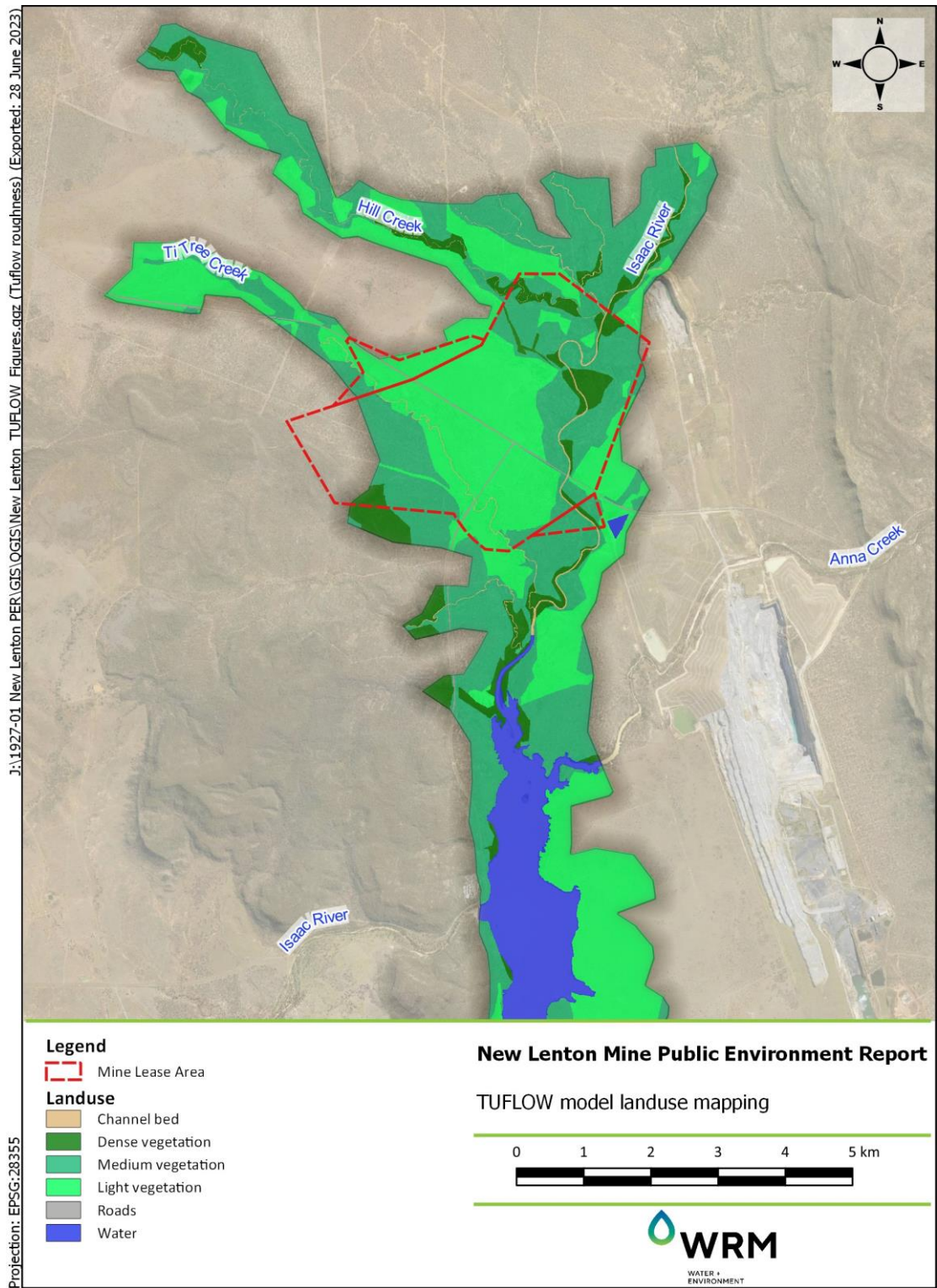


Figure B.4 TUFLOW landuse mapping

B.2.5 Hydraulic structures

The existing conditions TUFLOW model includes a number of hydraulic structures. The majority of these are cross drainage structures underneath Ellensfield Road and Suttor Developmental Road. Table B.2 summarises the locations and type of cross drainage included in the model. Invert levels of the culverts were estimated from the 1 m LiDAR data.

Table B.2 Cross drainage structures

Easting	Northing	Type	Diameter (m)	Width (m) x Height (m)	Number
614623	7617325	RCBC	-	0.9 x 1.2	2
615115	7617032	RCP	0.45	-	1
615919	7616538	RCBC	-	1.2 x 0.9	2
614177	7617436	RCP	0.9	-	3
612547	7617650	RCP	1.2	-	4
611473	7617805	RCBC	-	2.4 x 1.5	4
617801	7617376	RCP	0.9	-	3
616831	7614762	RCBC	-	1.8 x 1.8	9
616428	7613211	RCP	0.9	-	3
616271	7616321	RCBC	-	0.9 x 0.3	1
616933	7614913	RCP	1.2	-	3
616541	7614263	RCBC	-	1.2 x 0.6	2
616503	7614163	RCBC	-	1.2 x 0.6	6

The Suttor Developmental Road includes a bridge crossing of the Isaac River within the New Lenton MLs. In the developed and post mining case conditions, Suttor Developmental Road is realigned with a new bridge crossing the Isaac River approximately 700 m downstream of the existing bridge. The existing bridge is assumed to remain in place for these scenarios. The new bridge was assumed to have similar design details to the existing bridge. Table B.3 summarises the input data for the existing bridge crossing.

Table B.3 Suttor Developmental Road bridge details

Easting	Northing	Soffit (mAHD)	Deck Thickness (m)	Deck Width (m)
618206	7615128	305.45	1.05	7.4

B.3 TUFLOW MODEL CONFIGURATION – DEVELOPED AND POST-MIING CONDITIONS

The existing conditions flood model was adjusted to include the developed case for mining operations. The following changes were made to the model:

- Levees added along the Isaac River and crossing Ti-Tree Creek to prevent ingress of floodwaters in a 1 in 1,000 AEP event.

- Inclusion of the Ti-Tree Creek diversion designed by GHD to direct flows from Ti-Tree Creek to a small tributary that flows into the Isaac River. The diversion has been assumed to have a Mannings roughness value of 0.035 along the base of the channel with medium vegetation on the banks with a Mannings roughness value of 0.06.
- The design tins for the Suttor Developmental Road realignment. There are crossings over the Ti-Tree diversion with 3 x 3000 x 3000 RCBC culverts to pass flow through the road embankments. The Suttor Development Road realignment has a new bridge crossing of the Isaac River approximately 700 m downstream of the existing bridge.
- Local inflows inside the mining operational area have been removed. Internal runoff within the mine site has been assumed to be captured by an onsite water management system.

Figure B.5 shows the developed TUFLOW model configuration.

The post mining TUFLOW model scenario included the following changes to developed case conditions:

- The flood levees are replaced by a final landform designed to prevent the ingress of floodwaters to the final void by a PMF event.
- The realigned Suttor Development Road was kept in place along with the Ti-Tree Creek diversion.
- The final landform surface was incorporated into the model topography.

Figure B.6 shows the post mining TUFLOW model configuration.

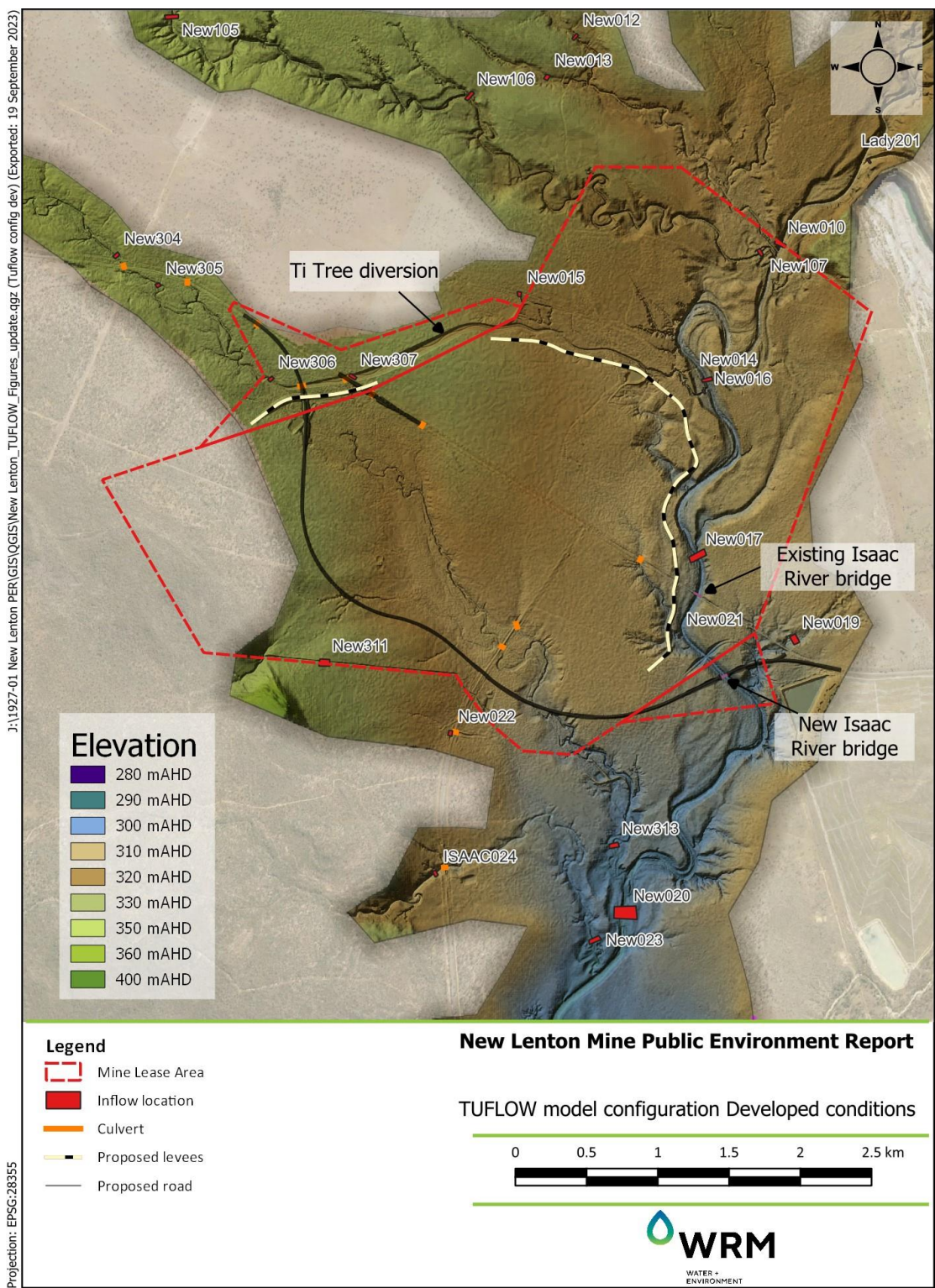


Figure B.5 TUFLOW developed conditions configuration

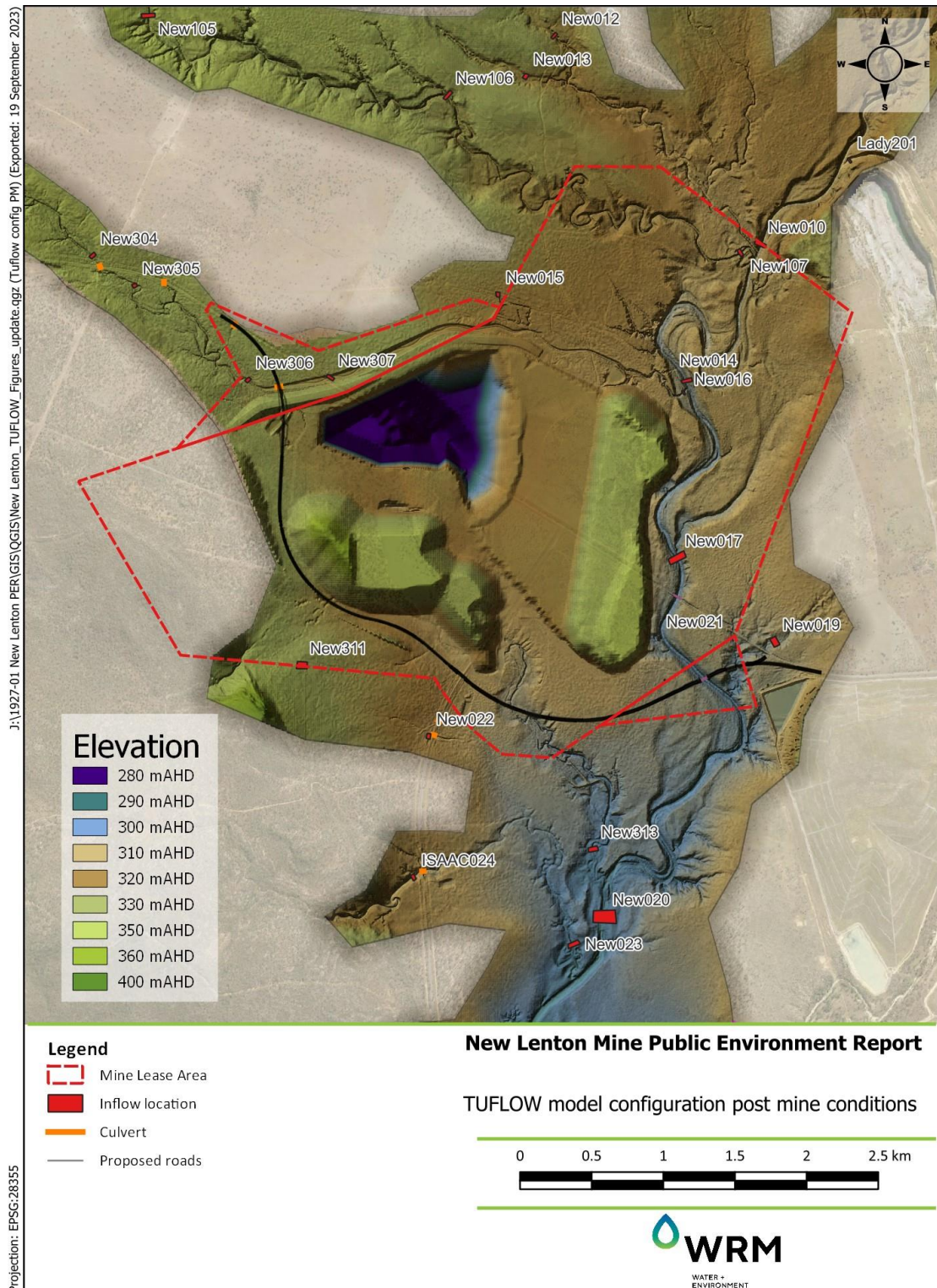


Figure B.6 TUFLOW post mining conditions configuration

APPENDIX C WATER BALANCE SENSITIVITY MODELLING

C.1 OVERVIEW

A sensitivity analysis has been undertaken to assess the potential impact of variations in the rainfall runoff parameters on the performance of the proposed water management system. The sensitivity scenarios that have been assessed are as follows:

- **Scenario 1:** Global increase in AWBM soil capacity by 20%.
- **Scenario 2:** Global decrease in AWBM soil capacity by 20%.

The results for Scenario 1 and Scenario 2 are presented below.

C.2 INCREASED (+20%) SOIL MOISTURE CAPACITY (SCENARIO 1)

C.2.1 Mine-affected water containment

Figure C.1 shows the combined forecast inventory for Transfer Dam, Pit Dam 1 and Pit Dam 2 for Scenario 1. This figure shows the following:

- For the 1%ile results (very wet climatic conditions), the peak inventory in the out-of-pit storages reaches a volume of around 550 ML (approximately 20 ML less than the Base Case), which is below the combined capacity of Transfer Dam, Pit Dam 1 and Pit Dam 2.
- The combined mine affected water inventory generally appears to recover following the annual wet seasons, and does not accumulate over consecutive wet seasons.
- The WMS inventory would be slightly decreased under Scenario 1, compared to the Base Case.

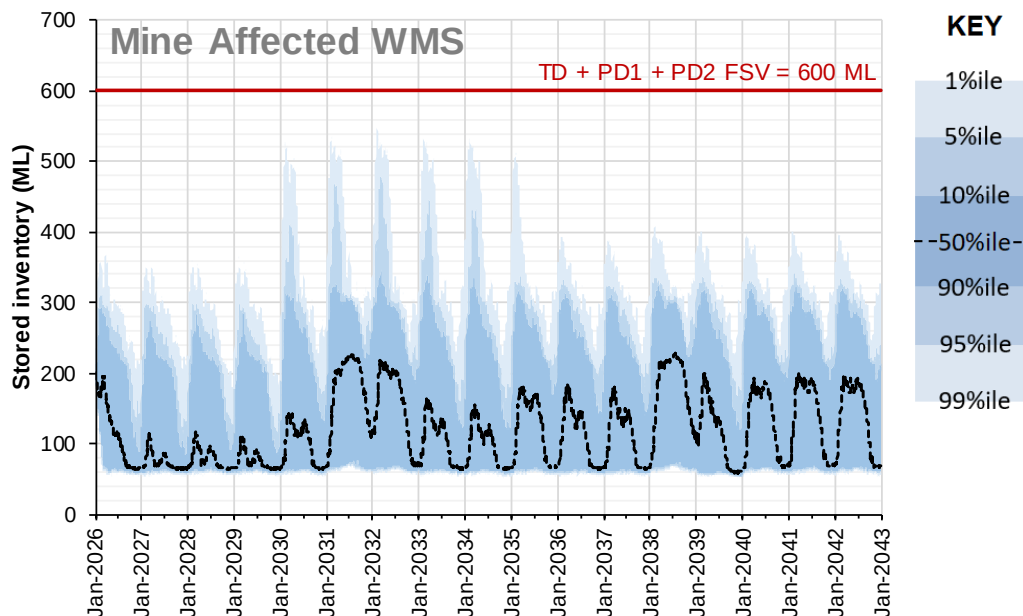


Figure C.1 Forecast mine affected water inventory (excluding active mine pits), Scenario 1

C.2.2 Burton Mine interaction

Figure C.2 shows the annual volumes transferred from Transfer Dam at New Lenton to Burton Mine for storage for Scenario 1. The following is of note regarding this result:

- Transfer Dam would generally only need to transfer to Burton Mine during climatic conditions wetter than the 50%ile.
- During 1%ile extreme wet climatic conditions, Transfer Dam may transfer an annual volume up to 1,100 ML to Burton Mine in 2032, approximately 150 ML less than the Base Case.

Figure C.3 shows the annual volumes transferred from Burton Mine to Transfer Dam to supplement demands at New Lenton for Scenario 1. This figure shows that import volume from Burton Mine to New Lenton are similar to the Base Case and generally range between 0 ML/a for 1%ile wet climatic conditions to 700 ML/a in 99%ile dry climatic conditions.

The import volumes from Burton are typically greater than the export volumes from Burton. Hence, under Scenario 1, the Project is generally a net importer of water from Burton Mine.

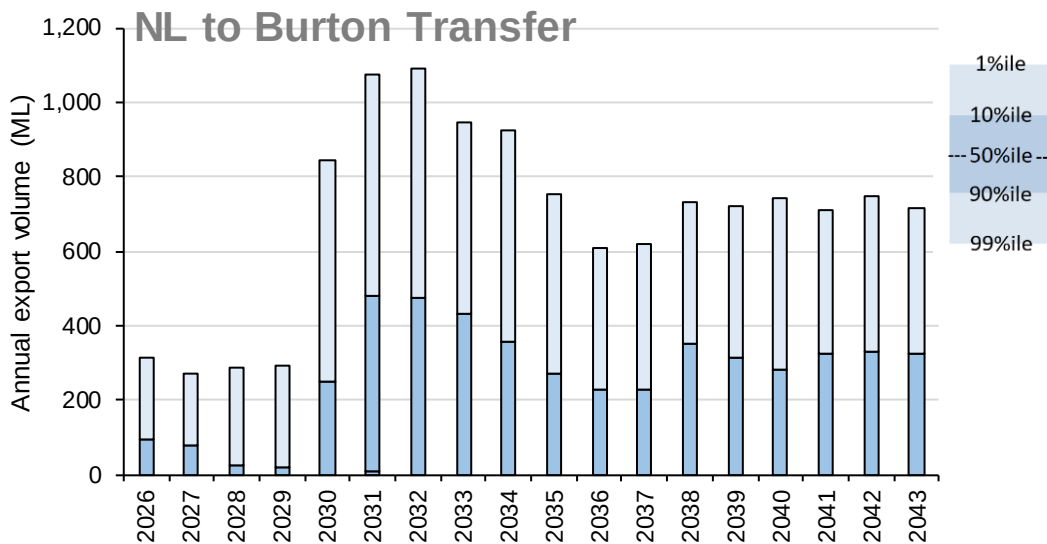


Figure C.2 Forecast transfer volumes from Transfer Dam to Burton Mine, Scenario 1



Figure C.3 Forecast transfer volumes from Burton Mine to Transfer Dam, Scenario 1

C.2.3 Uncontrolled offsite releases/spills

C.2.3.1 Mine water dams

There were no modelled overflows from Transfer Dam, Pit Dam 1 or Pit Dam 2 during any of the model realisations over the life of the Project under Scenario 1.

C.2.3.2 Sediment dams

The predicted annual combined sediment dam overflows for Scenario 1 are provided in Figure C.4. The results show that:

- During very wet climatic conditions (1%ile) where rainfall events often exceed the dam design standard, modelled sediment dam overflows are between 625 ML/year and 1,200 ML/year.
- During wet climatic conditions (10%ile) where rainfall events sometimes exceed the dam design standard, modelled sediment dam overflows are between 160 ML/year and 460 ML/year.
- During median and dry climatic conditions, there are no modelled sediment dam overflows.
- The magnitude sediment dam overflows for Scenario 1 is consistently less than the Base Case.

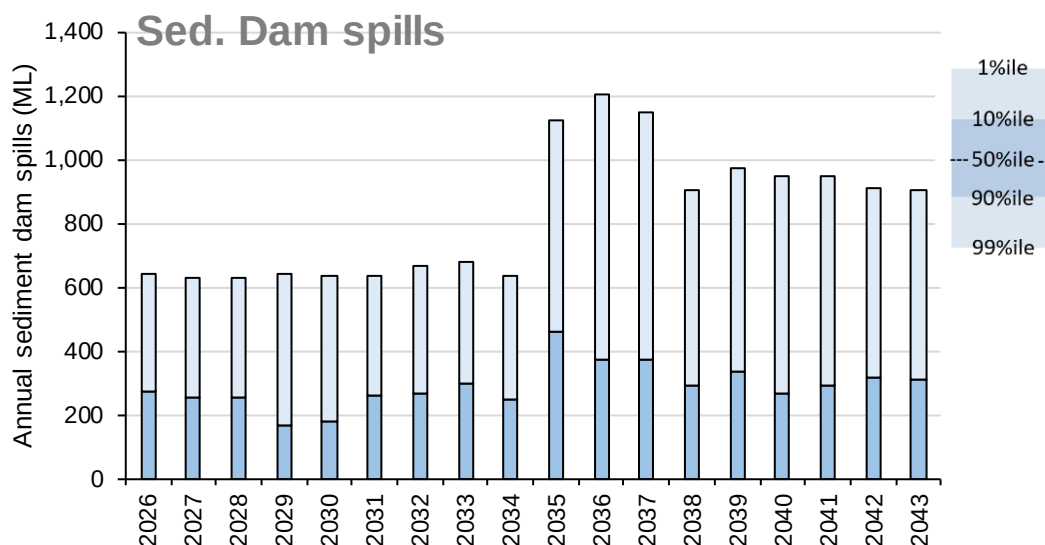


Figure C.4 Forecast annual sediment dam spill volumes, Scenario 1

C.3 DECREASED (-20%) SOIL MOISTURE CAPACITY (SCENARIO 2)

C.3.1 Mine-affected water containment

Figure C.5 shows the combined forecast inventory for Transfer Dam, Pit Dam 1 and Pit Dam 2 for Scenario 2. This figure shows the following:

- For the 1%ile results (very wet climatic conditions), the peak inventory in the out-of-pit storages reaches a volume of around 570 ML (similar to the Base Case), which is below the combined capacity of Transfer Dam, Pit Dam 1 and Pit Dam 2.
- The combined mine affected water inventory generally appears to recover following the annual wet seasons, and does not accumulate over consecutive wet seasons.
- The Scenario 2 WMS inventory would be similar to the Base Case WMS.

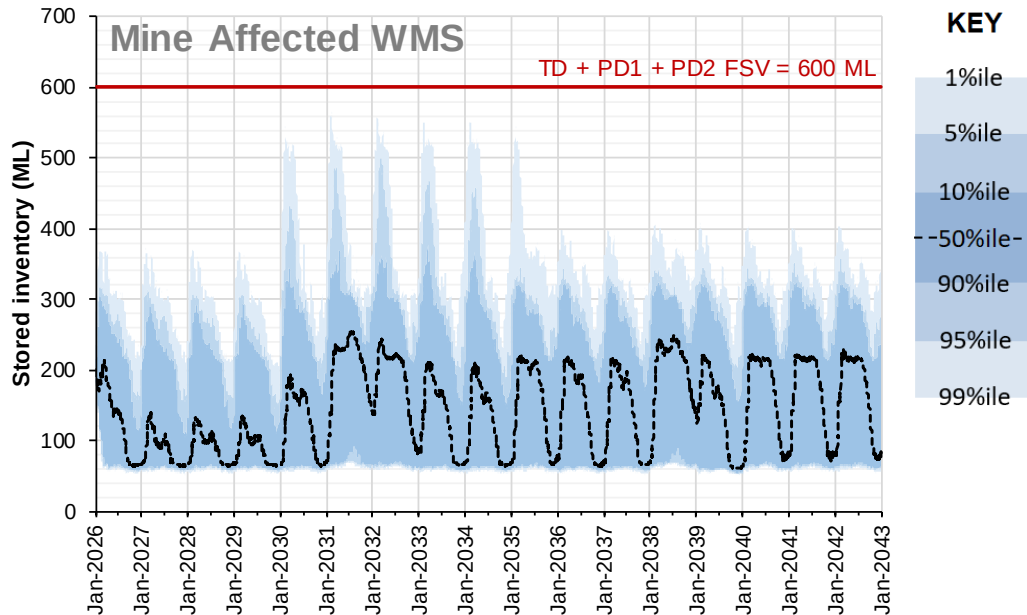


Figure C.5 Forecast mine affected water inventory (excluding active mine pits), Scenario 2

C.3.2 Burton Mine interaction

Figure C.6 shows the annual volumes transferred from Transfer Dam at New Lenton to Burton Mine for storage for Scenario 2. The following is of note regarding this result:

- Transfer Dam would generally only need to transfer to Burton Mine during climatic conditions wetter than the 50%ile.
- During 1%ile extreme wet climatic conditions, Transfer Dam may transfer an annual volume up to 1,270 ML to Burton Mine in 2031, approximately 20 ML more than the Base Case.

Figure C.7 shows the annual volumes transferred from Burton Mine to Transfer Dam to supplement demands at New Lenton for Scenario 2. This figure shows that import volume from Burton Mine to New Lenton are similar to the Base Case and generally range between 0 ML/a for 1%ile wet climatic conditions to 700 ML/a in 99%ile dry climatic conditions.

The import volumes from Burton are typically greater than the export volumes from Burton. Hence, under Scenario 2, the Project is generally a net importer of water from Burton Mine.

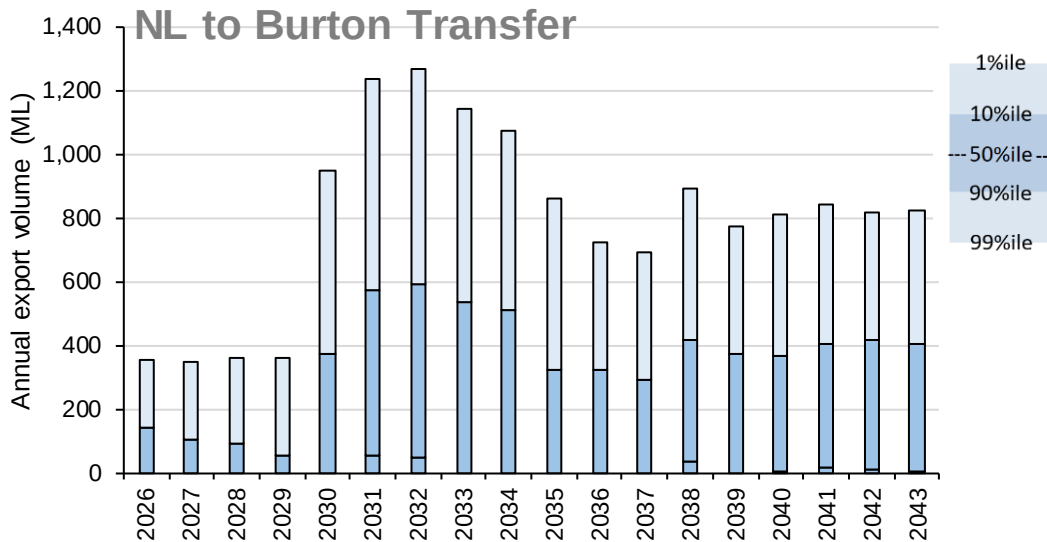


Figure C.6 Forecast transfer volumes from Transfer Dam to Burton Mine, Scenario 2

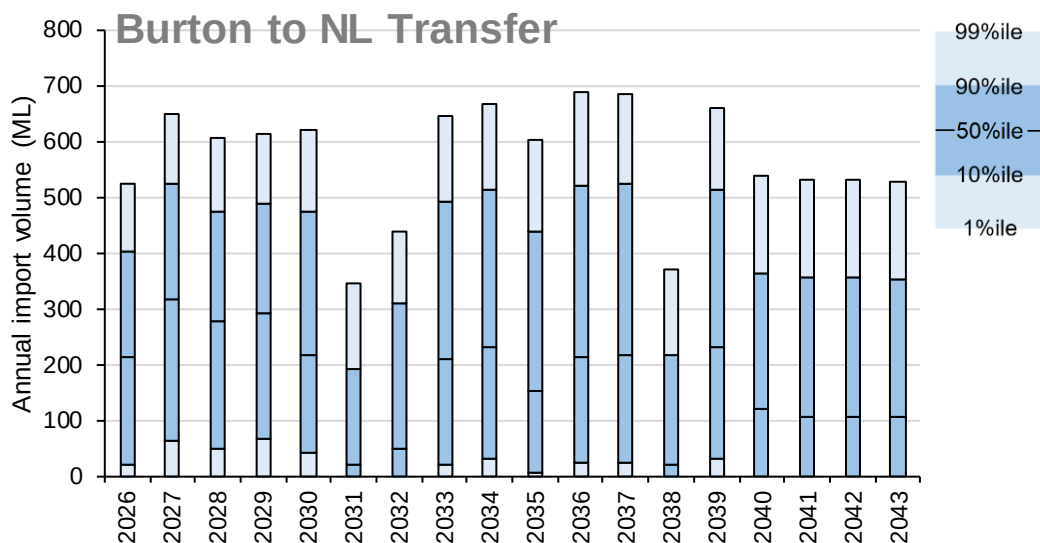


Figure C.7 Forecast transfer volumes from Burton Mine to Transfer Dam, Scenario 2

C.3.3 Uncontrolled offsite releases/spills

C.3.3.1 Mine water dams

There were no modelled overflows from Transfer Dam, Pit Dam 1 or Pit Dam 2 during any of the model realisations over the life of the Project under Scenario 2.

C.3.3.2 Sediment dams

The predicted annual combined sediment dam overflows for Scenario 2 are provided in Figure C.8. The results show that:

- During very wet climatic conditions (1%ile) where rainfall events often exceed the dam design standard, modelled sediment dam overflows are between 700 ML/year and 1,470 ML/year.
- During wet climatic conditions (10%ile) where rainfall events sometimes exceed the dam design standard, modelled sediment dam overflows are between 290 ML/year and 590 ML/year.
- During median and dry climatic conditions, there are no modelled sediment dam overflows.
- The magnitude sediment dam overflows for Scenario 2 are similar to or greater than the Base Case.

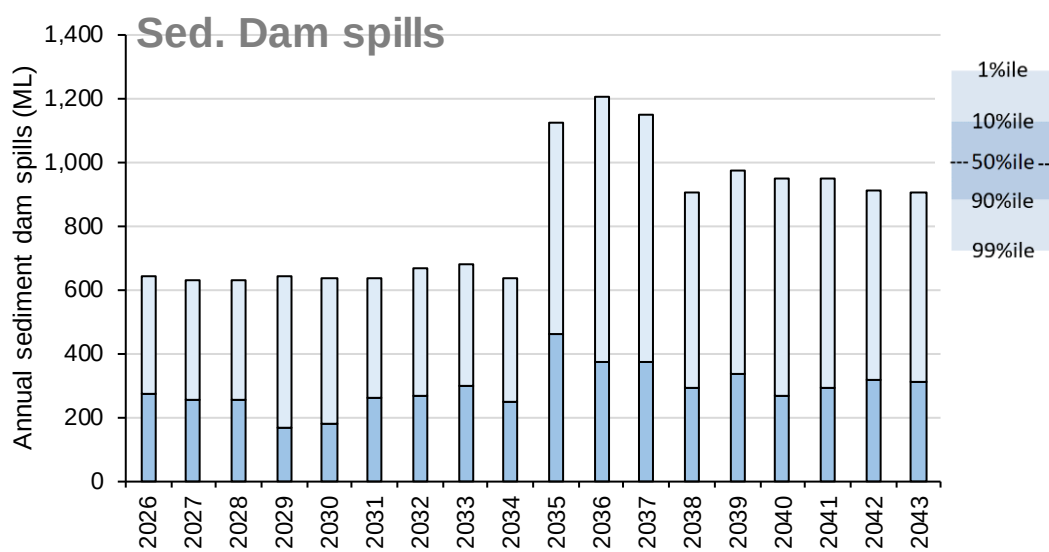


Figure C.8 Forecast annual sediment dam spill volumes, Scenario 1

APPENDIX D WATER QUALITY DATA

Sourced from "Copy of Lenton Issac River WQ data down stream included.xlsx" / Burton REMP 2023

Parameter	Unit	IR DS/S		IR U/S (suspect units on some readings)	
		28/11/2022	17/01/2023	1/11/2021	28/07/2022
pH Value	pH Unit	7.98	8.2	7.28	7.22
Electrical Conductivity @ 25°C	µS/cm	120	161	144	370
Suspended Solids (SS)	mg/L	1280	52	238	7
Turbidity	NTU	1380	263	290	123
Hydroxide Alkalinity as CaCO ₃	mg/L	<1	<1		
Carbonate Alkalinity as CaCO ₃	mg/L	<1	<1		
Bicarbonate Alkalinity as CaCO ₃	mg/L	58	19		
Total Alkalinity as CaCO ₃	mg/L	58	19	26	82
Sulfate as SO ₄ - Turbidimetric	mg/L	<1	<1	2	9
Sodium	µg/L	11000	15000	17	45
Dissolved Aluminium	µg/L	10	940	500	<10
Dissolved Arsenic	µg/L	<1	<1	<1	<1
Dissolved Barium	µg/L	22	37		
Dissolved Cadmium	µg/L	<0.1	<0.1	<1	<0.1
Dissolved Chromium	µg/L	<1	<1	<1	<1
Dissolved Cobalt	µg/L	<1	<1	<1	<1
Dissolved Copper	µg/L	2	2	<1	<1
Dissolved Lead	µg/L	<1	<1	<1	<1
Dissolved Manganese	µg/L	<1	3	100	56
Dissolved Molybdenum	µg/L	<1	<1	1	<1
Dissolved Nickel	µg/L	1	2	1	<1
Dissolved Selenium	µg/L	<10	<10	<10	<10
Dissolved Silver	µg/L	<1	<1	<1	<1
Dissolved Uranium	µg/L	<1	<1	<1	<1
Dissolved Zinc	µg/L	<5	<5	<5	<5
Dissolved Boron	µg/L	<50	50	<50	60
Dissolved Iron	µg/L	70	840	310	<50
Aluminium	µg/L	33000	6320	9080	
Arsenic	µg/L	4	<1	1	
Barium	µg/L	476	101	na	

Parameter	Unit	IR DS/S		IR U/S (suspect units on some readings)	
		28/11/2022	17/01/2023	1/11/2021	28/07/2022
Cadmium	µg/L	<0.1	<0.1	<0.1	
Chromium	µg/L	31	6	1.4	
Cobalt	µg/L	21	2	16	2
Copper	µg/L	38	5	10	
Lead	µg/L	21	3	5	
Manganese	µg/L	1100	67	211	100
Molybdenum	µg/L	<1	<1	<1	<1
Nickel	µg/L	39	6	16	
Selenium	µg/L	<10	<10	<10	
Silver	µg/L	<1	<1	<1	<1
Uranium	µg/L	<1	<1	<1	<1
Zinc	µg/L	73	15	24	
Boron	µg/L	60	60	50	60
Iron	µg/L	33800	6280	9740	
Dissolved Mercury	µg/L	<0.1	<0.1	<0.1	<0.1
Mercury	µg/L	<0.1	<0.1	<0.1	
Fluoride	µg/L	200	<100	<10	<100
Ammonium as N	µg/L	<10	<10		<10
Ammonia as N	µg/L	<10	<10	210	<10
Nitrite as N	µg/L	<10	<10		
Nitrate as N	µg/L	50	20	620	0.01
Nitrite + Nitrate as N	µg/L	50	20		
Total Kjeldahl Nitrogen as N	µg/L	2100	900		
Total Nitrogen as N	µg/L	2200	900	1600	<500
Total Phosphorus as P	µg/L	990	90	160	<50
Electrical Conductivity (Non Compensated)	µS/cm	135	151		
pH	pH Unit	8.61	7.76		
Temperature	°C	25.6	25		
Dissolved Oxygen	mg/L	8.1	9.2	na	na
C6 - C9 Fraction	µg/L	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	<50	<50		
C15 - C28 Fraction	µg/L	<100	<100		
C29 - C36 Fraction	µg/L	<50	<50		

Parameter	Unit	IR DS/S		IR U/S (suspect units on some readings)	
		28/11/2022	17/01/2023	1/11/2021	28/07/2022
C10 - C36 Fraction (sum)	µg/L	<50	<50	<100	<50
C6 - C10 Fraction	µg/L	<20	<20		
C6 - C10 Fraction minus BTEX (F1)	µg/L	<20	<20		
>C10 - C16 Fraction	µg/L	<100	<100		
>C16 - C34 Fraction	µg/L	<100	<100		
>C34 - C40 Fraction	µg/L	<100	<100		
>C10 - C40 Fraction (sum)	µg/L	<100	<100		
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	<100	<100		
Benzene	µg/L	<1	<1		
Toluene	µg/L	<2	<2		
Ethylbenzene	µg/L	<2	<2		
meta- & para-Xylene	µg/L	<2	<2		
ortho-Xylene	µg/L	<2	<2		
Total Xylenes	µg/L	<2	<2		
Sum of BTEX	µg/L	<1	<1	<1	<1
Naphthalene	µg/L	<5	<5		
Dissolved Vanadium	µg/L			<10	<10
Vanadium Total	µg/L			20	<10
Oxidised N *	µg/L			620	
FRP				10	<10
Total Suspended Solids	mg/L			144	7
Water hardness		30	75		
Total Petroleum Hydrocarbons	µg/L			<50	<50
Total Recoverable Hydrocarbons	µg/L			<100	<100

Sourced from "479676_GW and SW Monitoring Report March 2017 - July 2018_Rev 0.pdf"

Parameter	Units	CREEK	Isaac River (GW07)	SW01	SW07
		24/05/2014	1/04/2015	18/03/2017	21/02/2018
pH (Field)	pH Unts			7.36	7.13
Electrical conductivity (field)	µS/cm			315	406
Dissolved Oxygen (Field)	mg/L			1.3	6.7
DO (%S) (Field)	%S			16	39
Redox (Field)	mV			-14.2	90
Temperature (Field)	°C			27.9	20.5
pH (Lab)	pH Unts	8.56	8.13		
Electrical conductivity (lab)	µS/cm	1680	239		
Total Dissolved Solids	mg/L	1090	155	202	260
Alkalinity (Carbonate as CaCO ₃)	mg/L	92	<1	<1	<1
Alkalinity (Bicarbonate as CaCO ₃)	mg/L	695	110	71	70
Alkalinity (Hydroxide as CaCO ₃)	mg/L	<1	<1	<1	<1
Alkalinity (total as CaCO ₃)	mg/L	788	110	71	70
Hardness as CaCO ₃	mg/L	596	84		
Calcium	mg/L	31	19	18	11
Magnesium	mg/L	126	9	4	3
Potassium	mg/L	2	6	5	2
Sodium	mg/L	165	22	2	10
Chloride	mg/L	159	25	3	9
Sulfate	mg/L	6	<1	2	<1
Fluoride	mg/L	0.2	0.2	0.1	<0.1
Cations Total	meq/L	19.2	2.8	1.44	
Anions Total	meq/L	20.4	2.9	1.54	
Ionic Balance	%	3.1			
Ammonia as N	mg/L			0.04	0.1
Nitrate (as N)	mg/L			<0.01	0.3
Nitrite (as N)	mg/L			<0.01	<0.01
Nitrogen (Total Oxidised) (as N)	mg/L			<0.01	0.3
Nitrogen (Total)	mg/L			1.2	
Kjeldahl Nitrogen Total	mg/L			1.2	
Phosphorus (Total)	mg/L			0.34	0.61

Parameter	Units	CREEK	Isaac River (GW07)	SW01	SW07
		24/05/2014	1/04/2015	18/03/2017	21/02/2018
Reactive Silica	µg/L			8360	8610
Aluminium (Filtered)	mg/L			0.01	0.82
Antimony (Filtered)	mg/L			<0.001	<0.001
Arsenic (Filtered)	mg/L			<0.001	<0.001
Barium (Filtered)	mg/L			0.055	0.035
Beryllium (Filtered)	mg/L			<0.001	<0.001
Boron (Filtered)	mg/L			<0.05	<0.05
Cadmium (Filtered)	mg/L			<0.0001	<0.0001
Chromium (III+VI) (Filtered)	mg/L			<0.001	<0.001
Cobalt (Filtered)	mg/L			0.001	<0.001
Copper (Filtered)	mg/L			0.001	0.003
Iron (Filtered)	mg/L			<0.05	0.59
Lead (Filtered)	mg/L			<0.001	<0.001
Manganese (Filtered)	mg/L			0.228	0.009
Mercury (Filtered)	mg/L			<0.0001	<0.0001
Nickel (Filtered)	mg/L			0.002	0.002
Strontium (Filtered)	mg/L			0.204	0.214
Selenium (Filtered)	mg/L			<0.01	<0.01
Silver (Filtered)	mg/L			<0.001	<0.001
Uranium (Filtered)	mg/L			<0.001	<0.001
Tin (Filtered)	mg/L			<0.001	<0.001
Vanadium (Filtered)	mg/L			<0.01	<0.01
Zinc (Filtered)	mg/L			<0.005	0.012
Benzene	µg/L			<1	<1
Toluene	µg/L			<2	<2
Ethylbenzene	µg/L			<2	<2
Xylene (o)	µg/L			<2	<2
Xylene (m & p)	µg/L			<2	<2
Xylene Total	µg/L			<2	<2
Naphthalene (BTEXN)	µg/L			<5	<5
BTEX (Sum of Total) - Lab Calc	µg/L			<1	<1
F1 (C6-C10 minus BTEX)	µg/L			<20	<20
C6-C10 Fraction	µg/L			<20	<20

Parameter	Units	CREEK	Isaac River (GW07)	SW01	SW07
		24/05/2014	1/04/2015	18/03/2017	21/02/2018
F2 (>C10-C16 minus Naphthalene)	µg/L			<100	<100
>C10-C16 Fraction	µg/L			<100	<100
F3 (>C16-C34 Fraction)	µg/L			240	<100
F4 (>C34-C40 Fraction)	µg/L			<100	<100
>C10-C40 (Sum of Total)	µg/L			240	<100
C6-C9 Fraction	µg/L			<20	<20
C10-C14 Fraction	µg/L			<50	<50
C15-C28 Fraction	µg/L			200	<100
C29-C36 Fraction	µg/L			100	<50
C10-C36 (Sum of Total)	µg/L			300	<50
Acenaphthene	µg/L			<1	<1
Acenaphthylene	µg/L			<1	<1
Anthracene	µg/L			<1	<1
Benz(a)anthracene	µg/L			<1	<1
Benzo(a) pyrene	µg/L			<0.5	<0.5
Benzo[b+j]fluoranthene	µg/L			<1	<1
Benzo(k)fluoranthene	µg/L			<1	<1
Benzo(g,h,i)perylene	µg/L			<1	<1
Chrysene	µg/L			<1	<1
Dibenz(a,h)anthracene	µg/L			<1	<1
Fluoranthene	µg/L			<1	<1
Fluorene	µg/L			<1	<1
Indeno(1,2,3-c,d)pyrene	µg/L			<1	<1
Naphthalene-PAH	µg/L			<1	<1
Phenanthrene	µg/L			<1	<1
Pyrene	µg/L			<1	<1
PAHs (Sum of total) - Lab calc	µg/L			<0.5	<0.5
Total 8 PAHs (as BaP TEQ)(zero LOR) - Lab Calc	µg/L			<0.5	<0.5

Sourced from
 "20190827_Lenton_ConsolidatedAquaticsIReport_Final_w_Appendices(vA2126863).pdf"

February 2018 Survey	Unit	LOR	WQO	Isaac River			Ti-Tree Creek	
Parameter				LAq01	LAq02	LAq03	LAq04	LAq05
<u><i>In-situ water quality results</i></u>								
Temperature	°C		-	24.5	23.3	32.4	28.4	28.9
Dissolved Oxygen	%/L		-	100	100.9	102.8	15.2	72
Dissolved Oxygen	ppm		-	8.01	7.58	7.15	1.13	4.73
Specific Conductance	µS/cm		-	167.9	181.9	185.6	176.9	182.9
Electrical Conductivity	µS/cm		720	166.4	192.3	211.6	188.5	194.7
Total Dissolved Solids	mg/L		-	109.12	117.66	120.623	114.971	119.05
pH	pH unit		6.5-8.5	8.1	7.97	8.07	7.52	8.28
Oxygen Reduction Potential	mV		-	64.4	78.8	91.5	-134.9	47
Turbidity	NTU		<50	70	76	70.3	164.5	445
<u><i>Physico-chemical water quality results</i></u>								
pH Value	pH Unit	0.01	6.5-8.5a	6.81	7.2	7.27	6.99	7.5
Electrical Conductivity at 25°C	µS/cm	1	<720a	166	178	182	187	175
Total Dissolved Solids (Calc.)	mg/L	1	n/a	108	116	118	122	114
Suspended Solids	mg/L	5	<55	38	46	40	32	196
Turbidity	NTU	0.1	<50	70.9	74.1	73.5	84	264
<u><i>Dissolved metal water quality results</i></u>								
Aluminium	mg/L	0.01	0.055	2.3	0.33	0.84	1.94	3.55
Arsenic	mg/L	0.001	0.024	<0.001	<0.001	<0.001	0.001	<0.001
Barium	mg/L	0.001	-	0.087	0.1	0.078	0.054	0.065
Beryllium	mg/L	0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.05	0.37	<0.05	0.07	0.05	<0.05	<0.05
Cadmium	mg/L	0.0001	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	-	<0.001	<0.001	<0.001	0.002	0.006
Cobalt	mg/L	0.001	-	<0.001	<0.001	<0.001	0.002	0.003
Copper	mg/L	0.001	0.0014a	0.002	0.002	0.002	0.004	0.006
Lead	mg/L	0.001	0.0034	<0.001	<0.001	<0.001	<0.001	0.001
Manganese	mg/L	0.001	1.9	0.033	0.048	0.017	0.18	0.116
Mercury	mg/L	0.001	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	0.15	<0.001	<0.001	<0.001	<0.001	<0.001

February 2018 Survey	Unit	LOR	WQO	Isaac River			Ti-Tree Creek	
Parameter				LAq01	LAq02	LAq03	LAq04	LAq05
Nickel	mg/L	0.001	0.011	0.001	0.001	<0.001	0.007	0.01
Selenium	mg/L	0.01	0.011	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	0.001	0.00005	<0.001	<0.001	0.002	0.001	<0.001
Uranium	mg/L	0.001	0.2	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	0.01	-	<0.01	<0.01	<0.01	0.01	0.05
Zinc	mg/L	0.005	0.008	0.023	0.018	0.036	0.018	0.014
<u>Total metal water quality results</u>								
Aluminium	mg/L	0.01	0.055	3.08	2.54	2.78	3.57	20.2
Arsenic	mg/L	0.001	0.024	<0.001	<0.001	0.002	0.002	0.001
Barium	mg/L	0.001	-	0.064	0.074	0.077	0.045	0.066
Beryllium	mg/L	0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	mg/L	0.0001	0.002	<0.0001	<0.0001	0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	1	0.001	0.002	0.002	0.005	0.031
Cobalt	mg/L	0.001	1	<0.001	0.001	0.001	0.003	0.007
Copper	mg/L	0.001	0.0014	0.003	0.003	0.003	0.004	0.011
Lead	mg/L	0.001	0.0034	0.001	0.001	0.002	<0.001	0.002
Manganese	mg/L	0.001	1.9	0.065	0.062	0.059	0.186	0.184
Mercury	mg/L	0.001	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	0.15	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001	0.011	0.002	0.003	0.002	0.009	0.032
Selenium	mg/L	0.01	0.011	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	0.001	0.00005	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	0.001	0.2	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	0.01	-	<0.01	<0.01	<0.01	0.01	0.06
Zinc	mg/L	0.005	0.008	0.007	<0.005	<0.005	0.012	0.027
<u>Petroleum hydrocarbon water quality results</u>								
C6 - C9 Fraction	mg/L	20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	mg/L	50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	mg/L	100	<100	<100	<100	<100	240	<100
C29 - C36 Fraction	mg/L	50	<50	<50	<50	<50	60	<50
C10 - C36 Fraction (sum)	mg/L	50	<50	<50	<50	<50	300	<50

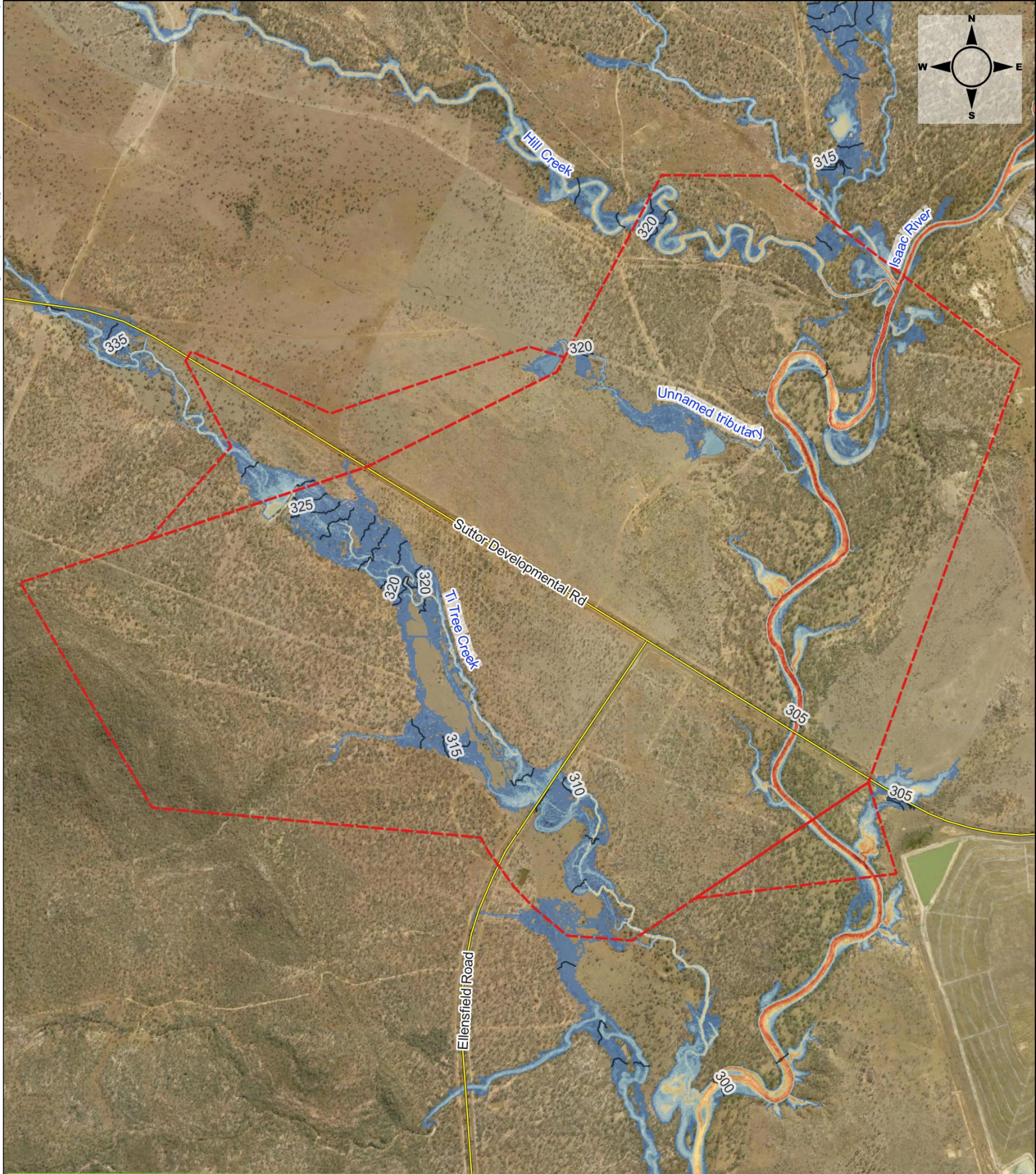
Sourced from "Final Baseline Water Quality Report_Rev1(vA637351).pdf / 2011 REMP

		Hill Creek														Ti Tree Creek										Isaac River							WQGL
Site> Parameter	Unit	HCK01	HCK01	HCK01	HCK01	HCK02	HCK02	HCK02	HCK02	HCK03	TTCK01	TTCK01	TTCK01	TTCK01	TTCK01	TTCK01	TTCK01	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK03	TTCK03	TTCK03	ISR01	ISR01	ISR01	ISR02	ISR02	ISR02	
Date		10/01/2008	1/12/2010	5/03/2013	18/04/2013	10/01/2008	1/12/2010	5/03/2013	18/04/2013	10/01/2008	22/11/2005	10/01/2008	19/11/2010	1/12/2010	2/02/2010	5/03/2013	17/04/2013	22/11/2005	2/02/2010	19/11/2010	1/12/2010	5/03/2013	17/04/2013	2/02/2010	6/03/2013	17/04/2013	2/02/2010	6/03/2013	17/04/2013				
pH (<i>in-situ</i>)	pH units	7.52	7.4	6.82	7.58	7.66	7.9	7.29	7.77	7.69	7.84	7.19	8.12	8.21	8.18	8.24	8.22	7.69	8.12	8.05	8.2	8.32	8.34	7.71	8.42	8.6	7.77	7.86	8.46	7.5	8.17	7.97	6.5-8.5
pH (laboratory)	pH units	-	-	7.27	7.46	-	-	7.64	7.82	-	-	-	-	-	-	8.43	8.43	-	-	-	-	8.46	8.44	-	8.54	8.64	-	7.91	8.23	-	-	-	6.5-8.5
Sodium adsorption ratio		-	-	2.03	1.44	-	-	1.47	1.27	-	-	-	-	-	-	4.6	4.15	-	-	-	-	4.56	4.34	-	2.39	4.28	-	1.16	1.28	-	-	-	-
EC (<i>in-situ</i>)	µS/cm	152	80	119	106	249	102	136	151	161	211	124	193	192	365	2505	1856	172	234	201	185	2493	1838	213	953	1744	145	211	285	188	176	146	720 (low flow) 250 (high flow)
EC (laboratory)	µS/cm	-	-	89	112	-	-	134	162	-	-	-	-	-	-	2460	1940	-	-	-	-	2470	1910	-	978	1810	-	209	290	-	-	-	720 (low flow) 250 (high flow)
TDS (<i>in-situ</i>)	mg/L	168	212	75	-	104	228	88	-	108	120	100	200	214	292	1625	-	102	286	193	158	1621	1300	264	619	-	244	137	-	304	180	224	600
TDS (laboratory)	mg/L	-	-	10	73	-	-	87	105	-	-	-	-	-	-	1600	1260	-	-	-	-	1600	1240	-	636	1180	-	136	188	-	-	-	600
TSS	mg/L	297	398	56	16	144	550	65	24	151	6980	275	102	230	7	8	5	3390	52	223	304	10	7	47	7	<5	88	82	16	398	307	764	55
Turbidity (<i>in-situ</i>)	NTU	-	-	92.5	58.4	-	-	122.8	66.1	-	-	-	-	-	7.9	0.38	1.4	-	85	-	-	0.24	-	95	11.32	3	220	139.7	40.6	600	533	907	25
turbidity (laboratory)	NTU	-	-	59	41	-	-	76	48	-	-	-	-	-	-	1.2	-	-	-	-	-	5.4	-	-	9.3	-	-	66	-	-	-	-	25
Total hardness as CaCO3	mg/L	-	-	7	13	-	-	22	26	-	-	-	-	-	-	690	541	-	-	-	-	672	574	-	281	509	-	50	84	-	-	-	200
Hydroxide alkalinity as CaCO3	mg/L	-	-	<1	<1	-	-	<1	<1	-	-	-	-	-	-	<1	<1	-	-	-	-	<1	<1	-	<1	<1	-	<1	<1	-	-	-	-
Carbonate alkalinity as CaCO3	mg/L	-	-	<1	<1	-	-	<1	<1	-	-	-	-	-	-	31	35	-	-	-	-	37	35	-	25	60	-	<1	<1	-	-	-	-
Bicarbonate alkalinity as CaCO3	mg/L	-	-	11	22	-	-	28	33	-	-	-	-	-	-	497	573	-	-	-	-	512	557	-	207	373	-	59	102	-	-	-	-
Total alkalinity as CaCO3	mg/L	-	-	11	22	-	-	28	33	-	-	-	-	-	-	528	608	-	-	-	-	549	591	-	232	434	-	59	102	-	-	-	-
Dissolved major anions: sulphate	mg/L	1	2	2	3	2	2	2	3	1	1	2	2	1	6	23	17	<1.0	3	2	1	24	17	3	8	17	4	4	2	2	4	2	25
Chloride	mg/L	2	-	12	16	12	-	17	24	<1	6	<1	11	10	-	497	319	5	-	11	7	495	319	-	177	366	-	25	34	-	-	-	250
Dissolved major cations: calcium	mg/L	11	-	1	2	12	-	4	4	11	20	11	13	13	-	75	42	17	-	14	12	73	45	-	35	34	-	12	19	-	15	11	-
Dissolved major cations: magnesium	mg/L	5	-	1	2	9	-	3	4	5	8	4	8	8	-	122	106	7	-	8	7	119	112	-	47	103	-	5	9	-	5	4	-
Dissolved major cations: sodium	mg/L	12	-	12	12	15	-	16	15	13	10	3	16	17	-	278	222	9	-	18	16	272	239	-	92	222	-	19	27	-	15	14	-
Dissolved major cations: potassium	mg/L	3	-	3	2	3	-	3	2	2	2	-	4	4	-	3	1	-	-	3	3	3	1	-	3	2	-	4	4	-	-	-	-
Total Major cations: calcium	mg/L	-	-	2	2	-	-	5	5	-	-	-	-	-	-	81	42	-	-	-	-	84	41	-	33	32	-	12	20	-	-	-	-
Total major cations: magnesium	mg/L	-	-	2	2	-	-	4	5	-	-	-	-	-	-	113	109	-	-	-	-	137	106	-	45	95	-	6	9	-	-	-	-
Aluminium	mg/L	-	0.88	1.93	1.54	-	0.61	2.05	1.47	-	-	-	1.06	1.58	0.65	0.06	0.06	-	2.33	1.77	1.91	0.08	0.06	3.26	0.56	0.13	4.39	3.37	0.95	11.5	1.67	1.2	0.055

		Hill Creek										Ti Tree Creek										Isaac River																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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Parameter		HCK01	HCK01	HCK01	HCK01	HCK02	HCK02	HCK02	HCK02	HCK03	TTCK01	TTCK01	TTCK01	TTCK01	TTCK01	TTCK01	TTCK01	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	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		Hill Creek															Ti Tree Creek										Isaac River							
Site> Parameter	Unit	HCK01	HCK01	HCK01	HCK01	HCK02	HCK02	HCK02	HCK02	HCK02	HCK03	TTCK01	TTCK01	TTCK01	TTCK01	TTCK01	TTCK01	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK02	TTCK03	TTCK03	TTCK03	ISR01	ISR01	ISR01	ISR02	ISR02	ISR02	WQGL	
Date		10/01/2008	1/12/2010	5/03/2013	18/04/2013	10/01/2008	1/12/2010	5/03/2013	18/04/2013	10/01/2008	22/11/2005	10/01/2008	19/11/2010	1/12/2010	2/02/2010	5/03/2013	17/04/2013	22/11/2005	2/02/2010	19/11/2010	1/12/2010	5/03/2013	17/04/2013	2/02/2010	6/03/2013	17/04/2013	2/02/2010	6/03/2013	17/04/2013					
Total anions	mg/L	-	-	0.6	0.95	-	-	1.08	1.4	-	-	-	-	-	-	25	21.5	-	-	-	-	25.4	21.2	-	9.79	19.4	-	1.97	3.04	-	-	-	-	
Total cations	mg/L	-	-	0.73	0.84	-	-	1.22	1.23	-	-	-	-	-	-	26	20.5	-	-	-	-	25.3	21.9	-	9.69	19.9	-	1.94	2.97	-	-	-	-	
Ionic balance	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.76	2.4	-	-	-	-	0.19	1.65	-	0.54	1.33	-	-	1.22	-	-	-	-	
Benzene	µg/L	-	-	<1	<1	-	-	<1	<1	-	-	-	-	-	-	<1	<1	-	-	-	-	<1	<1	-	<1	<1	-	<1	<1	-	-	-	950	
Toluene	µg/L	-	-	<2	<2	-	-	<2	<2	-	-	-	-	-	-	<2	<2	-	-	-	-	<2	<2	-	<2	<2	-	<2	<2	-	-	-	25	
Ethylbenzene	µg/L	-	-	<2	<2	-	-	<2	<2	-	-	-	-	-	-	<2	<2	-	-	-	-	<2	<2	-	<2	<2	-	<2	<2	-	-	-	300	
Meta- & para-xylene	µg/L	-	-	<2	<2	-	-	<2	<2	-	-	-	-	-	-	<2	<2	-	-	-	-	<2	<2	-	<2	<2	-	<2	<2	-	-	-	200	
Ortho-xylene	µg/L	-	-	<2	<2	-	-	<2	<2	-	-	-	-	-	-	<2	<2	-	-	-	-	<2	<2	-	<2	<2	-	<2	<2	-	-	-	350	
Total xylenes	µg/L	-	-	<2	<2	-	-	<2	<2	-	-	-	-	-	-	<2	<2	-	-	-	-	<2	<2	-	<2	<2	-	<2	<2	-	-	-	20	
Sum of BTEX	µg/L	-	-	<1	<1	-	-	<1	<1	-	-	-	-	-	-	<1	<1	-	-	-	-	<1	<1	-	<1	<1	-	<1	<1	-	-	-	-	
Naphthalene	µg/L	-	-	<5	<5	-	-	<5	<5	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	-	<5	<5	-	<5	<5	-	-	-	16	
C6 - C9 fraction	ug/L	-	<20	<20	<20	-	<20	<20	<20	-	-	-	<20	<20	<20	<20	<20	<20	<20	<20	-	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	-	
C10 - C14 fraction	ug/L	-	-	<50	<50	-	<50	<50	<50	-	-	-	-	-	-	<50	<50	-	-	-	-	<50	<50	-	<50	<50	-	<50	<50	-	-	-	-	
C15 - C28 fraction	ug/L	-	-	<100	<100	-	-	<100	<100	-	-	-	-	-	-	<100	<100	-	-	-	-	<100	<100	-	<100	<100	-	<100	<100	-	-	-	-	
C29 - C36 fraction	ug/L	-	-	<50	<50	-	-	<50	<50	-	-	-	-	-	-	<50	<50	-	-	-	-	<50	<50	-	<50	<50	-	<50	<50	-	-	-	-	
C10 - C36 fraction (sum)	ug/L	-	<50	<50	<50	-	-	<50	<50	-	-	-	<50	<50	<50	<50	<50	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	
C6 - C10 fraction	ug/L	-	-	<20	<20	-	-	<20	<20	-	-	-	-	-	-	<20	<20	-	-	-	-	<20	<20	-	<20	<20	-	<20	<20	-	-	-	-	
C6 - C10 fraction minus BTEX (F1)	ug/L	-	-	<20	<20	-	-	<20	<20	-	-	-	-	-	-	<20	<20	-	-	-	-	<20	<20	-	<20	<20	-	<20	<20	-	-	-	-	
>C10 - C16 fraction	ug/L	-	-	<100	<100	-	-	<100	<100	-	-	-	-	-	-	<100	<100	-	-	-	-	<100	<100	-	<100	<100	-	<100	<100	-	-	-	-	
>C16 - C34 fraction	ug/L	-	-	<100	<100	-	-	<100	<100	-	-	-	-	-	-	<100	<100	-	-	-	-	<100	<100	-	<100	<100	-	<100	<100	-	-	-	-	
>C34 - C40 fraction	ug/L	-	-	<100	<100	-	-	<100	<100	-	-	-	-	-	-	<100	<100	-	-	-	-	<100	<100	-	<100	<100	-	<100	<100	-	-	-	-	
>C10 - C40 fraction (sum)	ug/L	-	-	<100	<100	-	-	<100	<100	-	-	-	-	-	-	<100	<100	-	-	-	-	<100	<100	-	<100	<100	-	<100	-	-	-	-	-	
1,2-dichloroethane-D4	ug/L	-	-	92.8	96.3	-	-	85.9	104	-	-	-	-	-	-	88.3	104	-	-	-	-	91.2	101	-	112	108	-	113	97.9	-	-	-	-	
Toluene-D8	ug/L	-	-	99	103	-	-	89.7	99.8	-	-	-	-	-	-	90.8	90.1	-	-	-	-	82.1	90	-	114	94.5	-	113	96	-	-	-	-	
4-bromofluorobenzene	ug/L	-	-	104	95	-	-	93.5	97	-	-	-	-	-	-	96.1	101	-	-	-	-	91	102	-	102	109	-	104	107	-	-	-	-	
Temperature	Deg C	-	-	24.9	22.99	-	-	25.5	25.45	-	-	-	-	-	-	26.4	20.28	-	-	-	-	26.2	19.94	-	23.901	23.27	-	-	27.07	-	-	-	-	
Dissolved oxygen	%	-	-	92	94.7	-	-	97.3	83.7	-	-	-	-	-	-	100.3	80.6	-	-	-	-	92.1	86.1	-	164.1	80.3	-	-	94.2	-	-	-	90-110	
Dissolved oxygen	mg/L	-	-	7.65	7.81	-	-	7.94	6.6	-	-	-	-	-	4.9	8	7.63	-	5.3	-	-	7.5	7.34	3.8	13.69	6.41	5.4	10.01	7.05	3.9	8.05	-	-	
Redox	mV	-	-	159.2	142.1	-	-	104.6	167.5	-	-	-	-	-	-	116.6	205	-	-	-	-	20.1	181.4	-	67.2	178.3	-	-	177.8	-	-	-	-	

APPENDIX E FLOOD MAPPING



- Legend**
- Mine Lease Area
 - Roads

- Flood height contour (1m)
- Depth**
- up to 0.25m
 - 0.25 to 0.5m
 - 0.5 to 1.0m
 - 1.0 to 1.5m
 - 1.5 to 2.0m
 - 2.0 to 2.5m
 - 2.5 to 3.0m
 - 3.0 to 3.5m
 - 3.5 to 4.0m
 - 4.0 to 4.5m
 - > 4.5m

New Lenton Mine Public Environment Report

Existing conditions
50% AEP flood depth and heights





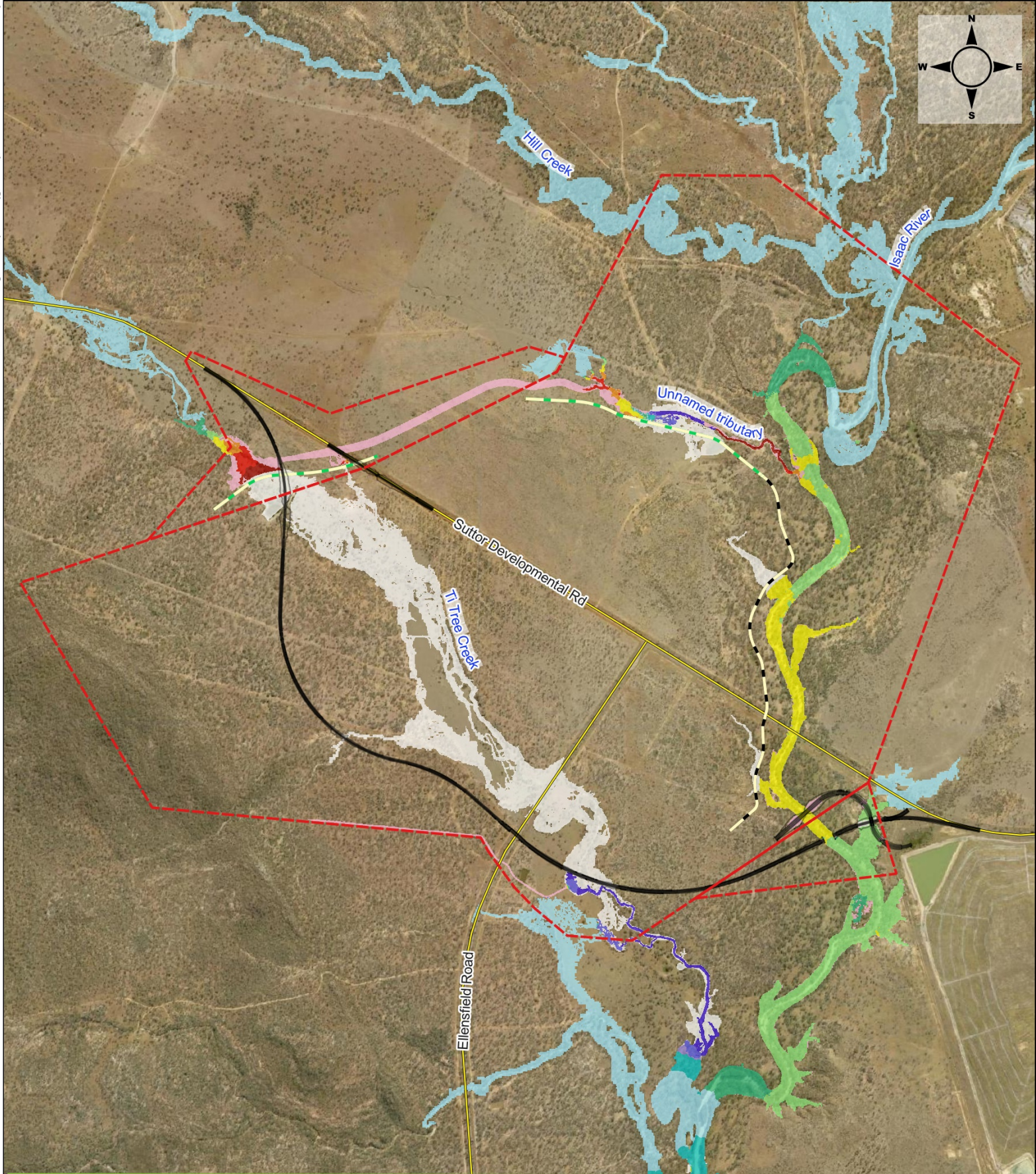
- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

—	Flood height contour (1m)
Depth	
	up to 0.25m
	0.25 to 0.5m
	0.5 to 1.0m
	1.0 to 1.5m
	1.5 to 2.0m
	2.0 to 2.5m
	2.5 to 3.0m
	3.0 to 3.5m
	3.5 to 4.0m
	4.0 to 4.5m
	> 4.5m

New Lenton Mine Public Environment Report

Developed conditions
50% AEP flood depth and heights





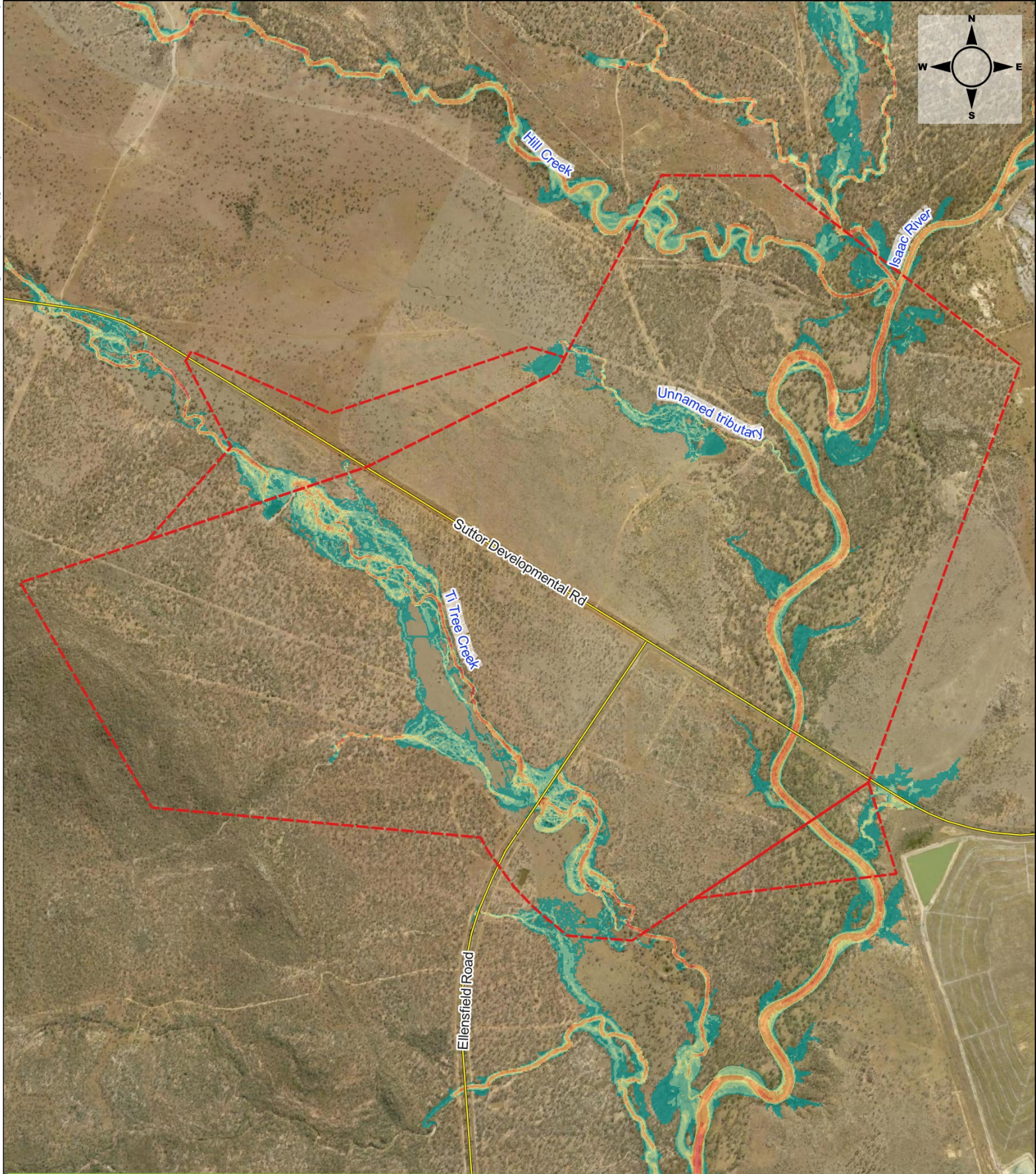
- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

Afflux	
	dWL < -0.25
	-0.25m < dWL < -0.10m
	-0.10m < dWL < -0.05m
	-0.05m < dWL < -0.01m
	-0.01m < dWL < 0.01m
	0.01m < dWL < 0.05m
	0.05m < dWL < 0.10m
	0.10m < dWL < 0.25m
	0.25m < dWL < 0.50m
	0.50m < dWL < 1.00m
	1.00 < dWL < 3.00m
	3.00 < dWL < 5.00m
	dWL > 5.00m
	Was wet now dry
	Was dry now wet

New Lenton Mine Public Environment Report

Developed conditions minus existing conditions
50% AEP afflux





Legend

 Mine Lease Area

 Roads

Velocity

 up to 0.25m/s

 0.25 to 0.5m/s

 0.5 to 0.75m/s

 0.75 to 1.0m/s

 1.0 to 1.5m/s

 1.5 to 2.0m/s

 2.0 to 3.0m/s

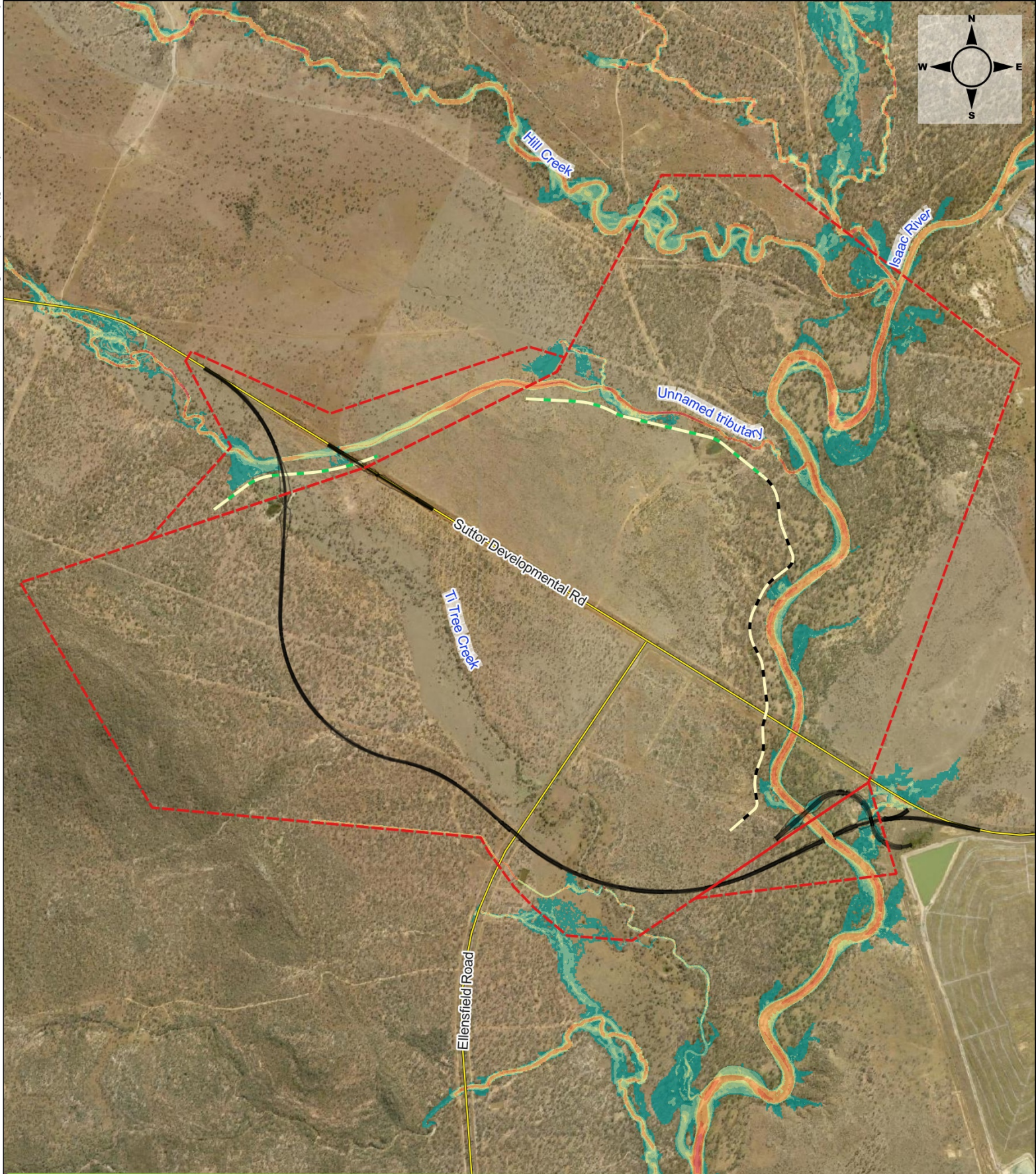
 > 3 m/s

New Lenton Mine Public Environment Report

Existing conditions
50% AEP velocity



J:\1927-01 New Lenton PER\GIS\QGIS\New Lenton_TUFLOW_Figures_update.qgz (Issued: 17 November 2023)



- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

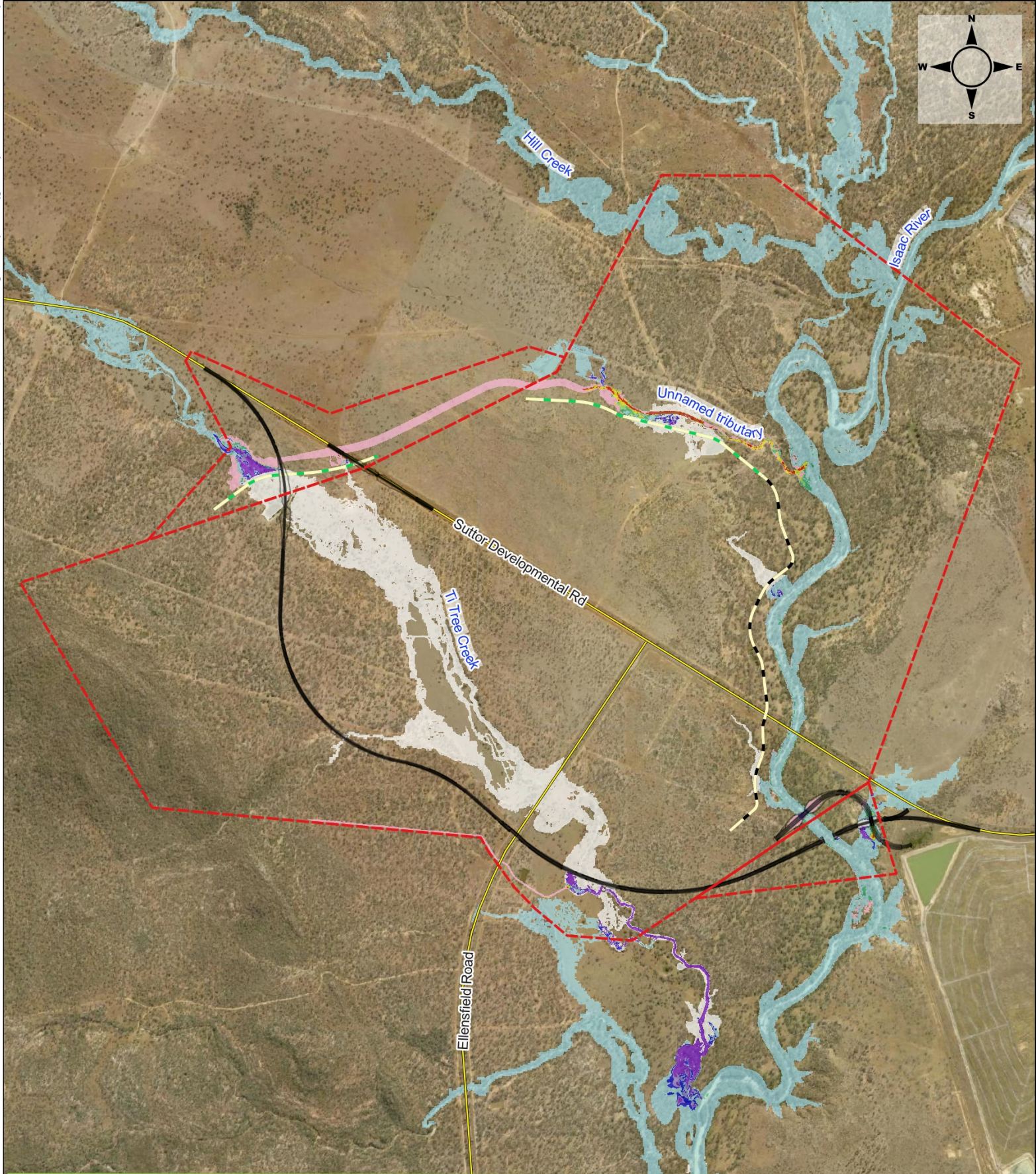
Velocity	
	up to 0.25m/s
	0.25 to 0.5m/s
	0.5 to 0.75m/s
	0.75 to 1.0m/s
	1.0 to 1.5m/s
	1.5 to 2.0m/s
	2.0 to 3.0m/s
	> 3 m/s

New Lenton Mine Public Environment Report

Developed conditions
50% AEP velocity



Projection: EPSG:28355



Legend

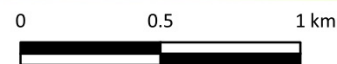
- Mine Lease Area
- Roads
- Proposed levees**
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

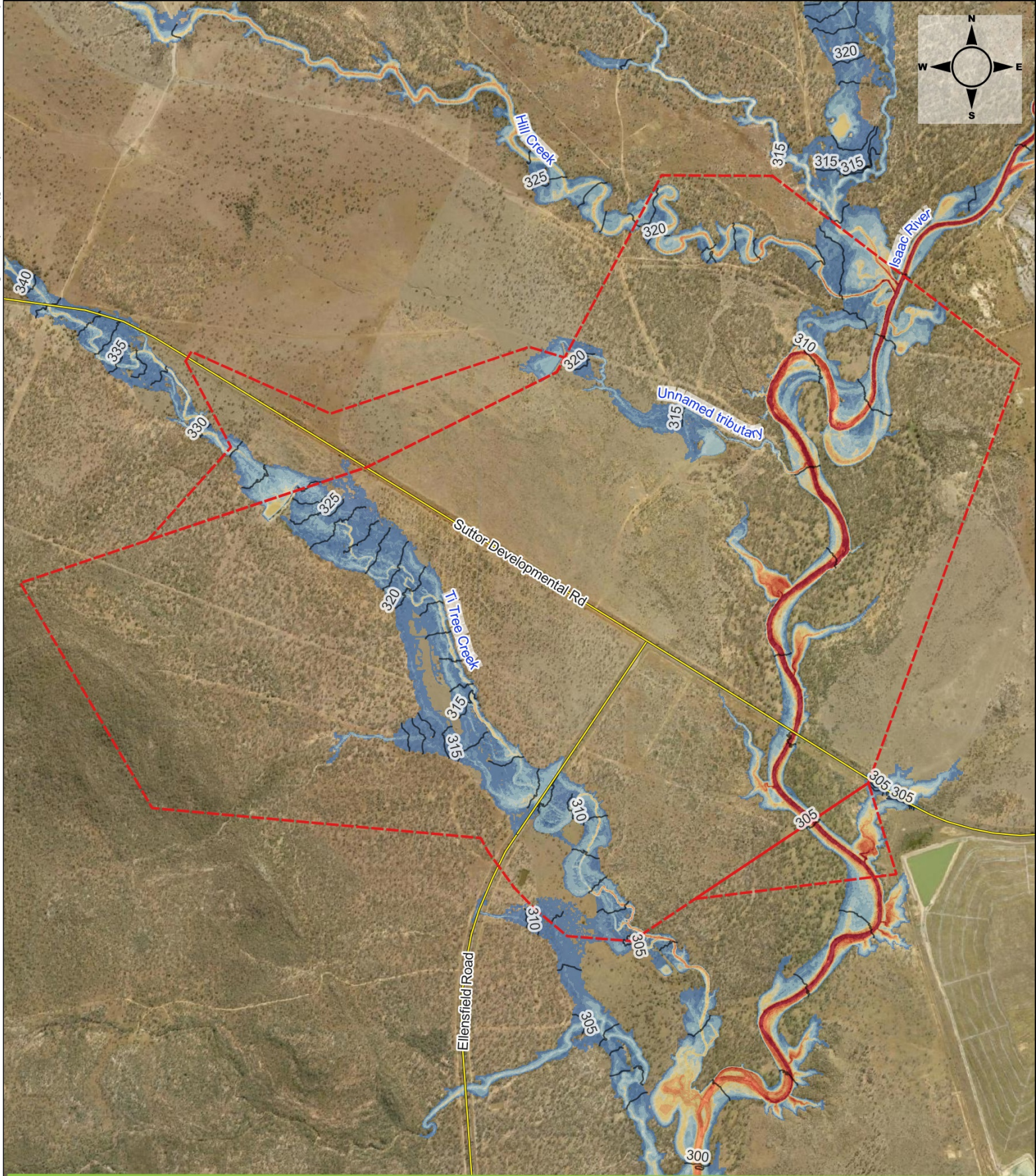
Velocity difference

- < -0.3 m/s
- 0.3 m/s to -0.2 m/s
- 0.2 m/s to -0.1 m/s
- 0.1 m/s to 0.1 m/s
- 0.1 m/s to 0.3 m/s
- 0.3 m/s to 0.5 m/s
- 0.5 m/s to 1.0 m/s
- 1.0 m/s to 1.5 m/s
- > 1.5 m/s
- Was wet now dry
- Was dry now wet

New Lenton Mine Public Environment Report

Developed conditions minus existing conditions
50% AEP velocity difference





Legend

- Mine Lease Area
- Roads

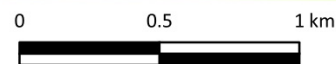
Flood height contour (1m)

Depth

- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

New Lenton Mine Public Environment Report

Existing conditions
10% AEP flood depth and heights





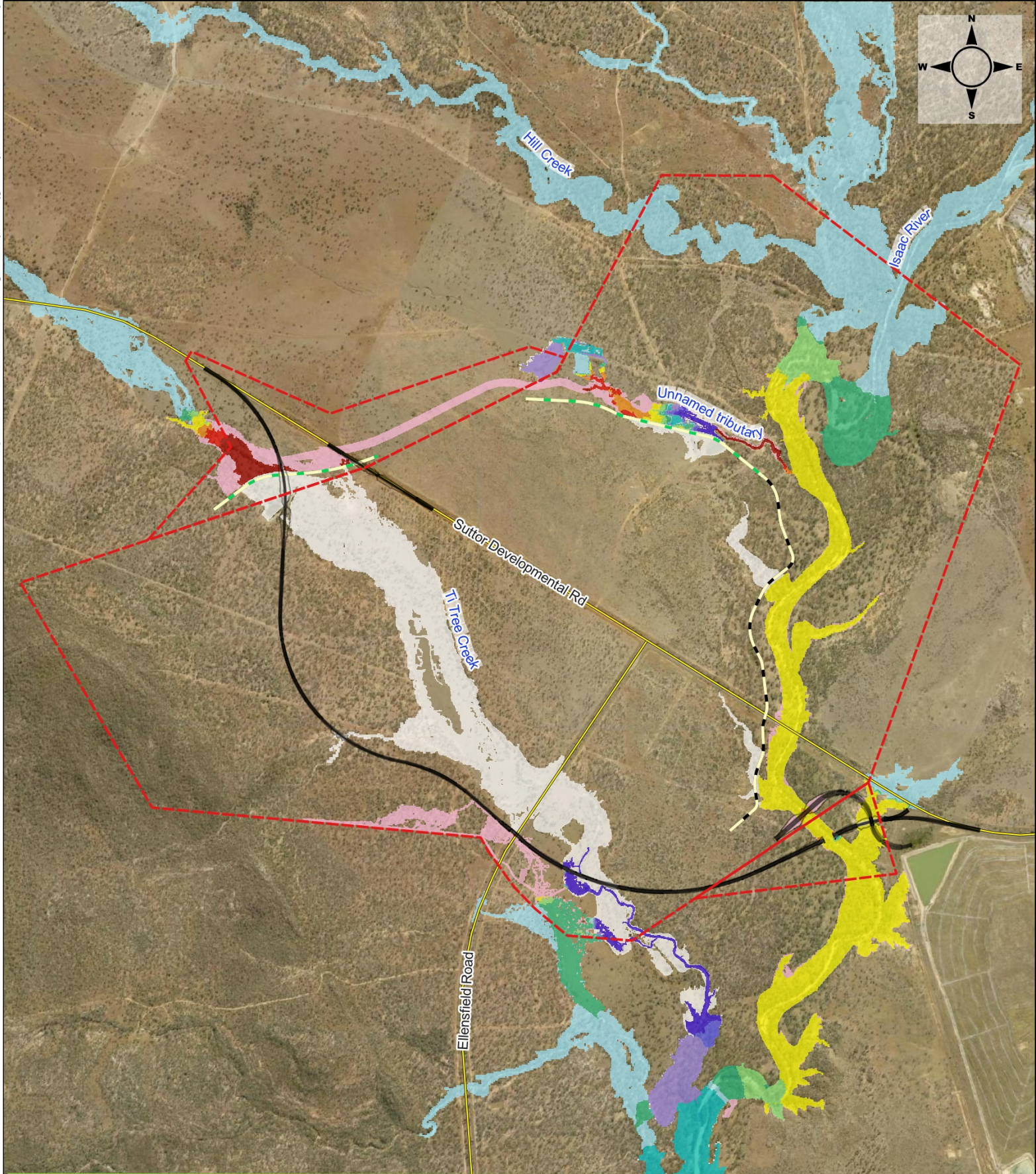
- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees**
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

	Flood height contour (1m)
Depth	
	up to 0.25m
	0.25 to 0.5m
	0.5 to 1.0m
	1.0 to 1.5m
	1.5 to 2.0m
	2.0 to 2.5m
	2.5 to 3.0m
	3.0 to 3.5m
	3.5 to 4.0m
	4.0 to 4.5m
	> 4.5m

New Lenton Mine Public Environment Report

Developed conditions
10% AEP flood depth and heights





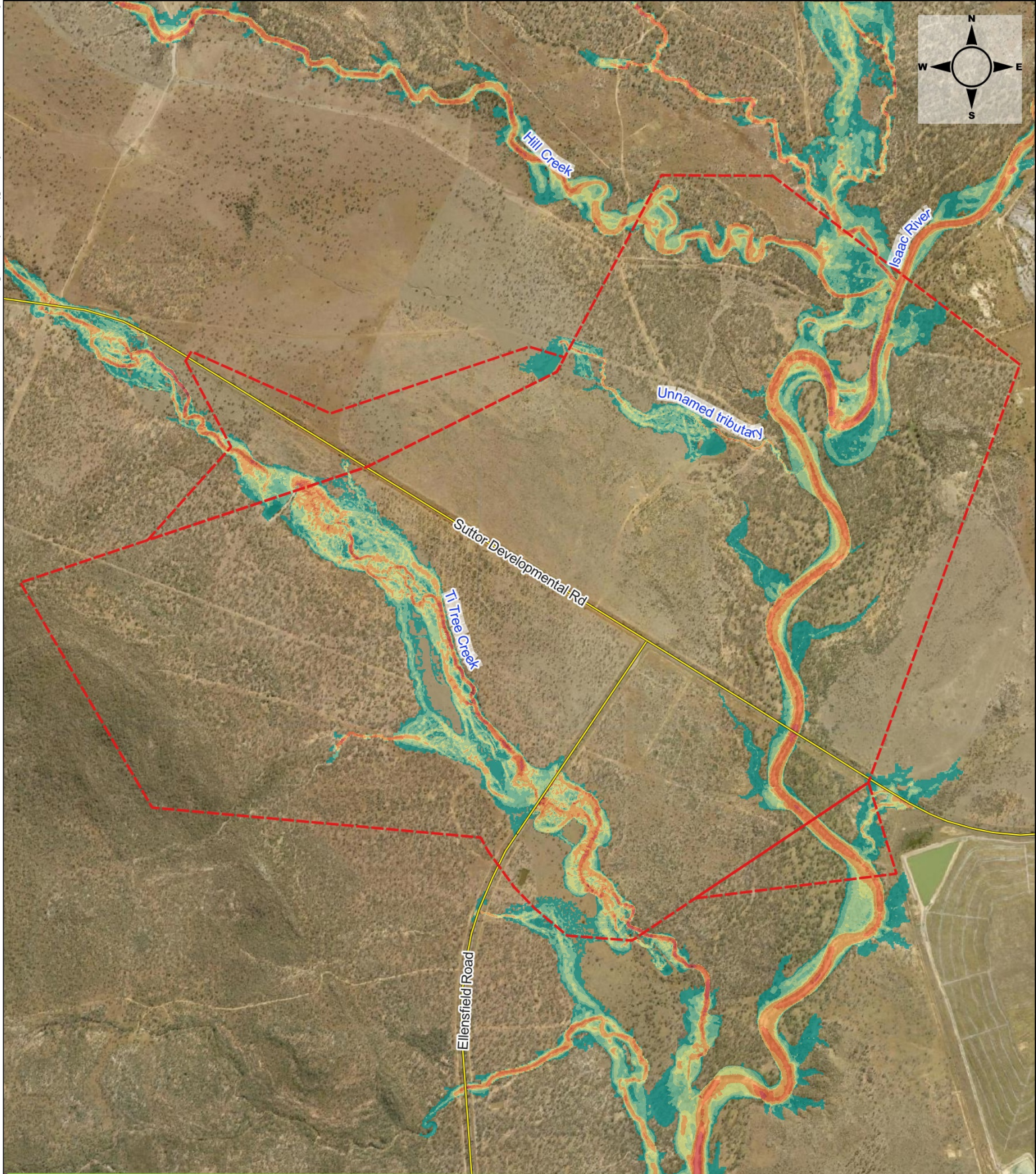
- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

Afflux	
	dWL < -0.25
	-0.25m < dWL < -0.10m
	-0.10m < dWL < -0.05m
	-0.05 m < dWL < -0.01 m
	-0.01 m < dWL < 0.01 m
	0.01 m < dWL < 0.05 m
	0.05 m < dWL < 0.10 m
	0.10 m < dWL < 0.25 m
	0.25 m < dWL < 0.50 m
	0.50 m < dWL < 1.00 m
	1.00 < dWL < 3.00m
	3.00 < dWL < 5.00m
	dWL > 5.00m
	Was wet now dry
	Was dry now wet

New Lenton Mine Public Environment Report

Developed conditions minus existing conditions
10% AEP afflux





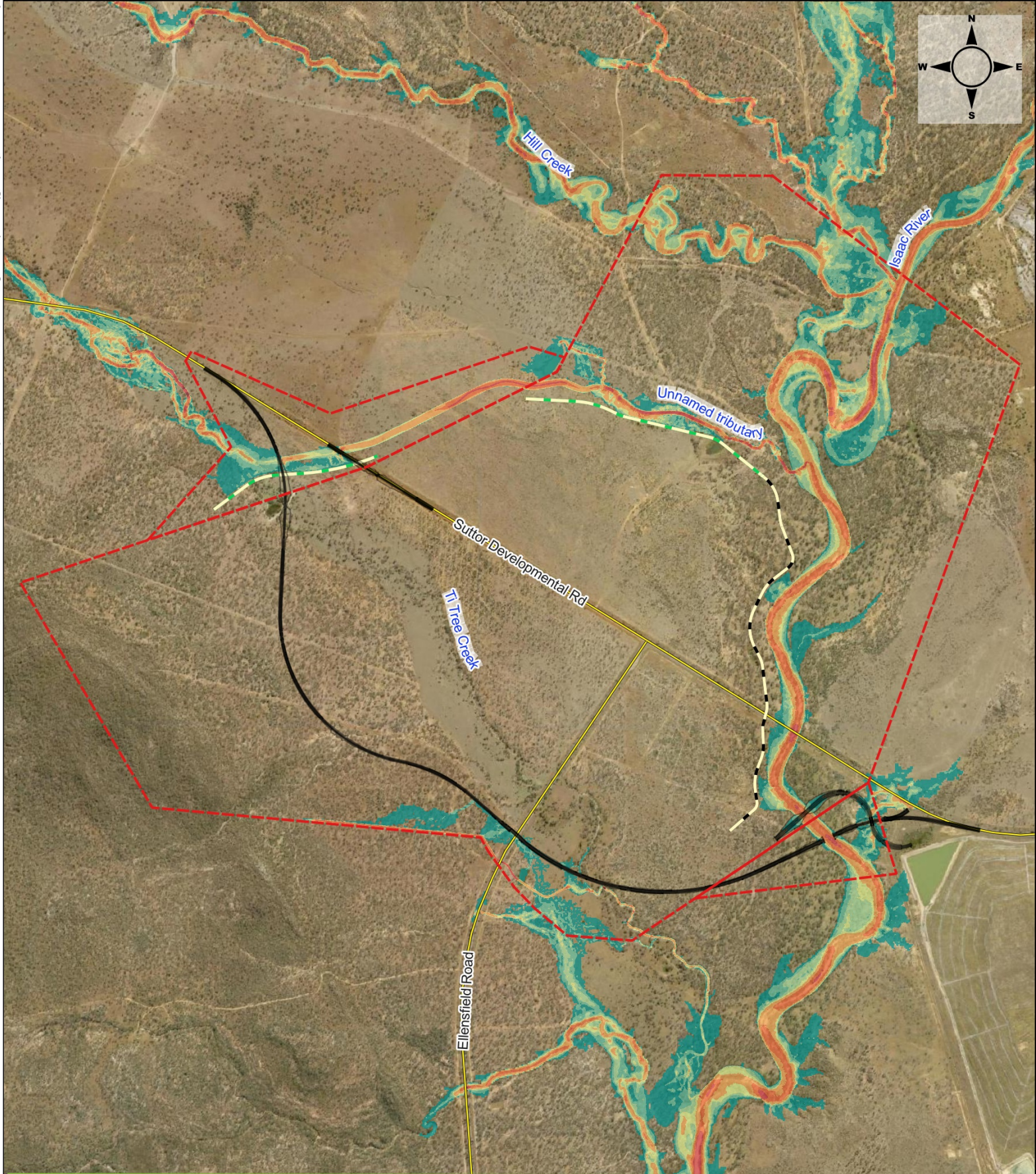
- Legend**
- Mine Lease Area
 - Roads

Velocity	
	up to 0.25m/s
	0.25 to 0.5m/s
	0.5 to 0.75m/s
	0.75 to 1.0m/s
	1.0 to 1.5m/s
	1.5 to 2.0m/s
	2.0 to 3.0m/s
	> 3 m/s

New Lenton Mine Public Environment Report

Existing conditions
10% AEP velocity





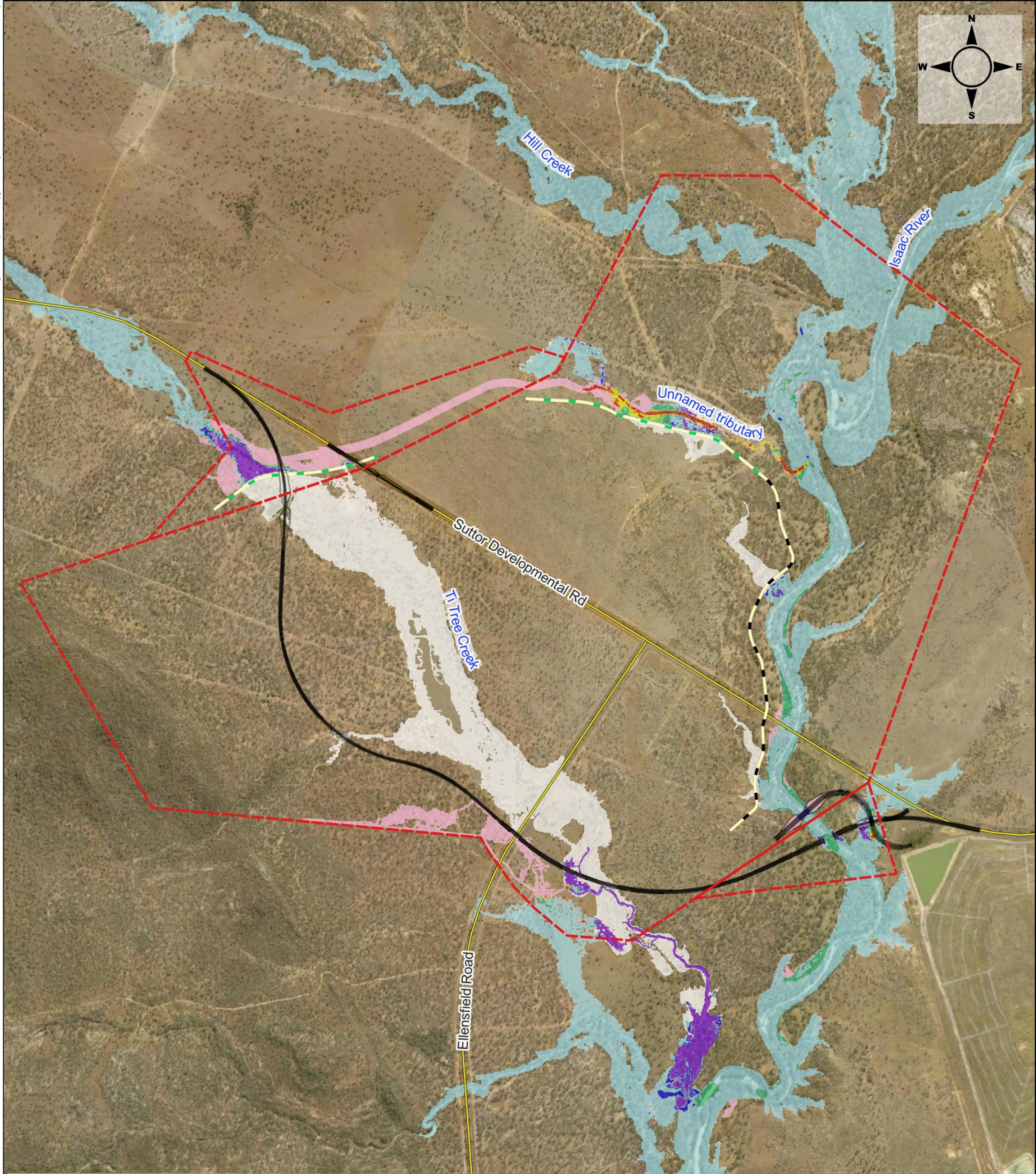
- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

Velocity	
	up to 0.25m/s
	0.25 to 0.5m/s
	0.5 to 0.75m/s
	0.75 to 1.0m/s
	1.0 to 1.5m/s
	1.5 to 2.0m/s
	2.0 to 3.0m/s
	> 3 m/s

New Lenton Mine Public Environment Report

Developed conditions
10% AEP velocity





Legend

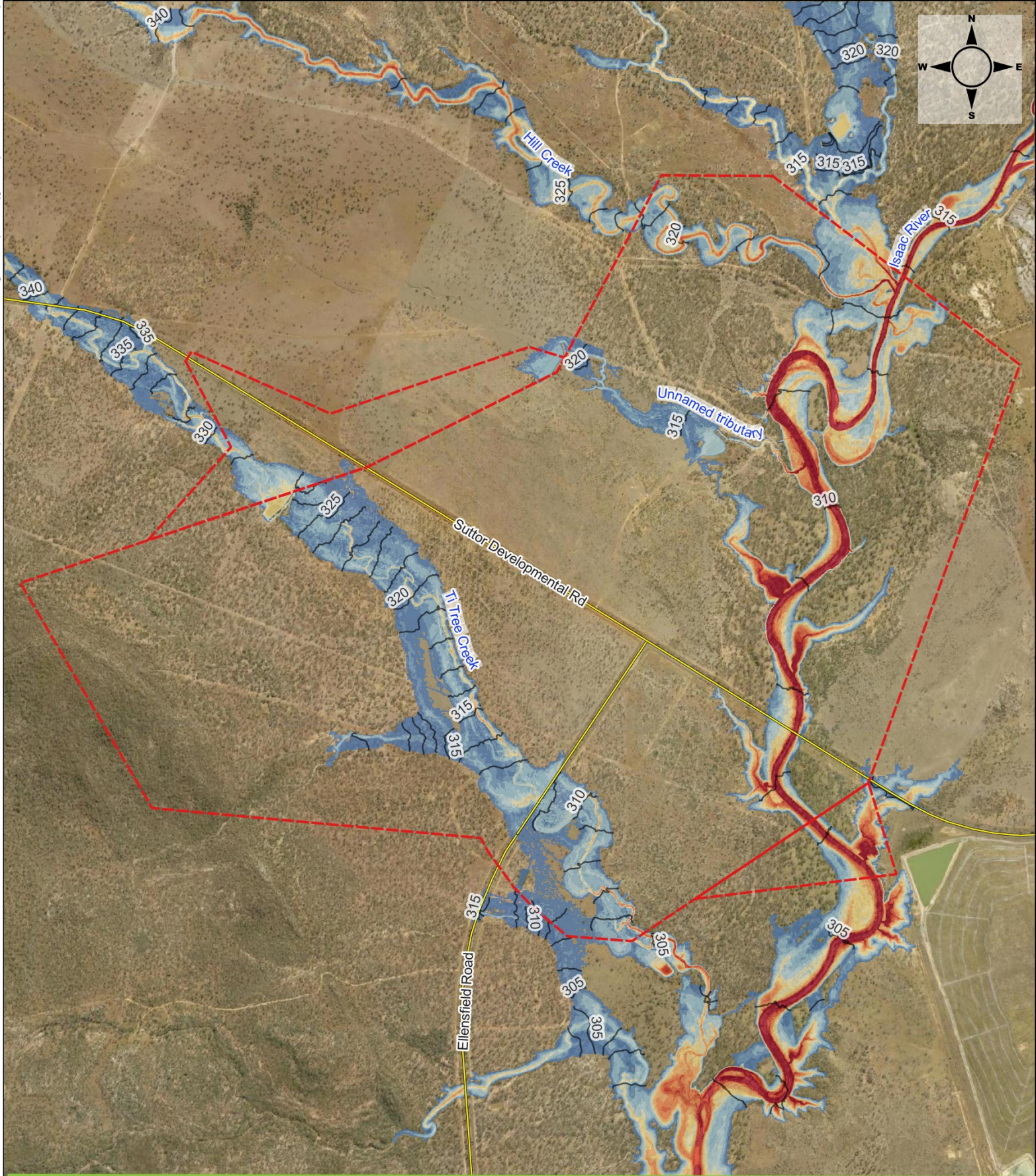
- Mine Lease Area
- Roads
- Proposed levees**
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

- Velocity difference**
- < -0.3 m/s
 - 0.3 m/s to -0.2 m/s
 - 0.2 m/s to -0.1 m/s
 - 0.1 m/s to 0.1 m/s
 - 0.1 m/s to 0.3 m/s
 - 0.3 m/s to 0.5 m/s
 - 0.5 m/s to 1.0 m/s
 - 1.0 m/s to 1.5 m/s
 - > 1.5 m/s
 - Was wet now dry
 - Was dry now wet

New Lenton Mine Public Environment Report

Developed conditions minus existing conditions
10% AEP velocity difference





- Legend**
- Mine Lease Area
 - Roads

- Flood height contour (1m)
- Depth**
- up to 0.25m
 - 0.25 to 0.5m
 - 0.5 to 1.0m
 - 1.0 to 1.5m
 - 1.5 to 2.0m
 - 2.0 to 2.5m
 - 2.5 to 3.0m
 - 3.0 to 3.5m
 - 3.5 to 4.0m
 - 4.0 to 4.5m
 - > 4.5m

New Lenton Mine Public Environment Report

Existing conditions
2% AEP flood depth and heights



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Legend

- Mine Lease Area
- Roads
- Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
- Proposed roads

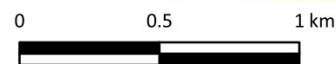
Flood height contour (1m)

Depth

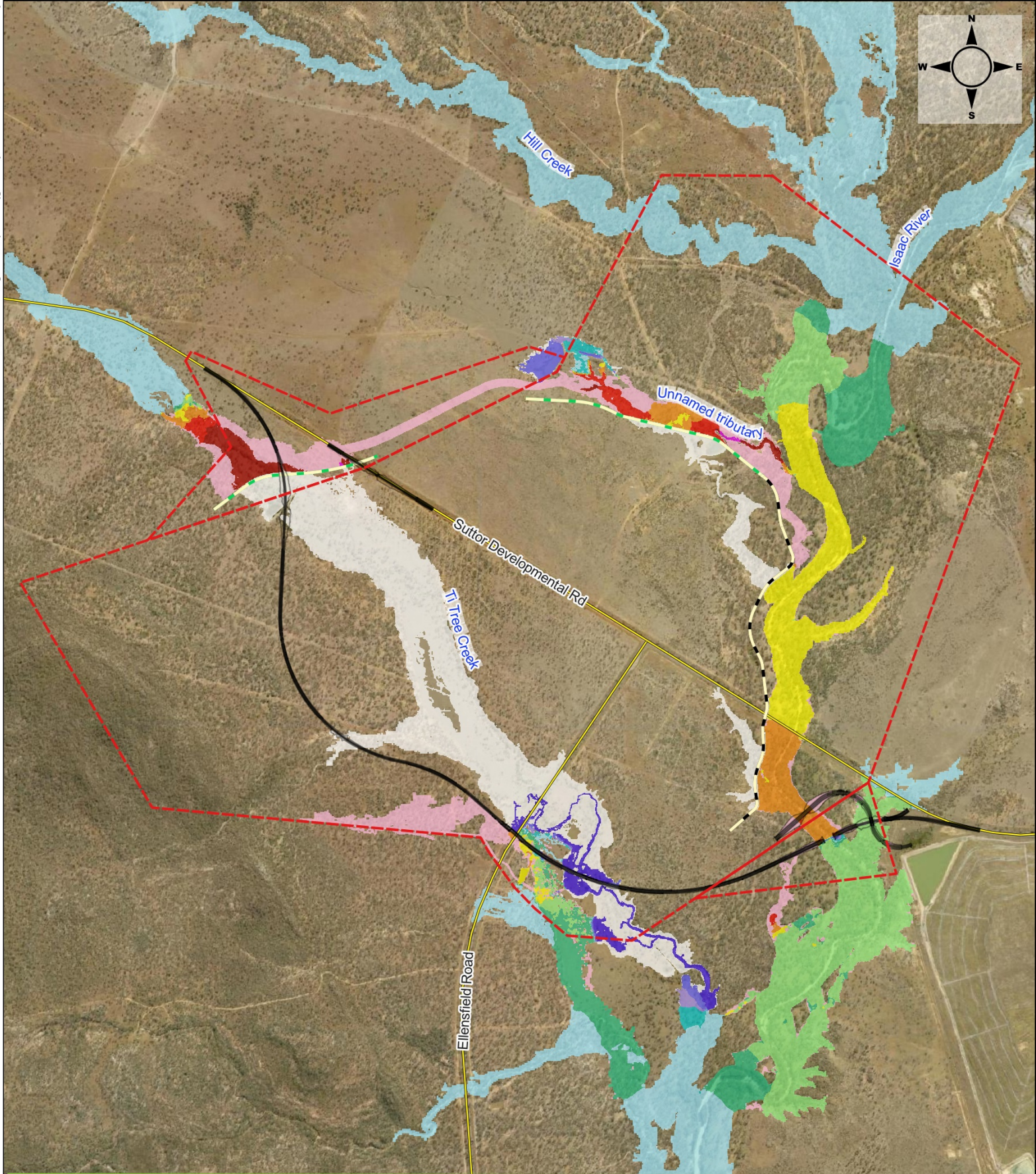
- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

New Lenton Mine Public Environment Report

Developed conditions
2% AEP flood depth and heights



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Legend

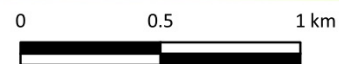
- Mine Lease Area
- Roads
- Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

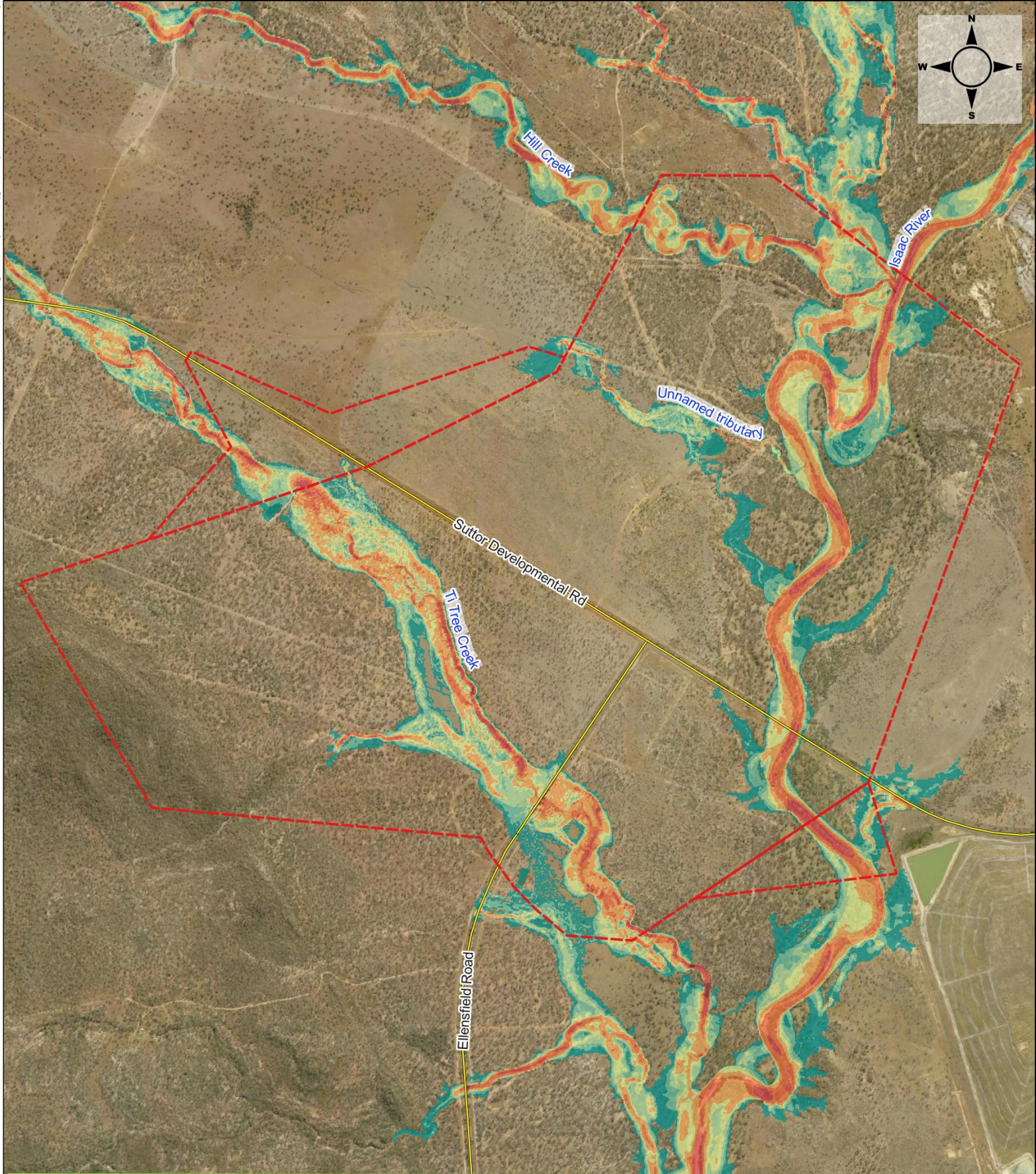
Afflux

- $dWL < -0.25$
- $-0.25\text{ m} < dWL < -0.10\text{ m}$
- $-0.10\text{ m} < dWL < -0.05\text{ m}$
- $-0.05\text{ m} < dWL < -0.01\text{ m}$
- $-0.01\text{ m} < dWL < 0.01\text{ m}$
- $0.01\text{ m} < dWL < 0.05\text{ m}$
- $0.05\text{ m} < dWL < 0.10\text{ m}$
- $0.10\text{ m} < dWL < 0.25\text{ m}$
- $0.25\text{ m} < dWL < 0.50\text{ m}$
- $0.50\text{ m} < dWL < 1.00\text{ m}$
- $1.00 < dWL < 3.00\text{ m}$
- $3.00 < dWL < 5.00\text{ m}$
- $dWL > 5.00\text{ m}$
- Was wet now dry
- Was dry now wet

New Lenton Mine Public Environment Report

Developed conditions minus existing conditions
2% AEP afflux





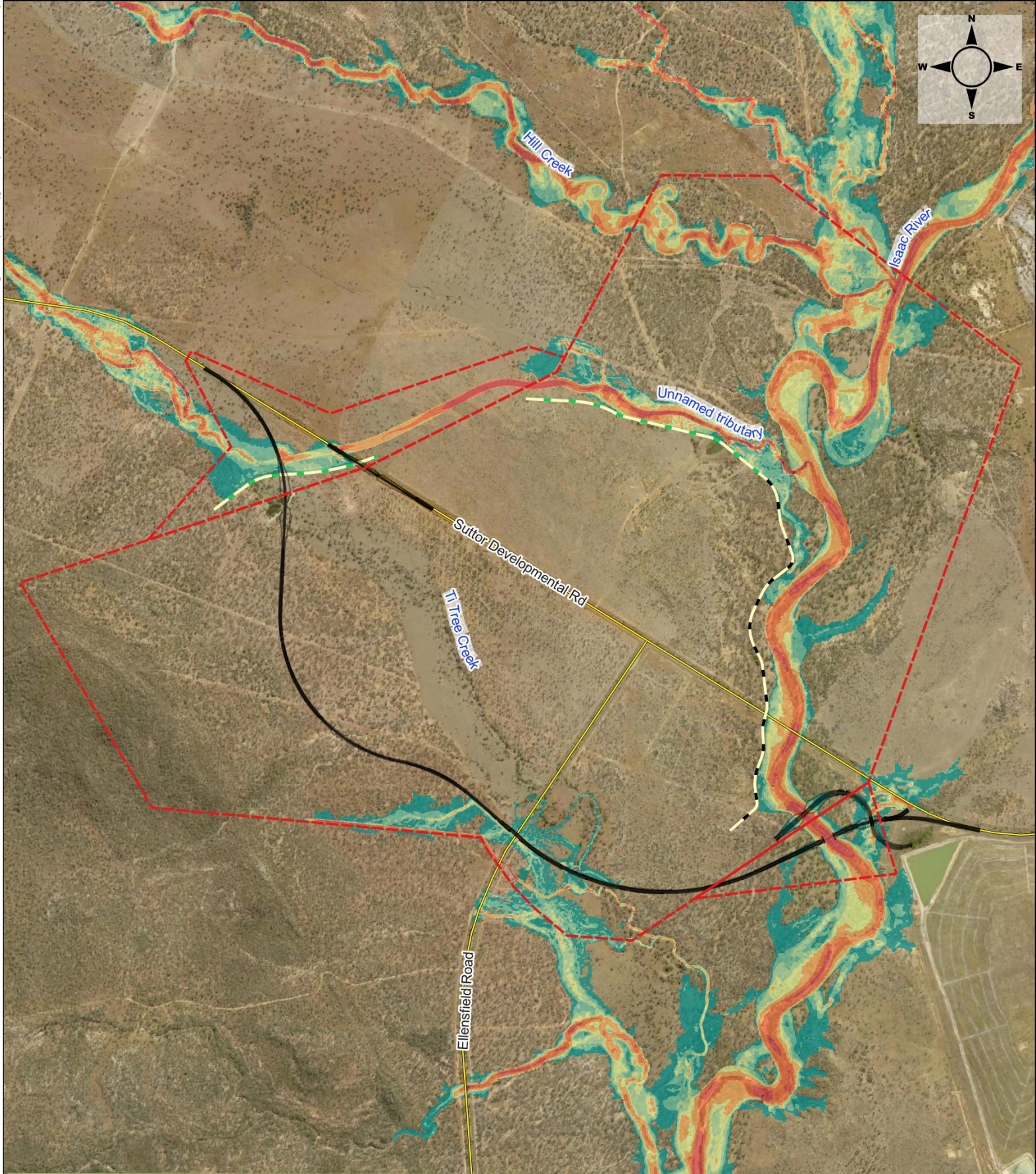
- Legend**
- Mine Lease Area
 - Roads

- Velocity**
- up to 0.25m/s
 - 0.25 to 0.5m/s
 - 0.5 to 0.75m/s
 - 0.75 to 1.0m/s
 - 1.0 to 1.5m/s
 - 1.5 to 2.0m/s
 - 2.0 to 3.0m/s
 - > 3 m/s

New Lenton Mine Public Environment Report

Existing conditions
2% AEP velocity





- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees**
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

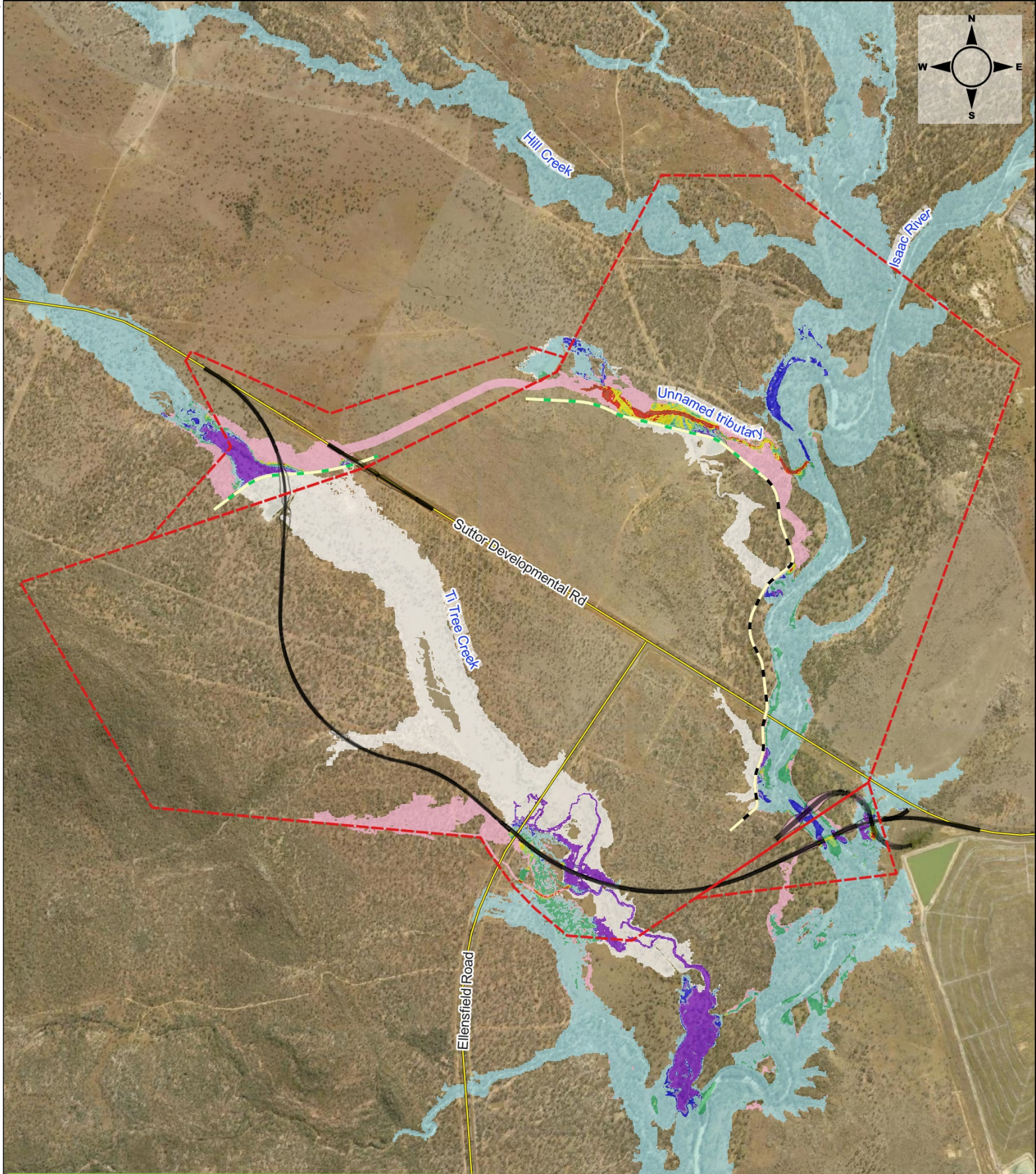
Velocity	
	up to 0.25m/s
	0.25 to 0.5m/s
	0.5 to 0.75m/s
	0.75 to 1.0m/s
	1.0 to 1.5m/s
	1.5 to 2.0m/s
	2.0 to 3.0m/s
	> 3 m/s

New Lenton Mine Public Environment Report

Developed conditions
2% AEP velocity



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Legend

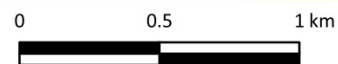
- Mine Lease Area
- Roads
- Proposed levees**
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

Velocity difference

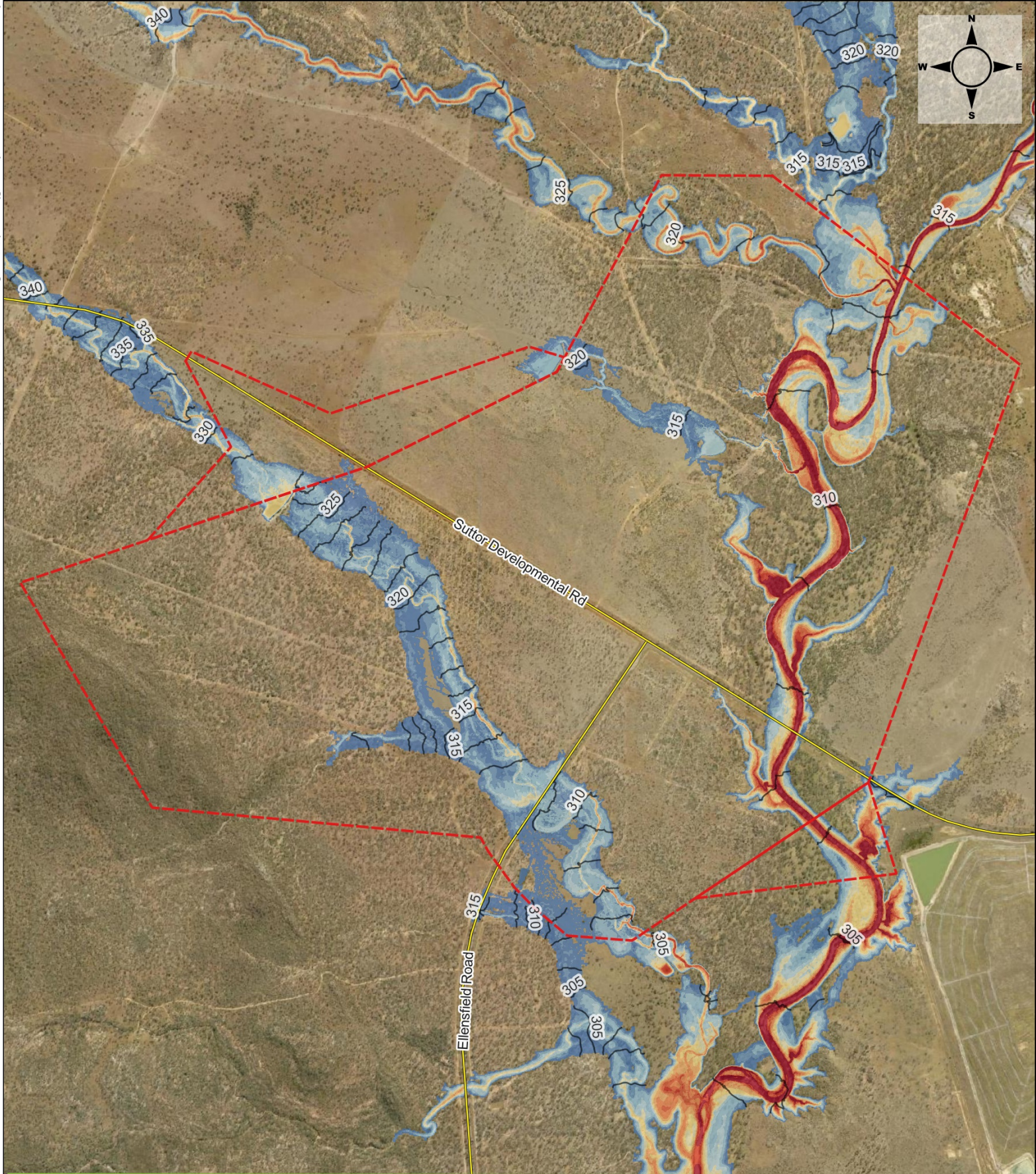
- < -0.3 m/s
- 0.3 m/s to -0.2 m/s
- 0.2 m/s to -0.1 m/s
- 0.1 m/s to 0.1 m/s
- 0.1 m/s to 0.3 m/s
- 0.3 m/s to 0.5 m/s
- 0.5 m/s to 1.0 m/s
- 1.0 m/s to 1.5 m/s
- > 1.5 m/s
- Was wet now dry
- Was dry now wet

New Lenton Mine Public Environment Report

Developed conditions minus existing conditions
2% AEP velocity difference



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Legend

- Mine Lease Area
- Roads

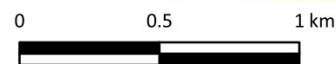
— Flood height contour (1m)

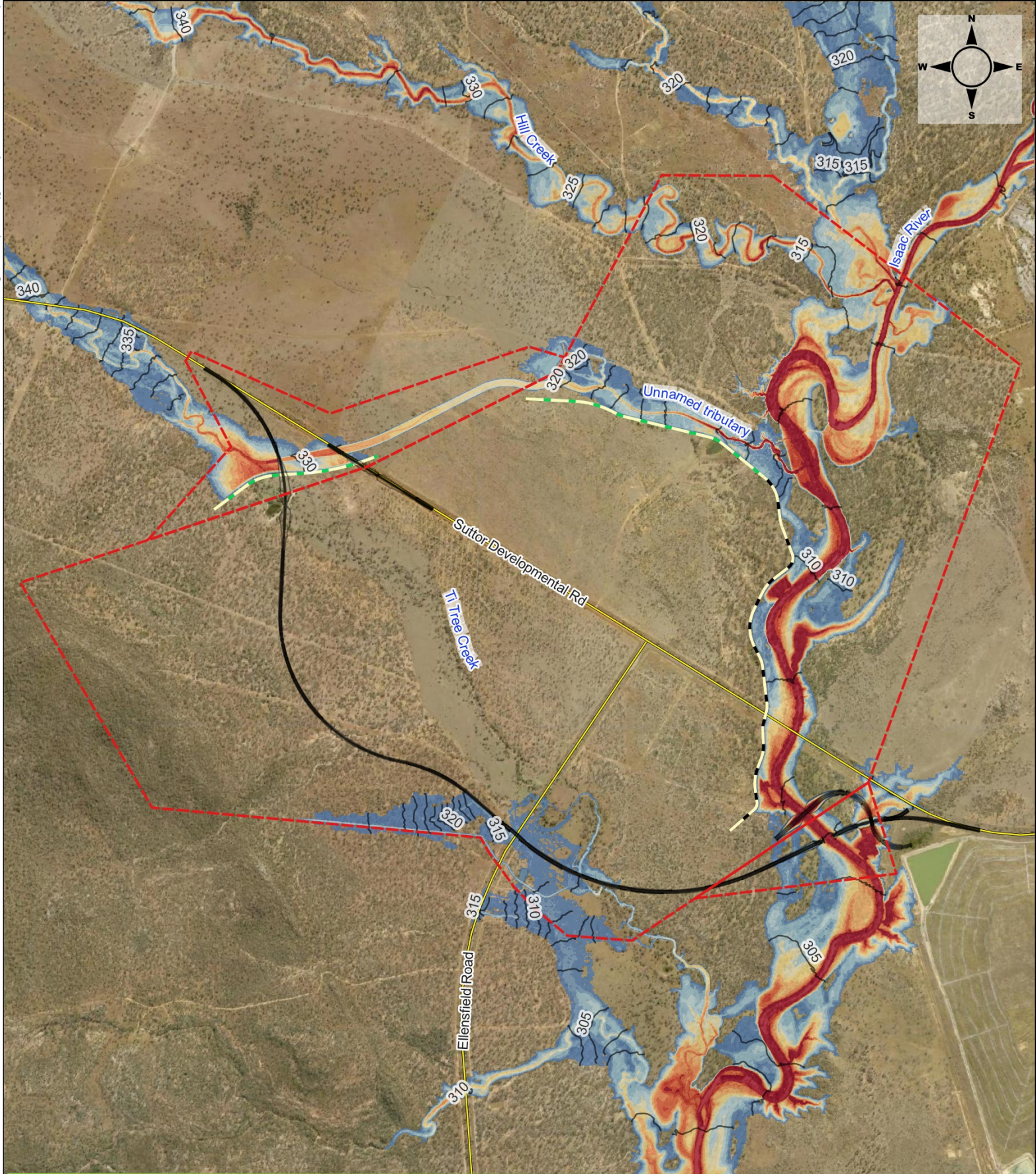
Depth

- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

New Lenton Mine Public Environment Report

Existing conditions
1% AEP flood depth and heights





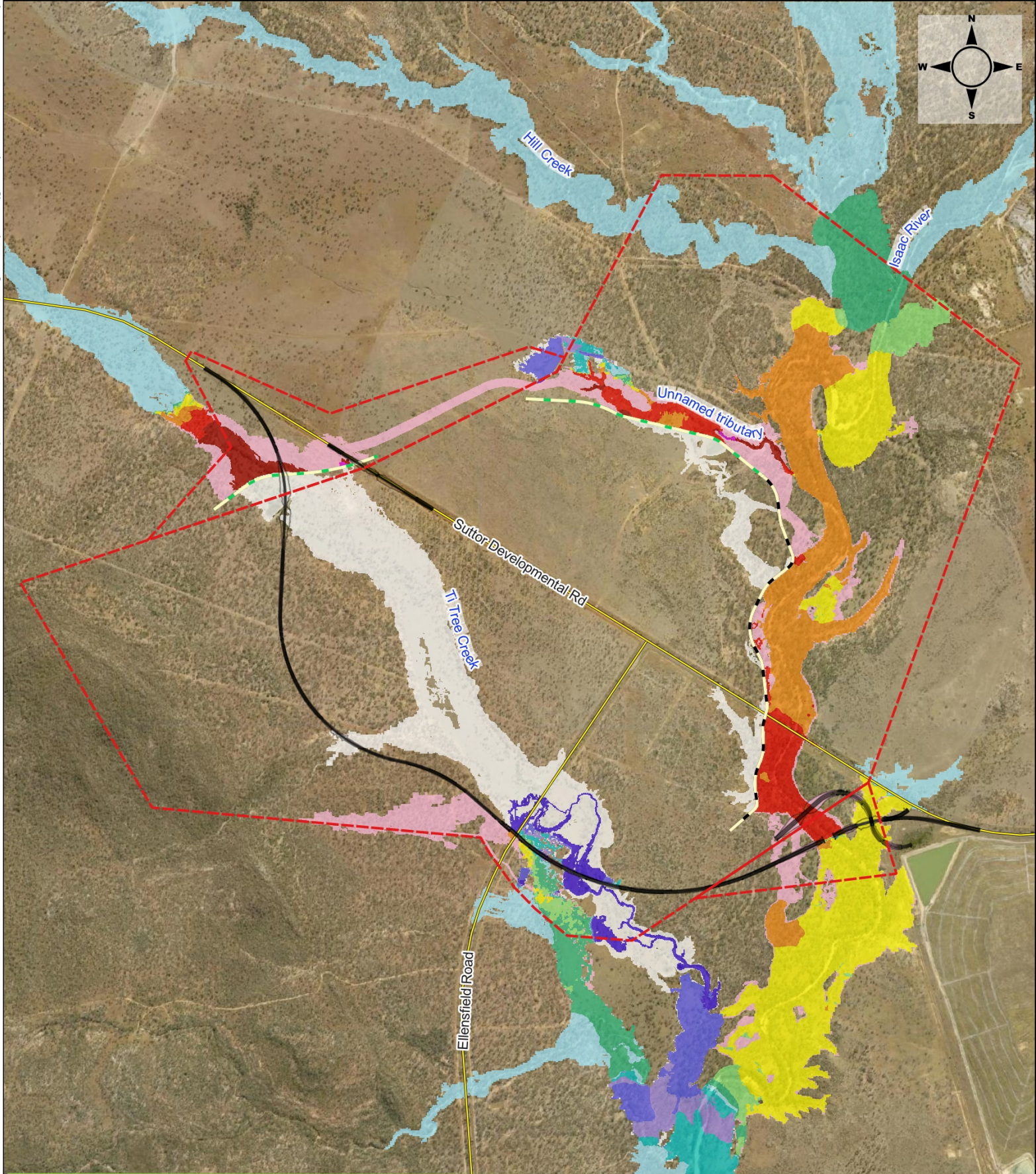
- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

—	Flood height contour (1m)
Depth	
	up to 0.25m
	0.25 to 0.5m
	0.5 to 1.0m
	1.0 to 1.5m
	1.5 to 2.0m
	2.0 to 2.5m
	2.5 to 3.0m
	3.0 to 3.5m
	3.5 to 4.0m
	4.0 to 4.5m
	> 4.5m

New Lenton Mine Public Environment Report

Developed conditions
1% AEP flood depth and heights



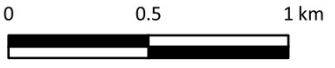


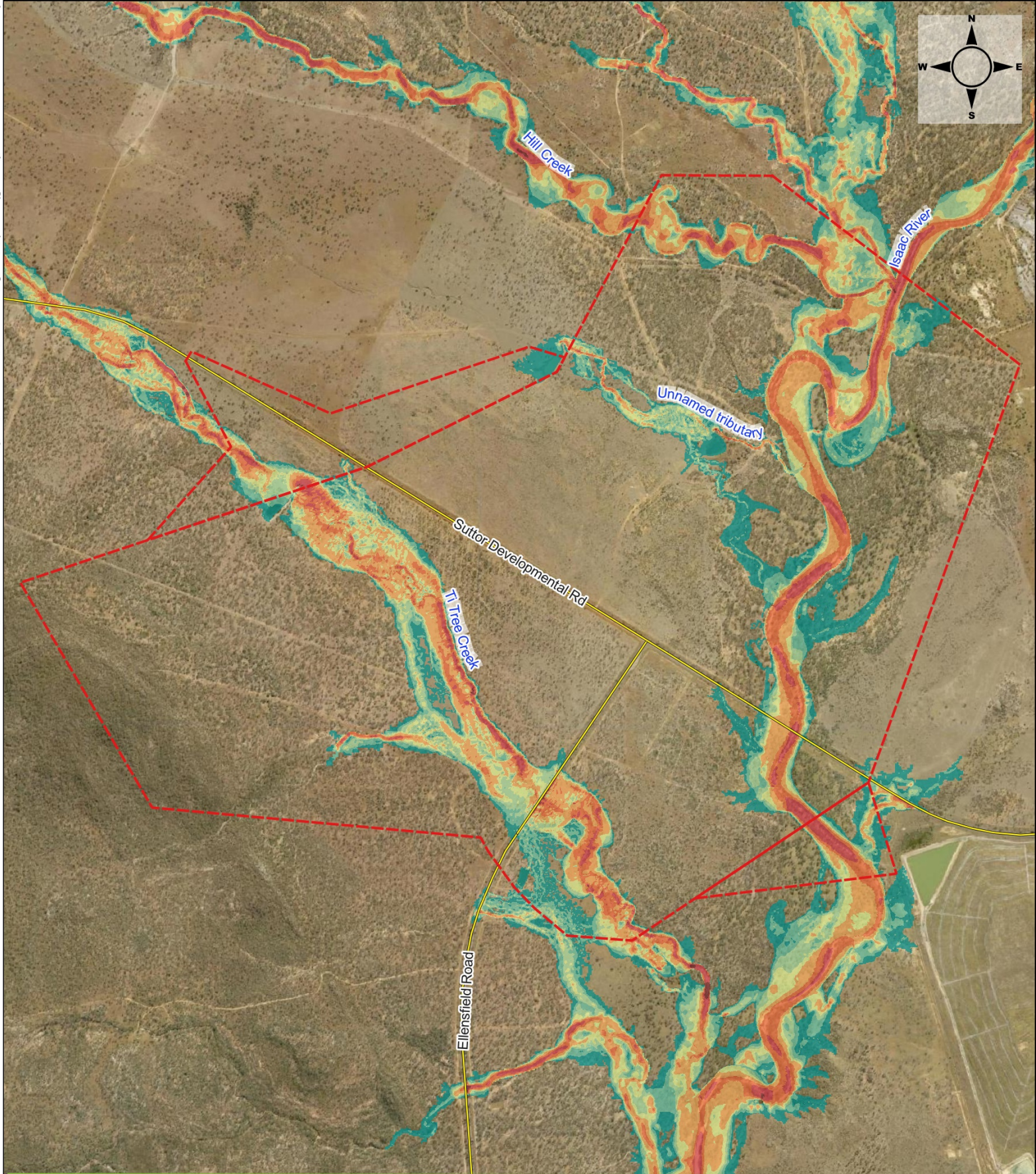
- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

Afflux	
	dWL < -0.25
	-0.25m < dWL < -0.10m
	-0.10m < dWL < -0.05m
	-0.05m < dWL < -0.01m
	-0.01m < dWL < 0.01m
	0.01m < dWL < 0.05m
	0.05m < dWL < 0.10m
	0.10m < dWL < 0.25m
	0.25m < dWL < 0.50m
	0.50m < dWL < 1.00m
	1.00 < dWL < 3.00m
	3.00 < dWL < 5.00m
	dWL > 5.00m
	Was wet now dry
	Was dry now wet

New Lenton Mine Public Environment Report

Developed conditions minus existing conditions
1% AEP afflux





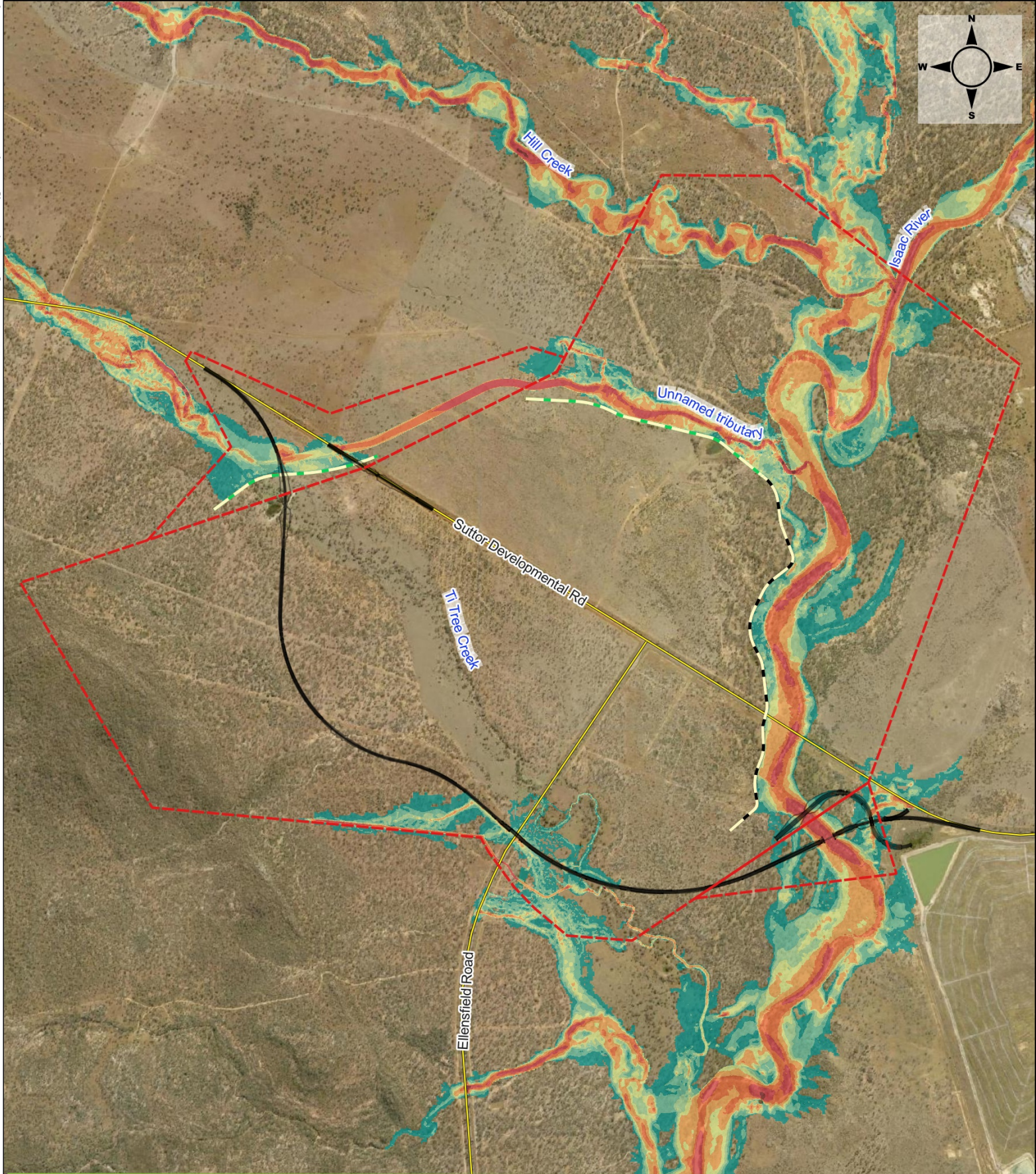
- Legend**
- Mine Lease Area
 - Roads

Velocity	
	up to 0.25m/s
	0.25 to 0.5m/s
	0.5 to 0.75m/s
	0.75 to 1.0m/s
	1.0 to 1.5m/s
	1.5 to 2.0m/s
	2.0 to 3.0m/s
	> 3 m/s

New Lenton Mine Public Environment Report

Existing conditions
1% AEP velocity





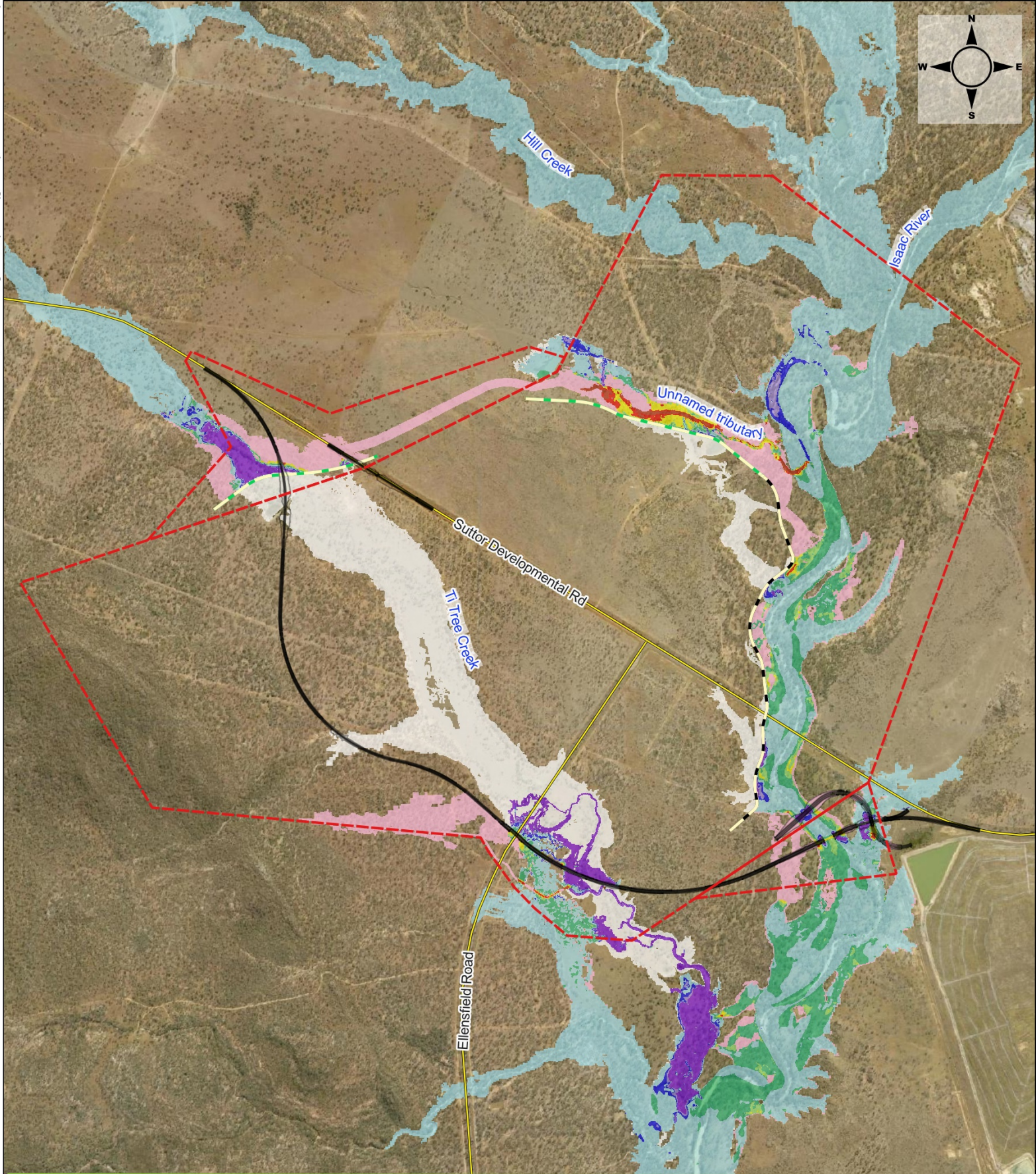
- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

Velocity	
	up to 0.25m/s
	0.25 to 0.5m/s
	0.5 to 0.75m/s
	0.75 to 1.0m/s
	1.0 to 1.5m/s
	1.5 to 2.0m/s
	2.0 to 3.0m/s
	> 3 m/s

New Lenton Mine Public Environment Report

Developed conditions
1% AEP velocity





Legend

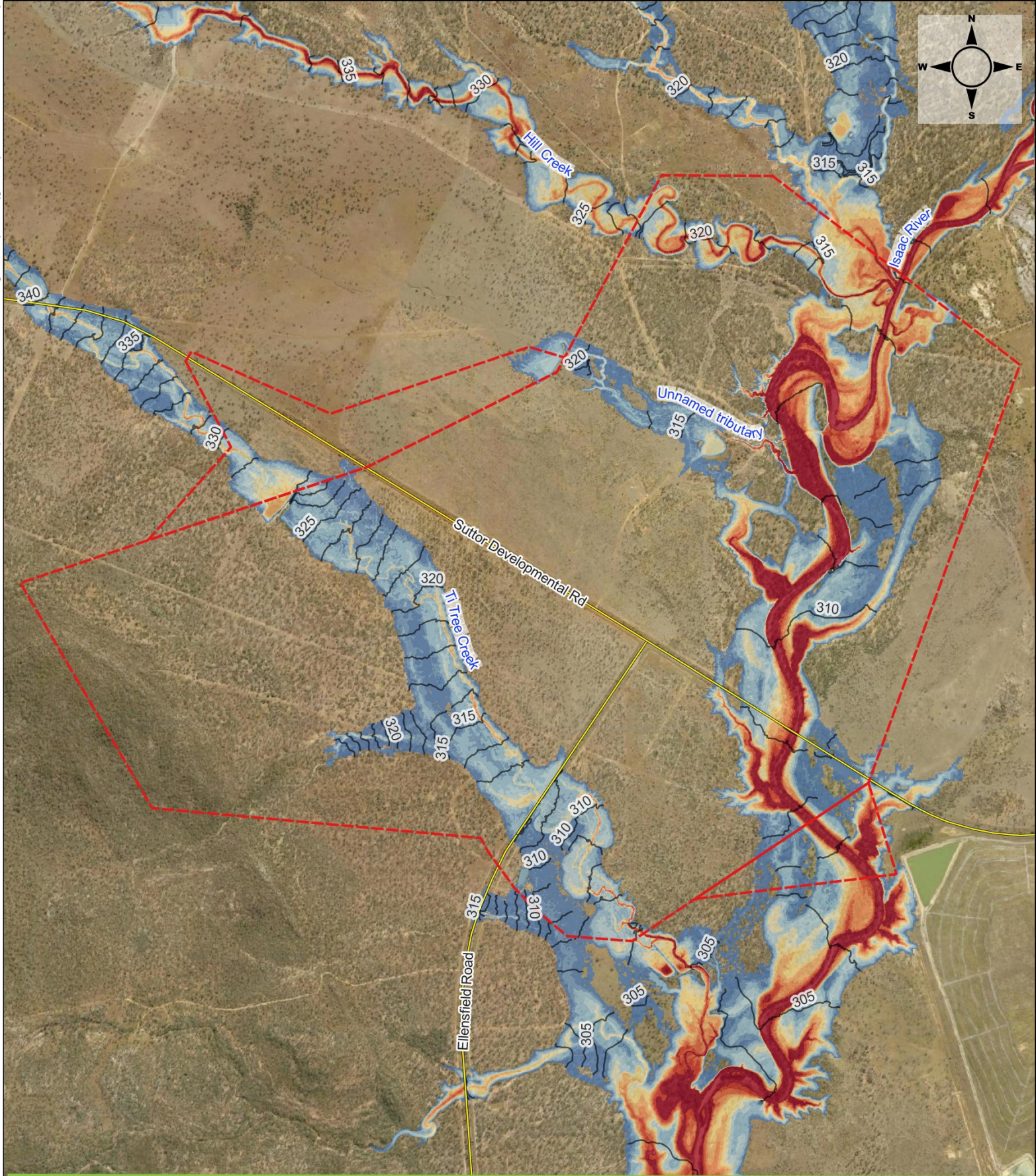
- Mine Lease Area
- Roads
- Proposed levees**
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

- Velocity difference**
- < -0.3 m/s
 - 0.3 m/s to -0.2 m/s
 - 0.2 m/s to -0.1 m/s
 - 0.1 m/s to 0.1 m/s
 - 0.1 m/s to 0.3 m/s
 - 0.3 m/s to 0.5 m/s
 - 0.5 m/s to 1.0 m/s
 - 1.0 m/s to 1.5 m/s
 - > 1.5 m/s
 - Was wet now dry
 - Was dry now wet

New Lenton Mine Public Environment Report

Developed conditions minus existing conditions
1% AEP velocity difference





Legend

- Mine Lease Area
- Roads

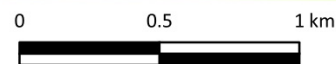
— Flood height contour (1m)

Depth

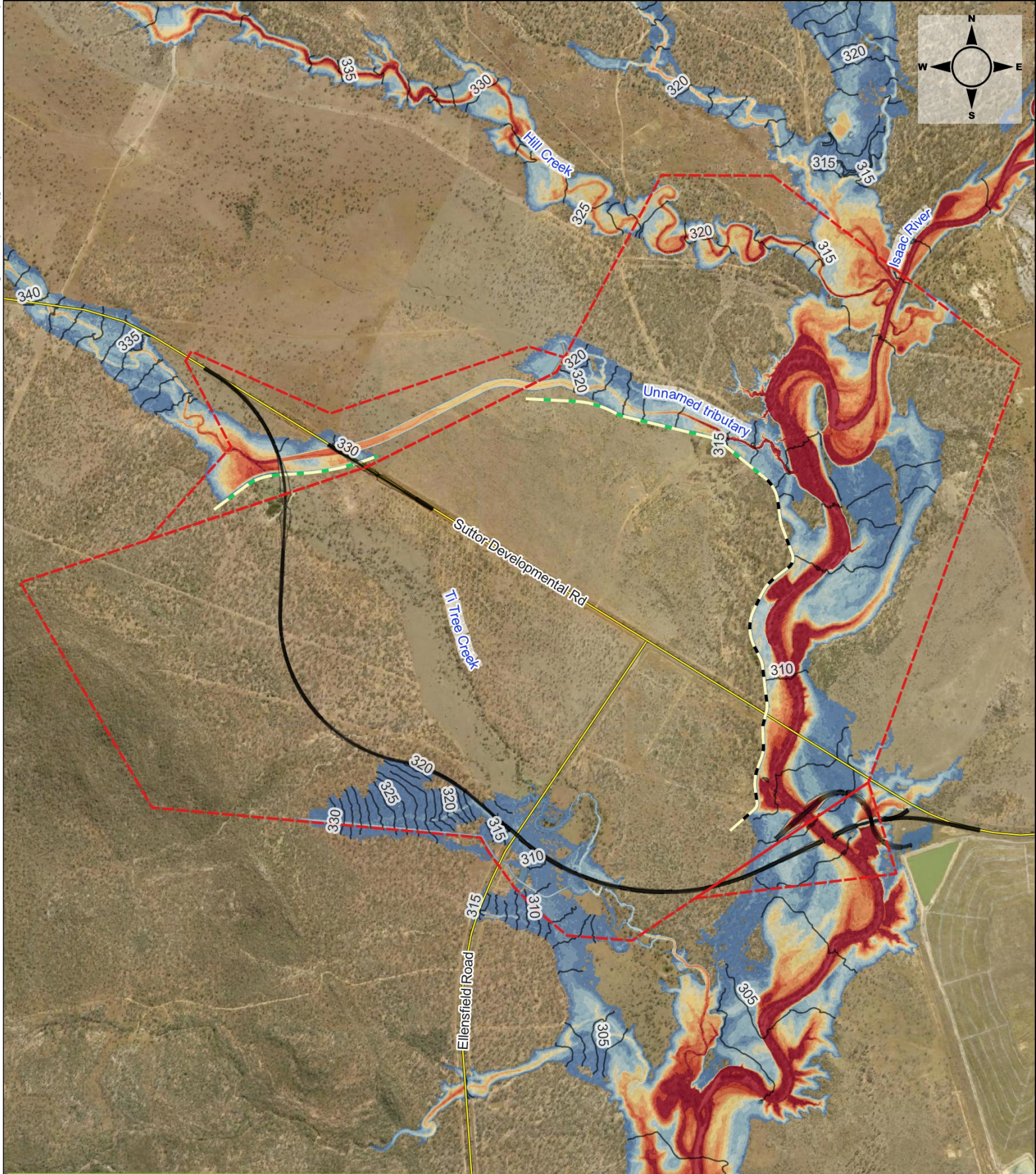
- up to 0.25m
- 0.25 to 0.5m
- 0.5 to 1.0m
- 1.0 to 1.5m
- 1.5 to 2.0m
- 2.0 to 2.5m
- 2.5 to 3.0m
- 3.0 to 3.5m
- 3.5 to 4.0m
- 4.0 to 4.5m
- > 4.5m

New Lenton Mine Public Environment Report

Existing conditions
1 in 1,000 AEP flood depth and heights



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- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

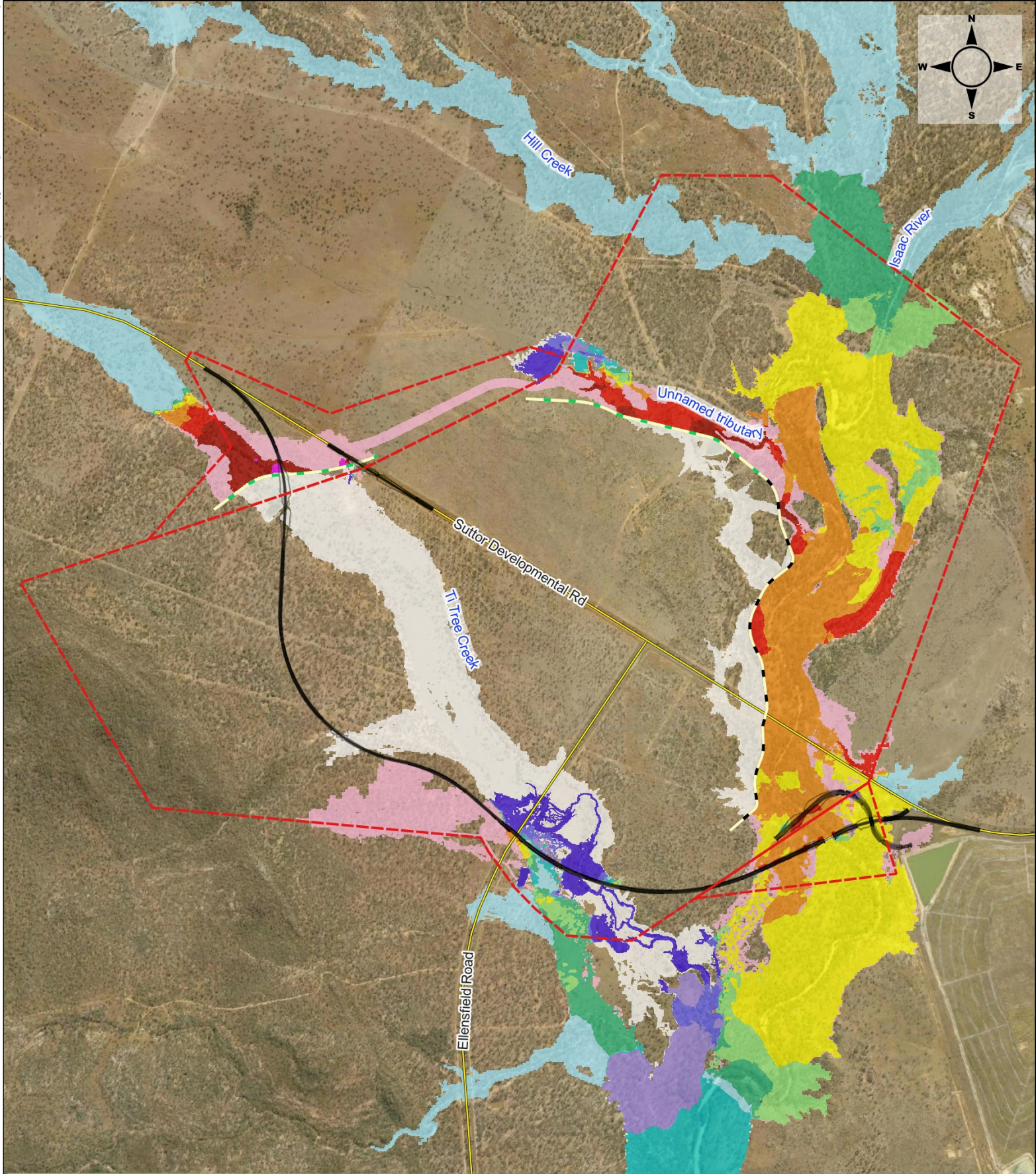
—	Flood height contour (1m)
Depth	
Blue	up to 0.25m
Light Blue	0.25 to 0.5m
Medium Blue	0.5 to 1.0m
Light Blue	1.0 to 1.5m
Yellow	1.5 to 2.0m
Orange	2.0 to 2.5m
Dark Orange	2.5 to 3.0m
Red	3.0 to 3.5m
Dark Red	3.5 to 4.0m
Dark Red	4.0 to 4.5m
Dark Red	> 4.5m

New Lenton Mine Public Environment Report

Developed conditions
1 in 1,000 AEP flood depth and heights



Projection: EPSG:28355



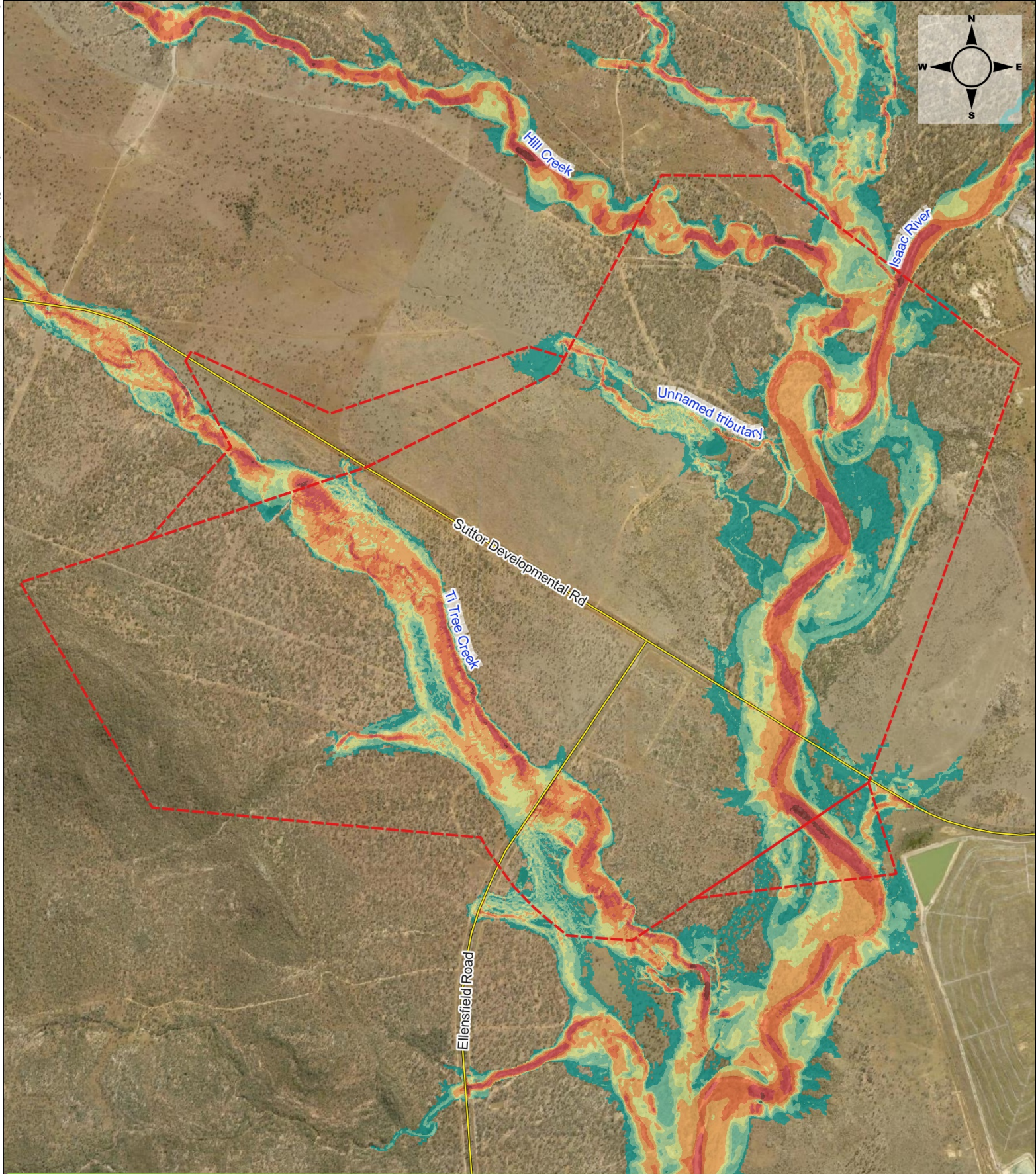
- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

Afflux	
	dWL < -0.25
	-0.25 m < dWL < -0.10 m
	-0.10 m < dWL < -0.05 m
	-0.05 m < dWL < -0.01 m
	-0.01 m < dWL < 0.01 m
	0.01 m < dWL < 0.05 m
	0.05 m < dWL < 0.10 m
	0.10 m < dWL < 0.25 m
	0.25 m < dWL < 0.50 m
	0.50 m < dWL < 1.00 m
	1.00 < dWL < 3.00 m
	3.00 < dWL < 5.00 m
	dWL > 5.00 m
	Was wet now dry
	Was dry now wet

New Lenton Mine Public Environment Report

Developed conditions minus existing conditions
1 in 1,000 AEP afflux





- Legend**
- Mine Lease Area
 - Roads

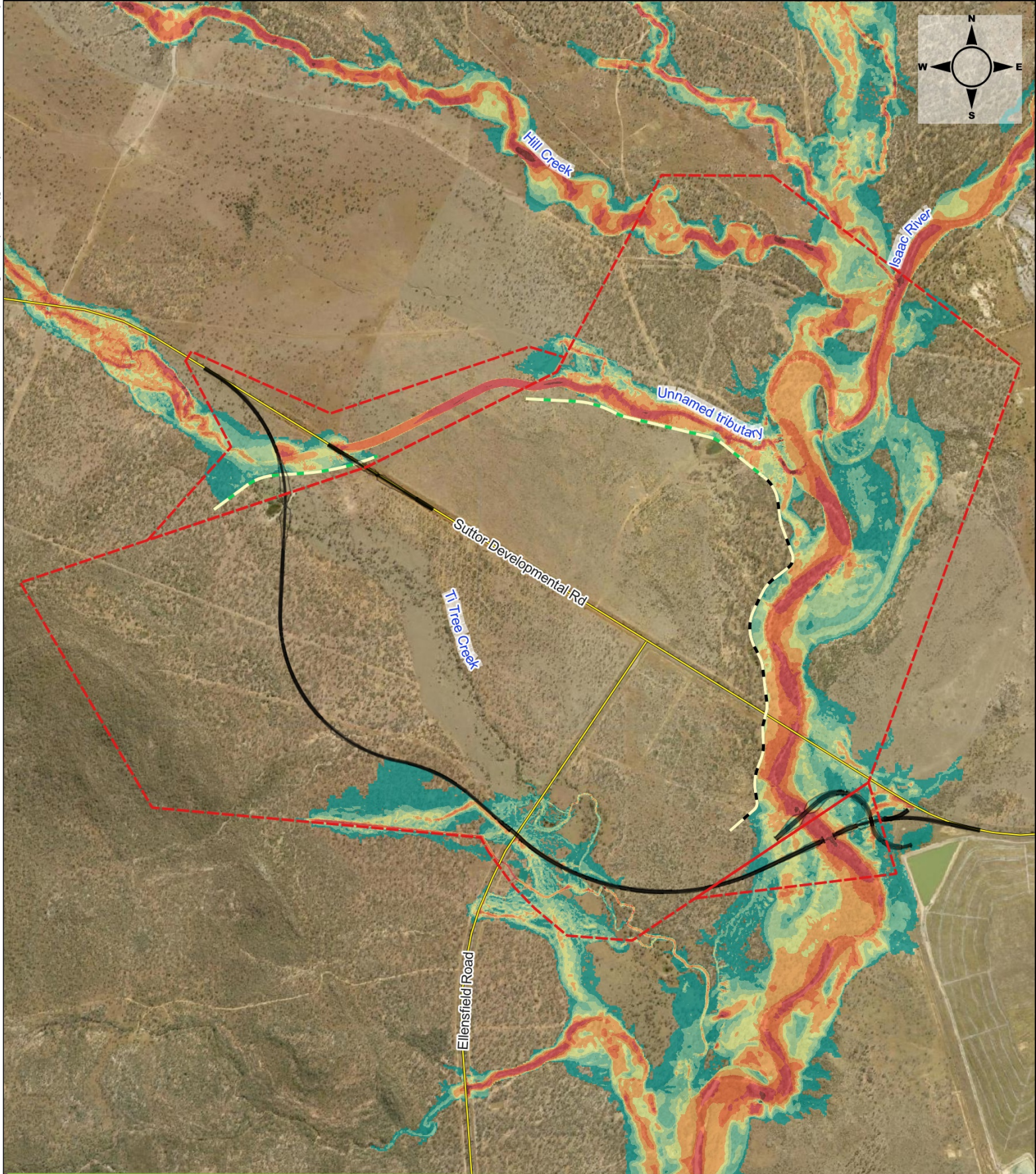
Velocity	
	up to 0.25m/s
	0.25 to 0.5m/s
	0.5 to 0.75m/s
	0.75 to 1.0m/s
	1.0 to 1.5m/s
	1.5 to 2.0m/s
	2.0 to 3.0m/s
	> 3 m/s

New Lenton Mine Public Environment Report

Existing conditions
1 in 1,000 AEP velocity



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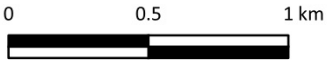


- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

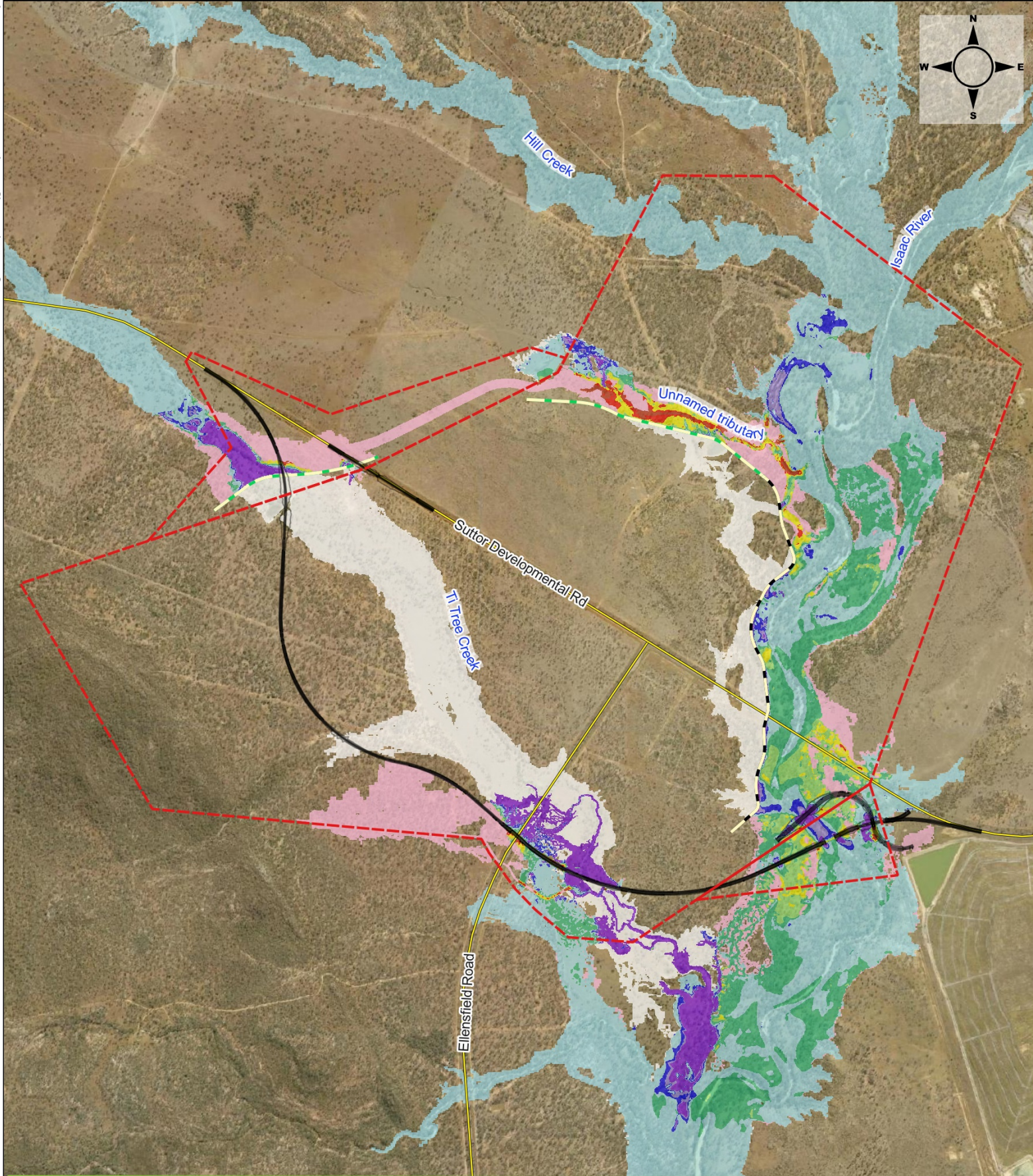
- Velocity**
- up to 0.25m/s
 - 0.25 to 0.5m/s
 - 0.5 to 0.75m/s
 - 0.75 to 1.0m/s
 - 1.0 to 1.5m/s
 - 1.5 to 2.0m/s
 - 2.0 to 3.0m/s
 - > 3 m/s

New Lenton Mine Public Environment Report

Developed conditions
1 in 1,000 AEP velocity



Projection: EPSG:28355



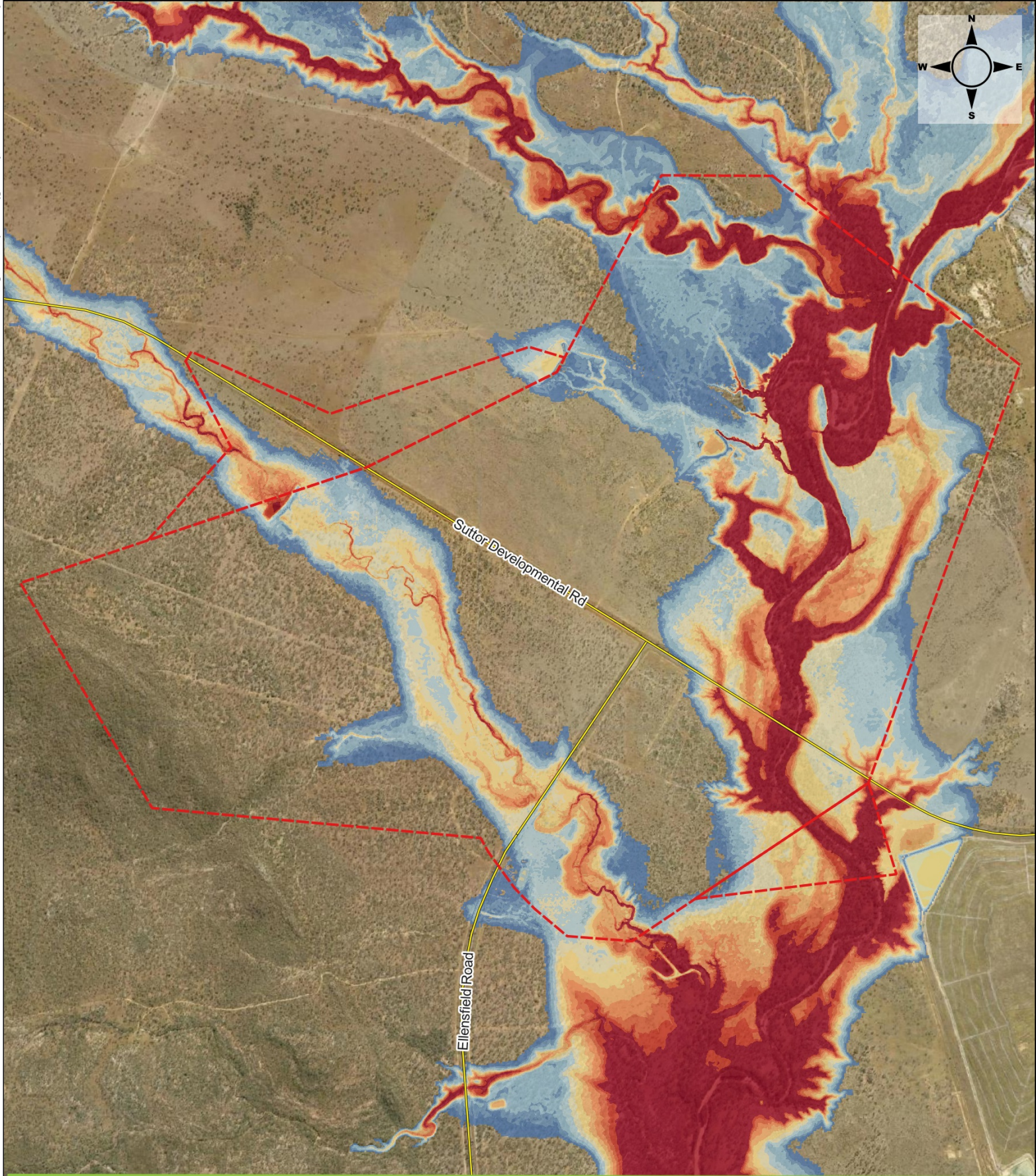
- Legend**
- Mine Lease Area
 - Roads
 - Proposed levees
 - Isaac River levee
 - Ti-Tree Creek levee
 - Proposed roads

- Velocity difference**
- < -0.3 m/s
 - 0.3 m/s to -0.2 m/s
 - 0.2 m/s to -0.1 m/s
 - 0.1 m/s to 0.1 m/s
 - 0.1 m/s to 0.3 m/s
 - 0.3 m/s to 0.5 m/s
 - 0.5 m/s to 1.0 m/s
 - 1.0 m/s to 1.5 m/s
 - > 1.5 m/s
 - Was wet now dry
 - Was dry now wet

New Lenton Mine Public Environment Report

Developed conditions minus existing conditions
1 in 1,000 AEP velocity difference



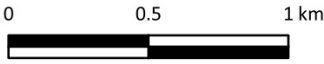


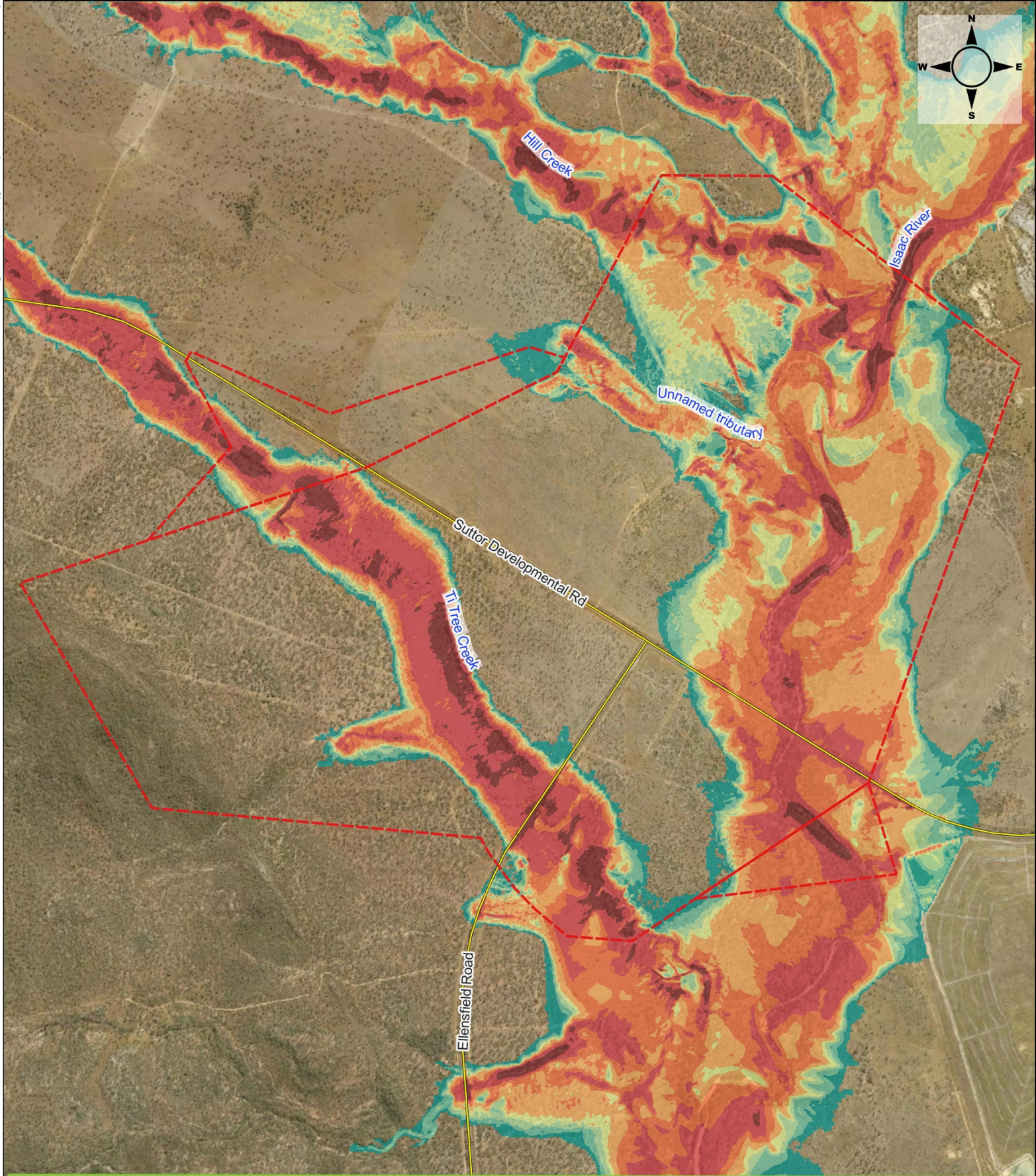
- Legend**
- Mine Lease Area
 - Roads

- Flood height contour (1m)
- Depth**
- up to 0.25m
 - 0.25 to 0.5m
 - 0.5 to 1.0m
 - 1.0 to 1.5m
 - 1.5 to 2.0m
 - 2.0 to 2.5m
 - 2.5 to 3.0m
 - 3.0 to 3.5m
 - 3.5 to 4.0m
 - 4.0 to 4.5m
 - > 4.5m

New Lenton Mine Public Environment Report

Existing conditions
PMF flood depth and heights





Legend

Mine Lease Area

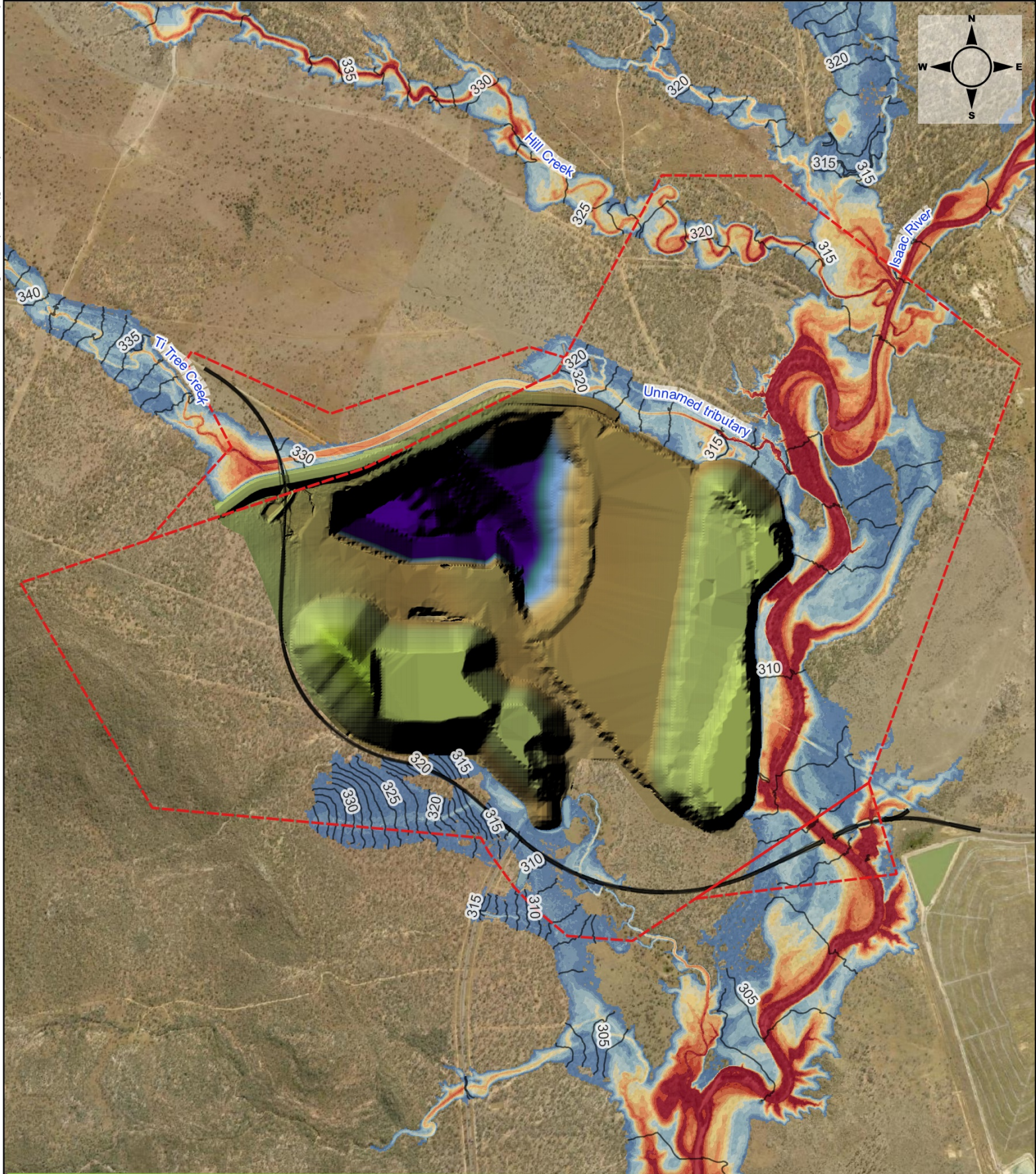
Roads

Velocity	
	up to 0.25m/s
	0.25 to 0.5m/s
	0.5 to 0.75m/s
	0.75 to 1.0m/s
	1.0 to 1.5m/s
	1.5 to 2.0m/s
	2.0 to 3.0m/s
	> 3 m/s

New Lenton Mine Public Environment Report

Existing conditions
PMF velocity





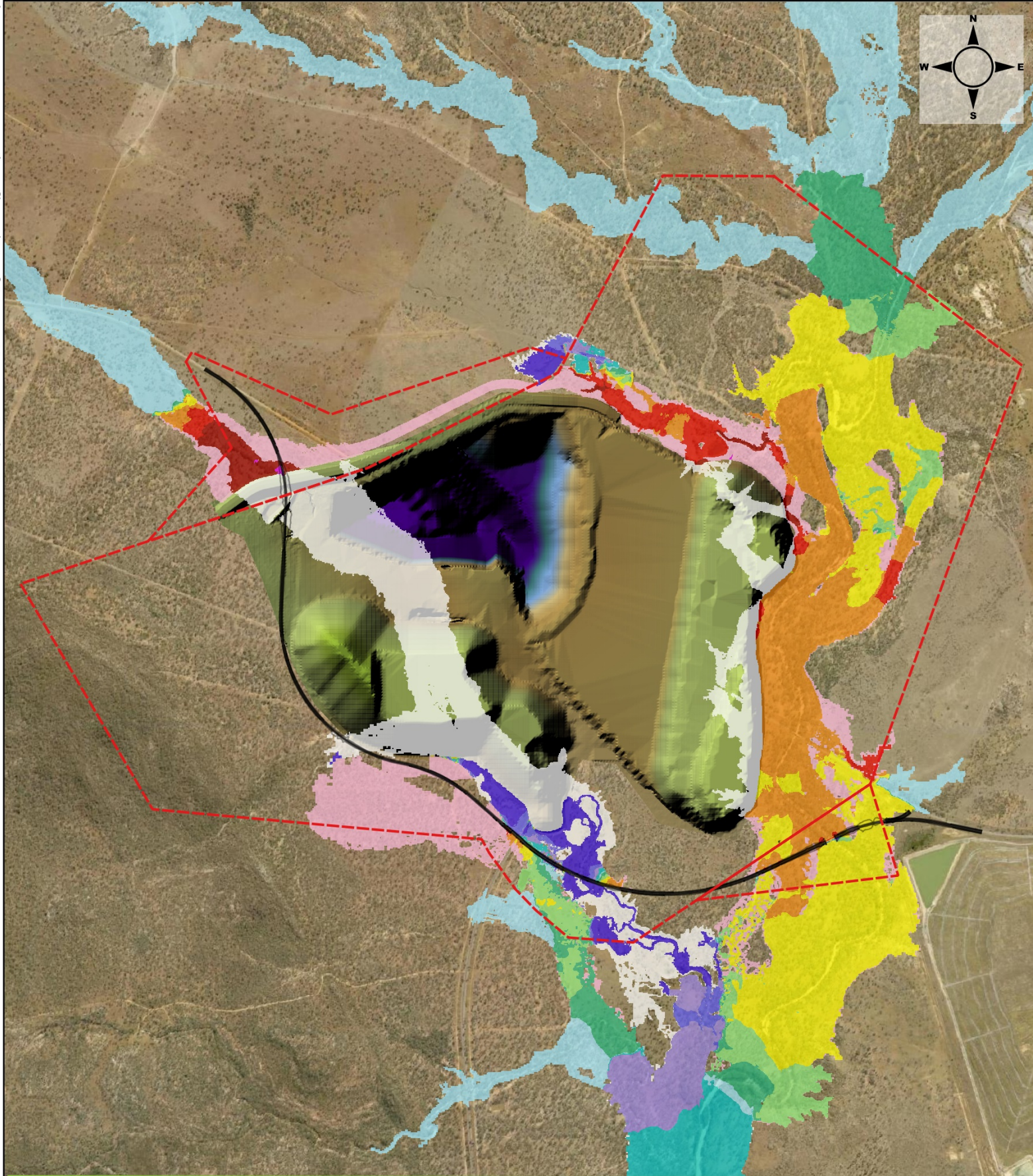
- Legend**
- Mine Lease Area
 - Proposed roads

- Flood height contour (1m)
- Depth**
- up to 0.25m
 - 0.25 to 0.5m
 - 0.5 to 1.0m
 - 1.0 to 1.5m
 - 1.5 to 2.0m
 - 2.0 to 2.5m
 - 2.5 to 3.0m
 - 3.0 to 3.5m
 - 3.5 to 4.0m
 - 4.0 to 4.5m
 - > 4.5m

New Lenton Mine Public Environment Report

Final landform conditions
1 in 1,000 AEP flood depth and heights





Legend

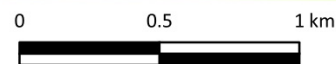
- Mine Lease Area
- Proposed roads

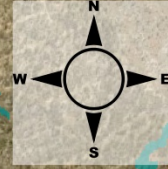
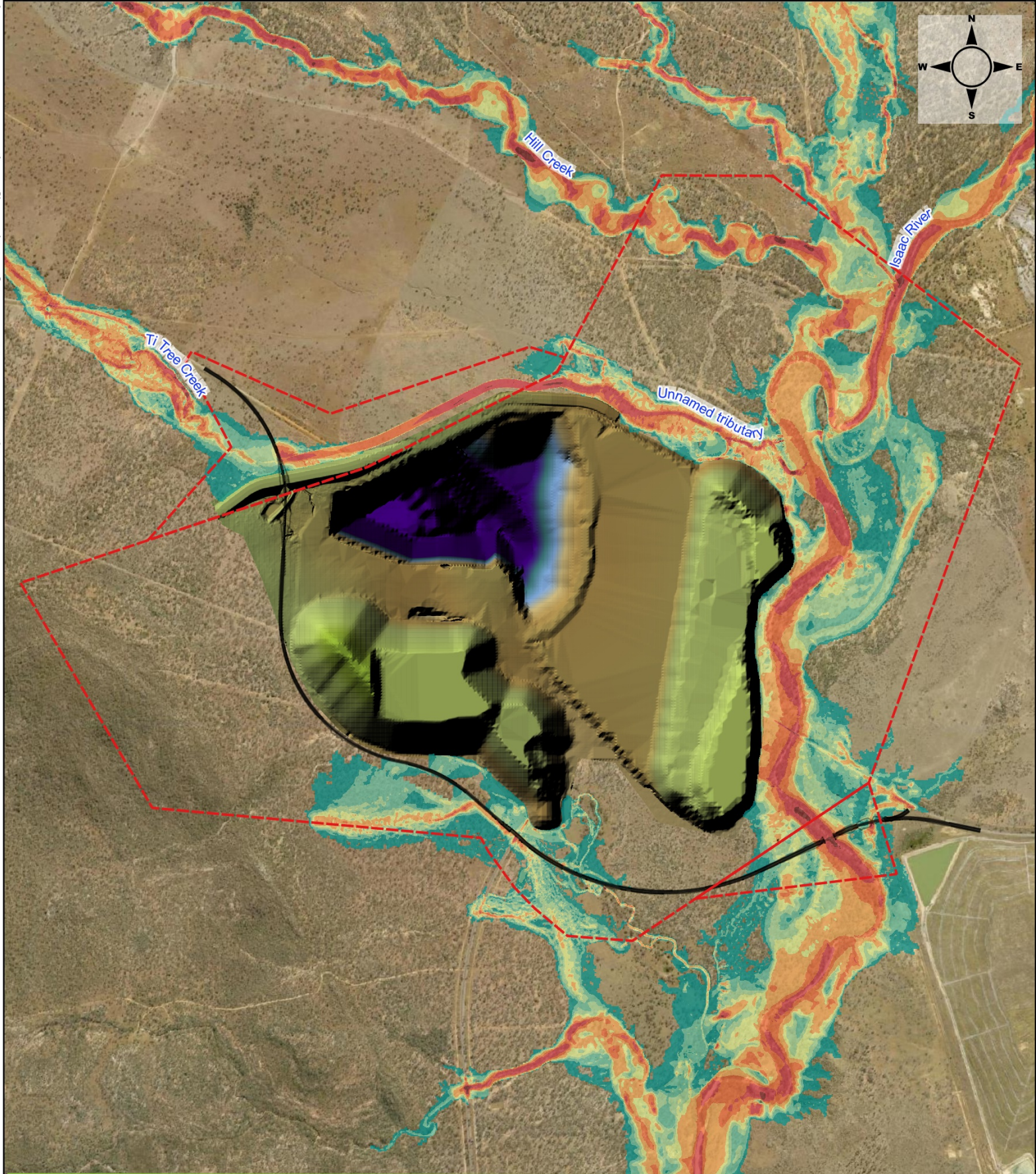
Afflux

- $dWL < -0.25$
- $-0.25\text{ m} < dWL < -0.10\text{ m}$
- $-0.10\text{ m} < dWL < -0.05\text{ m}$
- $-0.05\text{ m} < dWL < -0.01\text{ m}$
- $-0.01\text{ m} < dWL < 0.01\text{ m}$
- $0.01\text{ m} < dWL < 0.05\text{ m}$
- $0.05\text{ m} < dWL < 0.10\text{ m}$
- $0.10\text{ m} < dWL < 0.25\text{ m}$
- $0.25\text{ m} < dWL < 0.50\text{ m}$
- $0.50\text{ m} < dWL < 1.00\text{ m}$
- $1.00 < dWL < 3.00\text{ m}$
- $3.00 < dWL < 5.00\text{ m}$
- $dWL > 5.00\text{ m}$
- Was wet now dry
- Was dry now wet

New Lenton Mine Public Environment Report

Final landform conditions
1 in 1,000 AEP afflux





Legend

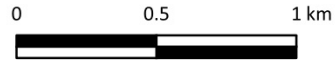
-  Mine Lease Area
-  Proposed roads

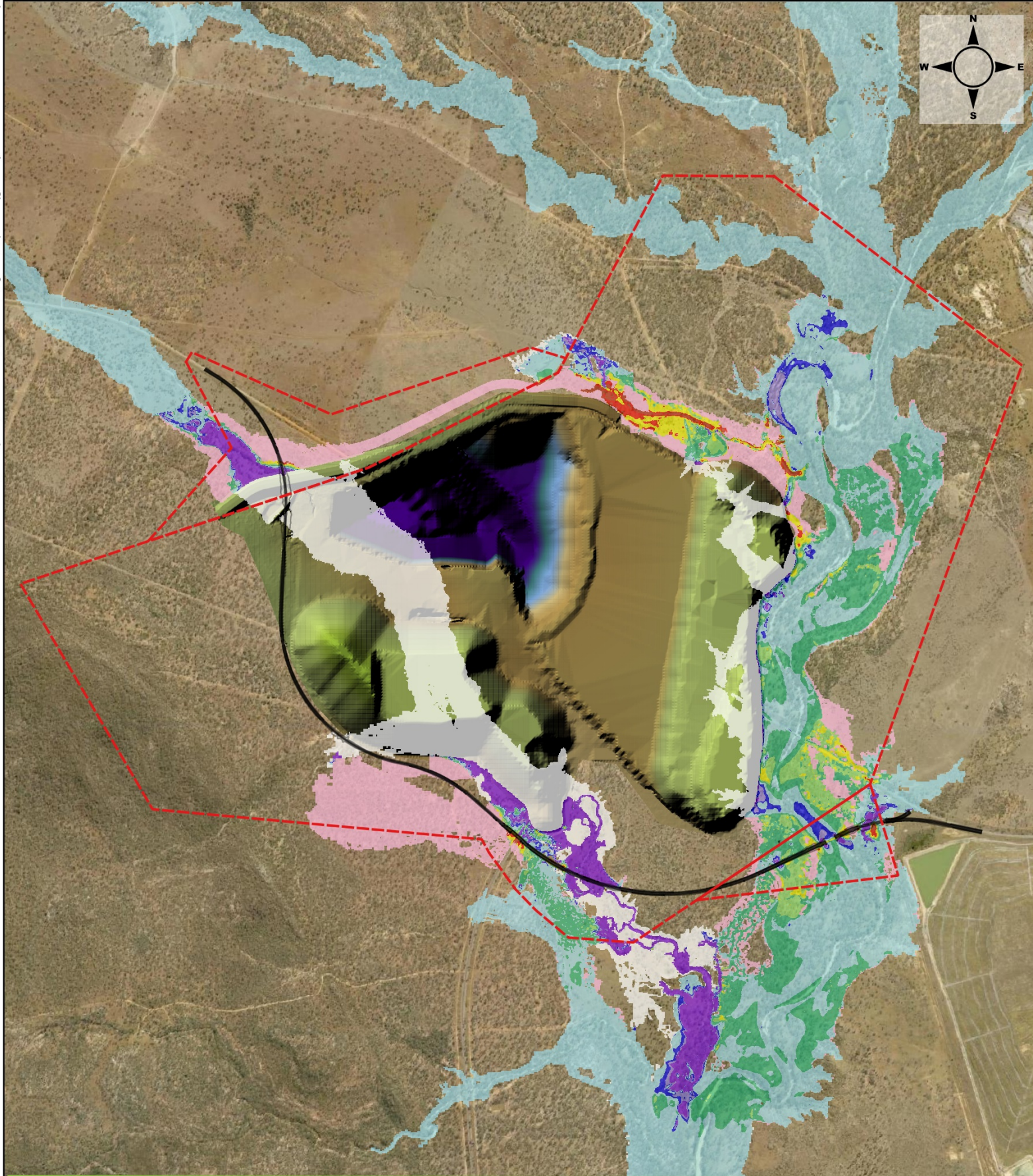
Velocity

-  up to 0.25m/s
-  0.25 to 0.5m/s
-  0.5 to 0.75m/s
-  0.75 to 1.0m/s
-  1.0 to 1.5m/s
-  1.5 to 2.0m/s
-  2.0 to 3.0m/s
-  > 3 m/s

New Lenton Mine Public Environment Report

Final landform conditions
1 in 1,000 AEP velocity





Legend

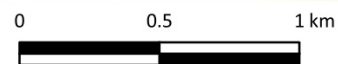
-  Mine Lease Area
-  Proposed roads

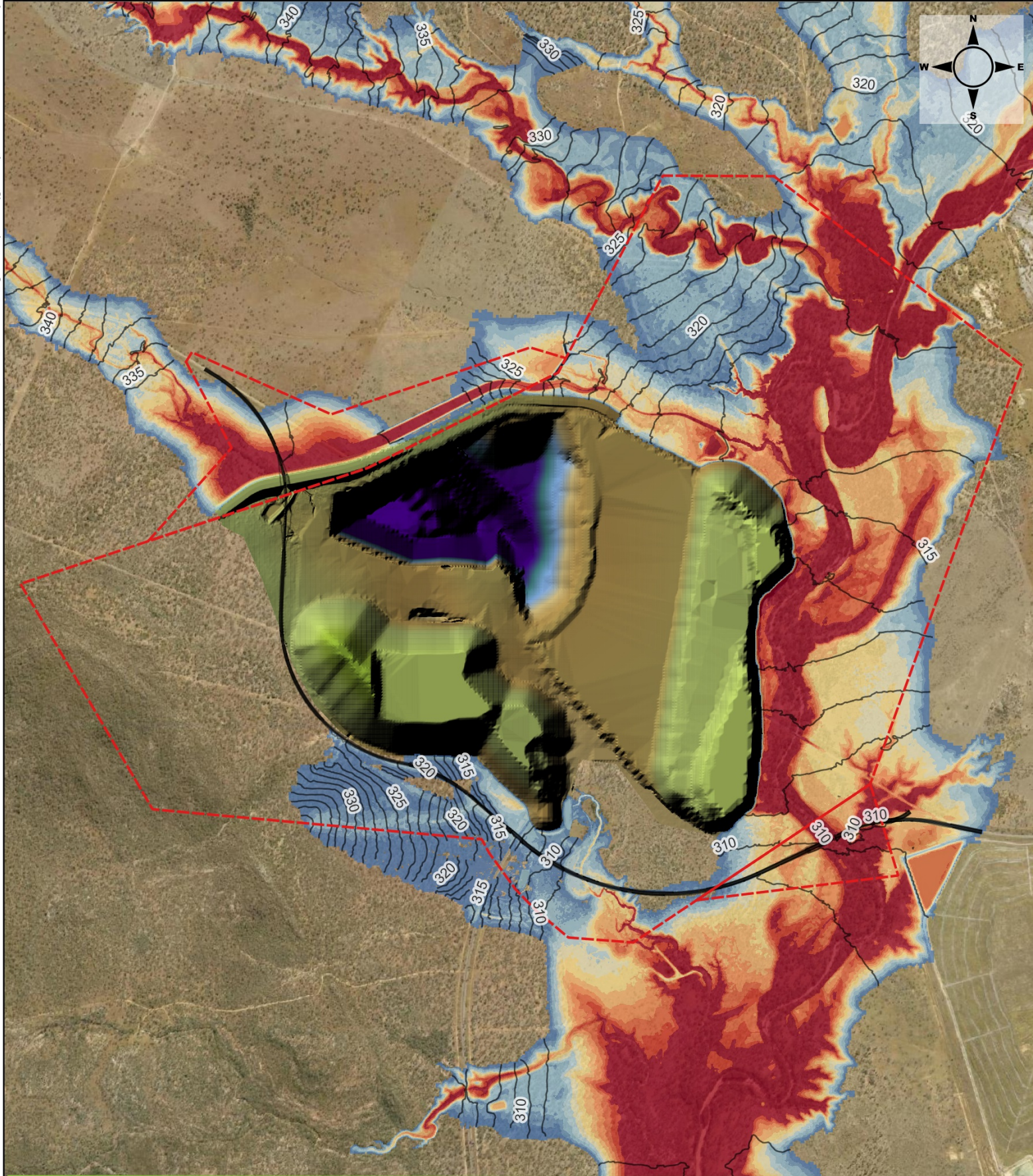
Velocity difference

-  < - 0.3 m/s
-  -0.3 m/s to -0.2 m/s
-  -0.2 m/s to -0.1 m/s
-  -0.1 m/s to 0.1 m/s
-  0.1 m/s to 0.3 m/s
-  0.3 m/s to 0.5 m/s
-  0.5 m/s to 1.0 m/s
-  1.0 m/s to 1.5 m/s
-  > 1.5 m/s
-  Was wet now dry
-  Was dry now wet

New Lenton Mine Public Environment Report

Final landform conditions
1 in 1,000 AEP velocity difference





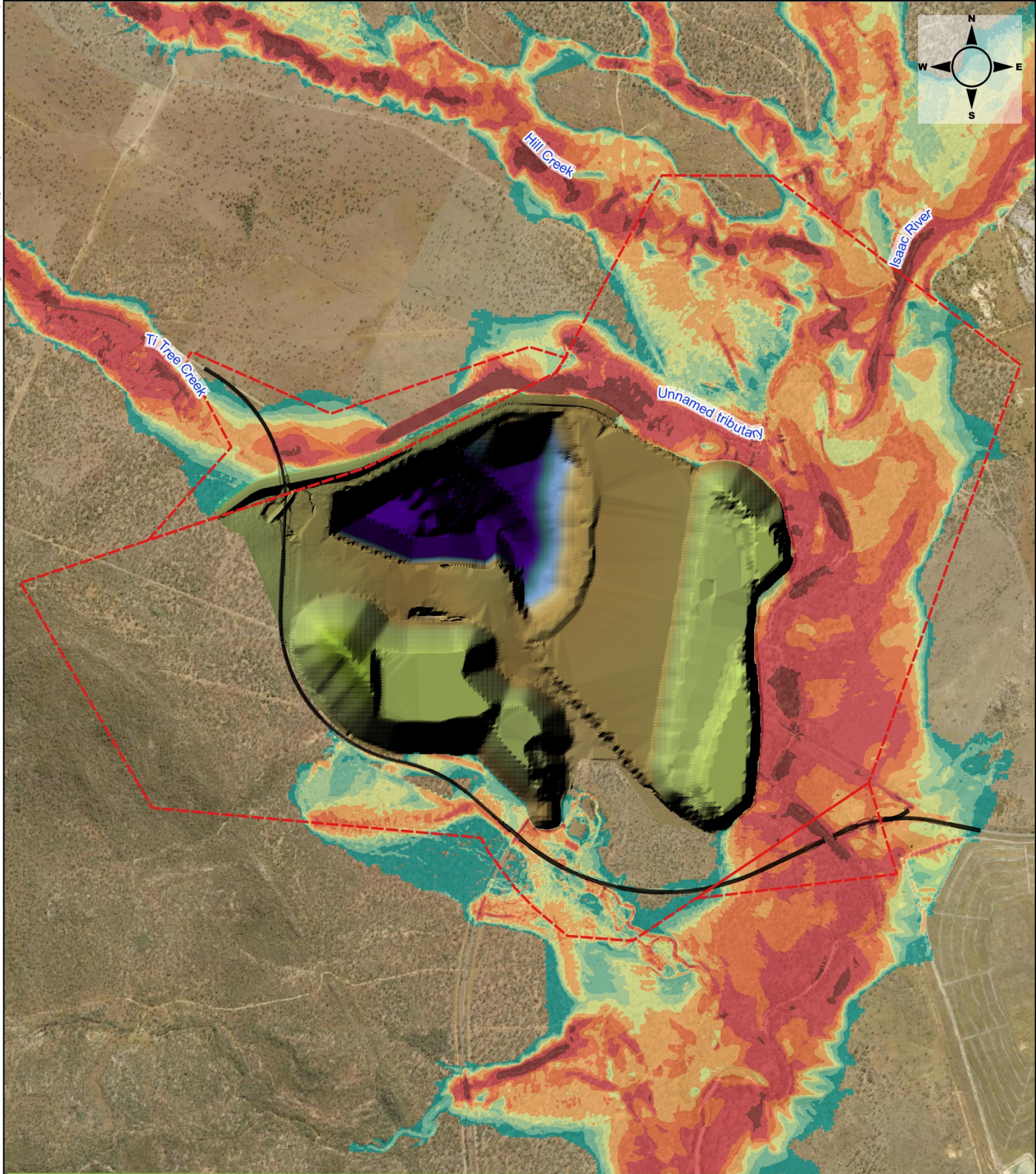
- Legend**
- Mine Lease Area
 - Proposed roads



New Lenton Mine Public Environment Report

Final landform conditions
PMF flood depth and heights





Legend

 Mine Lease Area

 Proposed roads

Velocity

	up to 0.25m/s
	0.25 to 0.5m/s
	0.5 to 0.75m/s
	0.75 to 1.0m/s
	1.0 to 1.5m/s
	1.5 to 2.0m/s
	2.0 to 3.0m/s
	> 3 m/s

New Lenton Mine Public Environment Report

Final landform conditions
PMF velocity





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