BLACKWATER MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN

Final Landform Flood Assessment

Whitehaven Coal Limited

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DETAILS

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1 INTRODUCTION

1.1 OVERVIEW

Whitehaven, the owners of Blackwater Mine (BWM), has requested WRM Water & Environment Pty Ltd (WRM) to undertake hydrologic and hydraulic modelling for the BWM final landform, to supplement the BWM Progressive Rehabilitation and Closure Plan (PRCP). BWM requires a PRCP to be completed in accordance with BWM's Environmental Authority (EA) (EPML00717813), and PRCP Guideline Requirements.

The BWM final landform will incorporate 15 final voids as Non-use Management Areas (NUMAs). Figure 1.1 shows the drainage characteristics of the study area under existing (current) conditions as well as the locations and extents of the proposed final voids.

SLR previously prepared the flood assessments for previous version of the BWM final landform (SLR, 2024a and 2024b). In the SLR (2024a and 2024b) studies, hydrologic modelling was undertaken using XP-RAFTS and hydraulic modelling was undertaken using TUFLOW. The SLR (2024a and 2024b) flood models were developed based on the XP-RAFTS and TUFLOW models originally developed by GHD for the 2021 Blackwater Mine Flood Study (GHD, 2021).

This "PRCP Final Landform Flood Modelling" report presents the methodology and results of hydrologic and hydraulic modelling for the following seven catchments, for an updated BWM final landform (post-closure) configuration (refer to Figure 1.1):

- Bonnie Doon Creek (BDC);
- Burngrove Creek (BGC);
- Blackwater Creek (including Taurus Creek and Two Mile Gully) (BWC);
- Sagittarius Creek (SGC);
- Speculation Creek (SPC);
- Sirius Creek (SRC); and
- Rockland Creek (RLC).

The report was prepared to address the requirements in Section 3.6.1 – General rehabilitation practices (flooding) of Department of Environment, Tourism, Science and Innovation (DETSI) (formally the Department of Environment, Science and Innovation) Progressive rehabilitation and closure plans (PRC plans) guideline (Version 3.01) (DETSI, 2024).

1.2 METHOD OF ASSESSMENT

New hydrologic models were developed using the URBS software package, which incorporates the latest climate change guidance from Australian Rainfall and Runoff 2019 Version 4.2 (ARR 2019 v4.2) (Ball et al, 2019). The URBS models were calibrated to recorded rainfall and water level data for the March 2017 and January 2020 events where suitable data is available. Details of the URBS model development and calibration are documented in the Hydrologic Model Development and Calibration Report provided in Appendix D.

The SLR (2024a and 2024b) TUFLOW hydraulic models were updated to incorporate the updated final landform as well as updated design inflows from the new URBS hydrologic models. Hydrologic and hydraulic modelling were undertaken for the 1% (1 in 100) and 0.1% (1 in 1,000) annual exceedance probability (AEP) as well as the Probable Maximum Flood (PMF) events.

A flood risk assessment was then undertaken to assess the risk of flood water ingress into the final voids, as well as the risk of erosion and scour due to floodwater being in contact with rehabilitated landform.

1.3 REPORT STRUCTURE

This report is structured as follows:

- Section 2 describes the drainage characteristics of the study area;
- Section 3 is an overview of the data available for this study;
- Section 4 describes the estimation of design discharges;
- Section 5 presents the hydraulic model development;
- Section 6 presents the hydraulic modelling results including the flood risk assessment;
- Section 7 presents a summary of the findings; and
- Section 8 is a list of references.

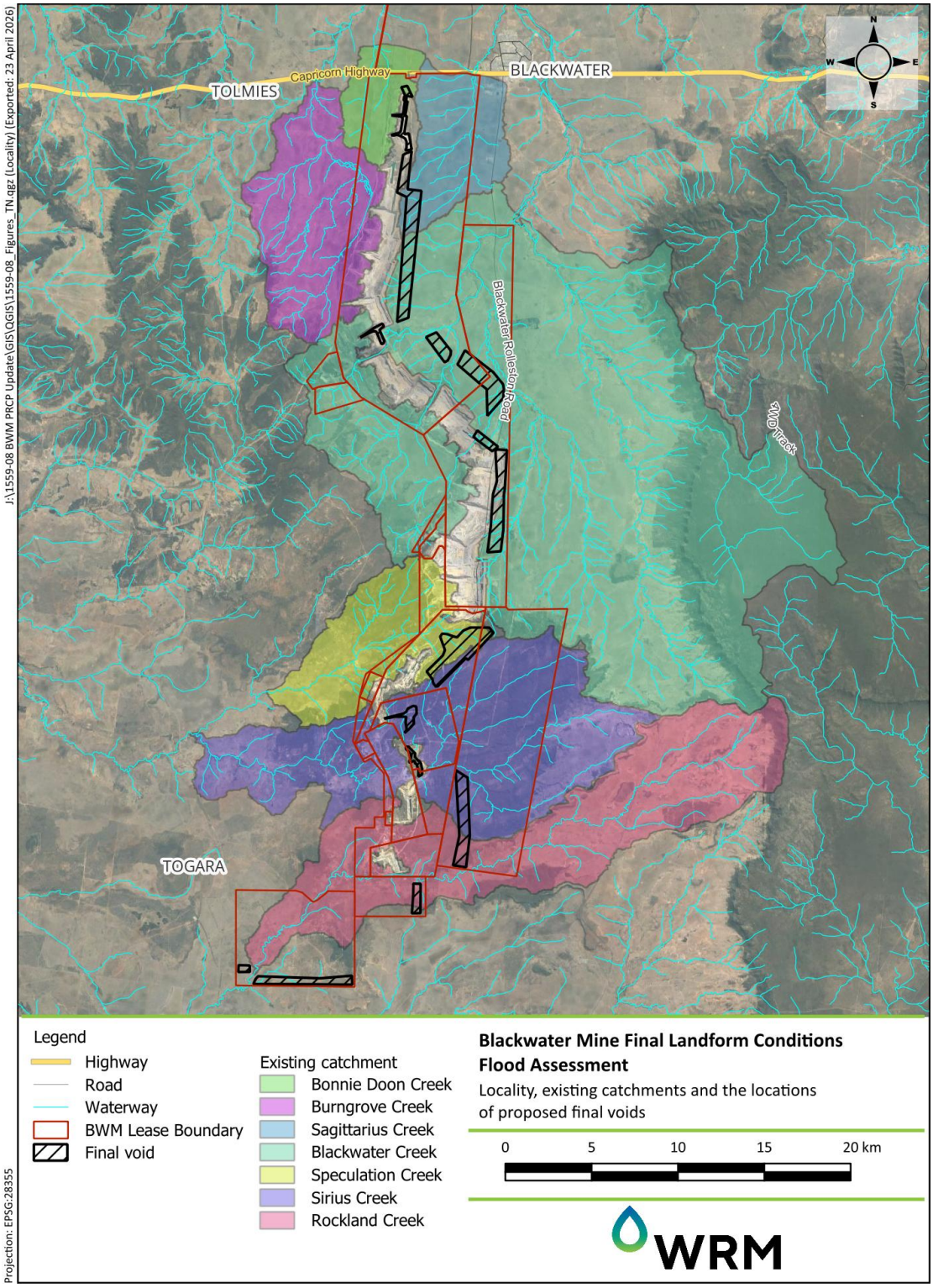


Figure 1.1 Locality, existing catchments and the locations of proposed final voids

2 FINAL LANDFORM CHARACTERISTICS

2.1 FINAL LANDFORM CONFIGURATION

Figure 2.1 shows the final landform configuration including the locations of the proposed final voids. Figure 6.1 to Figure 6.16 show the proposed final landform configuration and the extent of flooding for the 0.1% AEP design flood event.

- The BWM final landform will incorporate the following 15 residual voids:
  - Ramp 8 (R8) Void;
  - Bonnie Doon Void;
  - Mimosa Besgrove Void;
  - Ramp 30 (R30) Void;
  - Deep Creek Void;
  - Stewarton North Void;
  - Stewarton South Void;
  - Tannyfoil Void;
  - South Ballamoo Void;
  - Kenmare Void;
  - Ramp 74 (R74) Void;
  - Togara North Marshmead Void;
  - South Marshmead Void;
  - Comet Downs East Void; and
  - Kennedy Void.
- Temporary flood protection levees (in place during mining to protect the active mining pits from flooding) would be removed such that the rehabilitated out-of-pit overburden areas would prevent floodwater from entering the voids. These components of the final landform are referred to in this report as flood protection landforms.
- A total of 11 of the proposed voids would have flood protection landforms constructed to be at least 50 m wide at the crest, and with crest heights above the adjacent 0.1% AEP peak flood level.
- The remaining three voids (R8, Bonnie Doon, Stewarton South and Kenmare) would be located away from any major watercourses and outside of the floodplain of these watercourses.
- It is assumed that the final landform, including sections with potential to interact with floodwaters, would be rehabilitated to achieve the minimum groundcover requirements of rehabilitation milestone (RM) 6.3 of the PRCP schedule for BWM (the PRCP Schedule) (DETSI, 2026).

2.2 DRAINAGE CHARACTERISTICS

Figure 2.1 shows the drainage characteristics in the vicinity of BWM under final landform conditions, which are described as follows:

- Bonnie Doon Creek (BGC) drains in a northerly direction west of the BWM final landform.
- Sagittarius Creek (SGC) drains in a northerly direction east of the BWM final landform.
- The Burngrove Creek (BGC) catchment comprises the following three streams:

- Burngrove Creek, flows in a northeasterly direction west of the BWM final landform. A 3 km section of the natural Burngrove Creek channel was removed by the BWM operations and replaced by a diversion channel (licensed diversion reference 40137F) that drains north between the railway and the BWM. For this assessment, it is assumed that this diversion will remain under final landform conditions.
- Cabbagetree Creek originates from the southwest of the catchment and drains in a northeasterly direction west of the BWM final landform before joining Burngrove Creek.
- Tolmies Creek originates from the west of the catchment and drains in a northeasterly direction west of the BWM final landform before joining Burngrove Creek.

- The Blackwater Creek (BGC) catchment comprises the following five streams:
  - Blackwater Creek originates from the south of the catchment and flows in a northern direction. This creek does drain through the BWM mine lease.
  - Taurus Creek, a major tributary of Blackwater Creek, originates from the east of BWM and drains in a northeasterly direction downstream of the Emu Creek Diversion in between rehabilitated dumps, and then between the Deep Creek and Stewarton North voids, eventually joining Blackwater Creek about 6 km east of the BWM final landform.
  - Emu Creek, a tributary of Taurus Creek, originates from the west (upstream) of BWM and flows in a northeasterly direction. It is then diverted in a northwesterly direction via the Emu Creek Diversion, which drains to Taurus Creek just upstream (west) of the BWM final landform.
  - Deep Creek, a tributary of Taurus Creek, originates from the west of BWM and drains in a northeasterly direction via the Deep Creek temporary diversion in between rehabilitated dumps, and between the R30 and Deep Creek voids, before joining Taurus Creek about 3 km east of BWM final landform.

    A conceptual design of a permanent Deep Creek Diversion is currently being developed, but it has not been incorporated into the final landform assessed in this study.
  - Two Mile Gully, a tributary of Taurus Creek, flows in a northerly direction east of the BWM final landform and joins Taurus Creek about 5 km east of the Mimosa Besgrove void.
- Speculation Creek (SPC) originates from the western extents of BWM and flows in a southwesterly direction away from BWM. Runoff from rehabilitated dumps of the BWM final landform will drain west to the upper reaches of the Speculation Creek and its minor tributaries.
- Sirius Creek originates from the east (upstream) of BWM. It flows in a westerly direction through BWM via the Sirius Creek temporary diversion (licensed diversion reference 52652F), which drains around the southern side of the R74 void. Downstream of the Sirius Creek temporary diversion, Sirius Creek continues to drain in a westerly direction away from the BWM final landform.

  A conceptual design of a permanent Sirius Creek Diversion is currently being developed, but it has not been incorporated into the final landform assessed in this study.
- Rockland Creek originates from the east (upstream) of the BWM. It flows in a westerly direction adjacent to the South Marshmead void. Further downstream Rockland Creek then drains southwest adjacent to rehabilitated dumps and between the Comet Downs East and Kennedy voids. Rockland Dam, which currently exists within the BWM mine lease, will be decommissioned for the final landform.

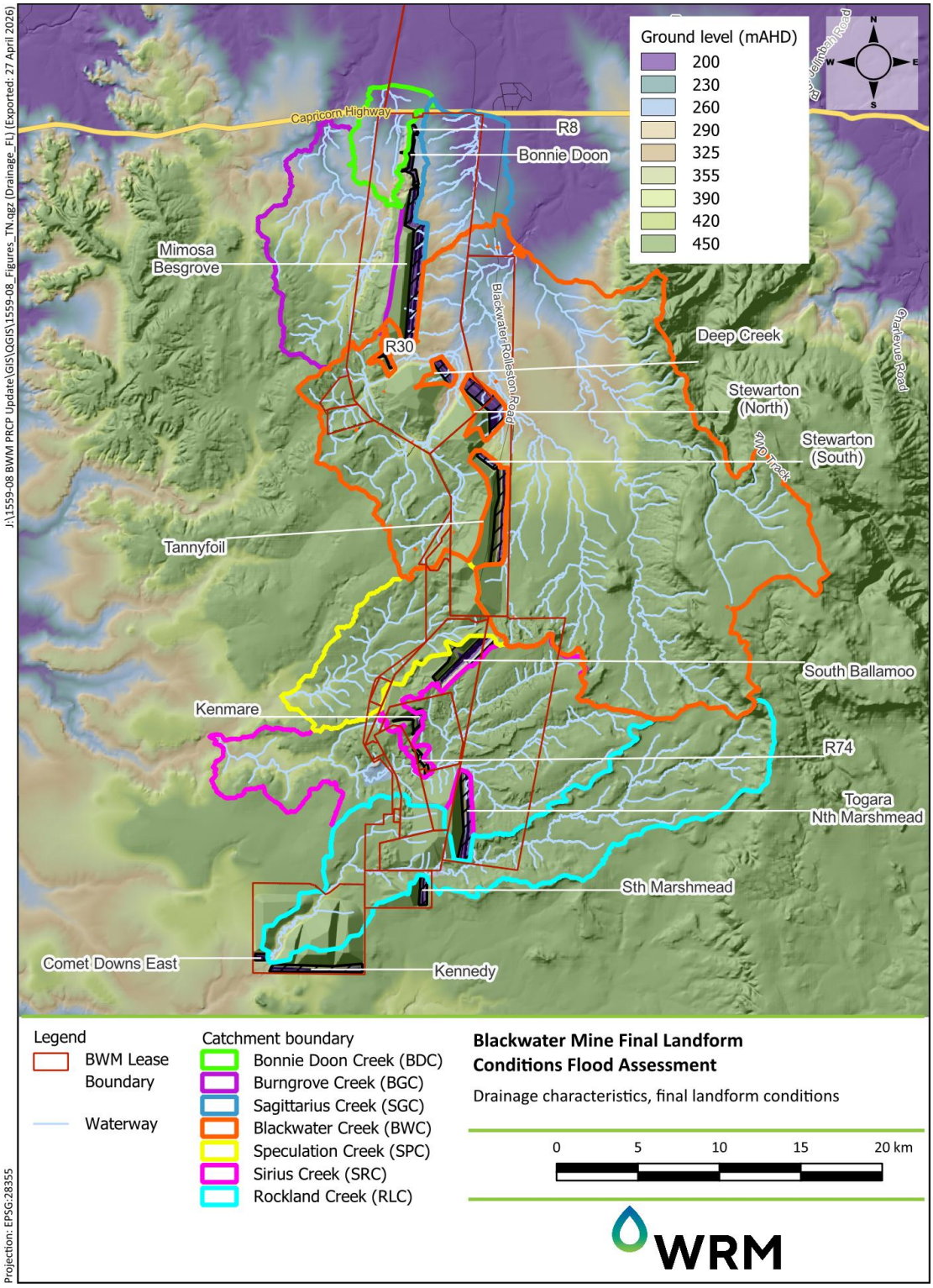


Figure 2.1 Final landform configuration and drainage characteristics

3 AVAILABLE DATA

3.1 OVERVIEW

Available data for this study was provided by Whitehaven and consisted of:

- Previous hydrologic and hydraulic studies;
- Recorded rainfall and water level data;
- LiDAR topographic data; and
- Proposed final landform surface.

3.2 PREVIOUS STUDIES

3.2.1 Blackwater Mine Flood Study (2021)

The Blackwater Mine Flood Study undertaken by GHD (2021) assessed existing flood risks across BWM. XP-RAFTS hydrologic and TUFLOW hydraulic models were developed for this study. In this study, the hydrologic models for Burngrove Creek and Speculation Creek were calibrated to recorded water level data. The GHD (2021) study report was provided for this study, but the XP-RAFTS and TUFLOW models were not available.

3.2.2 Blackwater Mine Progressive Rehabilitation and Closure Plan (2024)

The XP-RAFTS hydrologic and TUFLOW hydraulic models used by SLR (2024a and 2024b) for the previous PRCP flood assessment were provided for this study. These models appear to have been developed based on the GHD (2021) hydrologic and hydraulic models. Separate models were provided for the following catchments:

- Bonnie Doon Creek;
- Blackwater Creek;
- Burngrove Creek;
- Rockland Creek;
- Sagittarius Creek;
- Sirius Creek;
- Speculation Creek;
- Taurus Creek; and
- Two Mile Gully.

3.3 TOPOGRAPHIC DATA

The available topographic data used for this study is described as follows:

- A 1 m resolution LiDAR covering the BWM mine lease area captured in February 2024 (referred to as the 2024 LiDAR data);
- A 1 m resolution LiDAR covering the active mining pits of BWM captured in February 2025 (referred to as the 2025 LiDAR data);
- Topographic data embedded in the SLR (2024) TUFLOW hydraulic models;

- A 30 m resolution Copernicus Digital Surface Model (DSM) satellite ground level observation data obtained from the European Space Programme on 31 January 2025 (referred to as the Copernicus DSM data); and
- Proposed final landform design surface "20251104 BWM PRCP Rev3 LF4.2 1x1m grid" (Rev3 final landform) provided in November 2025.

3.4 RAINFALL AND WATER LEVEL DATA

Whitehaven supplied recorded rainfall data from three subdaily rainfall (pluviograph) stations and recorded water level data for six stream gauging stations across BWM. Rating curves were also provided for the stream gauging stations. The data was used to calibrate the URBS hydrologic models. Details of the station locations, the recorded data and the stream gauge rating curves are described in the Hydrologic Model Development Report in Appendix D.

4 ESTIMATION OF DESIGN DISCHARGES

4.1 OVERVIEW

4.1.1 Development and calibration of seven URBS hydrologic models

A total of seven URBS hydrologic models were developed for the following catchments:

- Bonnie Doon Creek;
- Blackwater Creek (including Taurus Creek and Two Mile Gully);
- Burngrove Creek;
- Rockland Creek;
- Sagittarius Creek;
- Sirius Creek;
- Speculation Creek.

The Burngrove Creek, Blackwater Creek (including Taurus Creek and Two Mile Gully) and Sirius Creek URBS models were calibrated to recorded data for the April 2017 and January 2020 flood events. The remaining four models could not be calibrated due to limitations of the available topographic data and rating curves.

Design discharges for the 1% AEP event from the seven URBS models were validated against estimates derived using the Rational Method, the Quantile Regression Technique (QRT) and the Regional Flood Frequency Estimation (RFFE) method. The purpose of the model validation is to derive appropriate initial losses (ILs) and continuing losses (CLs) for the seven models.

The hydrologic model development, calibration and validation are described in detail in the "Hydrologic Model Development and Calibration Report" given in Appendix D. The estimation of validation of design discharges were undertaken based on current (year 2025) catchment and climate conditions.

4.1.2 Modification of URBS hydrologic models for final landform conditions

For the final landform flood assessment, the calibrated and validated URBS models were modified to reflect catchment and climate conditions for the final landform. That is, the URBS model subcatchment boundaries were adjusted to reflect the final landform, and the design rainfalls were adjusted to reflect future climate conditions incorporating impacts of climate change for the year 2100, when the final landform expected to be in established.

The modified hydrologic models were then used to derive design discharges for the 1% AEP, 0.1% AEP and PMF design flood events for the proposed final landform conditions. Details on the hydrologic model updates and results are described below.

4.2 HYDROLOGIC MODEL CONFIGURATION

4.2.1 Subcatchment parameters

The boundaries of the URBS subcatchments were adjusted to represent the proposed final landform conditions. Figure A.1 to Figure A.7 in Appendix A shows the modified URBS model subcatchments configuration reflecting final landform conditions. The URBS model parameters were updated as necessary to reflect the =the catchment area, slope, imperviousness, and PERN. A summary of the final landform URBS model parameters is given in Table A.1 to Table A.7 in Appendix A.

4.2.2 Adopted global URBS model parameters

The global URBS model parameters, including channel lag parameter (alpha), catchment storage parameter (beta), catchment non-linearity (M) and channel routing exponent (N) for all seven hydrologic models are given below and were unchanged from the calibrated/validated hydrologic models.

- Channel routing "alpha" (α) = 0.1
- Catchment routing "beta" (β) = 1.0
- Catchment routing exponent (M) = 0.715
- Channel routing exponent (N) = 1.0

4.3 DESIGN RAINFALLS

4.3.1 Design rainfall depths

Design rainfall intensity-frequency-duration (IFDs) for the 1% and 0.1% AEP events were obtained from the Bureau of Meteorology (BoM).

For the Probable Maximum Precipitation (PMP) event, rainfall depths were estimated using the methodologies given in:

- *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method* (GSDM) (BoM, 2003) for durations up to 6 hours; and
- *Guidebook to the Estimation of Probable Maximum Precipitation: Generalised Tropical Storm Method* (GTSMR) (BoM, 2005) for durations 24 hours and longer.

Design rainfalls for durations between 6 and 24 hours were interpolated.

Aerial Reduction Factors (ARFs) were applied to the design rainfalls for each model based on a focal point at the location of the proposed voids in each catchment.

4.3.2 Temporal patterns

The ARR datahub[1] rare bin temporal patterns were adopted for the 1% AEP event. For the 0.1% AEP and PMP design events:

- The Jordan (2005) temporal patterns were adopted for durations up to 9 hours; and
- The GTSMR historical temporal patterns were adopted for durations longer than 9 hours.

Using the above approach, the 1%, 0.1% and PMF design events were modelled using the ensemble approach as recommended by ARR 2019.

4.3.3 Adjustment for climate change

Design rainfall IFDs were scaled up using uplift factors obtained from ARR datahub[2], corresponding to the SSP2-4.5 (year 2100) climate scenario. The associated pre-burst rainfalls were also scaled up accordingly.

Intensity-Frequency-Duration (IFD) design rainfalls and pre-burst estimates were uplifted in consistency with the SSP2-4.5 (year 2100) scaling factors provided by ARR datahub.

[1] https://data.arr-software.org/

[2] https://data.arr-software.org/

The SSP2-4.5 climate adjustments account for approximately 2.4°C of predicted global warming for the long term (2081-2100) since the historical baseline period of 1961-1990. Table 4.1 shows the corresponding design rainfall uplift factors for various storm durations (as percentage increases compared to the baseline IFD data).

Table 4.1 Adopted design rainfall uplift factors (SSP2-4.5 year 2100)

Storm duration	Rainfall uplift factor
<1 hour	41%
1.5 Hours	37%
2 Hours	35%
3 Hours	32%
4.5 Hours	29%
6 Hours	27%
9 Hours	25%
12 Hours	24%
18 Hours	22%
>24 Hours	21%

4.3.4 Losses

For the 1% AEP event, the validated initial (IL) and continuing (CL) losses were adopted and are shown in Table 4.2 (and in Appendix D). For the 0.1% AEP and PMF events, a conservative approach was adopted by adopting an IL of 0 mm and CL of 1 mm/h.

Table 4.2 Adopted design event initial (IL) and continuing (CL) losses for the 1% AEP event

URBS Model	1% AEP losses	
	IL (mm)	CL (mm/h)
Bonnie Doon Creek (BDC)	5	3.5
Burngrove Creek (BGC)	35	3.5
Sagittarius Creek (SGC)	0	2.0
Blackwater Creek (BWC)	0	3.5
Speculation Creek (SPC)	0	3.5
Sirius Creek (SRC)	50	3.5
Rockland Creek (RLC)	0	2.0

4.4 DESIGN PEAK DISCHARGES

Table 4.3 shows the URBS model-predicted design peak discharge, critical storm durations and representative temporal patterns for the 1% AEP, 0.1% AEP and PMF events for final landform conditions at key reporting locations (shown in Figure 4.1). The representative temporal patterns for the critical durations were selected based on the temporal pattern that produces a peak discharge slightly above the mean of the 10 temporal patterns for the critical duration.

Table 4.3 URBS model predicted design peak discharges and critical durations

Model	Location	Design Event								
		1% AEP			0.1% AEP			PMP		
		Critical Duration (h)	TP	Flow (m^3/s)	Critical Duration (h)	TP	Flow (m^3/s)	Critical Duration (h)	TP	Flow (m^3/s)
BDC	BDC_01	1	3	74	1	7	119	1	7	486
BGC	BGC_01	2	8	373	1.5	9	735	1.5	9	2,883
BWC	BWC_01	2	8	245	2	4	389	1.5	4	1,633
	BWC_02	2	8	209	3	7	341	2	4	1,590
	BWC_03	2	1	863	2	4	1,361	2	2	6,219
	TR2M	6	6	1,142	6	7	1,905	4.5	1	7,659
RLC	RLC_02	4.5	3	570	6	9	947	4.5	9	3,677
	RLC_03	6	1	595	6	9	974	4.5	9	3,715
	RLC_04	6	1	767	9	8	1,201	6	6	4,365
	RLC_Out	6	1	767	9	8	1,222	6	6	4,349
SGC	SGC_01	4.5	3	165	3	7	267	2	4	1,302
SRC	SRC_02	6	8	413	1.5	4	878	1	9	3,622
	SRC_03	6	8	808	2	4	1,704	2	9	7,254
SPC	SPC_01	2	8	108	2	7	171	1	4	738

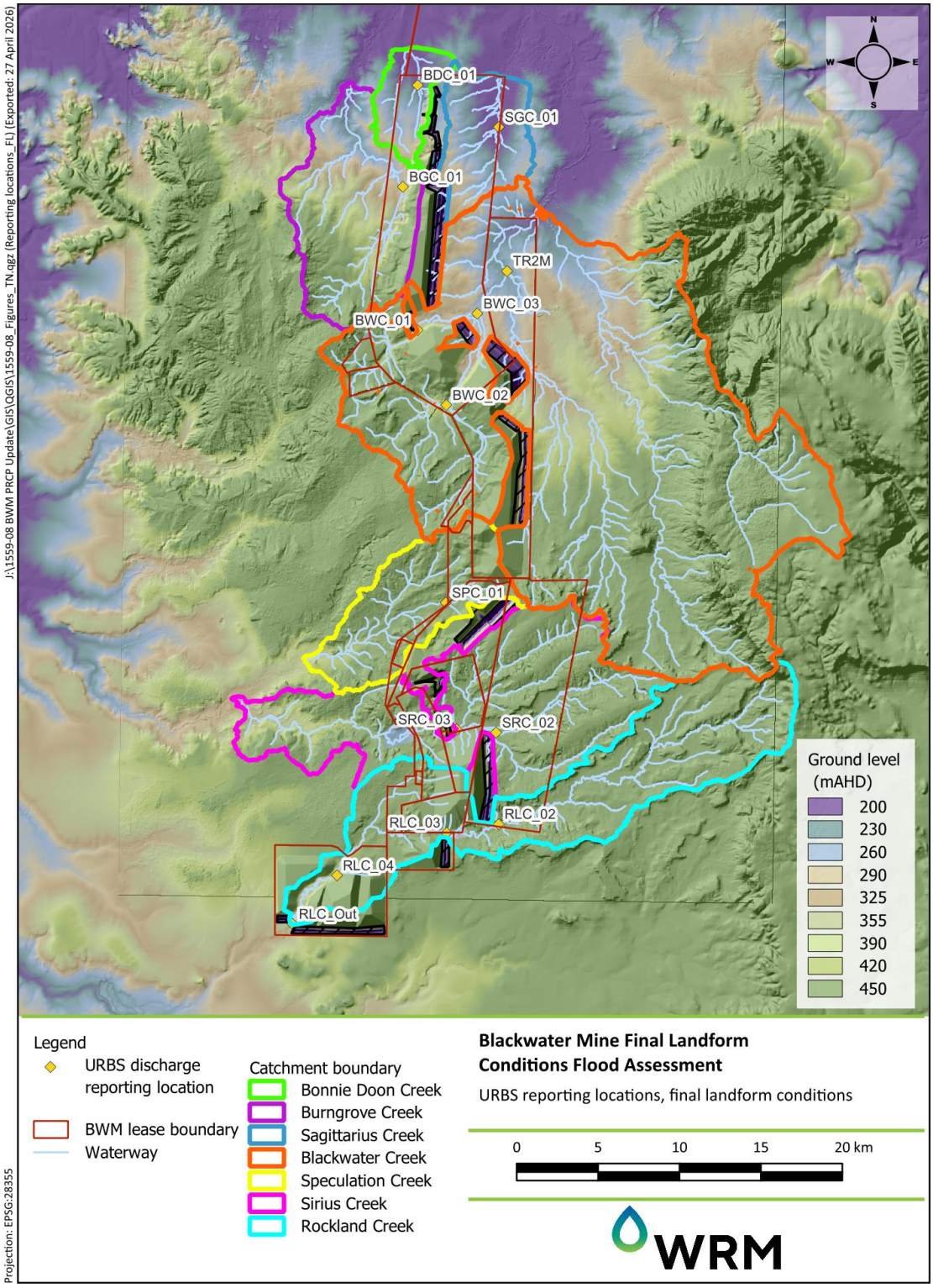


Figure 4.1 URBS discharge reporting locations

5 HYDRAULIC MODEL DEVELOPMENT

5.1 OVERVIEW

The seven (7) TUFLOW hydraulic models originally developed by SLR (2024b) were updated to incorporate the updated final landform and revised design discharges from the new URBS hydrologic models.

The updated hydraulic models were used to estimate design flood levels, depths, extents and velocities under final landform conditions, for the 1% AEP, 0.1% AEP and PMF design flood events for a subset of critical durations and temporal patterns selected based on hydrologic model results as well as preliminary hydraulic modelling results.

5.2 MODEL DEVELOPMENT

5.2.1 Model extent, resolution and topography

All seven TUFLOW models were configured with a 5 m grid cell size. Figure B.1 to Figure B.7 in Appendix B show the configuration and extent of the TUFLOW model models for this study.

The TUFLOW topography was configured as follows:

- The one metre resolution design final landform surface was used to represent the final landform and it supersedes all other topographic data across the mine lease area.
- The one metre resolution LiDAR data (dated 2024 and 2025) provided by Whitehaven was used in areas outside of the final landform within the BWM mine lease.
- A 30 m resolution Copernicus DEM was used over areas that were not covered by the one metre resolution DEM.

TUFLOW ‘z-shapes’ were used to improve the representation of roads and drainage features across the study area.

5.2.2 Boundary conditions

Design discharge hydrographs estimated using the URBS models were applied at the inflow boundary locations for the range of design events. Figure B.1 to Figure B.7 in A.6 show the location of inflow and outflow boundaries in the TUFLOW models. The inflow boundaries included in the models are as follows:

- Bonnie Doon Creek (BDC):
  - A total of 14 local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - Two ‘stage-discharge’ (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 1.3% and 0.7%;
- Burngrove Creek (BGC):
  - A total of 30 local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - Three total inflow boundary representing total inflows from URBS subcatchments outside of hydraulic model boundary;
  - One ‘stage-discharge’ (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 1.2%;
- Blackwater Creek (including Taurus Creek, Deep Creek and Two Mile Gully) (BWC):

- A total of 132 local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
- Three total inflow boundary representing total inflows from URBS subcatchments outside of hydraulic model boundary;
- One 'stage-discharge' (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 0.13%;

- Sagittarius Creek (SGC):
  - A total of 28 local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - One 'stage-discharge' (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 0.12%;
- Speculation Creek (SPC):
  - A total of Twenty-eight (28) local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - One (1) total inflow boundary representing total inflows from URBS subcatchments outside of hydraulic model boundary;
  - one (1) 'stage-discharge' (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 0.53%;
- Sirius Creek (SRC):
  - A total of 33 local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - Four total inflow boundary representing total inflows from URBS subcatchments outside of hydraulic model boundary;
  - One 'stage-discharge' (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 0.53%;
- Rockland Creek (RLC):
  - A total of 23 local inflow boundaries representing inflows from the URBS subcatchments within the hydraulic model boundary;
  - Two total inflow boundary representing total inflows from URBS subcatchments outside of hydraulic model boundary;
  - One 'stage-discharge' (HQ) type downstream outflow boundary, with a fixed downstream flood slope of 0.5%;

5.2.3 Hydraulic roughness

The TUFLOW model uses Manning's 'n' values to represent hydraulic resistance (notionally channel or floodplain roughness). Discrete regions of continuous vegetation types and land uses were mapped, and appropriate roughness values assigned to each region. Vegetation and land use mapping was undertaken using an aerial photograph. Table 5.1 shows the adopted Manning's 'n' values based on typical published values (Chow, 1959). The adopted hydraulic roughness coefficients for each surface type were unchanged from the SLR (2024b) study, but the hydraulic roughness mapping was updated slightly to reflect the updated final landform.

Table 5.1 Adopted hydraulic roughness coefficients

Surface type	Adopted Manning's 'n'
Short grass	0.04
Bare land	0.03
Sparse trees	0.06
Dense trees	0.08
Creek channel	0.05
Paved Roads	0.02
Rail embankment	0.03
Rehabilitated landform	0.04
Water surfaces	0.02

5.2.4 Hydraulic structures

1. The following approach was adopted for the configuration of hydraulic structures (i.e. culverts and bridges) in the TUFLOW hydraulic models:

- It was assumed that all hydraulic structures within the BWM mine lease area (i.e. Whitehaven assets) will be decommissioned post-closure.
- Hydraulic structures located along third-party infrastructure are assumed to remain post-closure. These third-party infrastructures include:
  - Existing access road west of the BWM mining area;
  - Existing railway line to the west of the BWM mining area; and
  - Blackwater Rolleston Road and Taurus Road to the east of the BWM mining area.

2. Out of the seven TUFLOW models developed for this study, three (BDC, BGC and BWC) include culverts and/or bridges along third party infrastructure that will remain post-closure. The remaining four models do not include culverts and/or bridges.
3. Details of the culverts included in the BDC, BGC and BWC models are provided in the Table B.1 to B.7 in Appendix B.

6 FINAL LANDFORM CONDITIONS FLOODING

6.1 OVERVIEW

Hydraulic modelling was undertaken for the 1% AEP, 0.1% AEP and PMF design flood events under proposed final landform conditions, and for the SSP2-4.5 (year 2100) future climate scenario.

Flood maps showing flood depths, levels, extents and velocities are shown in the following sections for the 0.1% (1 in 1,000) AEP event. The corresponding flood maps for the 1% AEP and PMF events are provided in Appendix C.

A summary of the model results for each catchment are presented in the following sections, focusing on the flood immunity of the proposed voids, the risk of erosion and scour in the vicinity of the proposed final voids as well as potential alterations in flow compared to existing conditions.

6.2 ADOPTED CRITERIA TO ASSESS COMPLIANCE

RM 3.12 of the PRCP Schedule requires proposed flood protection landforms around proposed residual voids to be designed to:

a. *Prevent inundation during a 0.1% AEP flood event, or a less likely event than a 0.1% AEP event if required per PRCP16(b)(ii); and*
b. *Mitigate the impacts of high-energy flow (≥2.5 m/s) against the constructed landforms, using techniques such as, but are not limited to, energy dissipation measures (e.g. rock lining) and consideration of surface roughness to increase erosional resistance of the landform surface and ensure stability of the landforms.*

On the basis of the above, it was assumed that sections of the final landform would be considered at risk of flood-induced erosion if exposed to flood velocities greater than 2.5 m/s during a 0.1% AEP design flood event.

6.3 FLOOD RISK ASSESSMENT

6.3.1 Bonnie Doon Creek catchment

Figure 6.1 and Figure 6.2 show the predicted 0.1 % AEP peak flood extents, levels, depths, and velocities along Bonnie Doon Creek in the vincity of the final landform.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C, as follows:

- Peak flood depths and extents - Figure C.1 and Figure C.2.
- Peak flood velocities - Figure C.3 and Figure C.4.

The model results indicate that:

- The R8 and Bonnie Doon voids would have 0.1% AEP flood immunity. These voids would be located outside of the Bonny Doon Creek floodplain.
- Flood velocities along the toe of rehabilitated overburden areas are generally less than 1 m/s for events up to 0.1% AEP. Hence the erosion risk in these areas is considered low.

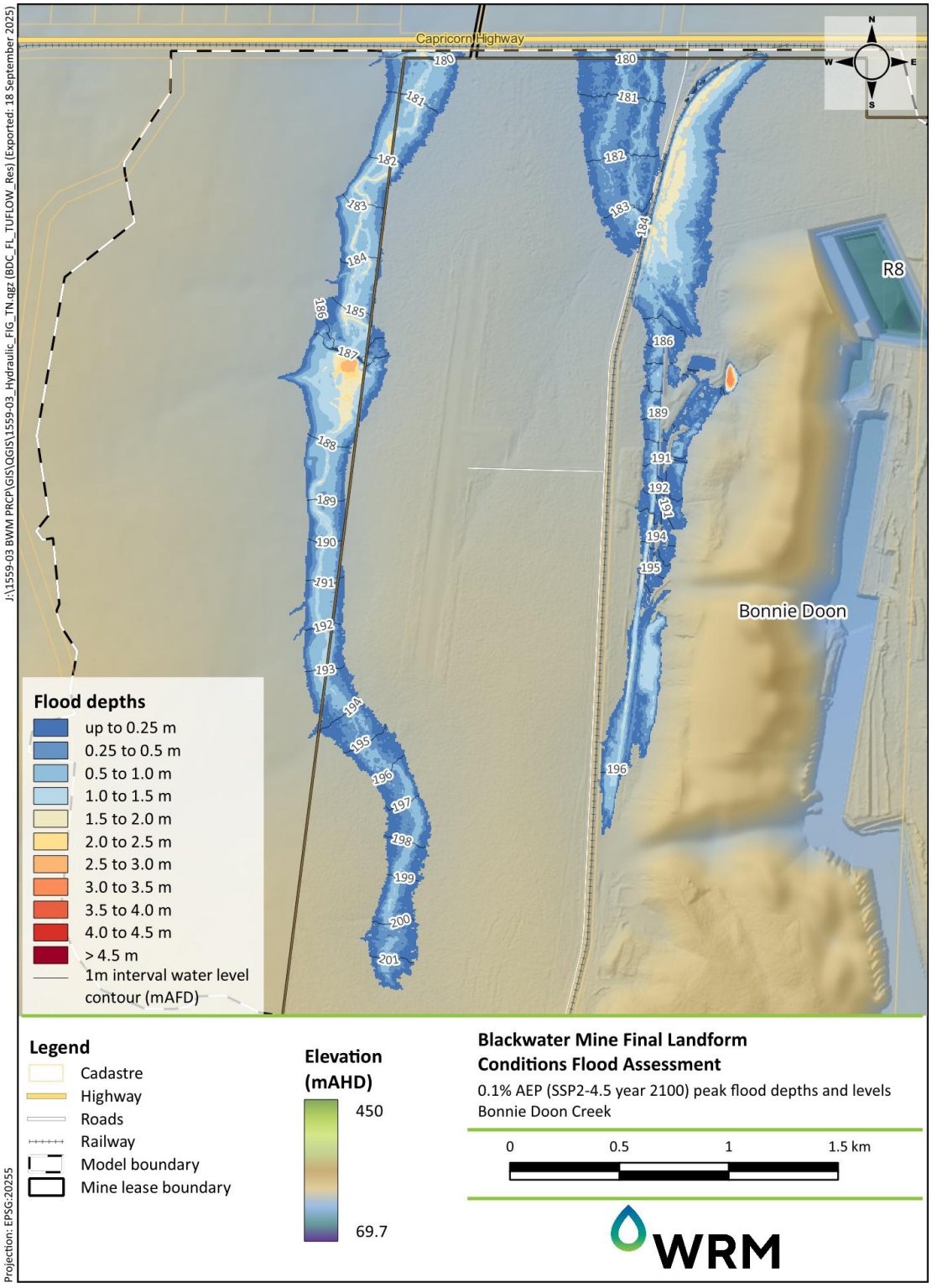


Figure 6.1 Final landform conditions 0.1% AEP peak flood depths, levels and extents, Bonnie Doon Creek

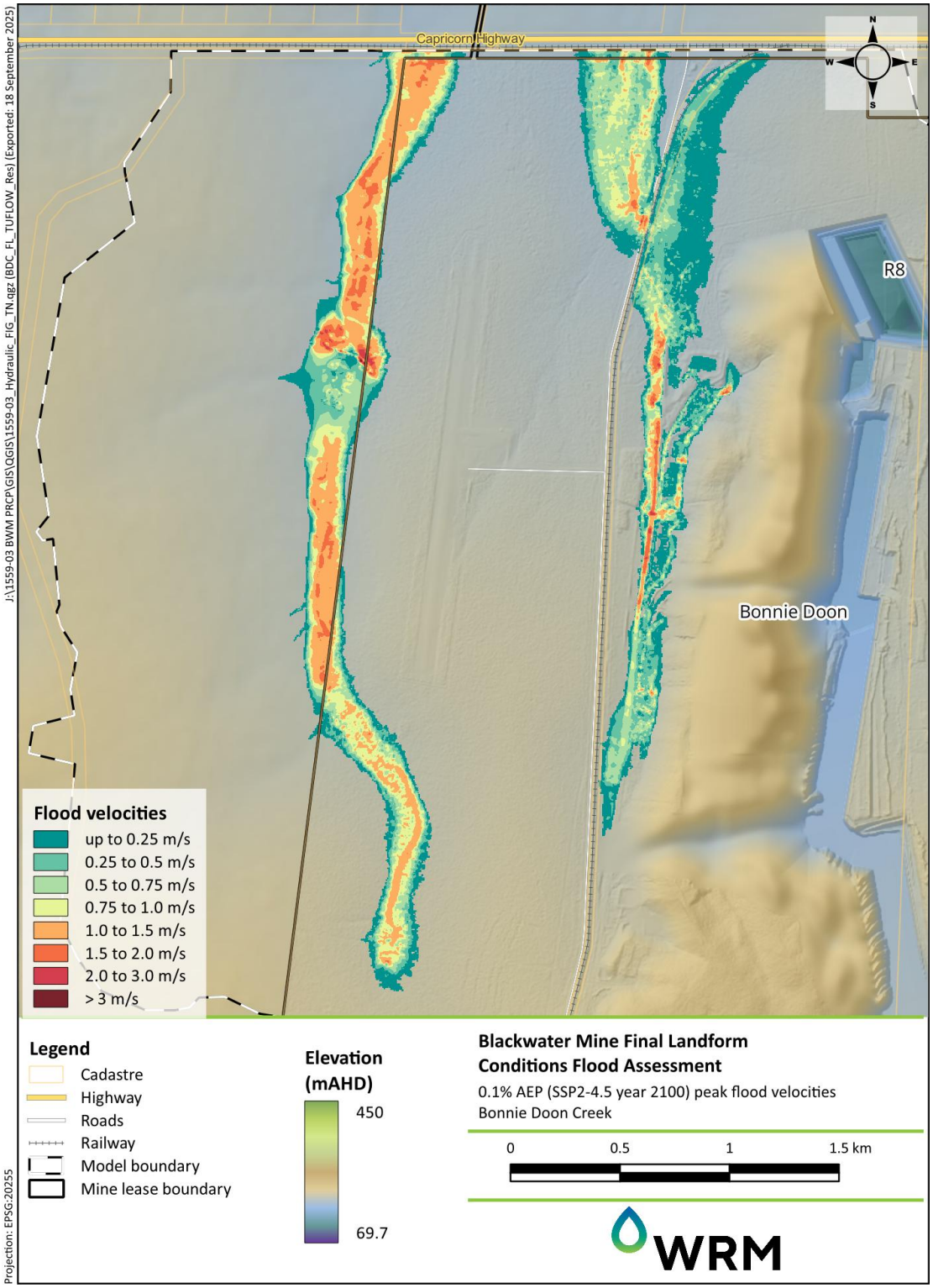


Figure 6.2 Final landform conditions 0.1% AEP peak velocities, Bonnie Doon Creek

6.3.2 Sagittarius Creek catchment

Figure 6.3 and Figure 6.4 show the predicted 0.1 % AEP peak flood extents, levels, depths, and velocities along Sagittarius Creek.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C, as follows:

- Peak flood depths and extents - Figure C.5 and Figure C.6.
- Peak flood velocities - Figure C.7 and Figure C.8.

The model results indicate that:

- The Bonnie Doon void would have 0.1% AEP flood immunity. This void would be located outside of the Sagittarius Creek floodplain.
- Rehabilitated overburden areas would be located outside of the Sagittarius Creek floodplain.

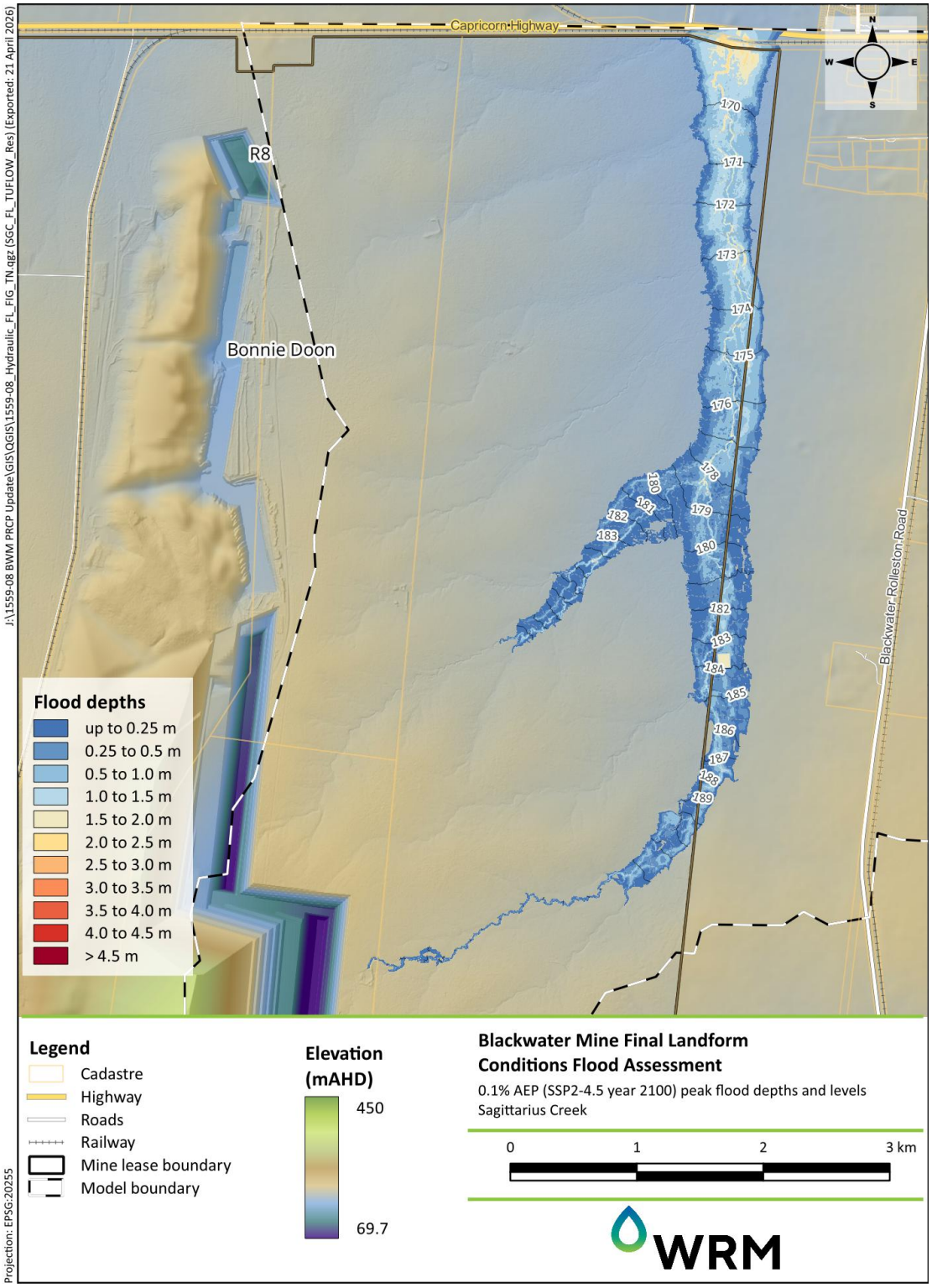


Figure 6.3 Final landform conditions 0.1% AEP peak flood depths, levels and extents, Sagittarius Creek

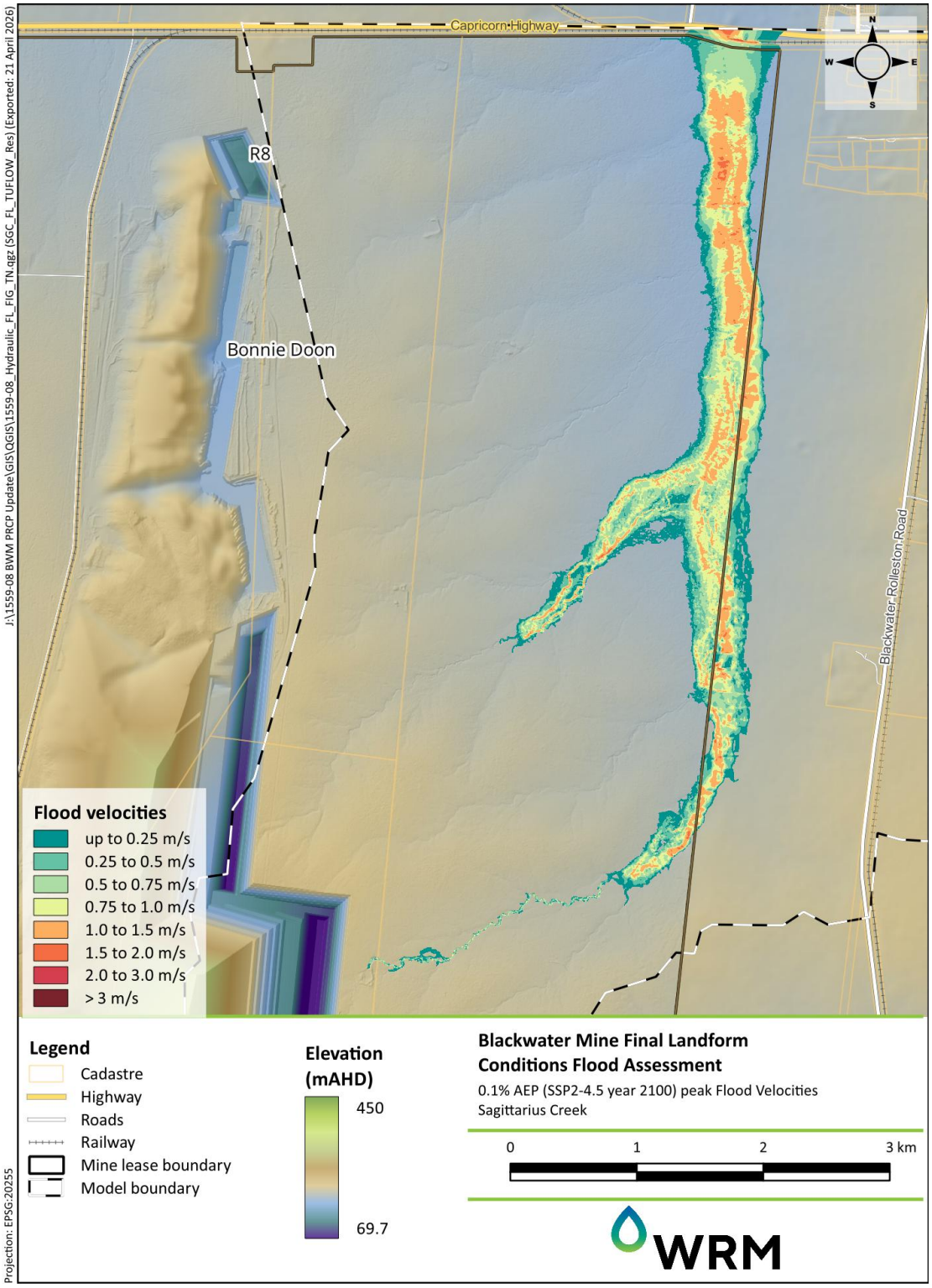


Figure 6.4 Final landform conditions 0.1% AEP peak velocities, Sagittarius Creek

6.3.3 Burngrove Creek catchment

Figure 6.5 and Figure 6.2 show the predicted 0.1 % AEP peak flood extents, levels, depths, and velocities along Burngrove Creek in the vincity of the final landform.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C as following:

- Peak flood depths and extents - Figure C.9 and Figure C.10.
- Peak flood velocities - Figure C.11 and Figure C.12.

The model results indicate that:

- The Mimosa Besgrove void would have 0.1% AEP flood immunity.
- Flood velocities along the toe of rehabilitated overburden areas (east of the Burngrove Creek Diversion) are generally less than 2 m/s for events up to 0.1% AEP. Hence the erosion risk in these areas is considered low.
- Velocities exceeding 2 m/s for the 0.1% AEP event are generally confined to the Burngrove Creek Diversion.

Note, the Burngrove Creek diversion is a licensed diversion (authorisation reference 40137F). Prior to relinquishment of the diversion license, a functional design assessment will assess whether the diversion meets the licence relinquishment criteria, or if additional remediation works are required. Additional remediation works to meet the functional design will be documented in future PRCPs.

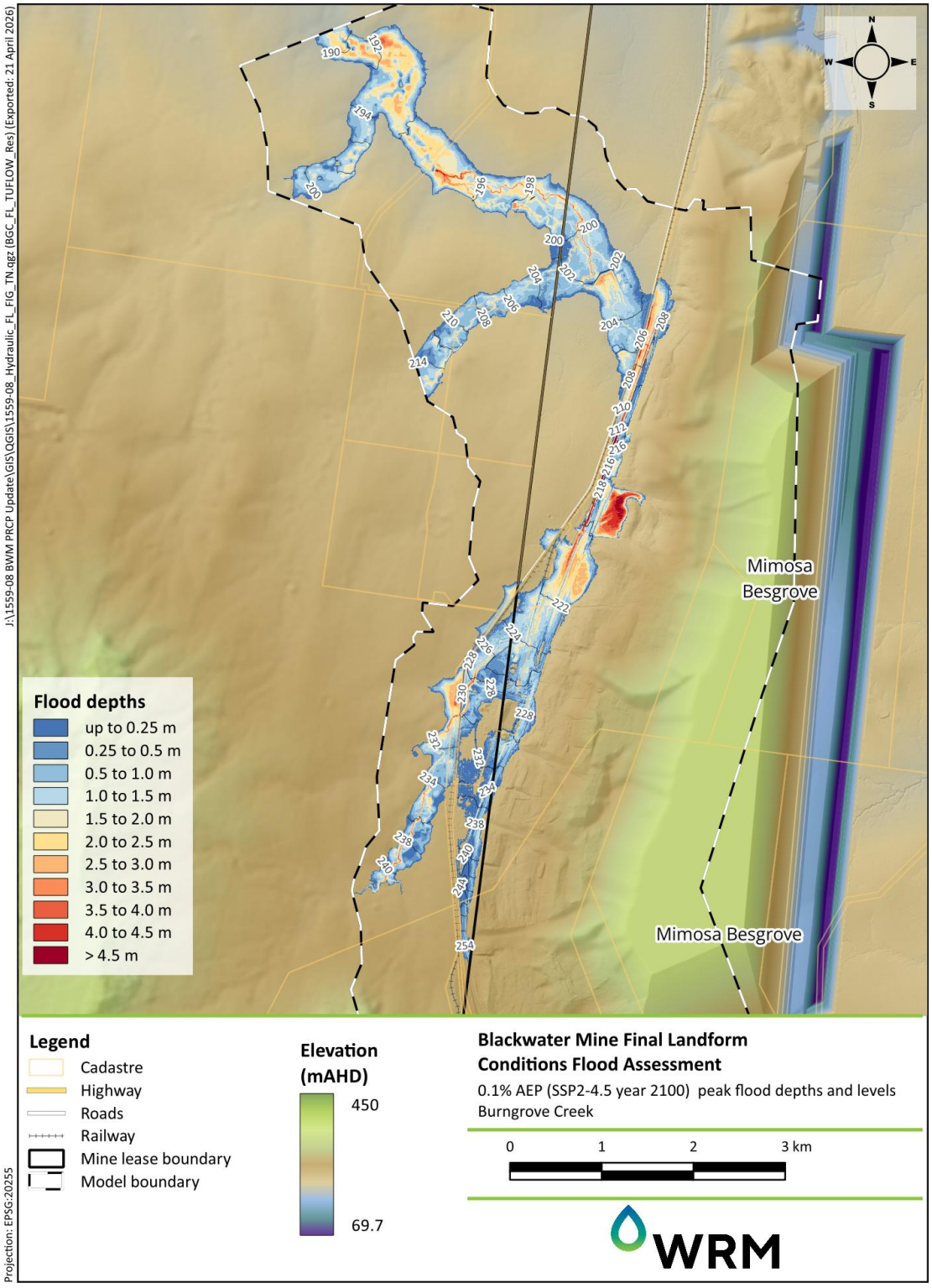


Figure 6.5 Final landform conditions 0.1% AEP peak flood depths, levels and extents, Burngrove Creek

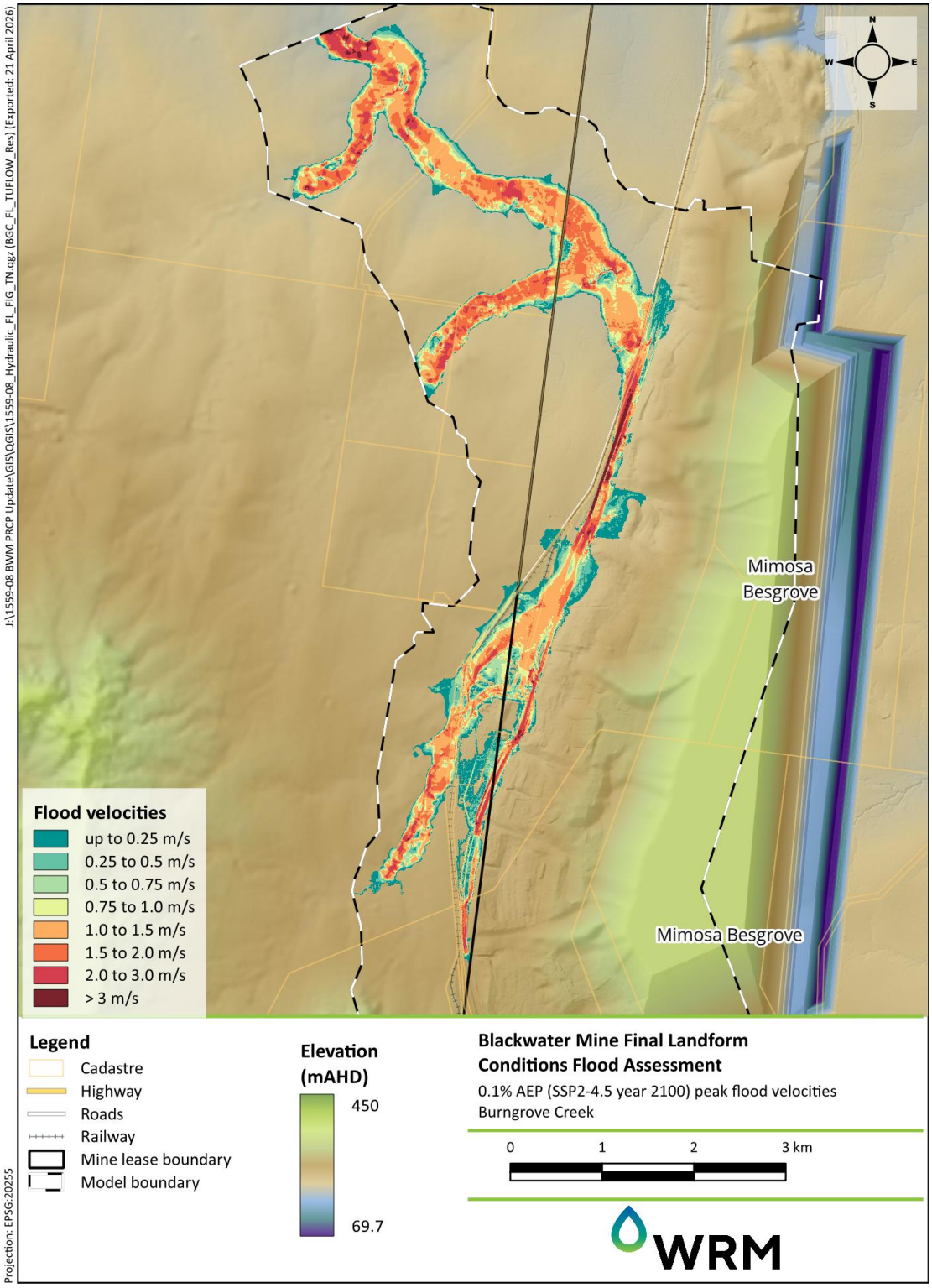


Figure 6.6 Final landform conditions 0.1% AEP peak velocities, Burngrove Creek

6.3.4 Blackwater Creek catchment (including Deep Creek, Taurus Creek and Two Mile Gully)

Figure 6.7 shows the predicted 0.1 % AEP peak flood depths, levels and extents along Emu Creek, Deep Creek, Taurus Creek and Two Mile Gully in the vincity of the final landform including the Mimosa Besgrove, R30, Deep Creek, Stewarton North and Stewarton South voids. Figure 6.9 shows the corresponding peak velocities.

Figure 6.8 shows the predicted 0.1 % AEP peak flood depths, levels and extents along Two Mile Gully in the vincity of the final landform and the Tannyfoil Void. Figure 6.10 shows the corresponding peak velocities.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C as following:

- Peak flood depths and extents - Figure C.13 to Figure C.16.
- Peak flood velocities - Figure C.17 to Figure C.20.

The model results indicate that:

- The Mimosa Besgrove, Deep Creek, Stewarton North, Stewarton South and Tannyfoil voids would have 0.1% AEP immunity.
- The R30 Void would have 0.1% AEP immunity. However, floodwater ingress into the R30 Void is predicted to occur during a PMF event. Section 6.3.8 describes how the risk of floodwater ingress into the R30 Void during events rarer than 0.1% AEP would be mitigated.
- Flood velocities along the toe of the proposed flood protection landform adjacent to the voids, for all events up to 0.1% AEP, are generally low (less than 1.0 m/s). Velocities of up to 2.0 m/s are predicted in isolated areas adjacent to the R30 void for events up to 0.1% AEP. These velocities are below the 2.5 m/s threshold for potential erosion risk from the PRCP Schedule.
- Flood velocities along the toe of rehabilitated overburden areas (adjacent to Deep Creek, Taurus Creek and Emu Creek) are generally less than 2.5 m/s for events up to 0.1% AEP, generally below the 2.5 m/s threshold for potential erosion risk from the PRCP Schedule.
- There are localised areas along the toe of rehabilitated overburden adjacent to Taurus Creek where velocities are predicted exceed 2.5 m/s during a 0.1% AEP event. Section 6.3.8 describes how the risk of localised high velocities adjacent to rehabilitated overburden areas would be mitigated.
- There is potentially higher erosion risks along these isolated sections along the tow of the overburden, which will be mitigated by one or a combination of the following measures:
  - rock lining;
  - establishing denser vegetation cover; and/or
  - channel works to contain high velocity areas to the middle of the channel and away from the toe of the rehabilitated overburden areas.

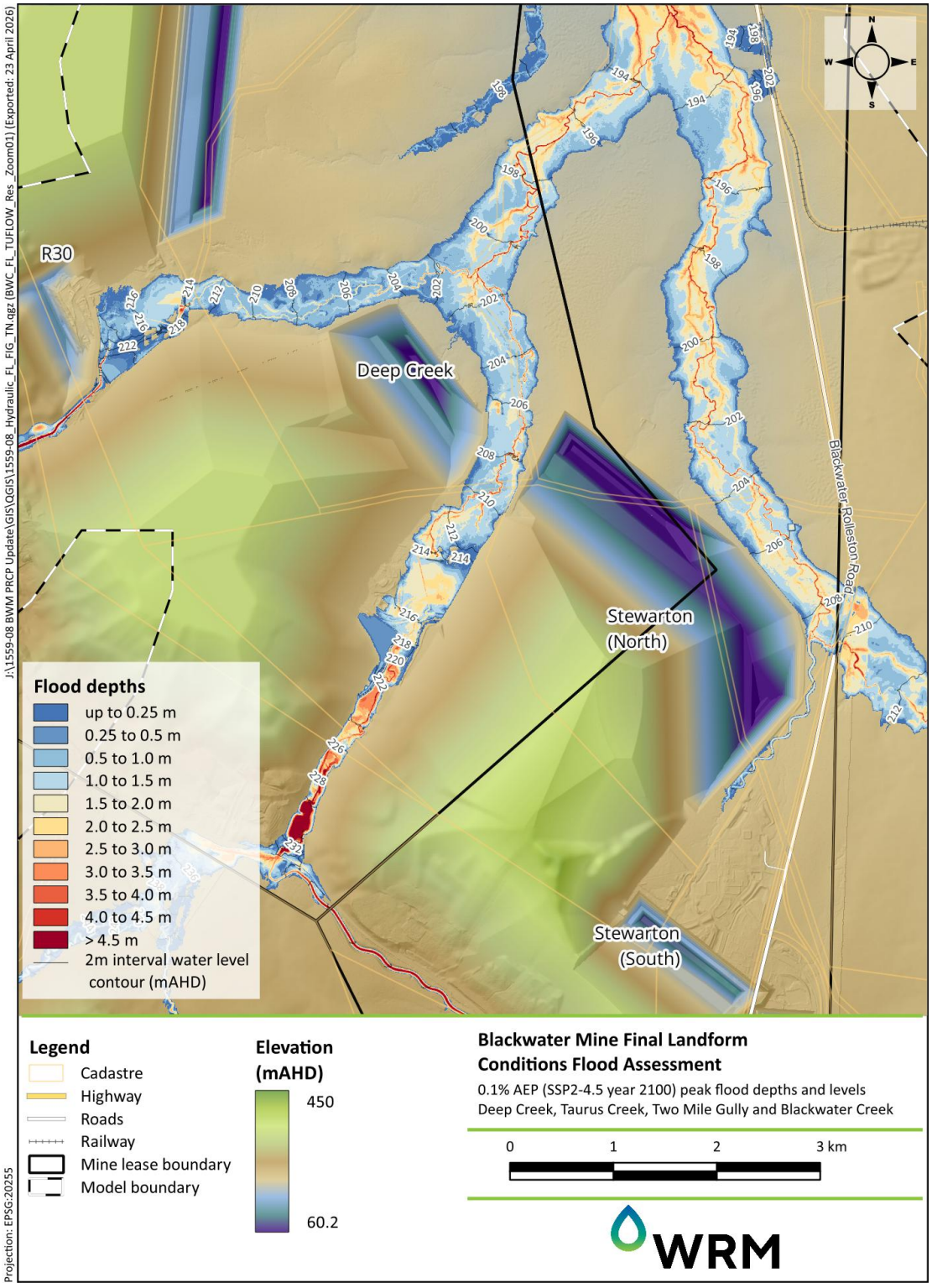


Figure 6.7 Final landform conditions 0.1% AEP peak flood depths, levels and extents, Deep Creek, Taurus Creek and Two Mile Gully (adjacent to the Stewarton South Void)

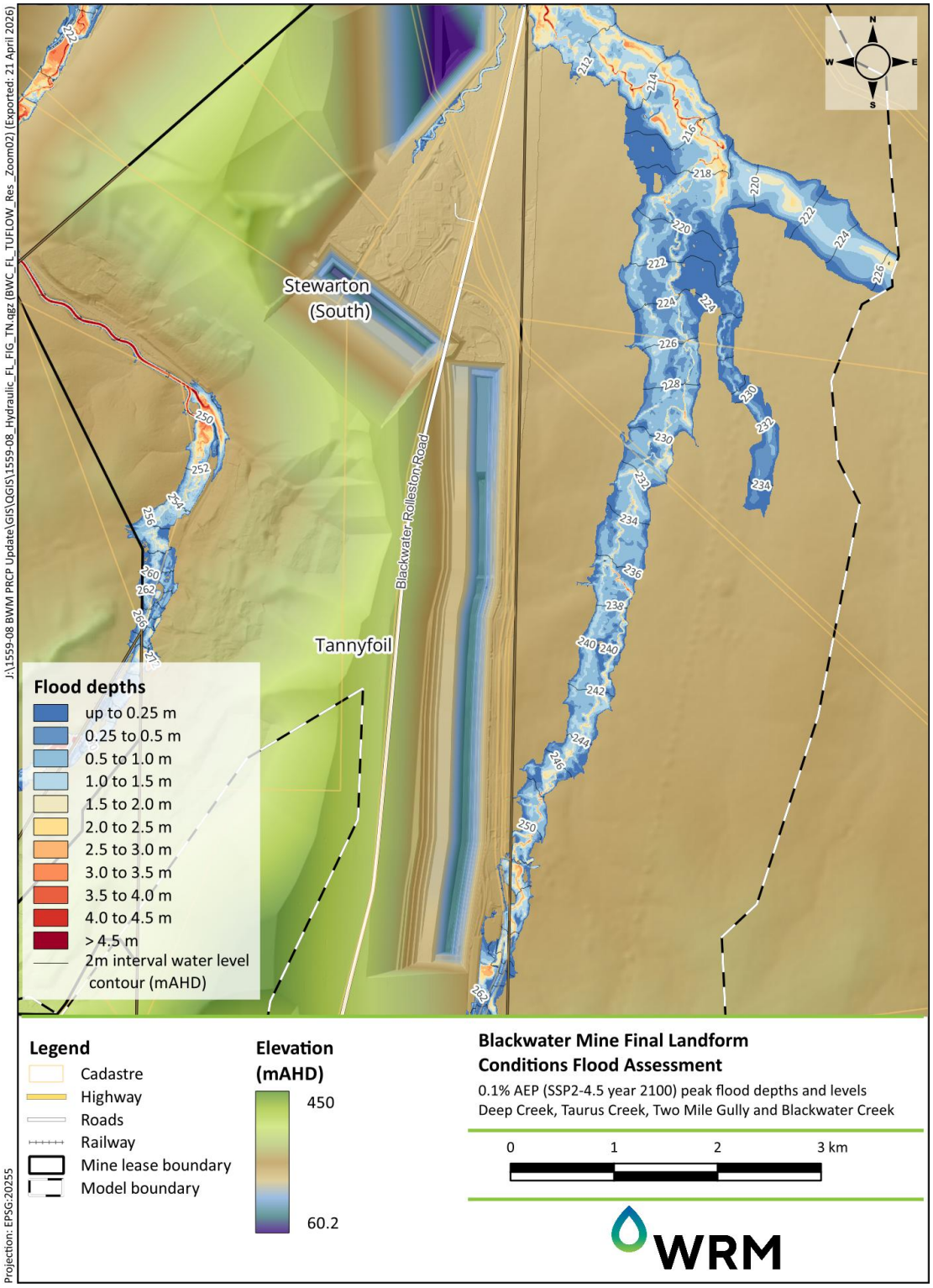


Figure 6.8 Final landform conditions 0.1% AEP peak flood depths, levels and extents, Two Mile Gully (adjacent to the Tannyfoil Void)

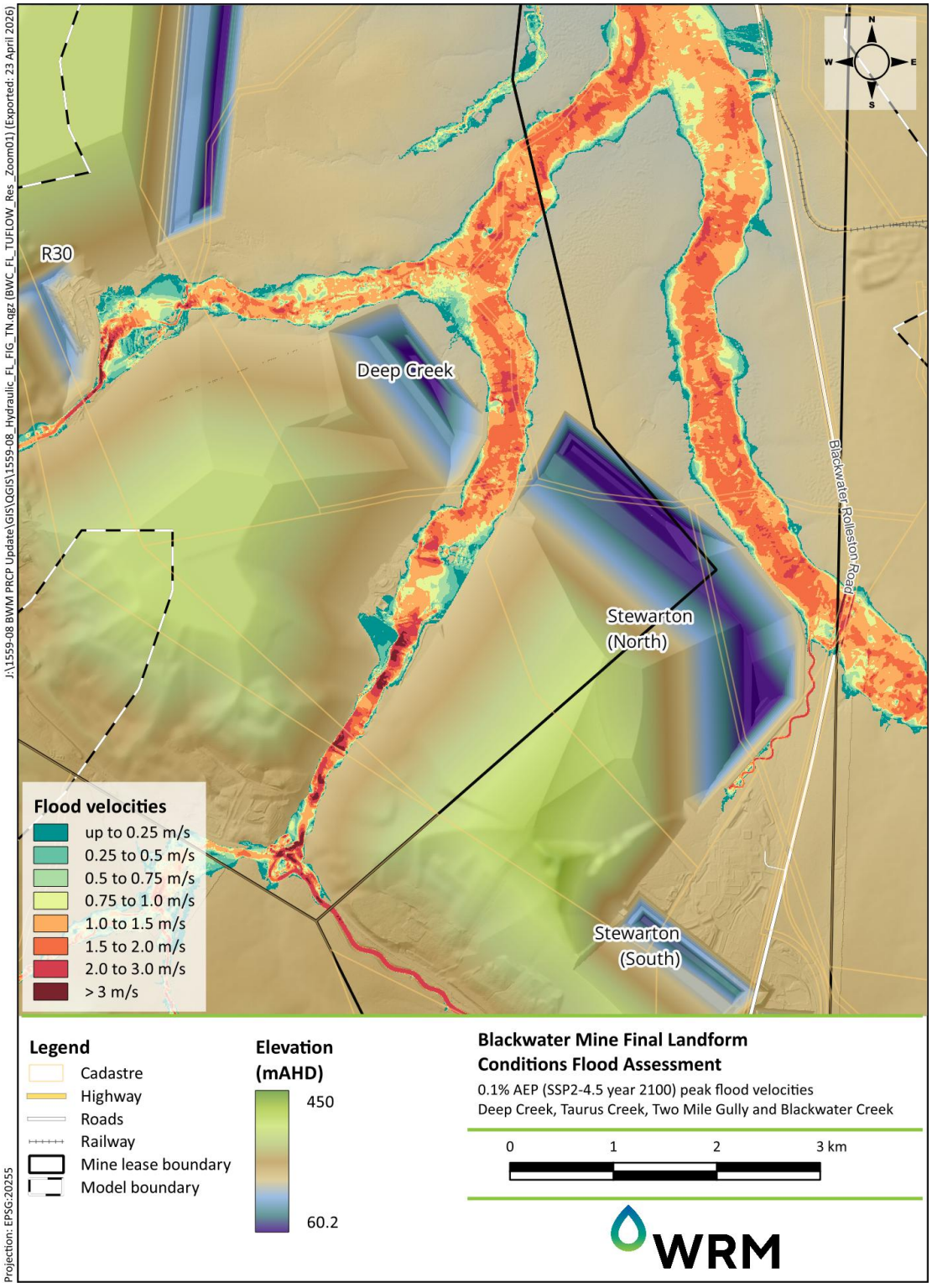


Figure 6.9 Final landform conditions 0.1% AEP peak velocities, Deep Creek, Taurus Creek and Two Mile Gully (adjacent to the Stewarton North Void)

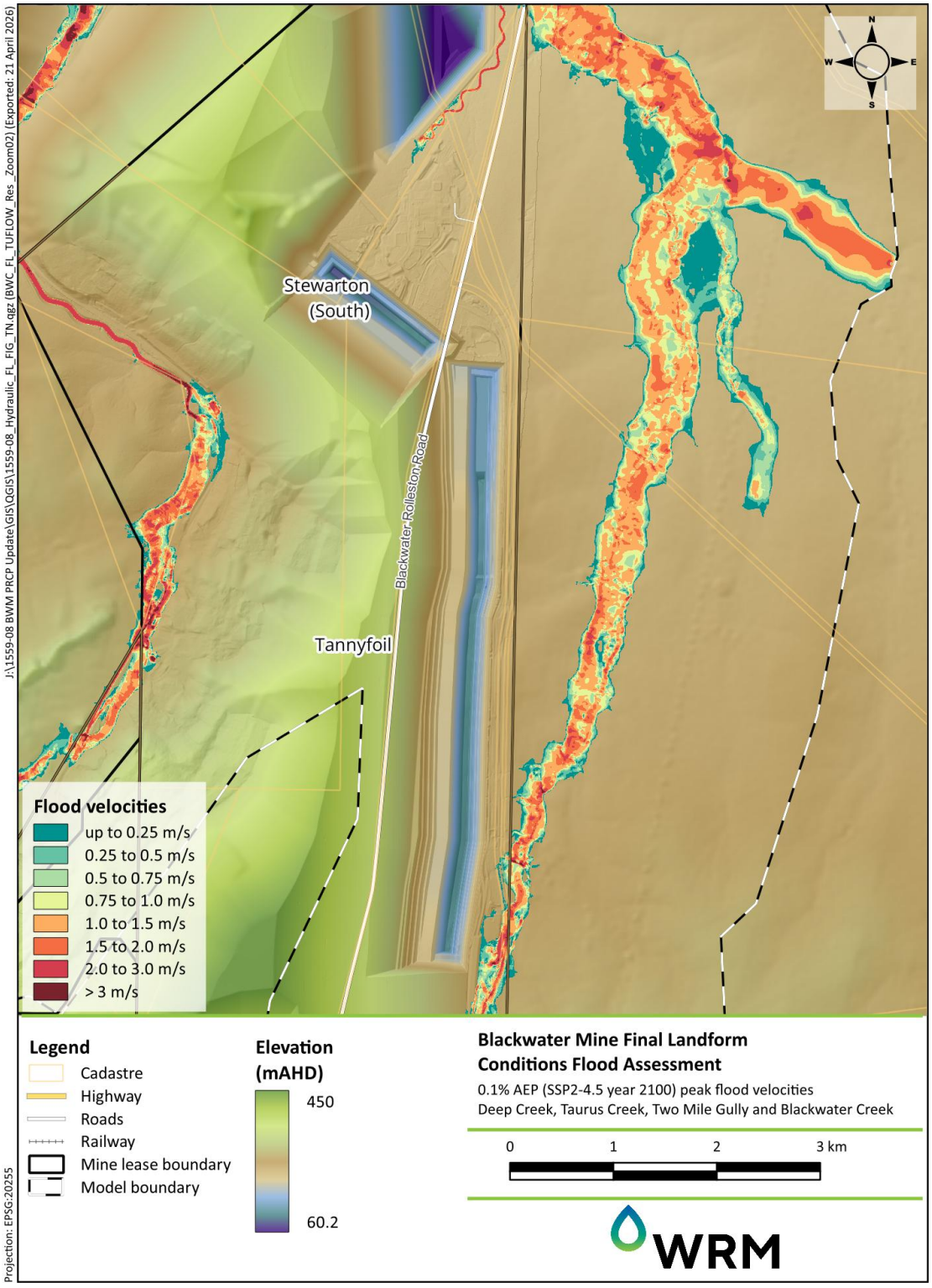


Figure 6.10 Final landform conditions 0.1% AEP peak flood velocities, Two Mile Gully (adjacent to the Tannyfoil Void)

6.3.5 Speculation Creek catchment

Figure 6.11 and Figure 6.12 show the predicted 0.1 % AEP peak flood extents, levels, depths, and velocities for Speculation Creek model, respectiverly.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C as following:

- Peak flood depths and extents - Figure C.21 and Figure C.22.
- Peak flood velocities - Figure C.23 and Figure C.24.

The model results indicate that:

- The South Ballamoo Void would have 0.1% AEP flood immunity. This void would be located outside of the Speculation Creek floodplain.
- Rehabilitated overburden areas would be located outside of the Speculation Creek floodplain.

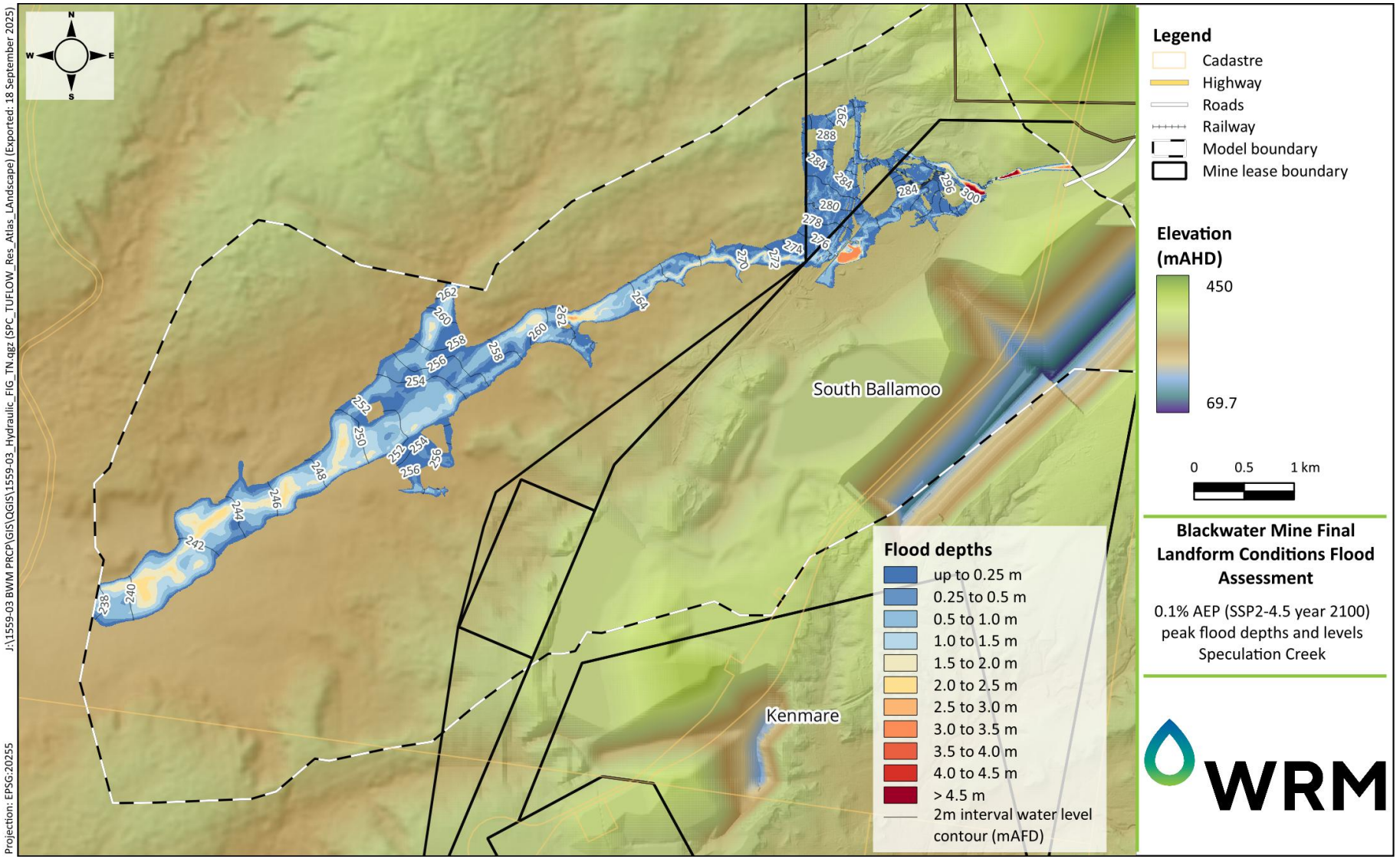


Figure 6.11 **Final landform conditions 0.1% AEP peak flood depths, levels and extents, Speculation Creek**

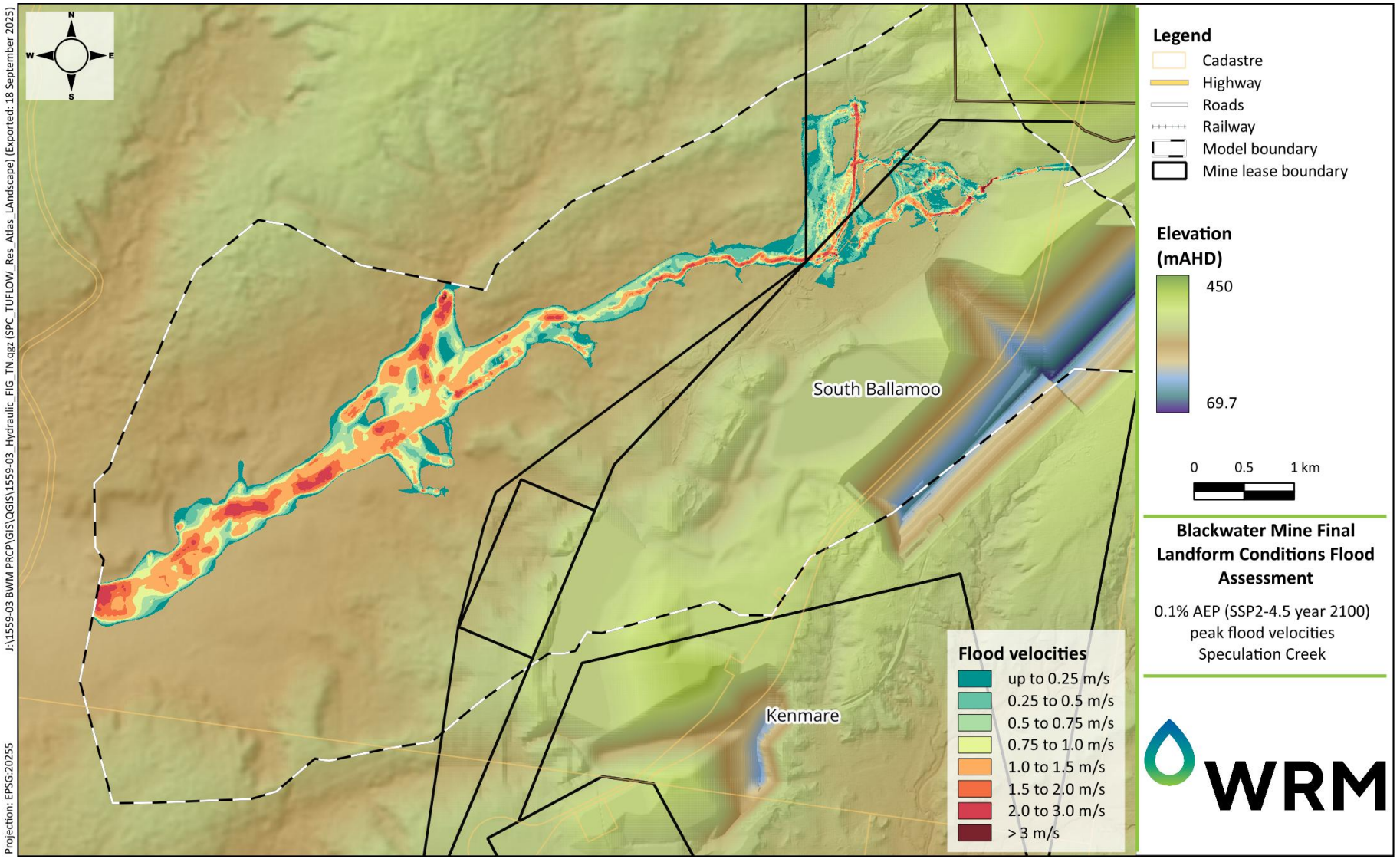


Figure 6.12 **Final landform conditions 0.1% AEP peak velocities, Speculation Creek**

6.3.6 Sirius Creek catchment

Figure 6.13 and Figure 6.14 show the predicted 0.1 % AEP peak flood extents, levels, depths, and velocities for Sirius Creek model, respectiverly.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C as following:

- Peak flood depths and extents - Figure C.25 and Figure C.26.
- Peak flood velocities - Figure C.27 and Figure C.28.

Model results indicate that:

- Under current (operational) conditions, there is a significant flood storage area formed by the R74 open cut pit's flood protection landform and the Sirius Creek Diversion. As a result, significant backwater flooding occurs over a large area upstream of the R74 pit during significant flood events under current (operational) conditions. This flood storage area would remain under post-mining conditions.
- The Togara/North Marshmead and R74 voids would have 0.1% AEP flood immunity. However, floodwater ingress into the Togara/North Marshmead and R74 voids is predicted to occur during a PMF event. Section 6.3.8 describes how the risk of floodwater ingress into these voids during events rarer than 0.1% AEP would be mitigated.
- Flood velocities adjacent to the proposed voids, for all events up to 0.1% AEP, are generally low (less than 0.5 m/s). These velocities are well below the 2.5 m/s threshold for potential erosion risk from the PRCP Schedule.
- Velocities in excess of 3 m/s are predicted in some sections of the Sirius Creek temporary diversion. Section 6.3.8 describes how the risk of high velocities along the Sirius Creek temporary diversion would be mitigated.

Note, the Sirius Creek diversion is a licensed diversion (authorisation reference 52652F). Prior to relinquishment of the diversion license, a functional design assessment will assess whether the diversion meets the licence relinquishment criteria, or if additional remediation works are required. Additional remediation works to meet the functional design will be documented in future PRCPs.

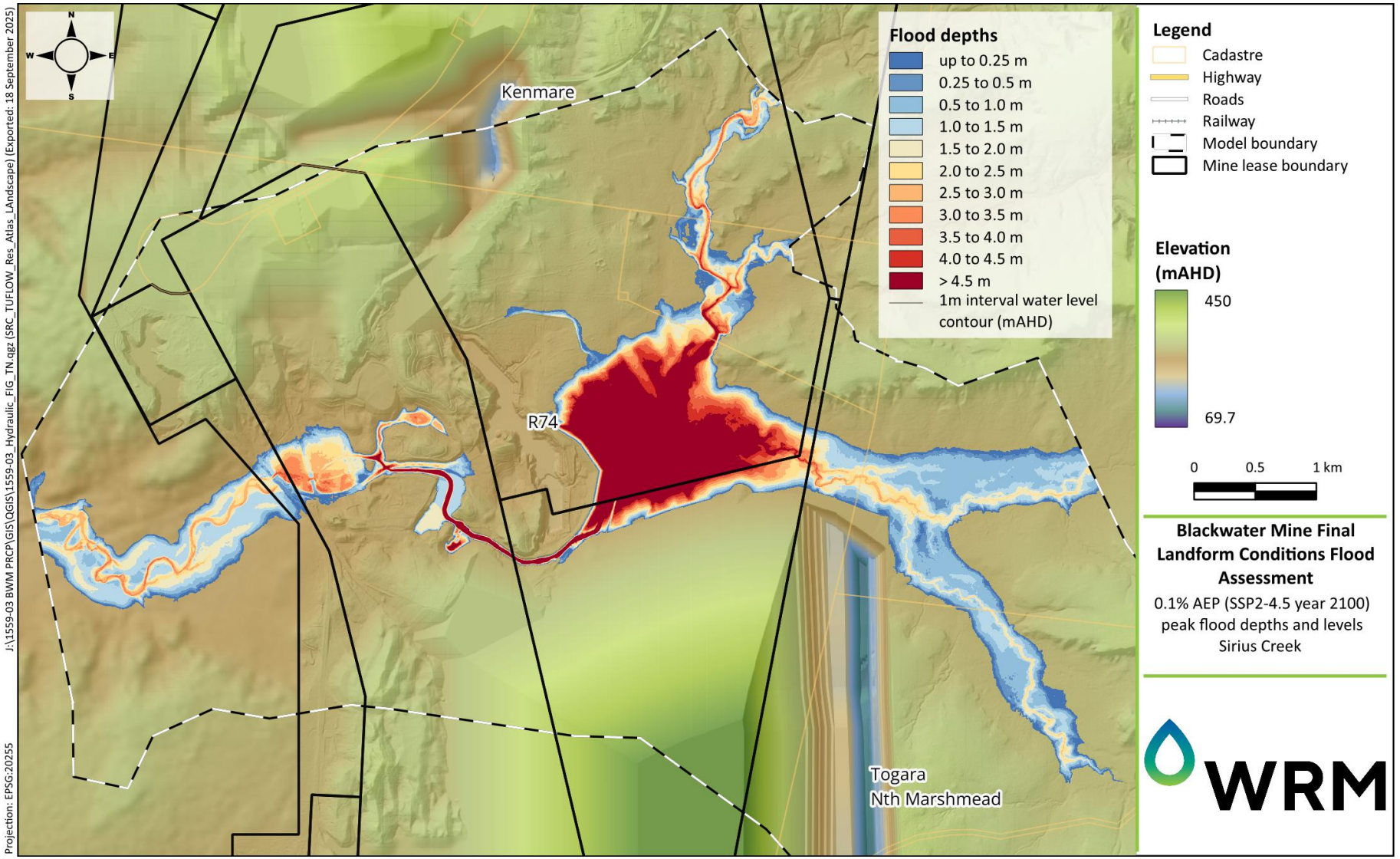


Figure 6.13 **Final landform conditions 0.1% AEP peak flood depths, levels and extents, Sirius Creek**

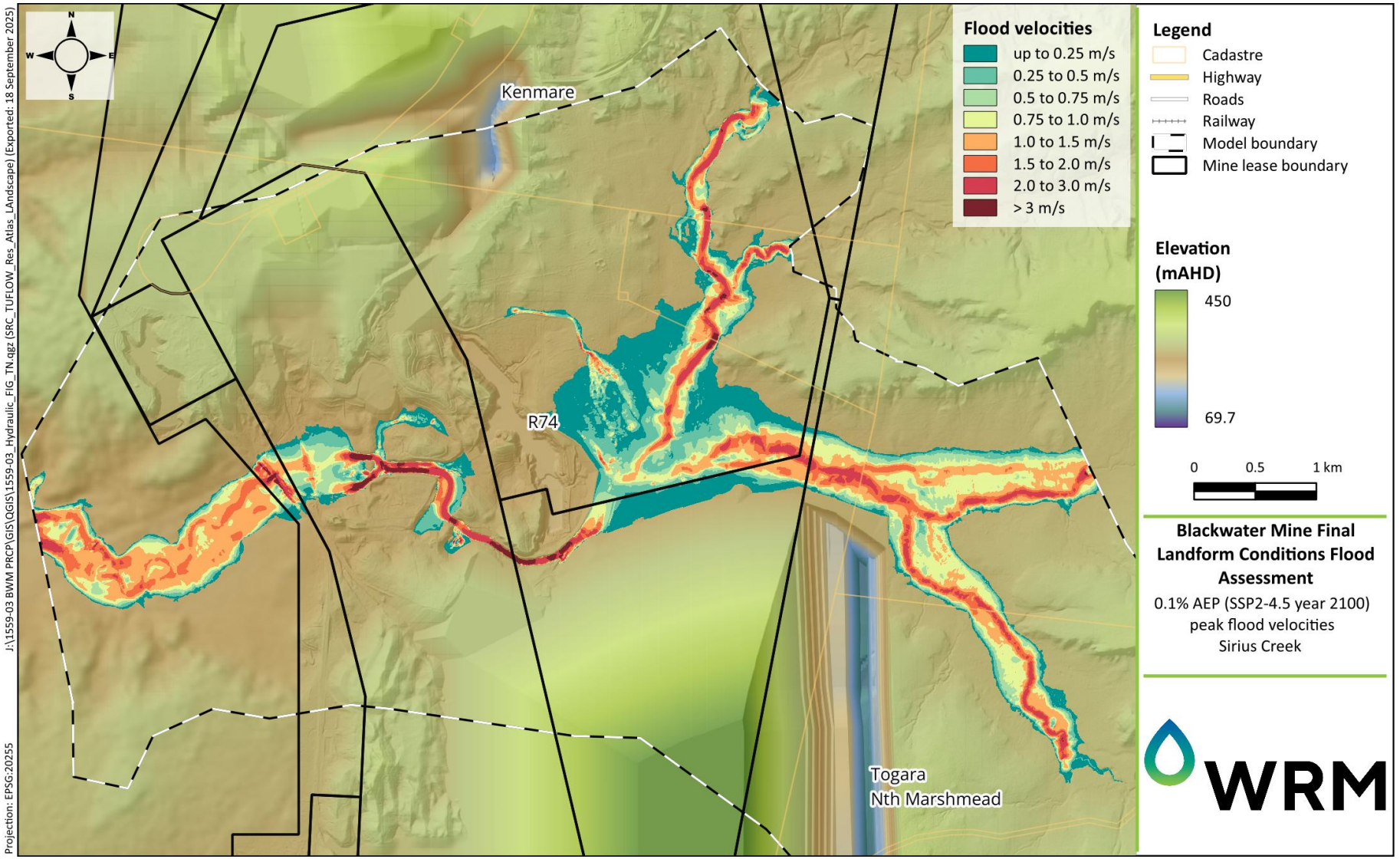


Figure 6.14 **Final landform conditions 0.1% AEP peak velocities, Sirius Creek**

6.3.7 Rockland Creek catchment

Figure 6.15 and Figure 6.16 show the predicted 0.1 % AEP peak flood extents, levels, depths, and velocities for Rockland Creek model, respectiverly.

Flood maps for the 1% AEP, and PMF events are provided in the Appendix C as following:

- Peak flood depths and extents - Figure C.29 and Figure C.30.
- Peak flood velocities - Figure C.31 and Figure C.32.

Model results indicate that:

- The South Marshmead void would have 0.1% AEP flood immunity.
- The Comet Downs East and Kennedy voids have 0.1% AEP flood immunity. However, floodwater ingress into the Comet Downs East and Kennedy voids is predicted to occur during a PMF event. Section 6.3.8 describes how the risk of floodwater ingress into these voids during events rarer than 0.1% AEP would be mitigated.
- Flood velocities along the toe of the flood protection landform adjacent to the South Marshmead void, for all events up to 0.1% AEP, are generally low (less than 0.5 m/s).
- Flood velocities along the toe of the flood protection landform adjacent to the Comet Downs East and Kennedy Voids are up to about 1.5 m/s for events up to and including the 0.1% AEP. These velocities are well below the 2.5 m/s threshold for potential erosion risk from the PRCP Schedule.

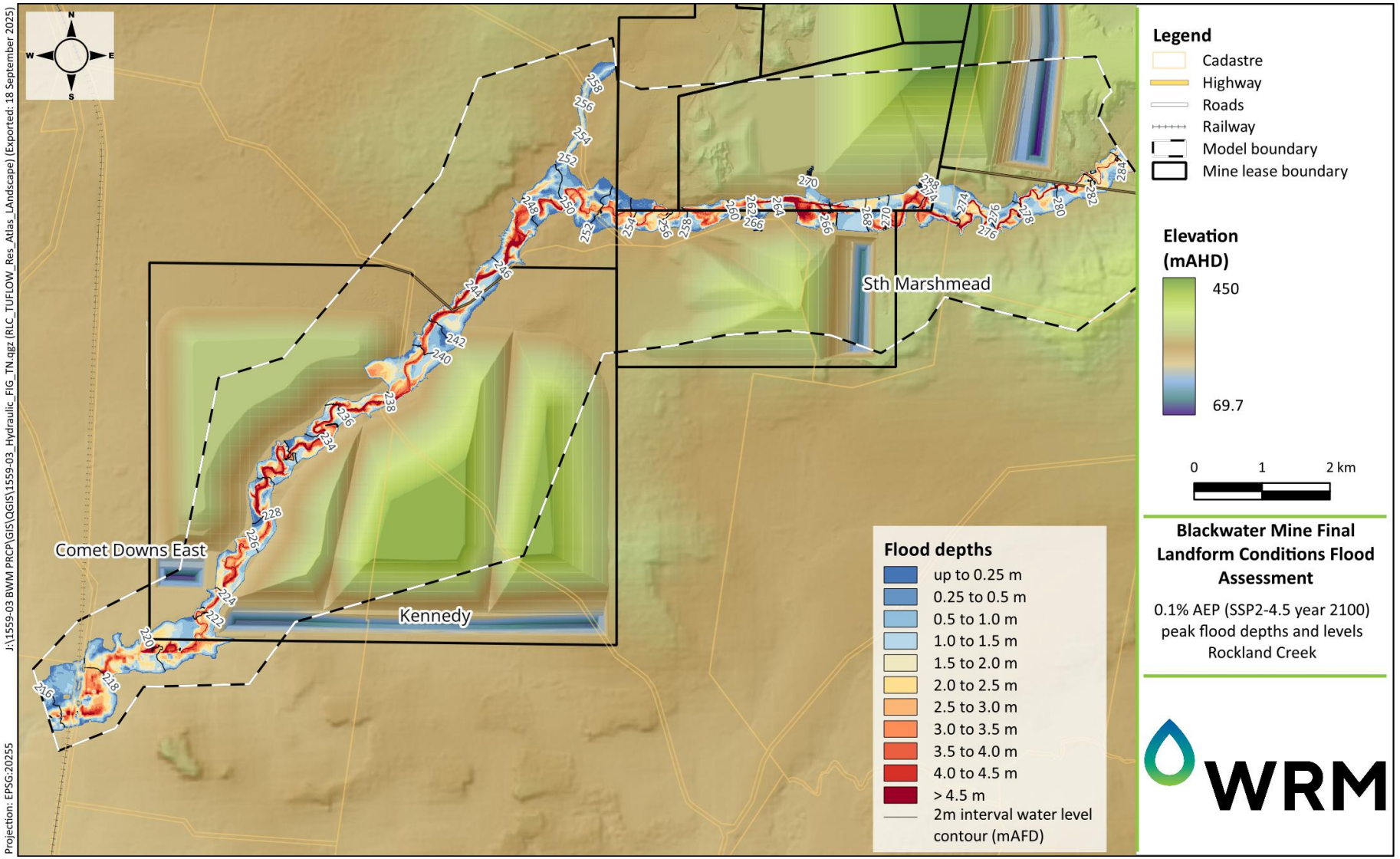


Figure 6.15 **Final landform conditions 0.1% AEP peak flood depths, levels and extents, Rockland Creek**

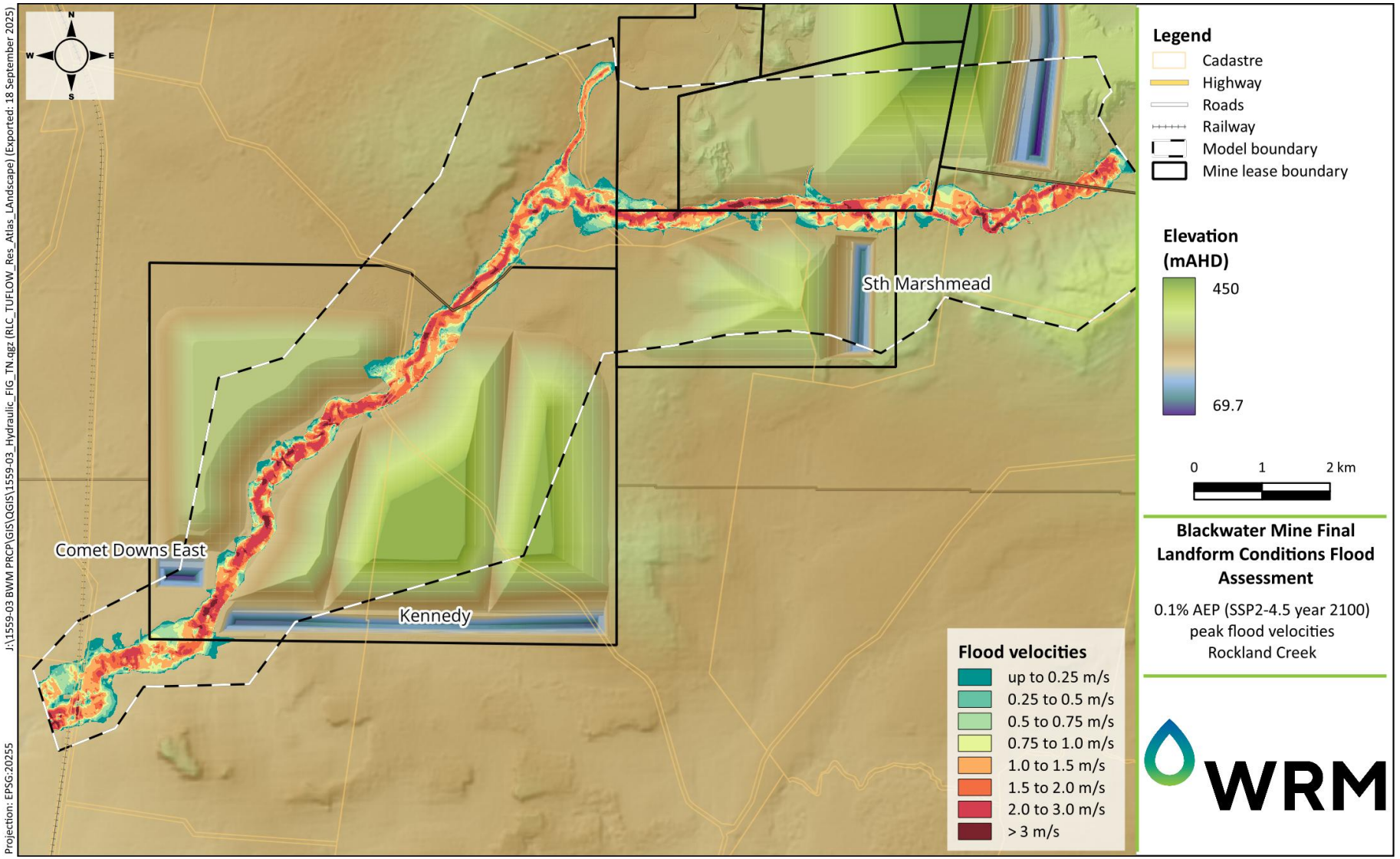


Figure 6.16 **Final landform conditions 0.1% AEP peak velocities, Rockland Creek**

6.3.8 Summary of residual flood risks and proposed mitigation measures

The hydraulic model results indicate that the BWM final landform as currently designed, would satisfy the key requirements of the PRCP guideline and the general conditions of the BWM PRCP Schedule (DETSI, 2026). However, further investigation is required to assess the following residual flood risks to the BWM final landform:

- Floodwater ingress to the R30, Togara/North Marshmead, R74, Comet Downs East and Kennedy voids during a PMF event (refer to Sections 6.3.4, 6.3.6 and 6.3.7);
- Localised high energy flows (≥2.5 m/s) in contact with the toe of rehabilitated overburden areas adjacent to Taurus Creek during a 0.1% AEP event (refer to Section 6.3.4); and
- High energy flows (≥2.5 m/s) along the Sirius Creek temporary diversion (refer to Section 6.3.6).

Table 6.1 summarises the potential consequences and proposed mitigation measures for the above residual risks.

Table 6.1 Residual flood risks and proposed mitigation measures

Risk ID	Description of risk	Potential Consequences	Mitigation measures
1	Floodwater ingress to the following voids during a PMF event: • R30 • Togara/North Marshmead • R74 • Comet Downs East • Kennedy	• Changes to the catchment hydrology and floodplain hydraulic characteristics. • Impacts on receiving water quality.	A flood susceptibility and impact assessment will be undertaken in accordance with conditions PRCP 15-17 of the PRCP Schedule. This process would include undertaking a Consequence Category Assessment (CCA) in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures* (ESR/2016/1933) (the CCA Manual) to determine if changes to the flood protection landform design may be required based on the potential consequence of floodwater ingress into these voids.

2	Localised high energy flows (≥2.5 m/s) in contact with the toe of rehabilitated overburden areas adjacent to Taurus Creek during a 0.1% AEP event.	Erosion and scour along the toe of rehabilitated overburden areas during rare and extreme flood events.	• The final landform would be rehabilitated to achieve the minimum groundcover requirements of RM 6.3 of the PRCP Schedule.
			• One or a combination of the following additional mitigation measures may be implemented in accordance with RM 3.12 of the PRCP schedule:
			  ○ rock lining at the affected areas;
			  ○ establishing denser vegetation cover at the affected areas; and/or
			  ○ channel remediation works to divert high velocity areas along Taurus Creek away from the toe of the rehabilitated overburden areas.

3	High energy flows (≥2.5 m/s) along the Sirius Creek temporary diversion.	• Structural damage to the Sirius Creek temporary diversion channel. • Erosion and scour leading to failure of the rehabilitated overburden areas adjacent to the diversion.	• A flood susceptibility and impact assessment will be undertaken for the Sirius Creek temporary diversion in accordance with conditions PRCP 15-17 of the PRCP Schedule. This process includes undertaking a CCA in accordance with the CCA Manual to determine if remediation works may be required based on the consequence of failure of the temporary diversion during extreme flood events. • Prior to relinquishment of the diversion license, a functional design assessment will assess whether the diversion meets the licence relinquishment criteria, or if additional remediation works are required. Additional remediation works to meet the functional design will be documented in future PRCPs.

6.4 CONSIDERATION FOR ALTERATION OF FLOWS

The potential alteration of flows upstream and downstream of BWM was assessed by comparing the catchment areas of the modelled creeks between final landform conditions and existing conditions. There is insufficient pre-mining topographical data available to undertake the assessment of catchment/flow alterations from pre-mining conditions. Table 6.2 shows the percentage change in catchment areas between existing and final landform conditions. It shows that:

- The changes in catchment areas are generally insignificant.
- The largest percentage change in catchment area is 12.7% at the Burngrove Creek catchment to the western ML boundary. However, the catchment area to the western ML boundary is relatively small. At the Capricorn Highway about 6.5 km downstream of the ML boundary, the Burngrove Creek catchment area is more than three times larger and hence, the change in catchment area is less than 4% at the Capricorn Highway.
- Overall, the predicted minor changes in catchment areas are not expected to cause adverse alterations to flow upstream and downstream of BWM between existing and final landform conditions.

Table 6.2 Change in catchment areas between existing and final landform conditions

Location	Catchment area under existing conditions (km^2)	Catchment area under final landform conditions (km^2)	Change
Bonnie Doon Creek at western ML boundary	21.6	21.3	-1.3%
Burngrove Creek at Western ML boundary	45.3	51.1	12.7%
Sagittarius Creek at northern ML boundary	42.7	39.6	-7.3%
Taurus Creek at eastern ML boundary / Blackwater Creek confluence	248.9	259.5	4.3%
Speculation Creek at the Speculation Creek stream gauge	45.3	48.9	7.9%
Sirius Creek at the Sirius Creek stream gauge / western ML boundary	120.2	113.8	-5.4%
Rockland Creek at southwestern ML boundary	158.6	157.9	-0.4%
Total	**682.6**	**692.1**	**1.4%**

7 SUMMARY OF FINDINGS

7.1 OVERVIEW

Hydrologic and hydraulic modelling for the BWM final landform was undertaken to supplement the BWM PRCP. As part of the PRCP for BWM, it is proposed to incorporate 15 final voids as NUMAs.

7.2 HYDROLOGIC AND HYDRAULIC MODEL DEVELOPMENT

Hydrologic and hydraulic modelling was undertaken to assess flood behaviour under the proposed BWM final landform conditions, in support of the Blackwater Mine PRCP.

New URBS hydrologic models were developed and calibrated to recorded data for the April 2017 and January 2020 flood events where data was available. Design event hydrologic modelling was undertaken in accordance with ARR 2019, for the 1% AEP, 0.1% AEP and PMF design flood events. The new URBS models incorporate the latest climate change guidance from Australian Rainfall and Runoff 2019 Version 4.2 (ARR 2019 v4.2) (Ball et al, 2019). Design flood discharges were estimated based on the SSP2-4.5 (year 2100) future climate scenario.

TUFLOW hydraulic models previously developed by SLR (2024a and 2024b) were updated to incorporate updated BWM final landform, and to incorporate new design discharge from the new URBS hydrologic models. The updated hydraulic models were used to estimate flood levels, depths, extents and velocities for 1% AEP, 0.1% AEP and PMF design events.

7.3 FLOOD RISKS

Flood modelling results demonstrate that all 15 residual voids at BWM would have 0.1% AEP flood immunity under future (year 2100) climate conditions. Flood velocities along the toe of proposed rehabilitated overburden areas are generally less than 2.5 m/s for all events up to the 0.1% AEP design flood event, which is the threshold above which the final landform would be considered at risk of flood-induced erosion. As such, the final landform is expected to remain stable for all events up to the 0.1% AEP design flood event.

Further investigation is required to assess the following residual flood risks to the BWM final landform, and determine the appropriate mitigation measures:

- Floodwater ingress to the R30, Togara/North Marshmead, R74, Comet Downs East and Kennedy voids during a PMF event;
- Localised high energy flows (≥2.5 m/s) in contact with the toe of rehabilitated overburden areas adjacent to Taurus Creek during a 0.1% AEP event; and
- High energy flows (≥2.5 m/s) along the Sirius Creek temporary diversion.

The above residual risks will be addressed by undertaking a flood susceptibility and impact assessment in accordance with conditions PRCP 15-17 of the PRCP Schedule. This process includes undertaking a CCA in accordance with the CCA Manual to determine the appropriate mitigation measures based on the potential consequences.

7.4 CONSIDERATION FOR ALTERATION OF FLOWS

The potential alteration of flows upstream and downstream of BWM was assessed by comparing the catchment areas of the modelled creeks between final landform conditions and existing conditions. The changes in catchment areas are generally insignificant. Considering all catchments that traverse BWM, the total predicted net change in catchment areas between existing and final landform conditions is approximately 1.4% and are not expected to cause adverse alterations to flow upstream and downstream of BWM.

8 REFERENCES

DNRME, 2019	Australian Coal Association Research Program, July 2022, *Guideline: Works that interfere with water in a watercourse—watercourse diversions*
Alluvium, 2014	Alluvium, March 2014, *Criteria for functioning river landscape units in mining and post mining landscapes*, Final report for ACARP Project C20017.
Ball et al., 2019	Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, 2019, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia (Geoscience Australia), Version 4.2.
BoM, 2003	Commonwealth Bureau of Meteorology, June 2003, *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method,* Hydrometeorological Advisory Service.
BoM, 2005	Commonwealth Bureau of Meteorology, September 2005, *Guidebook to the Estimation of Probable Maximum Precipitation: Generalised Tropical Storm Method*, Hydrometeorological Advisory Service.
DETSI, 2024	Department of Environment, Tourism, Science and Innovation, September 2024, *Statutory guideline – Progressive rehabilitation and closure plan (PRC plans)*, Queensland Government
DETSI, 2026	Department of Environment, Tourism, Science and Innovation, May 2026, *PRCP schedule P-PRCP-100758455 Blackwater Mine*, Queensland Government
GHD, 2021	GHD, June 2021, *Blackwater Mine Flood Study*.
Jordan, 2005	Phillip Jordan et al, 2005, *Growth curves and temporal patterns of short duration design storms for extreme events.*
SLR, 2024a	SLR Consulting Australia, October 2024, *Blackwater Mine – Progressive Rehabilitation and Closure Plan – Rehabilitation Flood Assessments*.
SLR, 2024b	SLR Consulting Australia, October 2024, *Blackwater Mine – Progressive Rehabilitation and Closure Plan – Voids in Floodplain Modelling.*

APPENDIX AURBS MODEL CONFIGURATION

A.1 BONNIE DOON CREEK (BDC) CATCHMENT

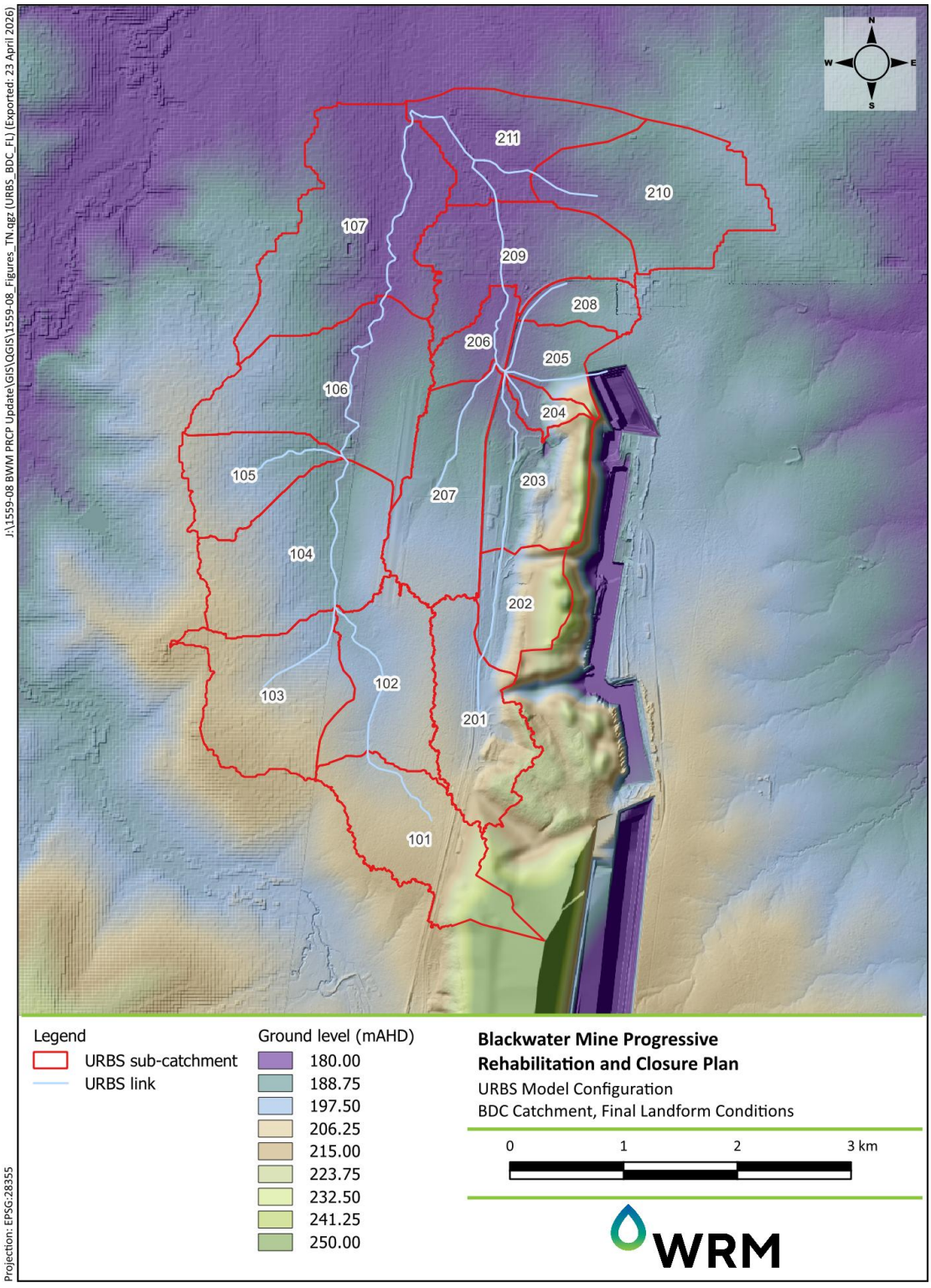


Figure A.1 URBS model configuration, Bonnie Doon Creek catchment, final landform conditions

Table A.1 URBS model subcatchment parameters, Bonnie Doon Creek catchment

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.37	0	0.035	0.019
102	1.26	0	0.035	0.006
103	1.46	0	0.035	0.010
104	1.83	0	0.035	0.007
105	0.83	0	0.035	0.011
106	2.02	0	0.035	0.005
107	2.46	0	0.035	0.007
201	1.20	0	0.035	0.009
202	0.73	0	0.035	0.031
203	1.07	0	0.035	0.012
204	0.18	0	0.035	0.026
205	0.47	0	0.035	0.033
206	0.39	0	0.035	0.005
207	1.36	0	0.035	0.007
208	0.38	0	0.035	0.006
209	1.39	0	0.035	0.007
210	1.72	0	0.035	0.006
211	1.19	0	0.035	0.005

A.2 SAGITTARIUS CREEK (SGC) CATCHMENT

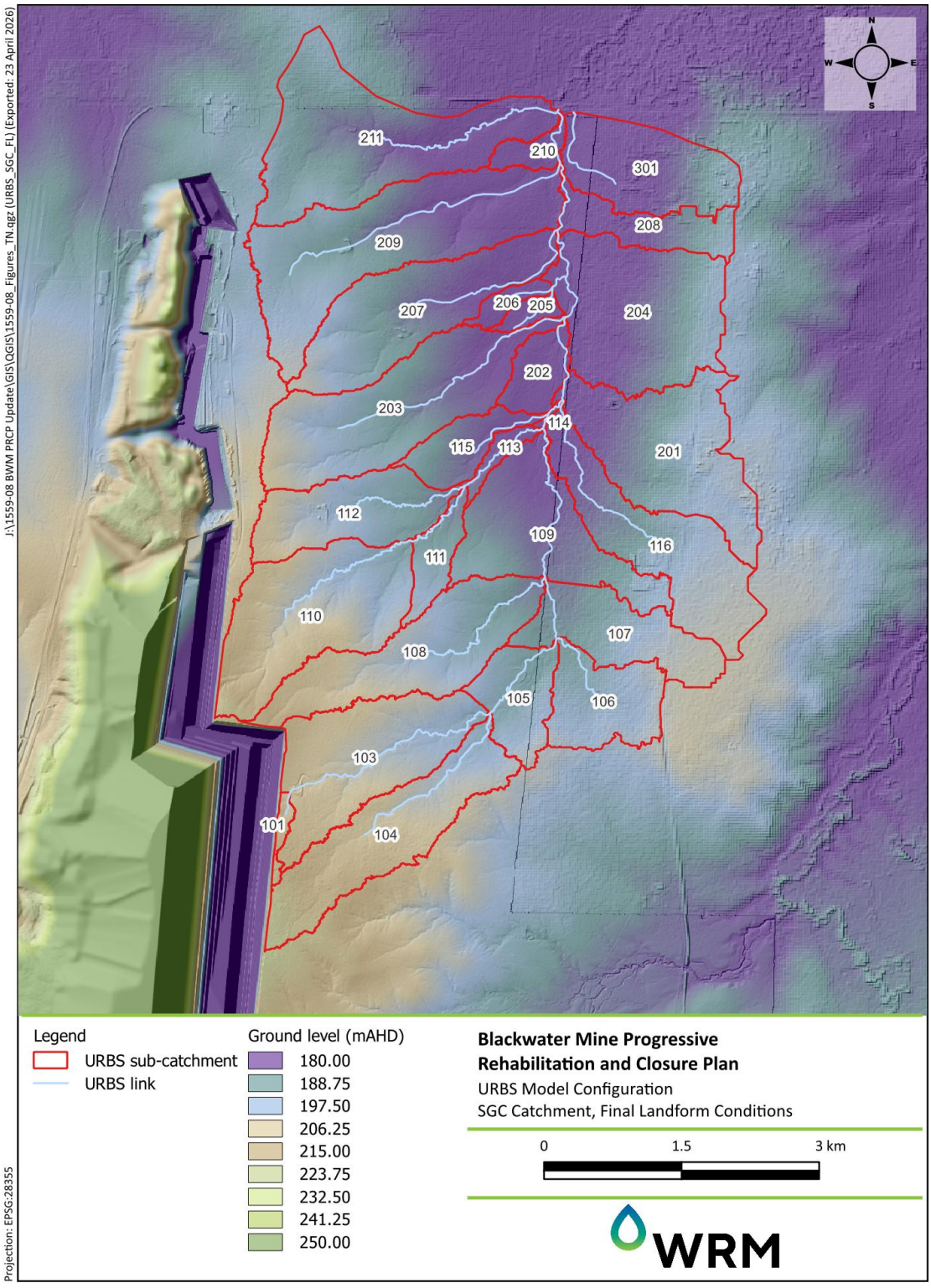


Figure A.2 URBS model configuration, Sagittarius Creek catchment, final landform conditions

Table A.2 URBS model subcatchment parameters, Sagittarius Creek catchment

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	0.11	0	0.070	0.008
103	2.25	0	0.070	0.007
104	2.10	0	0.070	0.007
105	0.87	0	0.070	0.007
106	1.14	0	0.070	0.008
107	1.37	0	0.070	0.009
108	2.18	0	0.070	0.008
109	2.02	0	0.070	0.007
110	2.57	0	0.070	0.008
111	0.46	0	0.070	0.009
112	1.46	0	0.070	0.009
113	0.19	0	0.070	0.007
114	0.02	0	0.070	0.005
115	0.63	0	0.070	0.007
116	2.12	0	0.070	0.007
201	2.44	0	0.070	0.010
202	0.51	0	0.070	0.004
203	2.72	0	0.070	0.007
204	2.69	0	0.070	0.010
205	0.17	0	0.070	0.007
206	0.20	0	0.070	0.007
207	2.22	0	0.070	0.008
208	0.81	0	0.070	0.008
209	3.34	0	0.070	0.007
210	0.27	0	0.070	0.003
211	3.14	0	0.070	0.005
301	1.58	0	0.070	0.008

A.3 BURNGROVE CREEK (BGC) CATCHMENT

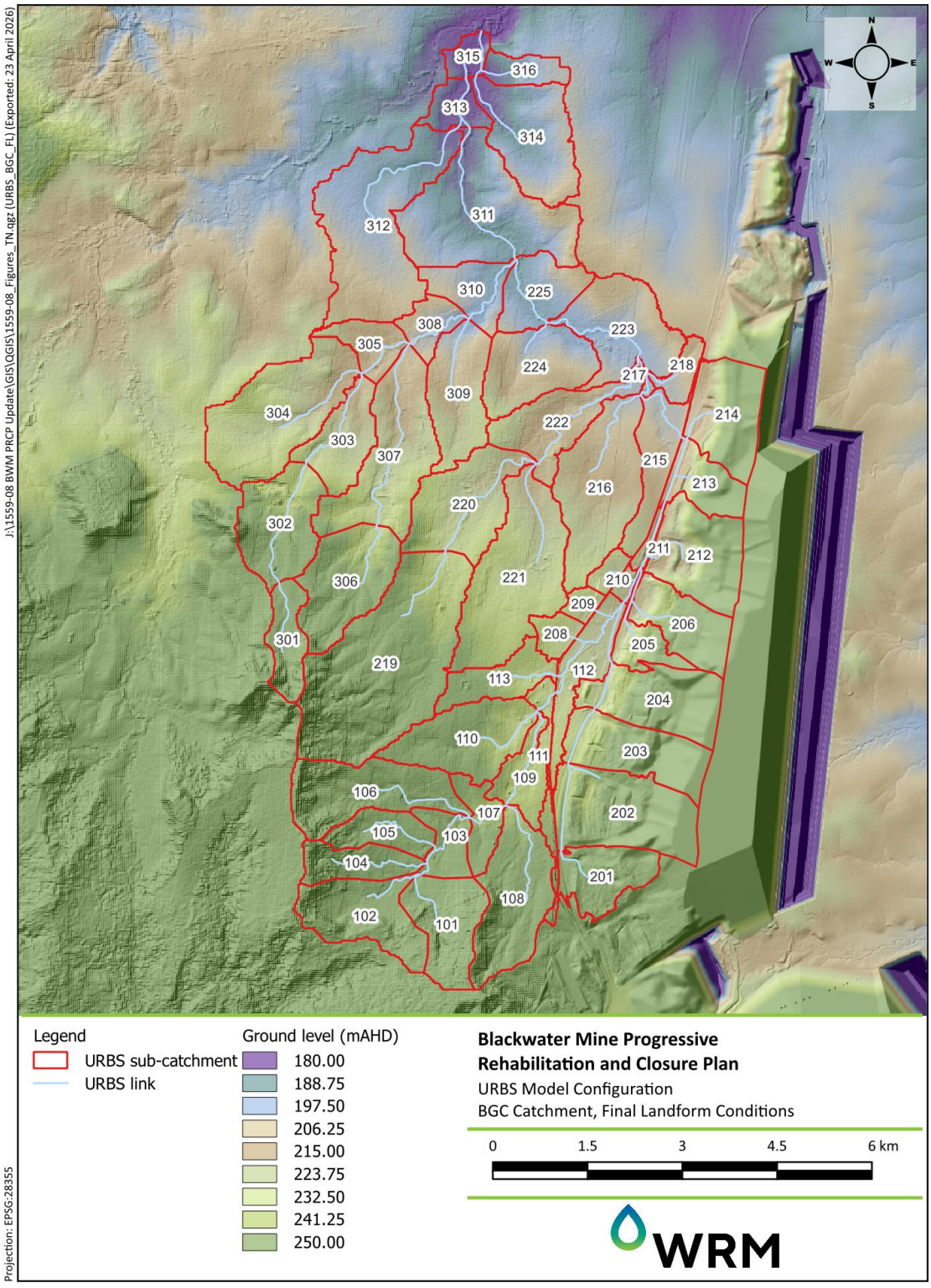


Figure A.3 URBS model configuration, Burngrove Creek catchment, final landform conditions

Table A.3 URBS model subcatchment parameters, Burngrove Creek catchment

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.66	0	0.035	0.017
102	1.90	0	0.035	0.019
103	0.72	0	0.035	0.007
104	0.96	0	0.035	0.010
105	0.89	0	0.035	0.009
106	2.25	0	0.035	0.023
107	0.72	0	0.035	0.007
108	2.37	0	0.035	0.024
109	0.87	0	0.035	0.009
110	2.07	0	0.035	0.021
111	0.54	0	0.035	0.005
112	1.22	0	0.035	0.012
113	1.04	0	0.035	0.010
201	1.35	0	0.035	0.022
202	2.68	0	0.035	0.037
203	1.91	0	0.035	0.042
204	2.04	0	0.035	0.047
205	0.68	0	0.035	0.052
206	1.42	0	0.035	0.047
207	0.15	0	0.035	0.002
208	0.41	0	0.035	0.004
209	0.25	0	0.035	0.003
210	0.27	0	0.035	0.003
211	0.17	0	0.035	0.012
212	2.00	0	0.035	0.033
213	0.98	0	0.035	0.032
214	1.80	0	0.035	0.047
215	1.26	0	0.035	0.013
216	2.89	0	0.035	0.029
217	0.06	0	0.035	0.001
218	0.42	0	0.035	0.004
219	5.72	0	0.035	0.057
220	2.24	0	0.035	0.022
221	3.52	0	0.035	0.035

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
222	1.69	0	0.035	0.017
223	2.17	0	0.035	0.022
224	1.87	0	0.035	0.019
225	1.26	0	0.035	0.013
301	0.93	0	0.035	0.009
302	2.00	0	0.035	0.020
303	1.33	0	0.035	0.013
304	3.27	0	0.035	0.033
305	0.76	0	0.035	0.008
306	2.17	0	0.035	0.022
307	2.89	0	0.035	0.029
308	0.63	0	0.035	0.006
309	1.81	0	0.035	0.018
310	1.00	0	0.035	0.010
311	3.79	0	0.035	0.038
312	4.12	0	0.035	0.041
313	0.61	0	0.035	0.006
314	2.26	0	0.035	0.023
315	0.40	0	0.035	0.010
316	0.58	0	0.035	0.010

A.4 BLACKWATER CREEK (BWC) CATCHMENT

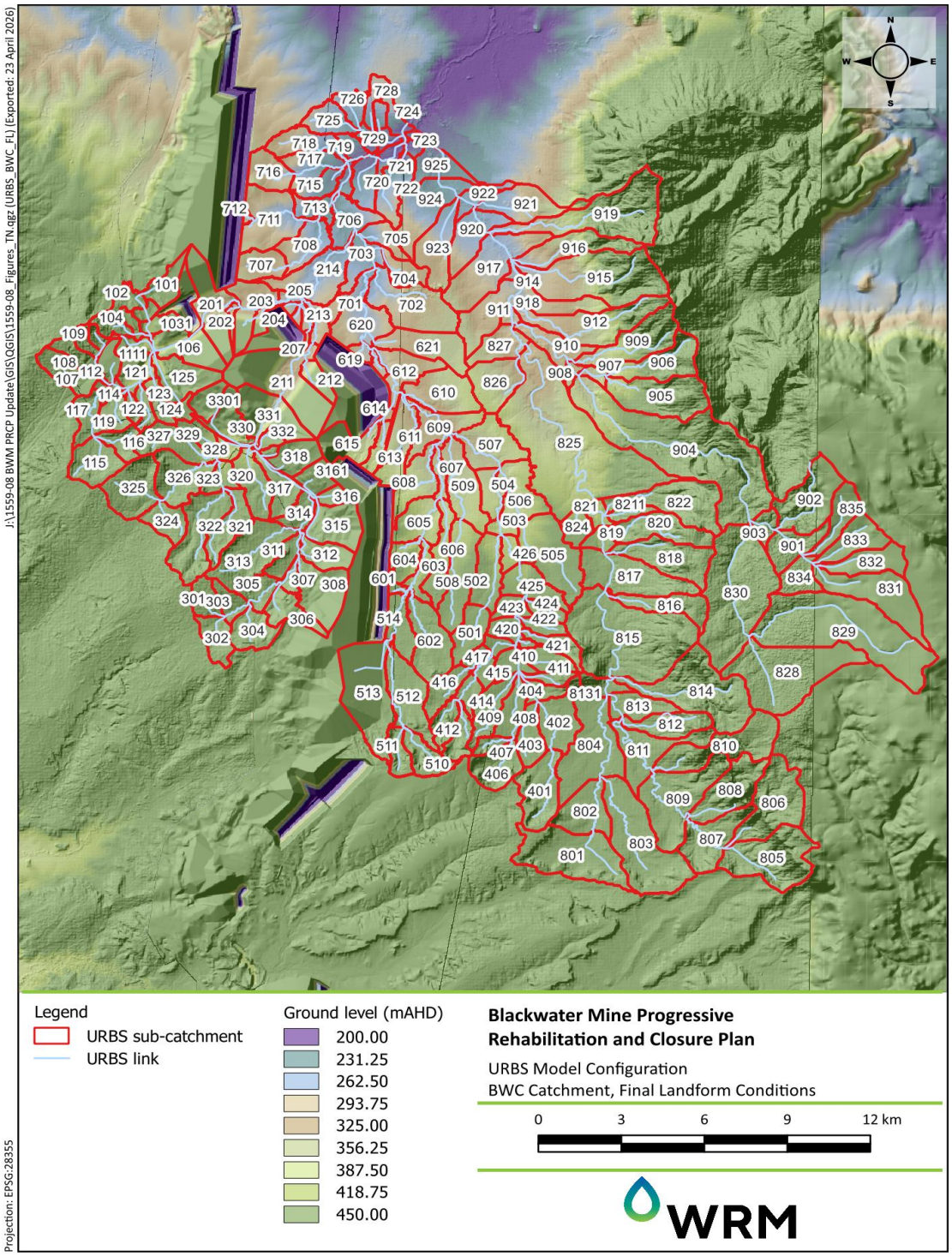


Figure A.4 URBS model configuration, Blackwater Creek catchment (including Deep Creek, Taurus Creek and Two Mile Gully), final landform conditions

Table A.4 URBS model subcatchment parameters, Blackwater Creek catchment

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.48	0	0.08	0.039
102	0.88	0	0.08	0.009
103	0.47	0	0.08	0.022
104	0.97	0	0.08	0.028
105	0.51	0.5	0.07	0.021
106	2.85	0	0.07	0.052
107	2.02	0	0.10	0.030
108	1.10	0	0.10	0.070
109	0.65	0	0.10	0.028
110	0.42	0	0.10	0.044
111	0.02	0	0.07	0.006
112	0.10	0	0.07	0.009
113	0.99	0.5	0.07	0.005
114	0.33	0	0.07	0.020
115	2.55	0	0.08	0.017
116	1.21	0	0.08	0.015
117	1.61	0	0.08	0.012
118	0.28	0	0.07	0.010
119	1.14	0	0.07	0.036
120	0.50	0	0.07	0.029
121	1.40	0	0.08	0.009
122	0.79	0	0.07	0.023
123	1.05	0	0.08	0.018
124	0.60	0	0.08	0.027
125	2.70	0	0.80	0.013
201	3.69	0	0.07	0.030
202	0.33	0	0.07	0.072
203	2.46	0	0.07	0.033
204	0.51	0	0.07	0.032
205	0.31	0	0.07	0.002
206	0.20	0	0.07	0.008
207	0.15	0	0.07	0.007
208	0.40	0	0.07	0.003
209	0.20	0	0.07	0.008

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
211	6.33	0	0.07	0.026
212	0.98	0	0.07	0.070
213	0.94	0	0.07	0.004
214	3.78	0	0.07	0.004
301	1.34	0	0.07	0.033
302	1.71	0	0.07	0.018
303	1.05	0	0.07	0.026
304	2.10	0	0.07	0.026
305	1.23	0	0.07	0.009
306	1.79	0	0.07	0.038
307	0.62	0	0.07	0.030
308	3.47	0	0.07	0.048
311	1.08	0	0.07	0.015
312	1.74	0	0.07	0.037
313	4.53	0	0.07	0.017
314	1.21	0	0.07	0.004
315	2.80	0	0.07	0.033
316	0.68	0	0.07	0.074
317	1.81	0	0.07	0.009
318	1.84	0	0.07	0.041
319	0.22	0	0.07	0.105
320	2.47	0	0.07	0.013
321	2.35	0	0.07	0.017
322	4.18	0	0.07	0.016
323	1.05	0	0.07	0.013
324	1.70	0	0.07	0.019
325	3.44	0	0.08	0.023
326	3.05	0	0.07	0.013
327	2.57	0	0.07	0.013
328	0.67	0	0.07	0.004
329	1.04	0	0.07	0.015
330	2.11	0	0.07	0.023
331	3.40	0	0.07	0.048
332	0.55	0	0.07	0.045
401	3.50	0	0.07	0.015

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
402	2.59	0	0.07	0.011
403	1.73	0	0.07	0.012
404	0.92	0	0.07	0.017
405	0.74	0	0.07	0.032
406	2.38	0	0.07	0.018
407	0.62	0	0.07	0.027
408	1.72	0	0.07	0.012
409	2.13	0	0.07	0.015
410	1.21	0	0.07	0.007
411	1.35	0	0.07	0.030
412	1.33	0	0.07	0.022
413	1.28	0	0.07	0.024
414	0.97	0	0.07	0.016
415	0.66	0	0.07	0.015
416	1.65	0	0.07	0.013
417	0.55	0	0.07	0.011
418	0.57	0	0.07	0.011
419	0.21	0	0.07	0.018
420	1.00	0	0.07	0.015
421	1.25	0	0.07	0.026
422	0.87	0	0.07	0.015
423	1.00	0	0.07	0.008
424	0.79	0	0.07	0.016
425	2.31	0	0.07	0.009
426	1.00	0	0.07	0.005
501	2.03	0	0.07	0.010
502	2.62	0	0.07	0.006
503	0.56	0	0.07	0.005
504	1.46	0	0.07	0.005
505	4.78	0	0.07	0.007
506	2.93	0	0.07	0.006
507	3.35	0	0.07	0.004
508	3.88	0	0.07	0.006
509	3.46	0	0.07	0.006
510	1.80	0	0.07	0.032

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
511	1.23	0	0.07	0.031
512	3.76	0	0.07	0.015
513	6.14	0	0.07	0.036
514	1.96	0	0.07	0.007
601	0.32	0	0.07	0.012
602	3.63	0	0.07	0.008
603	1.13	0	0.07	0.005
604	1.49	0	0.07	0.011
605	2.43	0	0.07	0.006
606	2.29	0	0.07	0.007
607	0.69	0	0.07	0.004
608	2.44	0	0.07	0.005
609	2.66	0	0.07	0.006
610	3.38	0	0.07	0.006
611	2.88	0	0.07	0.007
612	2.47	0	0.07	0.006
613	0.96	0	0.07	0.009
614	0.21	0	0.07	0.002
615	2.21	0	0.07	0.047
618	0.32	0	0.07	0.003
619	0.43	0	0.07	0.009
620	2.77	0	0.07	0.008
621	3.18	0	0.07	0.009
701	1.23	0	0.07	0.005
702	4.86	0	0.07	0.007
703	1.80	0	0.07	0.005
704	1.35	0	0.07	0.006
705	1.22	0	0.07	0.012
706	2.13	0	0.07	0.005
707	1.84	0	0.07	0.007
708	2.27	0	0.07	0.007
711	4.15	0	0.07	0.008
712	0.16	0	0.07	0.006
713	1.27	0	0.07	0.014
714	0.55	0	0.07	0.002

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
715	1.15	0	0.07	0.006
716	1.95	0	0.07	0.011
717	1.89	0	0.07	0.009
718	2.25	0	0.07	0.008
719	0.73	0	0.07	0.007
720	1.69	0	0.07	0.005
721	0.77	0	0.07	0.004
722	2.29	0	0.07	0.009
723	0.36	0	0.07	0.002
724	0.88	0	0.07	0.008
725	1.67	0	0.07	0.007
726	1.07	0	0.07	0.007
727	0.61	0	0.07	0.008
728	0.92	0	0.07	0.012
729	0.52	0	0.07	0.004
730	0.46	0	0.07	0.012
801	6.29	0	0.07	0.011
802	3.02	0	0.07	0.013
803	7.28	0	0.07	0.009
804	6.31	0	0.07	0.009
805	5.39	0	0.07	0.075
806	4.86	0	0.07	0.108
807	3.45	0	0.07	0.040
808	3.68	0	0.07	0.107
809	5.80	0	0.07	0.044
810	4.62	0	0.07	0.106
811	3.55	0	0.07	0.008
812	2.30	0	0.07	0.059
813	1.92	0	0.07	0.021
814	7.10	0	0.07	0.074
815	11.57	0	0.07	0.015
816	2.31	0	0.07	0.104
817	4.75	0	0.07	0.072
818	3.83	0	0.07	0.076
819	0.74	0	0.07	0.010

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
820	3.15	0	0.07	0.039
821	0.75	0	0.07	0.005
822	4.47	0	0.07	0.062
824	1.24	0	0.07	0.010
825	17.80	0	0.07	0.004
826	2.94	0	0.07	0.014
827	2.01	0	0.07	0.008
828	8.08	0	0.07	0.019
829	12.06	0	0.07	0.015
830	10.24	0	0.07	0.009
831	4.87	0	0.07	0.030
832	2.36	0	0.07	0.039
833	2.38	0	0.07	0.070
834	1.62	0	0.07	0.034
835	2.01	0	0.07	0.045
901	2.16	0	0.07	0.037
902	4.27	0	0.07	0.034
903	0.86	0	0.07	0.031
904	15.68	0	0.07	0.028
905	4.65	0	0.07	0.041
906	3.15	0	0.07	0.034
907	0.56	0	0.07	0.006
908	0.42	0	0.07	0.010
909	3.92	0	0.07	0.027
910	2.02	0	0.07	0.005
911	0.34	0	0.07	0.005
912	4.87	0	0.07	0.022
914	0.39	0	0.07	0.004
915	8.00	0	0.07	0.022
916	3.12	0	0.07	0.022
917	5.05	0	0.07	0.006
918	5.11	0	0.07	0.005
919	7.07	0	0.07	0.030
920	2.75	0	0.07	0.007
921	3.07	0	0.07	0.011

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
922	0.80	0	0.07	0.002
923	3.09	0	0.07	0.007
924	4.33	0	0.07	0.005
925	2.19	0	0.07	0.002
1031	0.81	0.5	0.07	0.012
1111	0.94	0.5	0.07	0.021
3161	1.32	0	0.07	0.048
3301	1.25	0	0.07	0.067
8131	1.06	0	0.07	0.021
8211	0.76	0	0.07	0.026

A.1 SPECULATION CREEK (SPC) CATCHMENT

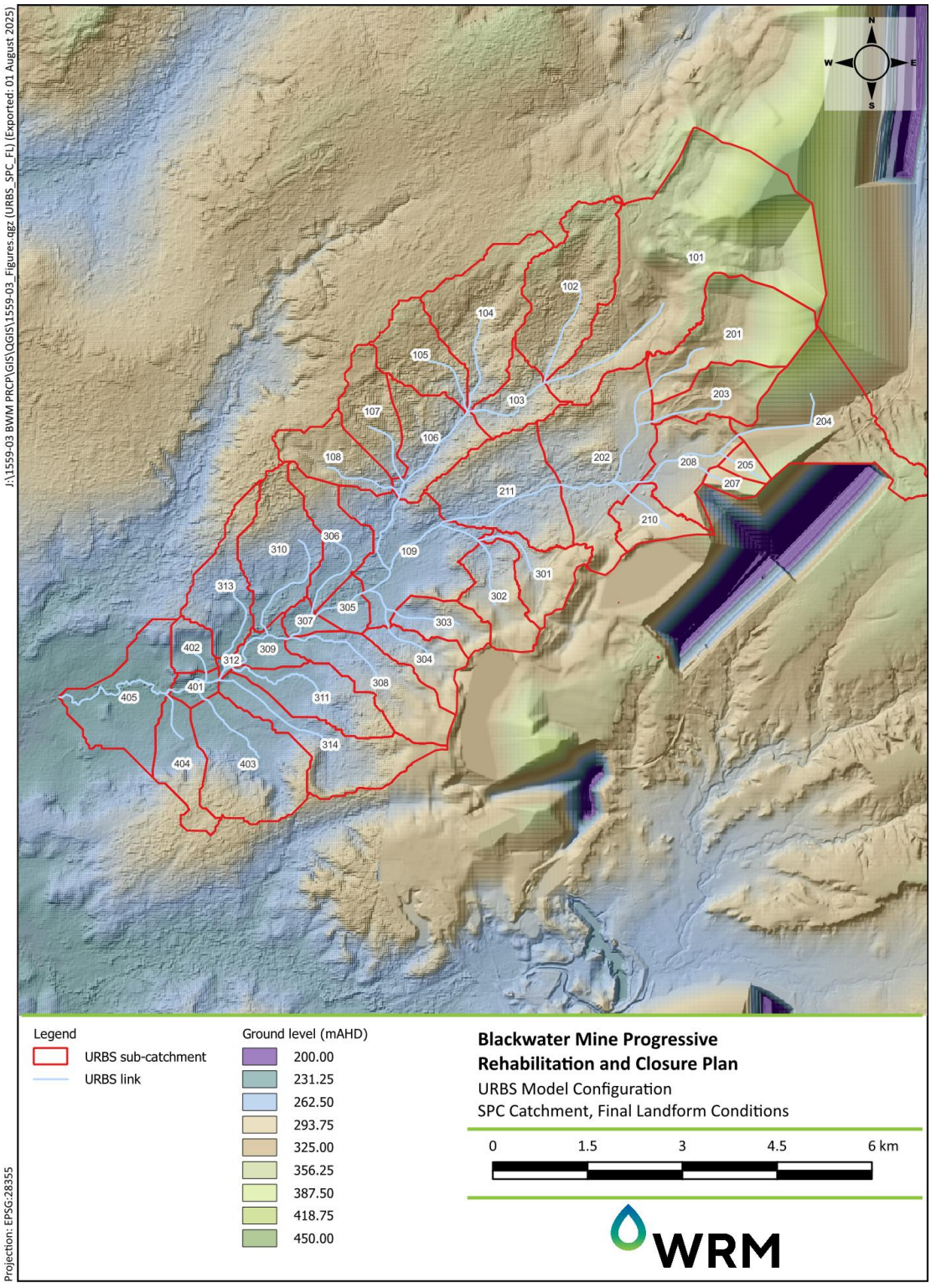


Figure A.5 URBS model configuration, Speculation Creek catchment, final landform conditions

Table A.5 URBS model subcatchment parameters, Speculation Creek catchment

ID	Total Area (km2)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	8.37	0	0.070	0.025
102	2.89	0	0.100	0.018
103	1.00	0	0.100	0.016
104	2.70	0	0.100	0.016
105	1.47	0	0.100	0.028
106	1.69	0	0.100	0.017
107	1.31	0	0.100	0.027
108	1.27	0	0.100	0.027
109	2.90	0	0.070	0.009
201	2.74	0	0.070	0.032
202	3.60	0	0.100	0.007
203	1.26	0	0.070	0.031
204	3.55	0	0.070	0.020
205	0.27	0	0.070	0.110
207	0.28	0	0.070	0.099
208	1.56	0	0.100	0.011
210	0.83	0	0.070	0.033
211	2.77	0	0.100	0.011
301	1.10	0	0.080	0.017
302	1.35	0	0.100	0.022
303	0.87	0	0.080	0.024
304	1.00	0	0.080	0.022
305	0.49	0	0.070	0.009
306	1.32	0	0.070	0.010
307	0.31	0	0.070	0.009
308	1.96	0	0.080	0.019
309	0.53	0	0.080	0.005
310	2.18	0	0.100	0.017
311	1.56	0	0.100	0.015
312	0.07	0	0.070	0.006
313	1.57	0	0.070	0.013
314	2.19	0	0.100	0.012
401	0.33	0	0.070	0.014
402	0.52	0	0.070	0.024

ID	Total Area (km2)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
403	2.73	0	0.070	0.019
404	1.19	0	0.070	0.025
405	2.24	0	0.070	0.007

A.5 SIRIUS CREEK (SRC) CATCHMENT

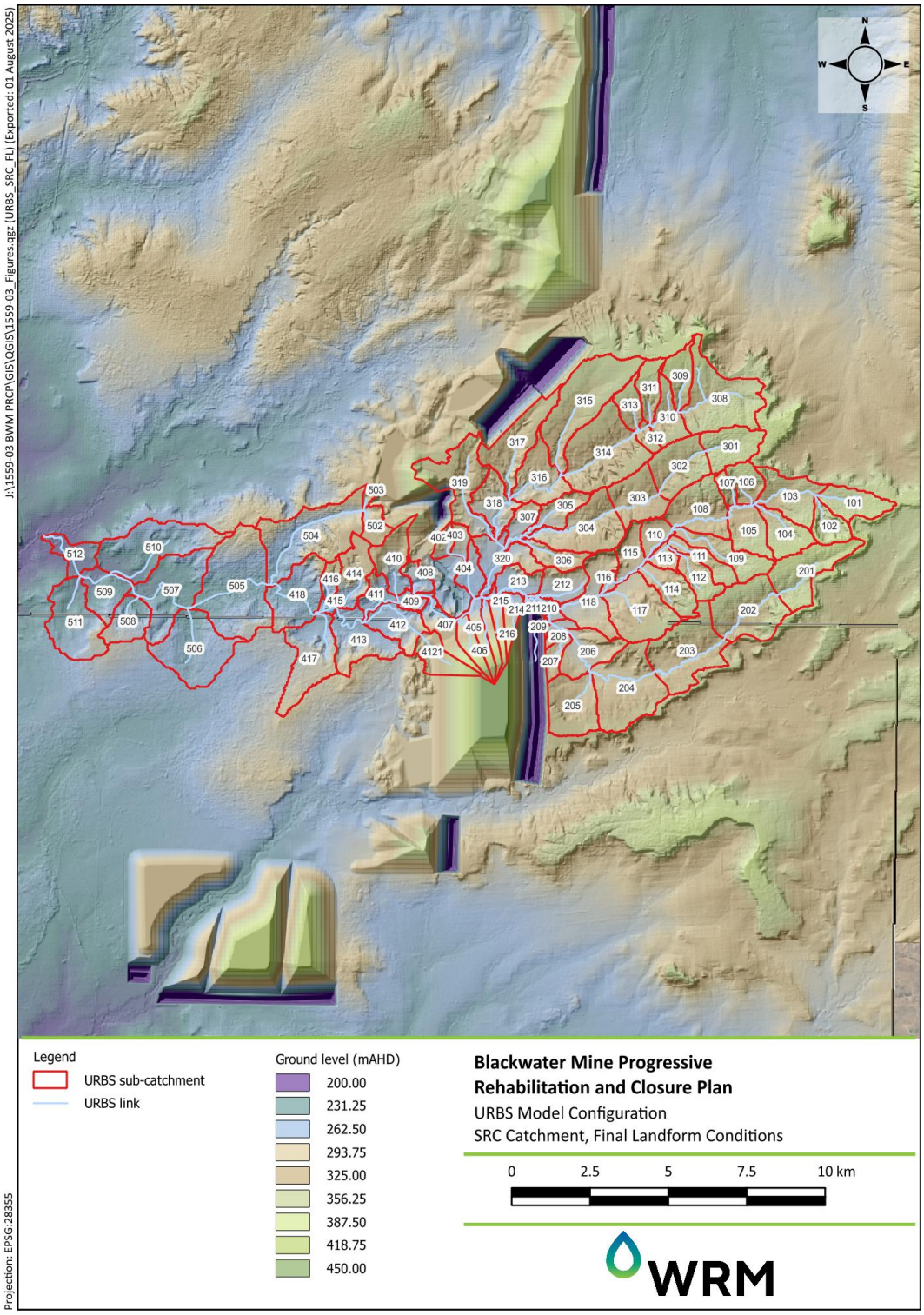


Figure A.6 URBS model configuration, Sirius Creek catchment, final landform conditions

Table A.6 URBS catchment parameters of the SRC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.70	0	0.045	0.016
102	1.18	0	0.045	0.016
103	2.37	0	0.045	0.016
104	1.66	0	0.045	0.024
105	1.75	0	0.045	0.027
106	1.13	0	0.045	0.039
107	0.48	0	0.045	0.048
108	2.73	0	0.045	0.019
109	1.92	0	0.045	0.017
110	0.88	0	0.045	0.010
111	1.09	0	0.045	0.022
112	1.22	0	0.045	0.030
113	0.56	0	0.045	0.013
114	1.67	0	0.045	0.025
115	1.17	0	0.045	0.009
116	0.22	0	0.045	0.015
117	3.37	0	0.045	0.025
118	2.53	0	0.045	0.013
201	2.99	0	0.045	0.015
202	3.67	0	0.045	0.010
203	4.14	0	0.045	0.016
204	4.50	0	0.045	0.017
205	2.75	0	0.045	0.022
206	2.04	0	0.045	0.017
207	0.64	0	0.045	0.023
208	0.49	0	0.045	0.027
209	0.07	0	0.045	0.028
210	0.21	0	0.045	0.014
211	0.35	0	0.045	0.005
212	1.40	0	0.045	0.020
213	1.11	0	0.045	0.016
214	0.79	0	0.045	0.061
215	0.13	0	0.045	0.007
216	0.60	0	0.045	0.085

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
217	0.62	0	0.045	0.081
301	2.00	0	0.045	0.015
302	2.56	0	0.045	0.014
303	2.28	0	0.045	0.031
304	3.32	0	0.045	0.011
305	1.21	0	0.045	0.013
306	1.09	0	0.045	0.022
307	0.88	0	0.045	0.015
308	4.36	0	0.045	0.012
309	1.31	0	0.045	0.028
310	1.47	0	0.045	0.024
311	1.18	0	0.045	0.032
312	0.45	0	0.045	0.053
313	0.99	0	0.045	0.033
314	4.85	0	0.045	0.014
315	4.80	0	0.045	0.019
316	2.33	0	0.045	0.021
317	2.84	0	0.045	0.018
318	1.76	0	0.045	0.012
319	3.55	0	0.045	0.016
320	1.98	0	0.045	0.008
402	0.48	0	0.045	0.022
403	0.50	0	0.045	0.023
404	0.91	0	0.045	0.004
405	0.86	0	0.045	0.073
406	0.87	0	0.045	0.091
407	1.52	0	0.045	0.034
408	0.63	0	0.045	0.006
409	0.43	0	0.045	0.017
410	1.84	0	0.045	0.030
411	0.90	0	0.045	0.011
412	1.82	0	0.045	0.010
413	2.61	0	0.045	0.005
414	1.90	0	0.045	0.016
415	0.22	0	0.045	0.032

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
416	0.59	0	0.045	0.037
417	3.27	0	0.045	0.020
418	2.92	0	0.045	0.021
502	0.85	0	0.045	0.040
503	0.19	0	0.045	0.036
504	5.27	0	0.045	0.012
505	6.15	0	0.045	0.006
506	4.05	0	0.045	0.017
507	3.90	0	0.045	0.007
508	1.60	0	0.045	0.034
509	1.75	0	0.045	0.019
510	4.43	0	0.045	0.008
511	3.38	0	0.045	0.015
512	1.25	0	0.045	0.003
4121	1.44	0	0.045	0.064

A.6 ROCKLAND CREEK (RLC) CATCHMENT

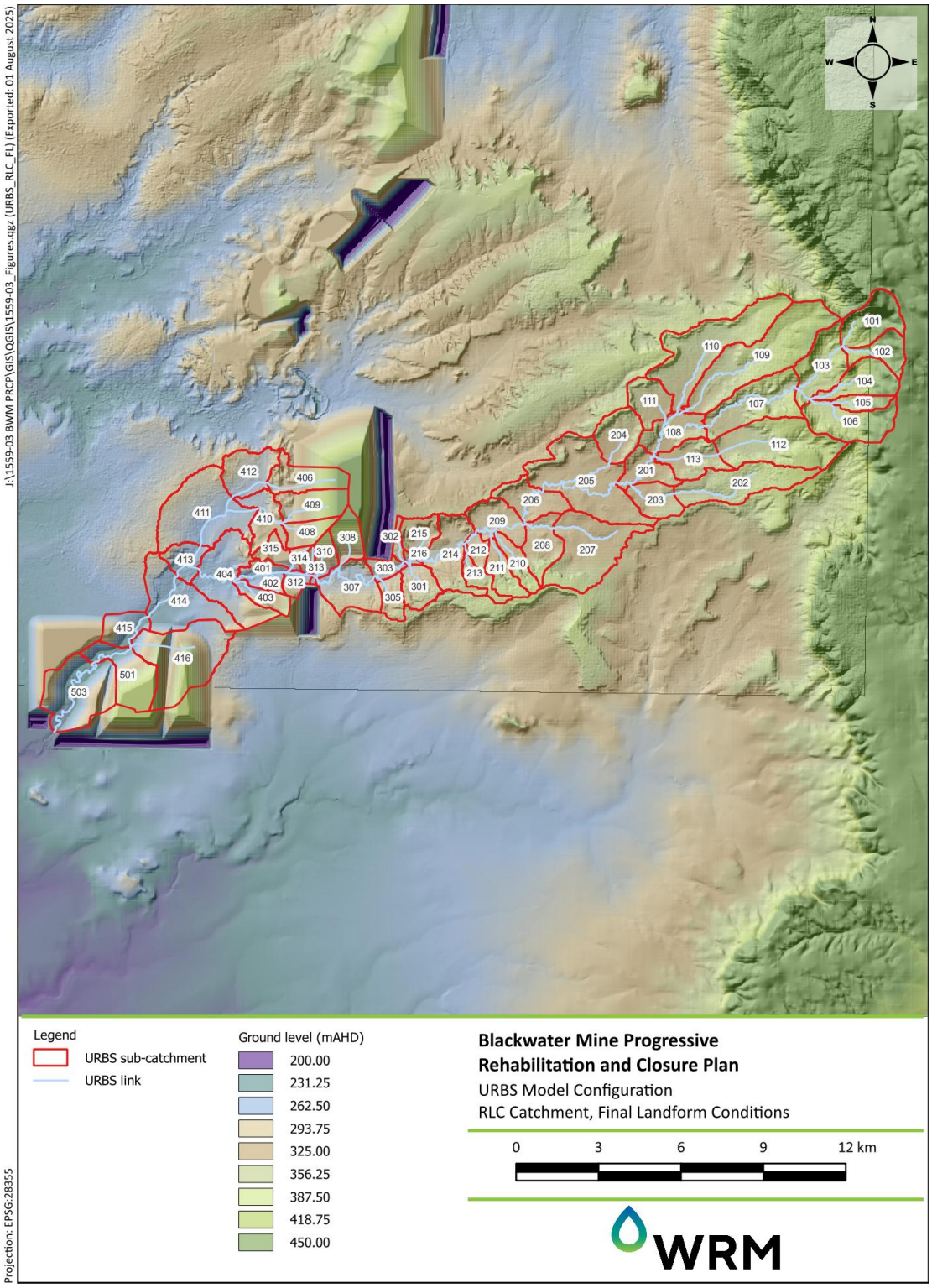


Figure A.7 URBS model configuration, Rockland Creek catchment, final landform conditions

Table A.7 URBS model subcatchment parameters, Rockland Creek catchment

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	3.11	0	0.080	0.086
102	1.89	0	0.080	0.058
103	3.55	0	0.070	0.022
104	2.73	0	0.080	0.040
105	1.05	0	0.080	0.046
106	3.77	0	0.080	0.023
107	4.87	0	0.070	0.010
108	2.46	0	0.070	0.008
109	8.51	0	0.070	0.011
110	7.54	0	0.070	0.010
111	2.19	0	0.070	0.015
112	6.42	0	0.070	0.014
113	2.49	0	0.070	0.010
201	2.00	0	0.070	0.009
202	4.84	0	0.080	0.012
203	1.99	0	0.070	0.014
204	2.59	0	0.070	0.016
205	7.98	0	0.070	0.010
206	2.57	0	0.070	0.010
207	6.24	0	0.070	0.009
208	2.46	0	0.070	0.018
209	2.48	0	0.070	0.008
210	1.37	0	0.080	0.033
211	1.66	0	0.080	0.033
212	0.75	0	0.070	0.035
213	1.16	0	0.080	0.039
214	3.65	0	0.080	0.025
215	1.56	0	0.070	0.026
216	0.23	0	0.070	0.035
301	1.82	0	0.080	0.039
302	0.44	0	0.070	0.043
303	0.81	0	0.070	0.009
305	1.23	0	0.070	0.036
307	3.29	0	0.070	0.011

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
308	1.75	0	0.070	0.086
310	1.13	0	0.070	0.065
312	0.74	0	0.070	0.043
313	0.41	0	0.070	0.076
314	0.27	0	0.070	0.064
315	1.08	0	0.070	0.035
401	1.36	0	0.070	0.011
402	0.16	0	0.070	0.108
403	1.19	0	0.070	0.033
404	4.98	0	0.070	0.026
406	2.66	0	0.070	0.064
408	1.38	0	0.070	0.070
409	2.66	0	0.070	0.069
410	2.22	0	0.070	0.011
411	6.86	0	0.070	0.012
412	2.78	0	0.070	0.006
413	1.56	0	0.070	0.023
414	5.16	0	0.070	0.035
415	1.73	0	0.070	0.022
416	6.88	0	0.070	0.028
501	3.59	0	0.070	0.040
503	5.69	0	0.070	0.031

APPENDIX B TUFLOW MODEL CONFIGURATION

B.1 MODEL CONFIGURATION

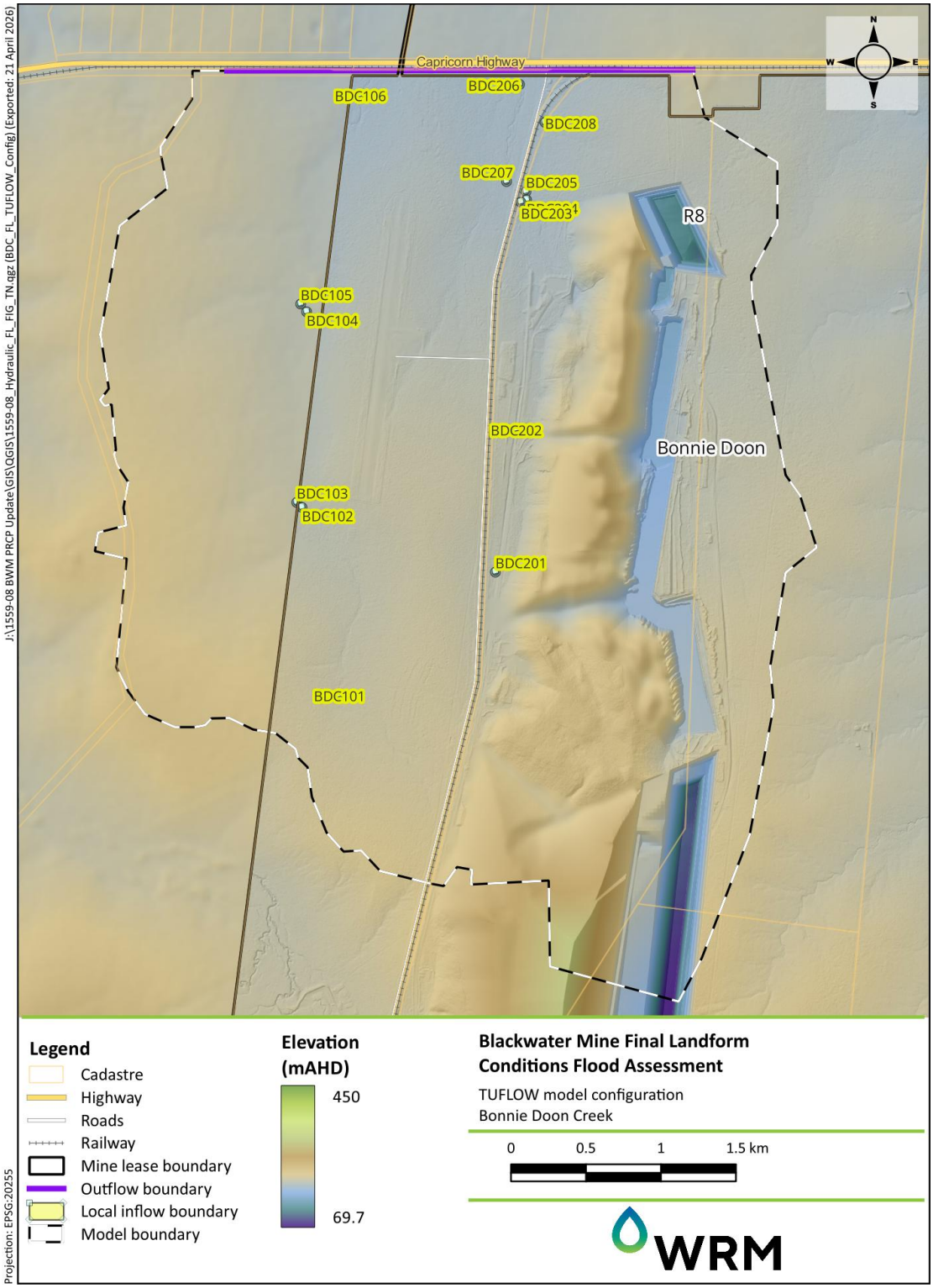


Figure B.1 Bonnie Doon Creek TUFLOW model configuration, final landform conditions

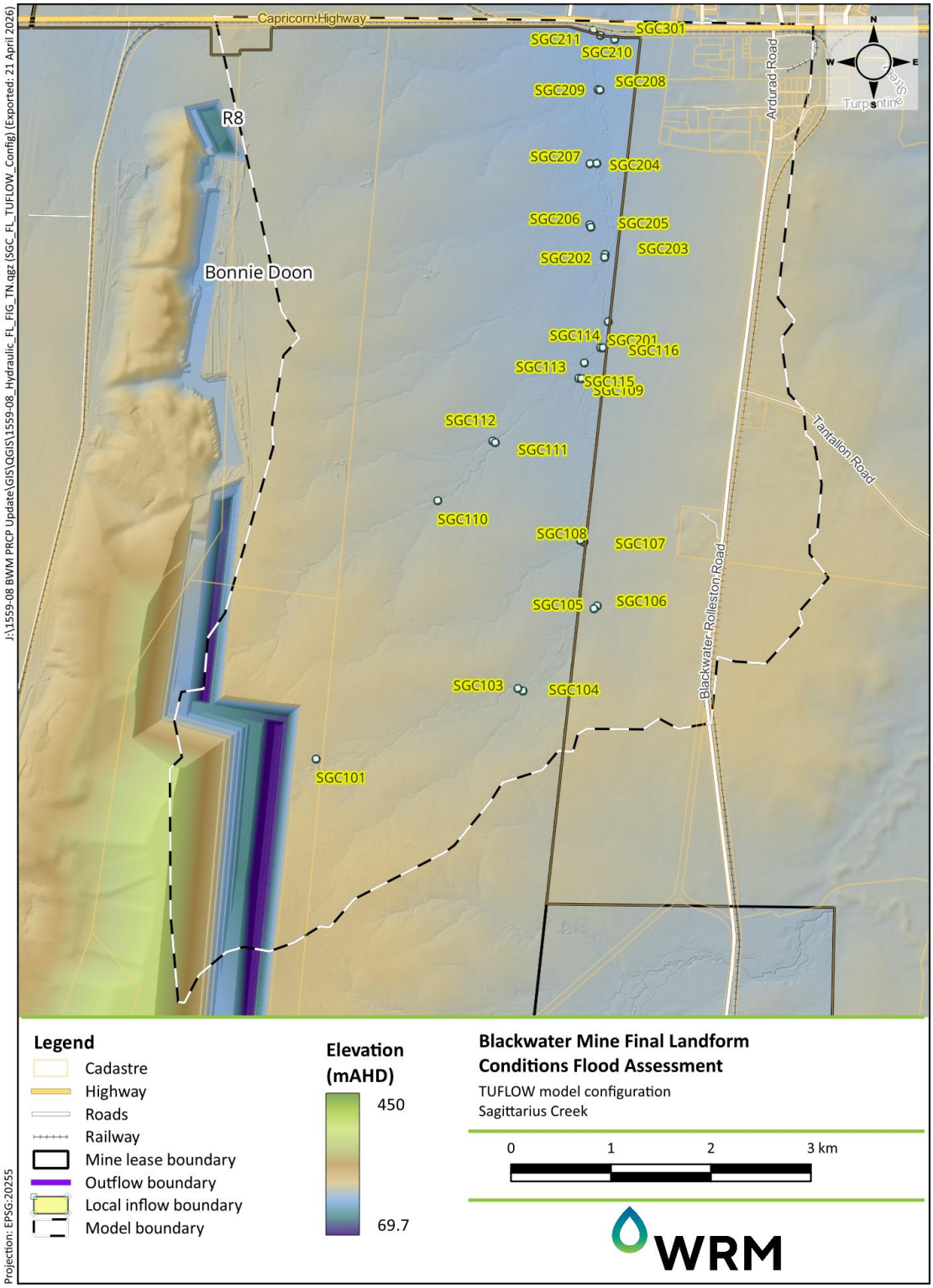


Figure B.2 Sagittarius Creek TUFLOW model configuration, final landform conditions

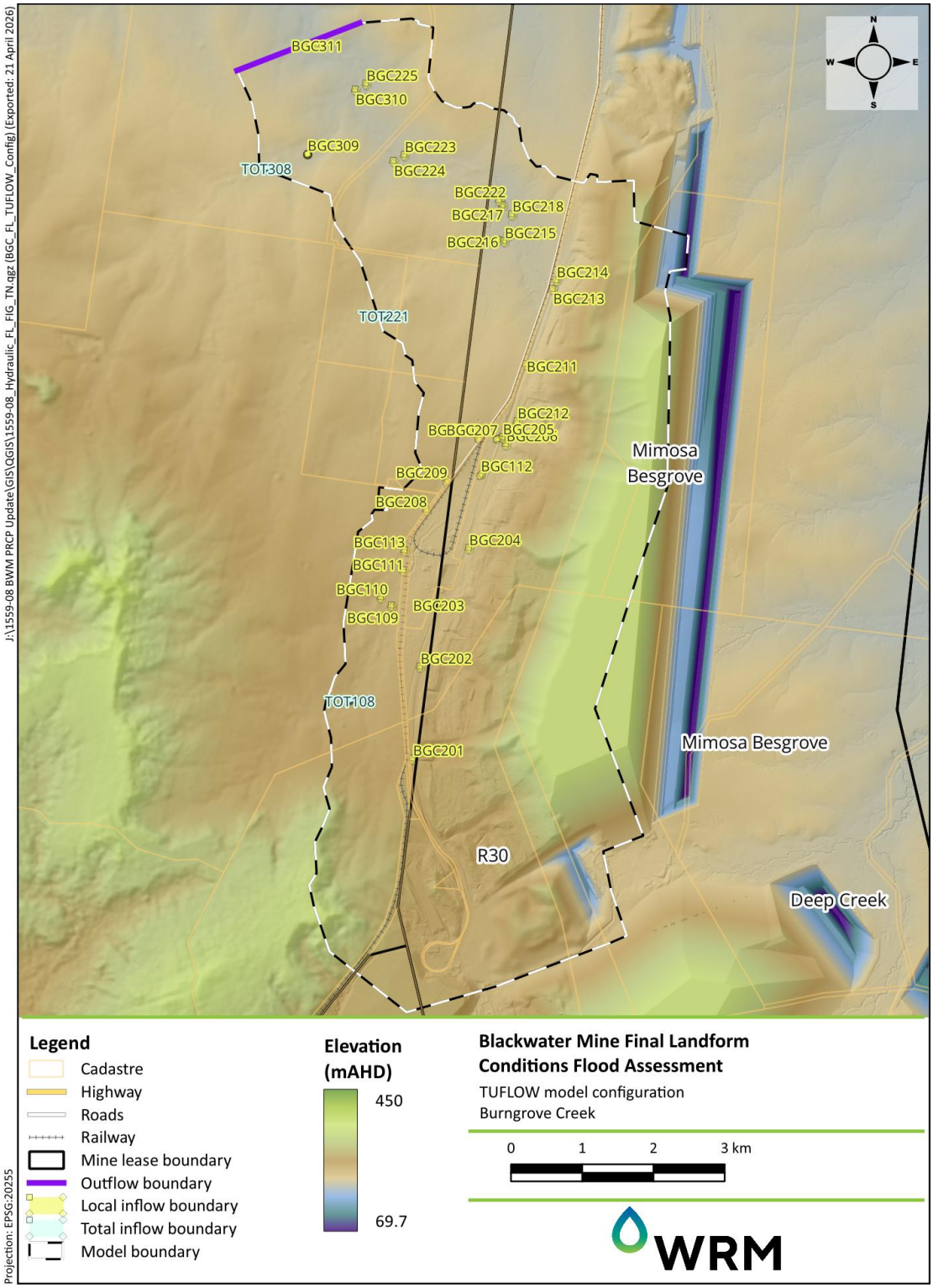


Figure B.3 Burngrove Creek TUFLOW model configuration, final landform conditions

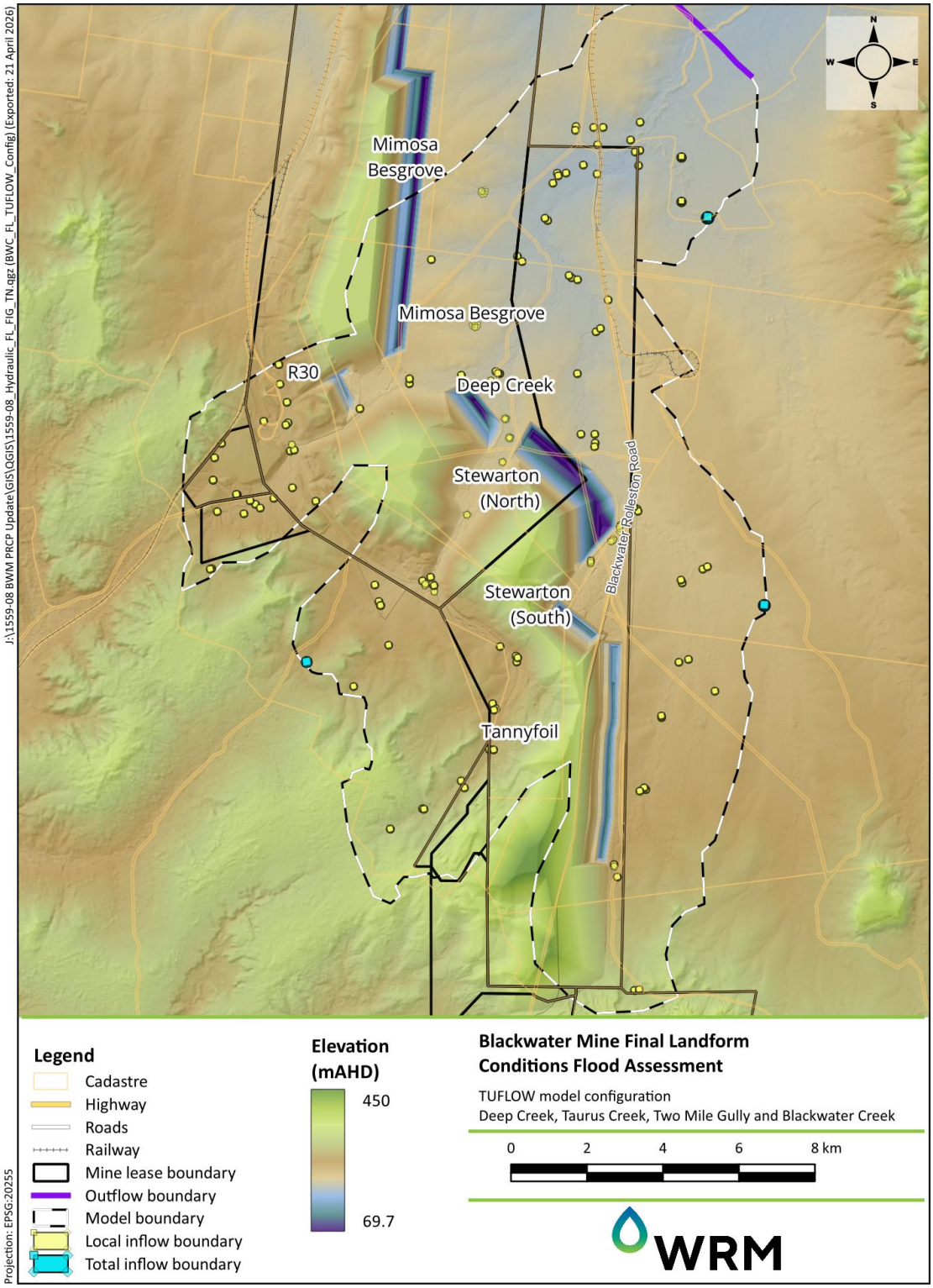


Figure B.4 Blackwater Creek (including Deep Creek, Taurus Creek and Two Mile Gully) TUFLOW model configuration, final landform conditions

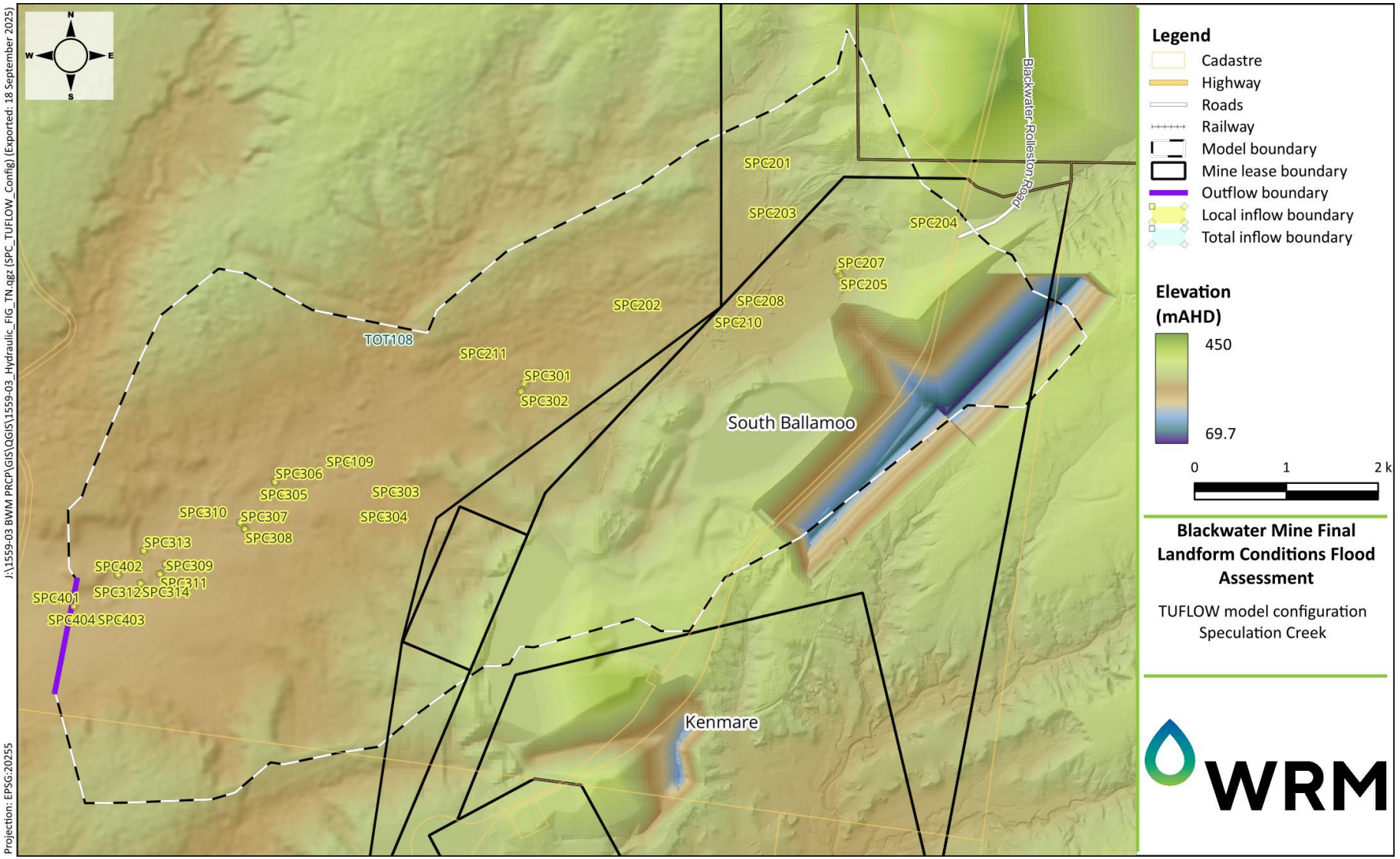


Figure B.5 Speculation Creek TUFLOW model configuration, final landform conditions

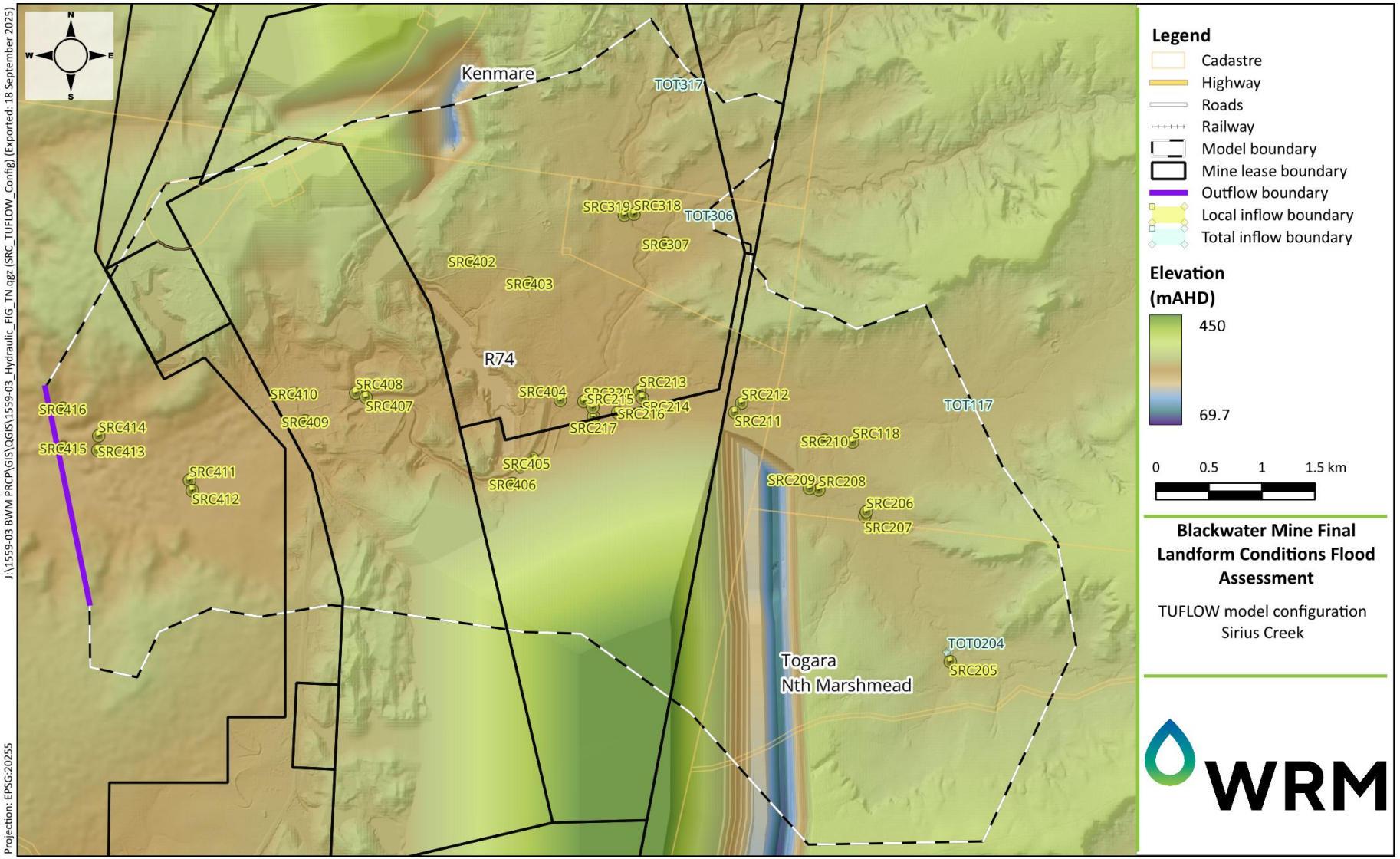


Figure B.6 Sirius Creek TUFLOW model configuration, final landform conditions

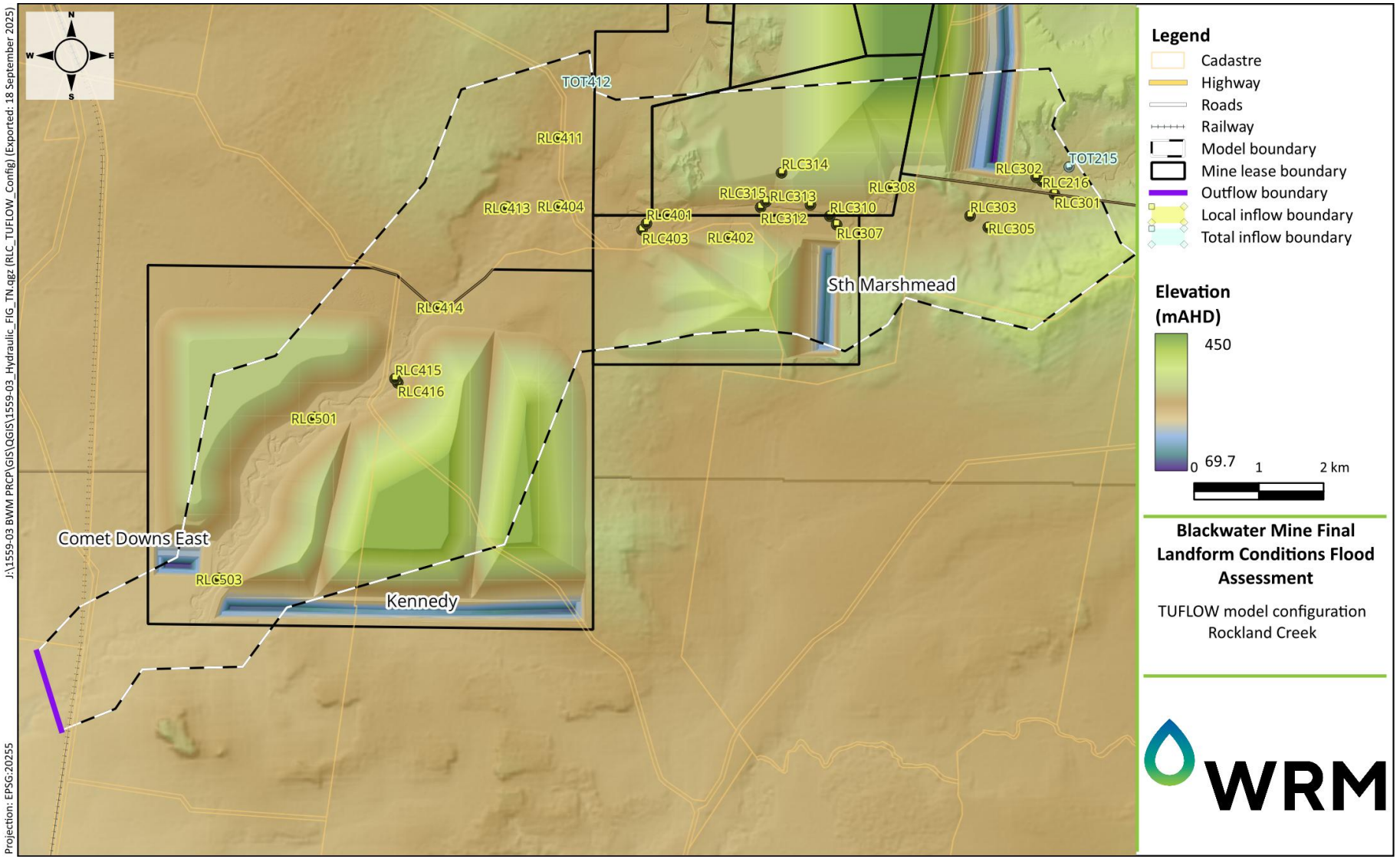


Figure B.7 Rockland Creek TUFLOW model configuration, final landform conditions

B.2 HYDRAULIC STRUTURES

Table B.1 Bonnie Doon Creek TUFLOW model culvert details

ID	Type	Upstream IL (mAHD)	Downstream IL (mAHD)	Width/ Diameter (m)	Height (m)	Barrel (No.)
649	RCP	207.55	207.45	0.6	0	1
650	RCP	196.039	195.63	0.6	0	3
69379b	RCP	182.4	182.3	1.3	0	7
649_Rail	RCP	207.4	207.35	0.6	0	1
May222	RCP	192.9	192.8	0.6	0	1
6937a	RBCP	182.5	182.4	3	3	5

Table B.2 Burngrove Creek TUFLOW model culvert details

ID	Type	Upstream IL (mAHD)	Downstream IL (mAHD)	Width/ Diameter (m)	Height (m)	Barrel (No.)
1003	RCP	264.4	263.8	0.9	0	8
1003a	RCP	264.2	263.1	0.9	0	8
440	RCP	247.1	245.4	0.9	0	1
442	RCP	243.577	243.256	1.2	0	2
647	RCP	224.02	222.65	0.6	0	1
648	RCP	221.61	221.043	0.6	0	1
652	RCP	226.98	226.56	0.6	0	1
69379	RCP	202.86	202.45	1.3	0	7
72793	RCP	225.007	224.921	0.9	3	2
727931	RCP	225.007	224.921	0.9	0	2
73301a	RCP	226.86	226.36	1	0	3
73307	RCP	226.86	226.36	1.3	0	2
999a	RCP	261.3	260.69	0.9	0	8
Assumed_02	RCP	252.02	251.96	1.3	0	2
69386	RBCP	203.01	202.85	3	3	7
69489	RBCP	226.6	225.9	2	1.8	4
72792	RBCP	223.423	223.054	1.2	0.9	2
727921	RBCP	223.423	223.054	1.2	0.9	1
99a	RBCP	225.87	225.56	1.2	0.9	3

Table B.3 Blackwater Creek TUFLOW model culvert details

ID	Type	Upstream IL (mAHD)	Downstream IL (mAHD)	Width/ Diameter (m)	Height (m)	Barrel (No.)
440	RCP	247.1	245.4	0.9		1
441	RCP	243.341	243.399	1.1		3
442	RCP	243.577	243.256	1.2		2
1003	RCP	264.4	263.8	0.9		8
1013	RCP	247.515	247.246	0.9		1
1015	RCP	245.442	245.1	0.9		1
1016	RCP	243.821	243.88	0.9		1
1017	RCP	243.393	243.221	0.9		1
1018	RCP	245.882	245.556	0.9		1
1019	RCP	245.354	244.718	0.9		1
1020	RCP	236.93	236.707	0.45		1
1021	RCP	235.552	235.323	0.45		1
1022	RCP	230.409	230.269	0.75		2
1023	RCP	230.058	229.816	0.75		2
1003a	RCP	264.2	263.1	0.9		8
Assumed	RCP	230.15	230.046	0.6		1
Assumed_02	RCP	252.02	251.96	1.3		2
TMR_36587	RCP	204.88	204.5	1.8		6
TMR_24546	RBCP	180.09	180.06	3.05	2.74	2

APPENDIX C FINAL LANFORM CONDITIONS FLOOD MAPS

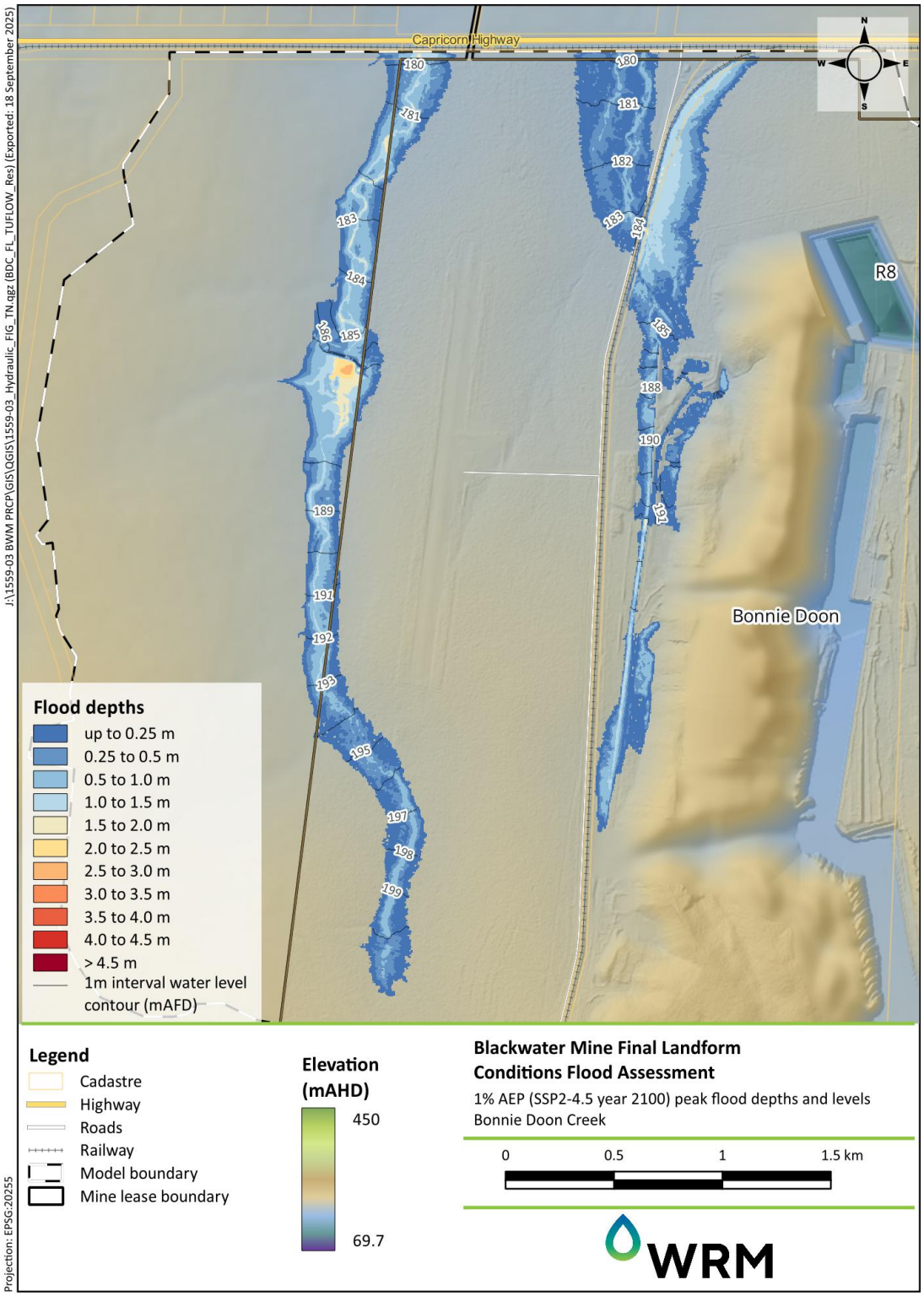


Figure C.1 Final landform conditions 1% AEP peak flood depths, levels and extents, Bonnie Doon Creek

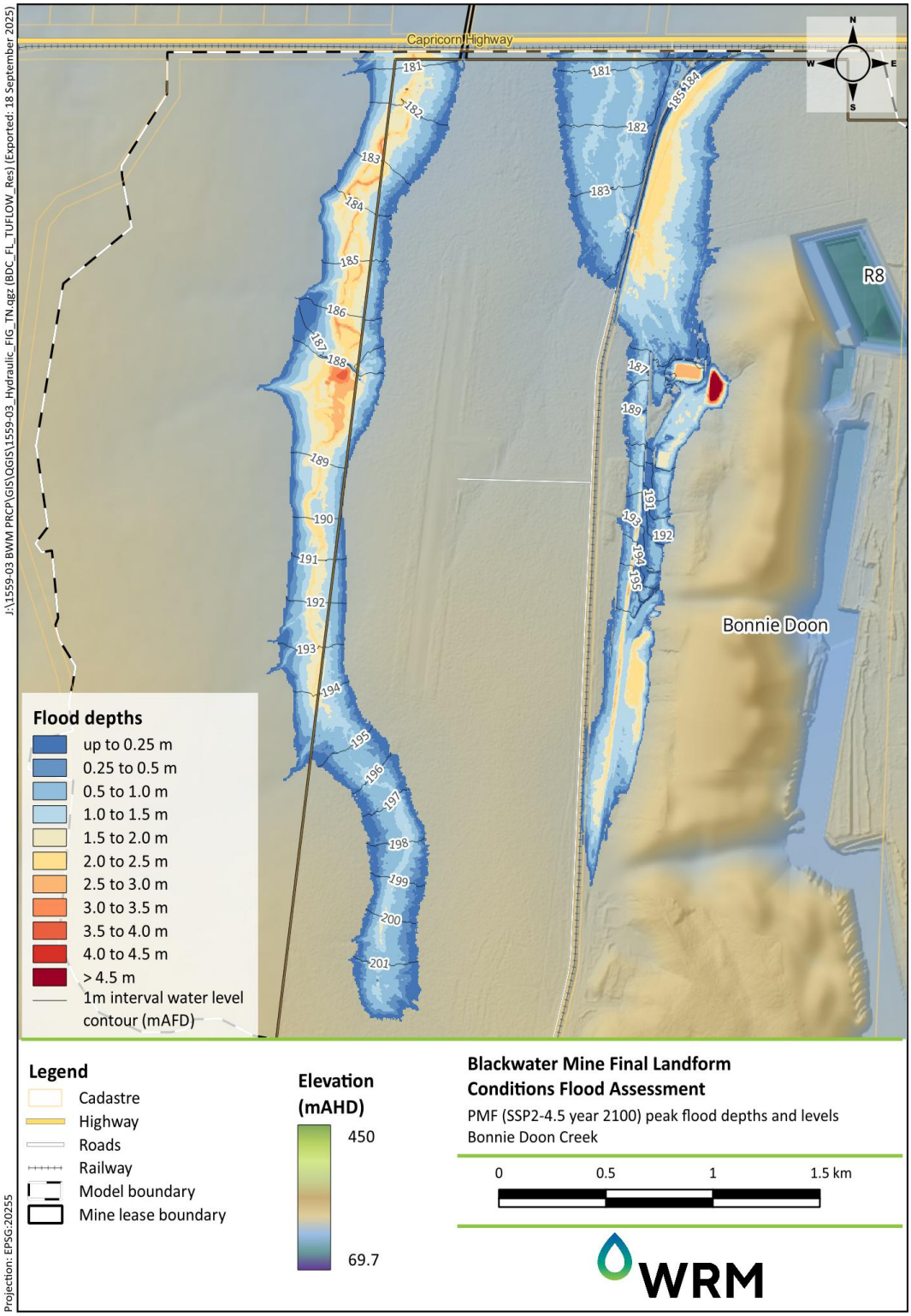


Figure C.2 Final landform conditions PMF peak flood depths, levels and extents, Bonnie Doon Creek

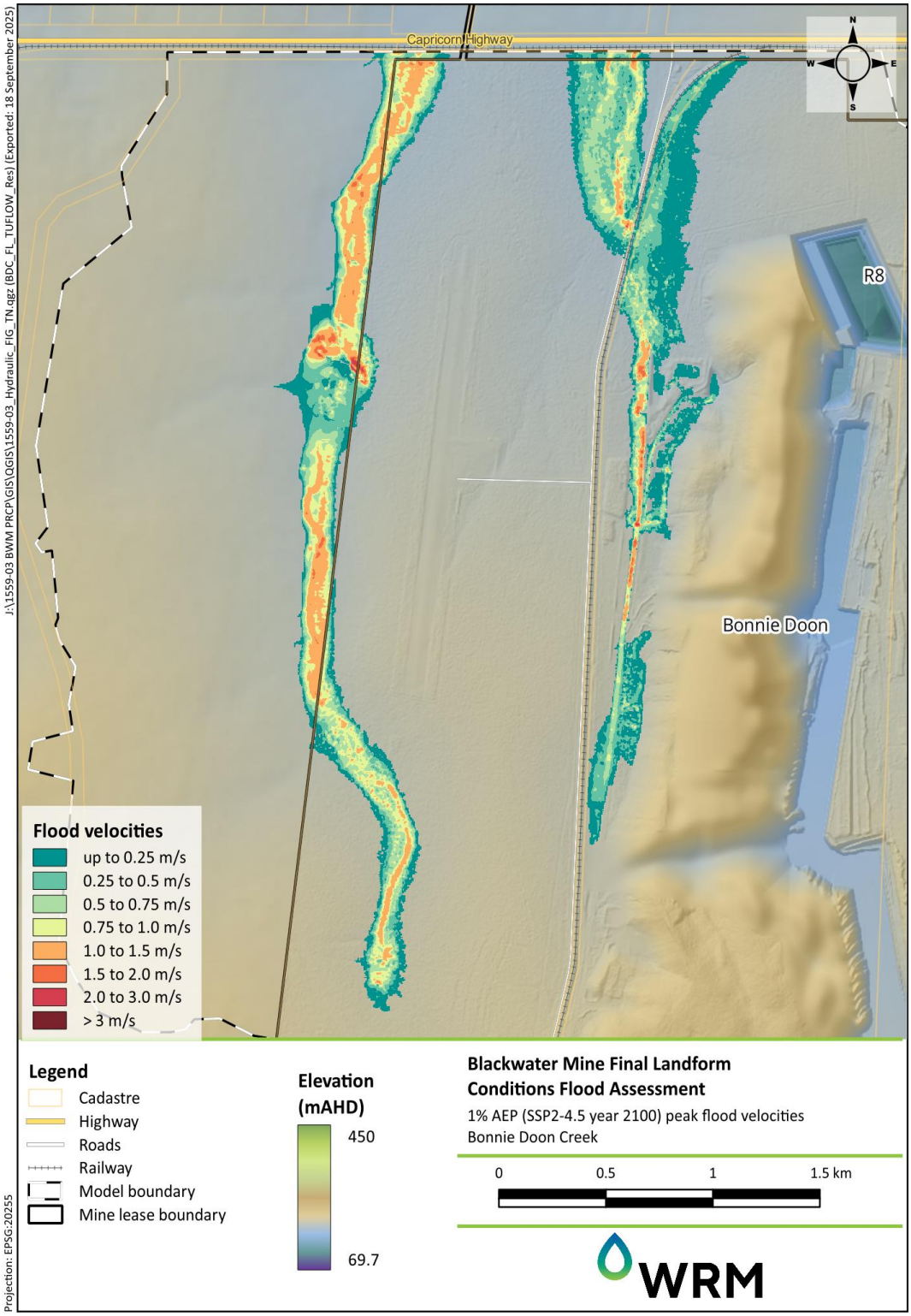


Figure C.3 Final landform conditions 1% AEP peak flood velocities, Bonnie Doon Creek

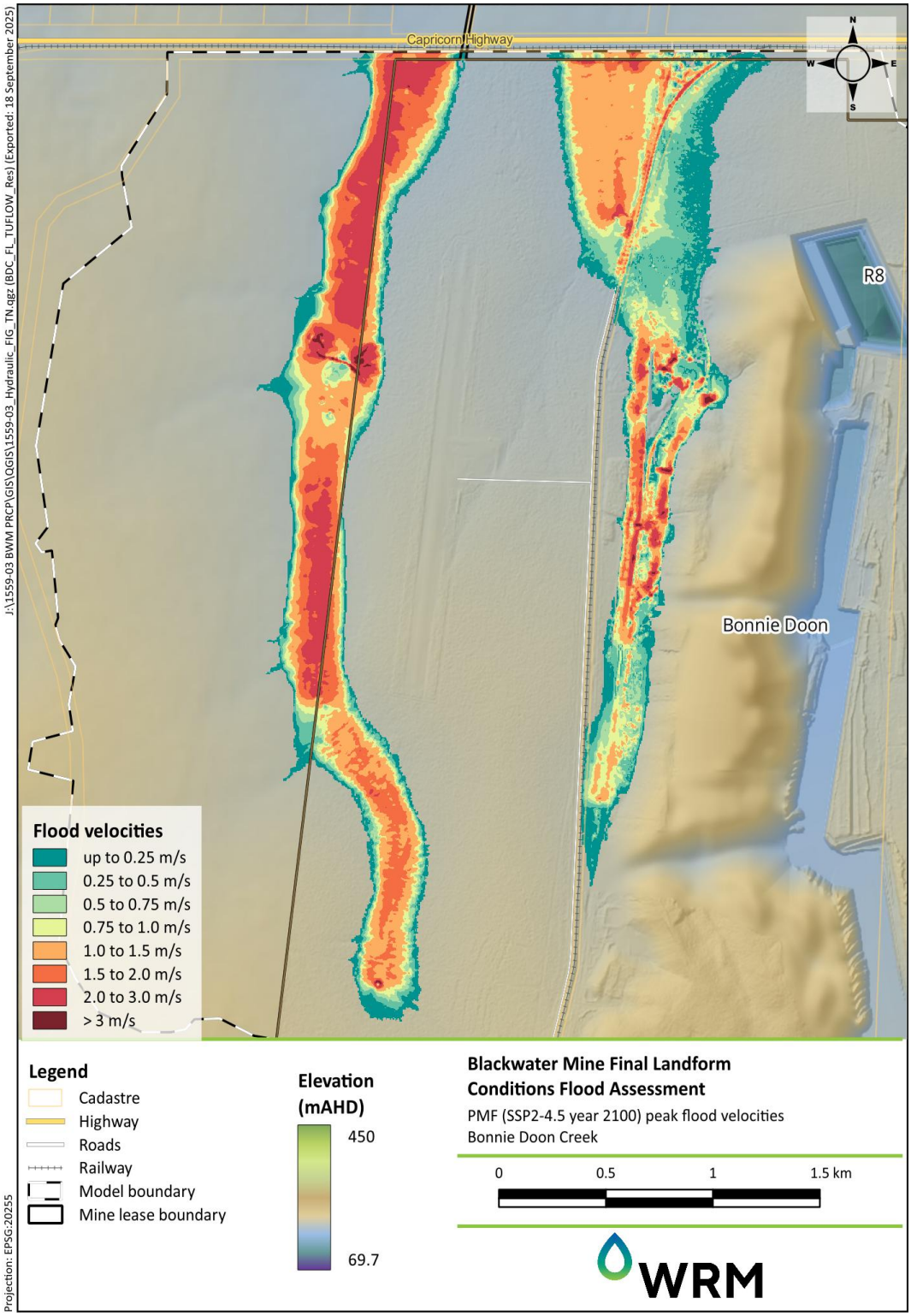


Figure C.4 Final landform conditions PMF peak flood velocities, Bonnie Doon Creek

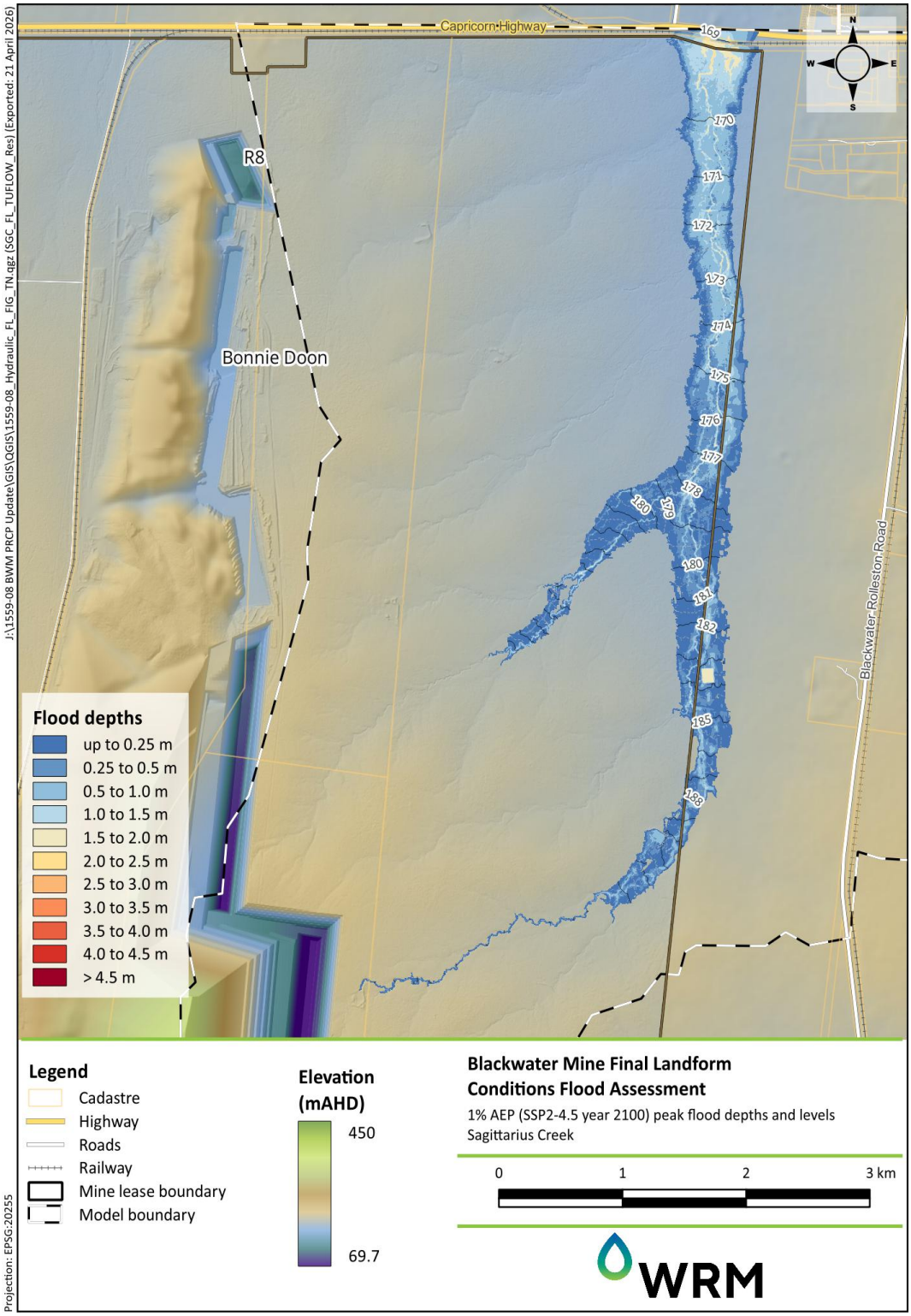


Figure C.5 Final landform conditions 1% AEP peak flood depths, levels and extents, Sagittarius Creek

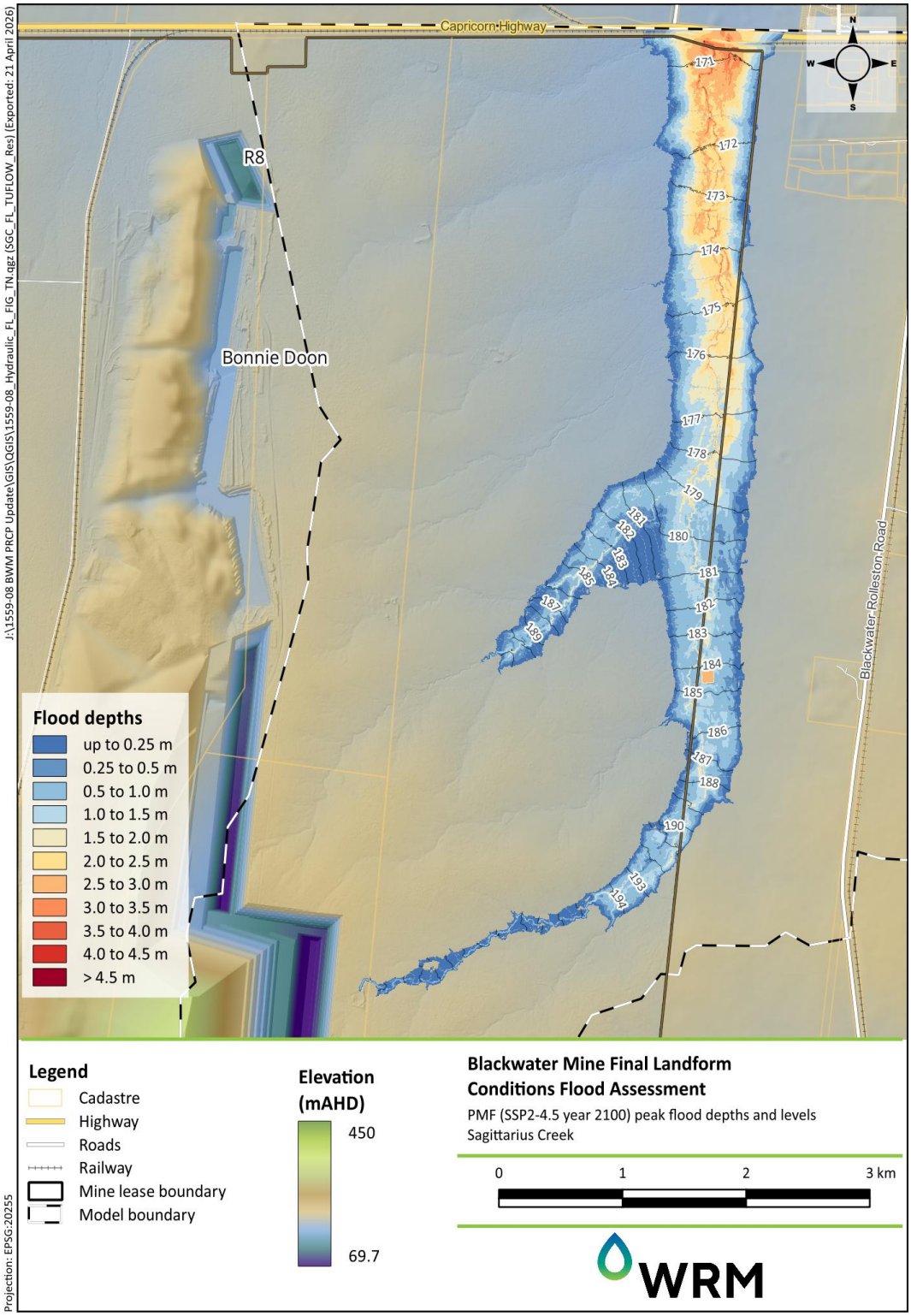


Figure C.6 Final landform conditions PMF peak flood depths, levels and extents, Sagittarius Creek

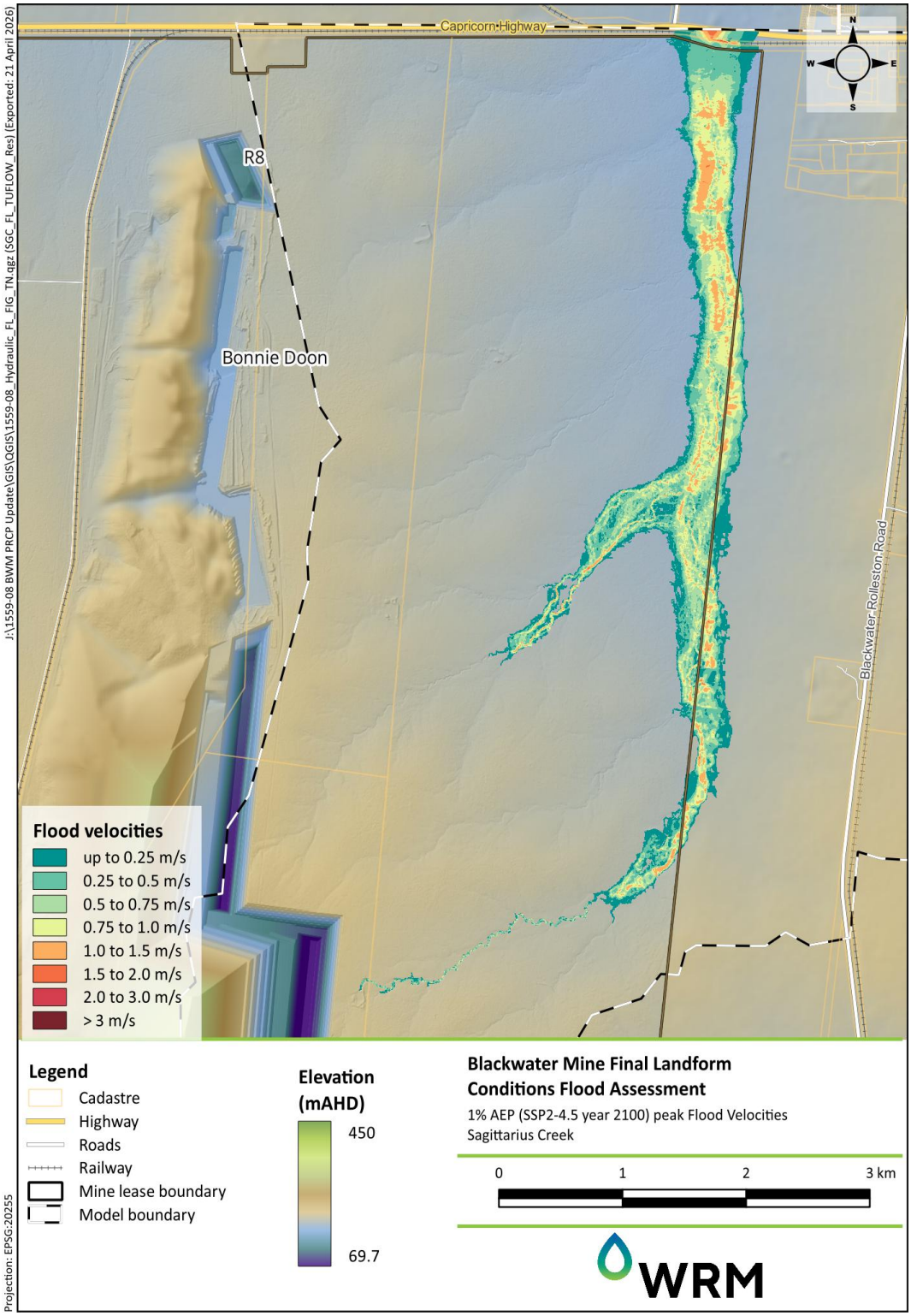


Figure C.7 Final landform conditions 1% AEP peak flood velocities, Sagittarius Creek

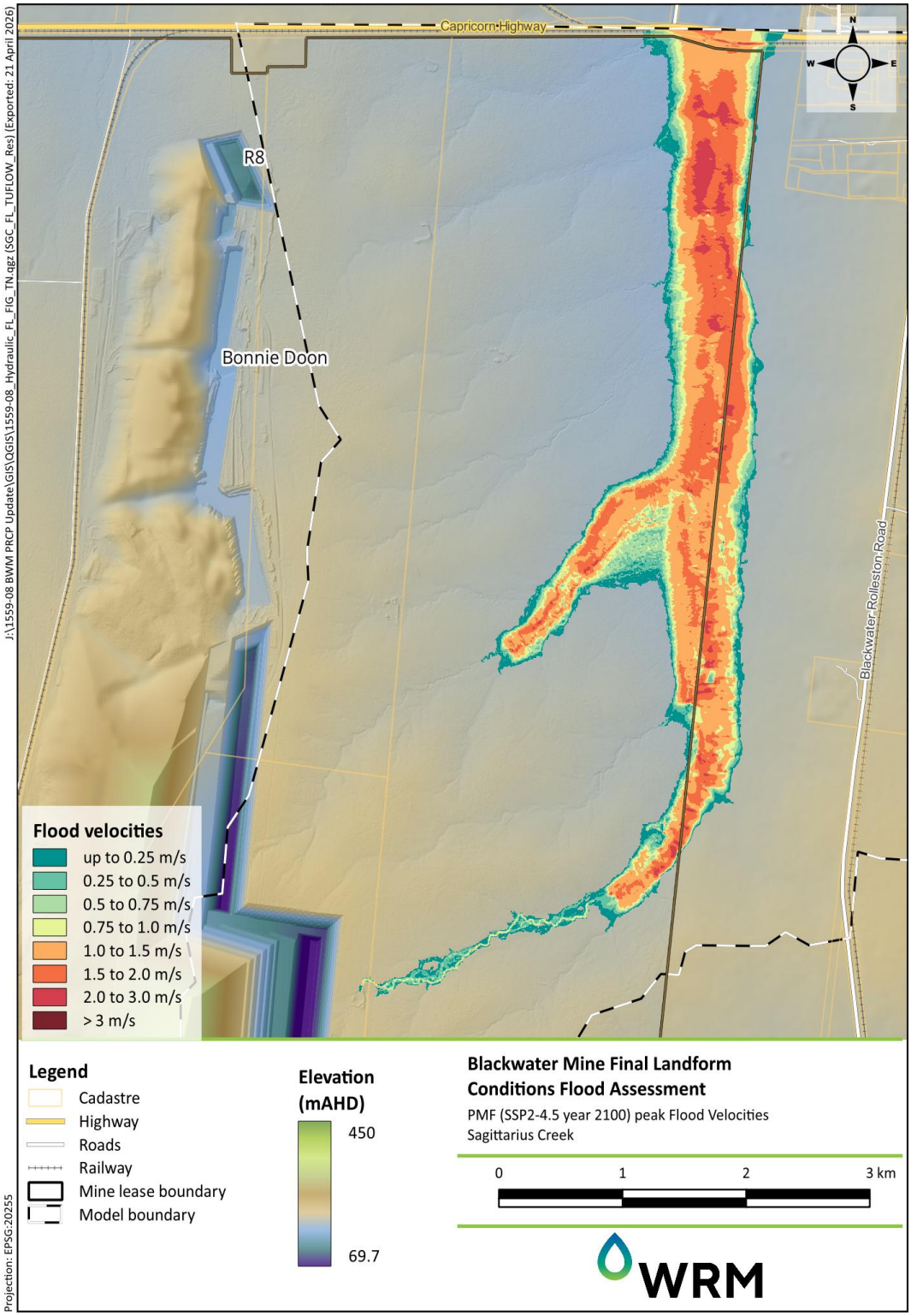


Figure C.8 Final landform conditions PMF peak flood velocities, Sagittarius Creek

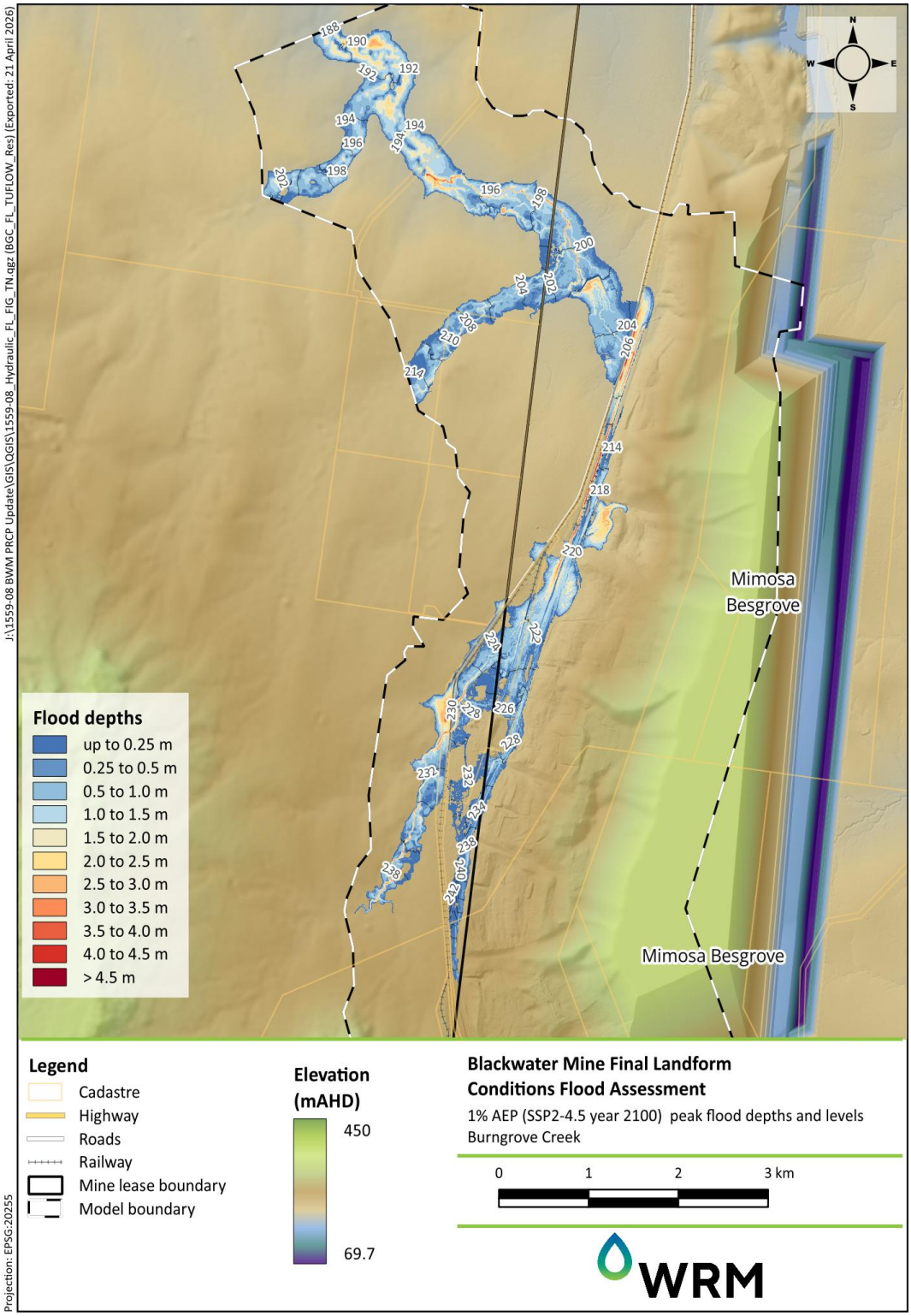


Figure C.9 Final landform conditions 1% AEP peak flood depths, levels and extents, Burngrove Creek

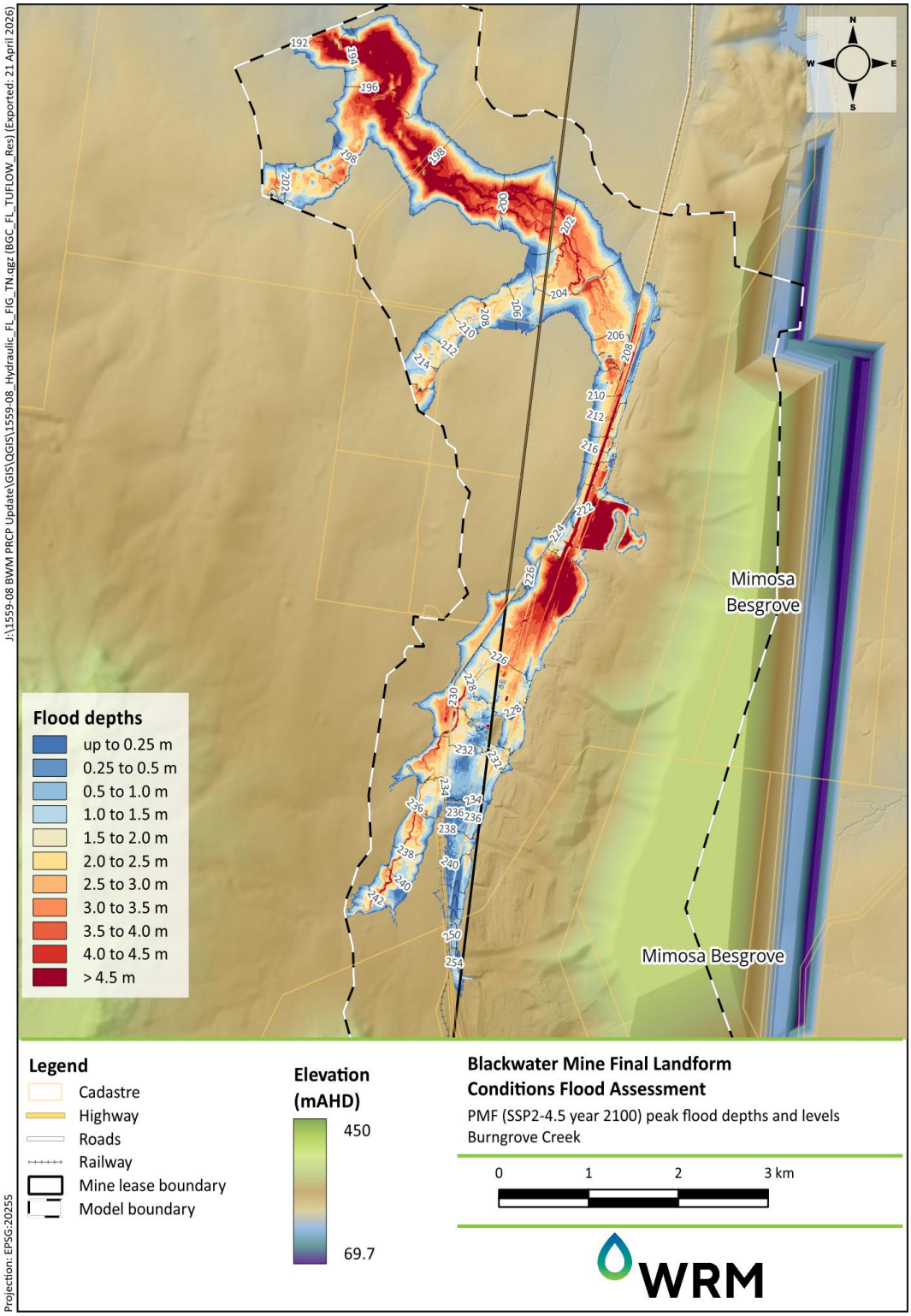


Figure C.10 Final landform conditions PMF peak flood depths, levels and extents, Burngrove Creek

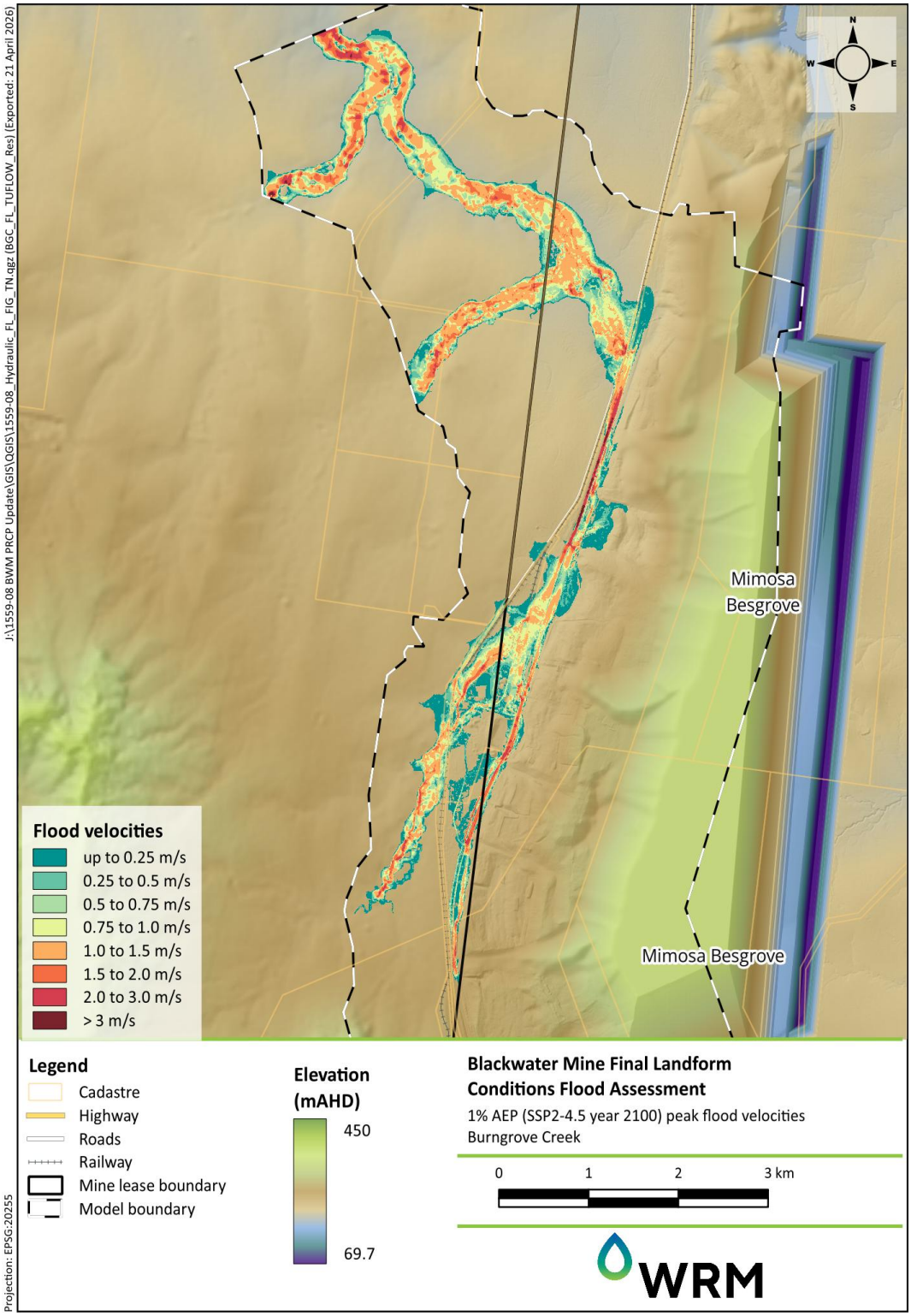


Figure C.11 **Final landform conditions 1% AEP peak flood velocities, Burngrove Creek**

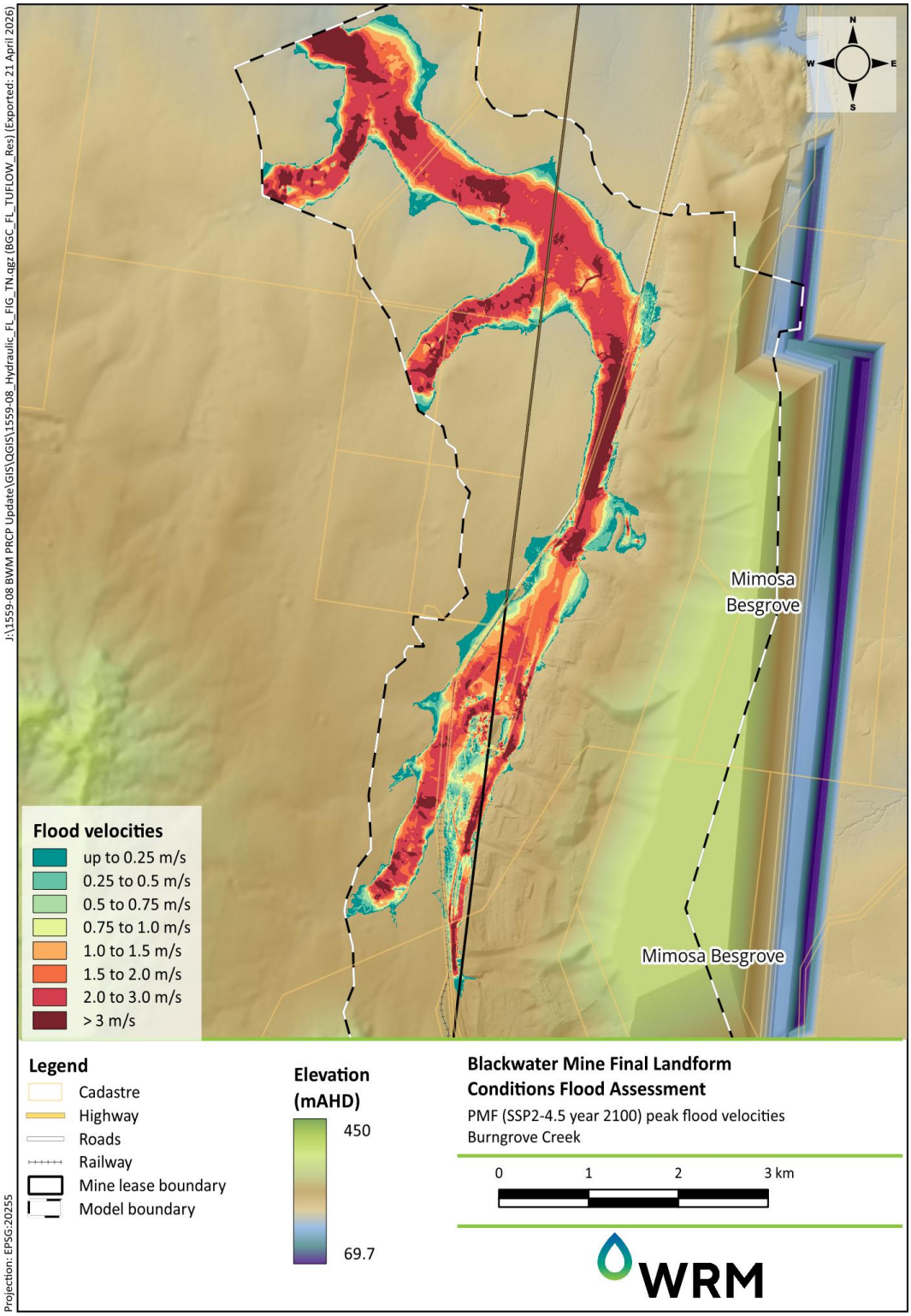


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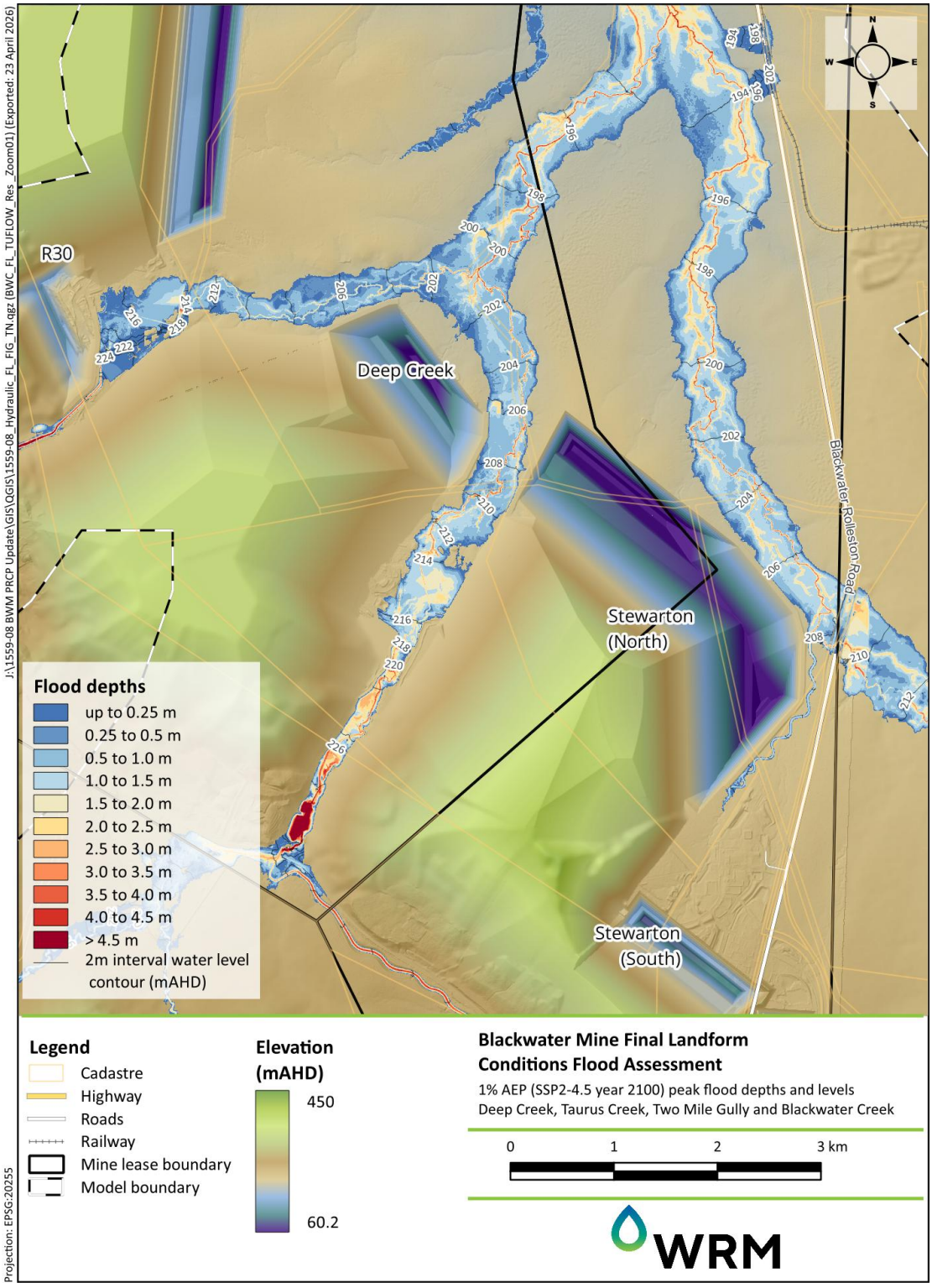


Figure C.13 Final landform conditions 1% AEP peak flood depths, levels and extents, Deep Creek, Taurus Creek and Two Mile Gully (adjacent to the Stewarton North Void)

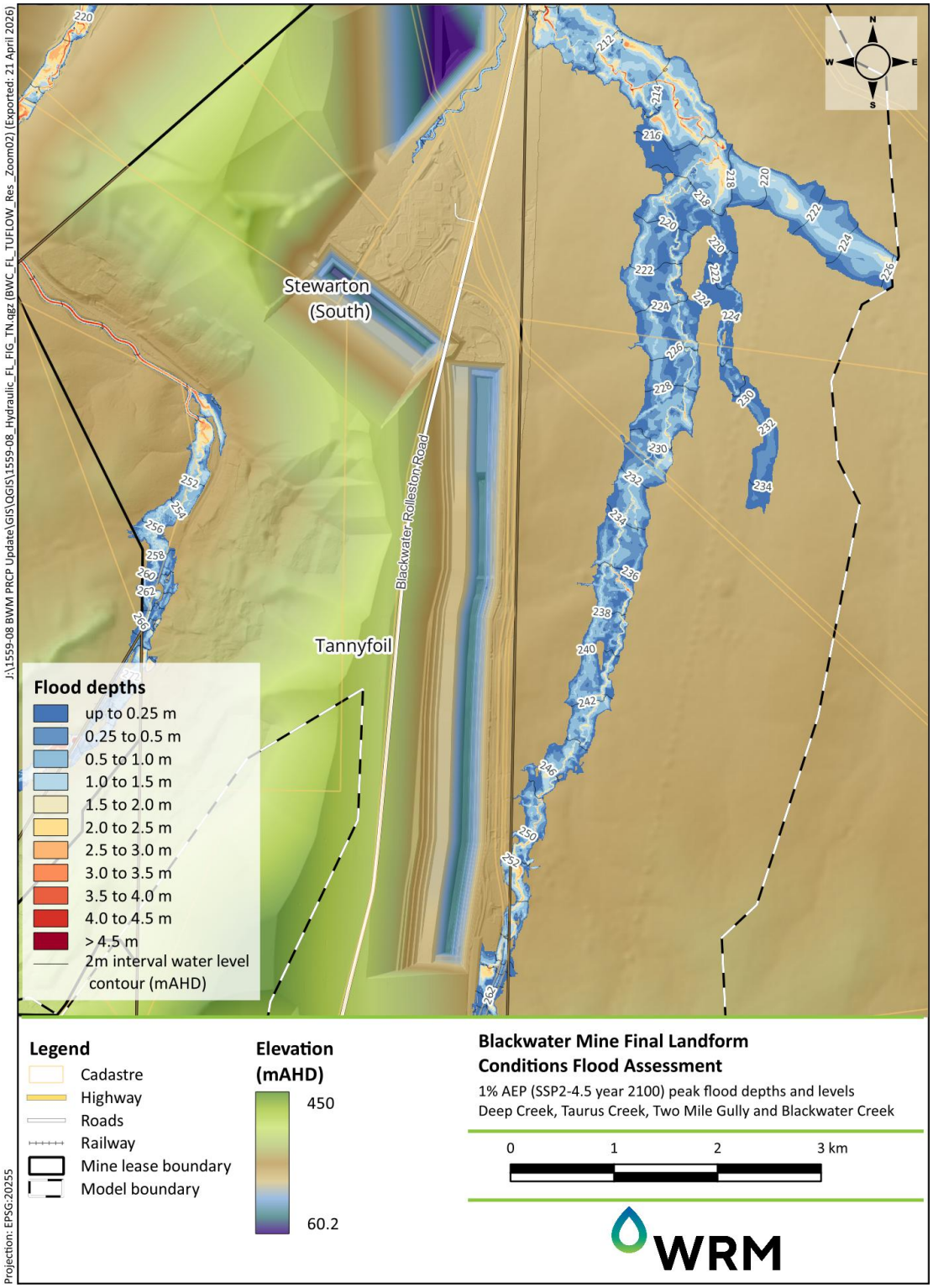


Figure C.14 Final landform conditions 1% AEP peak flood depths, levels and extents, Two Mile Gully (adjacent to the Tannyfoil Void)

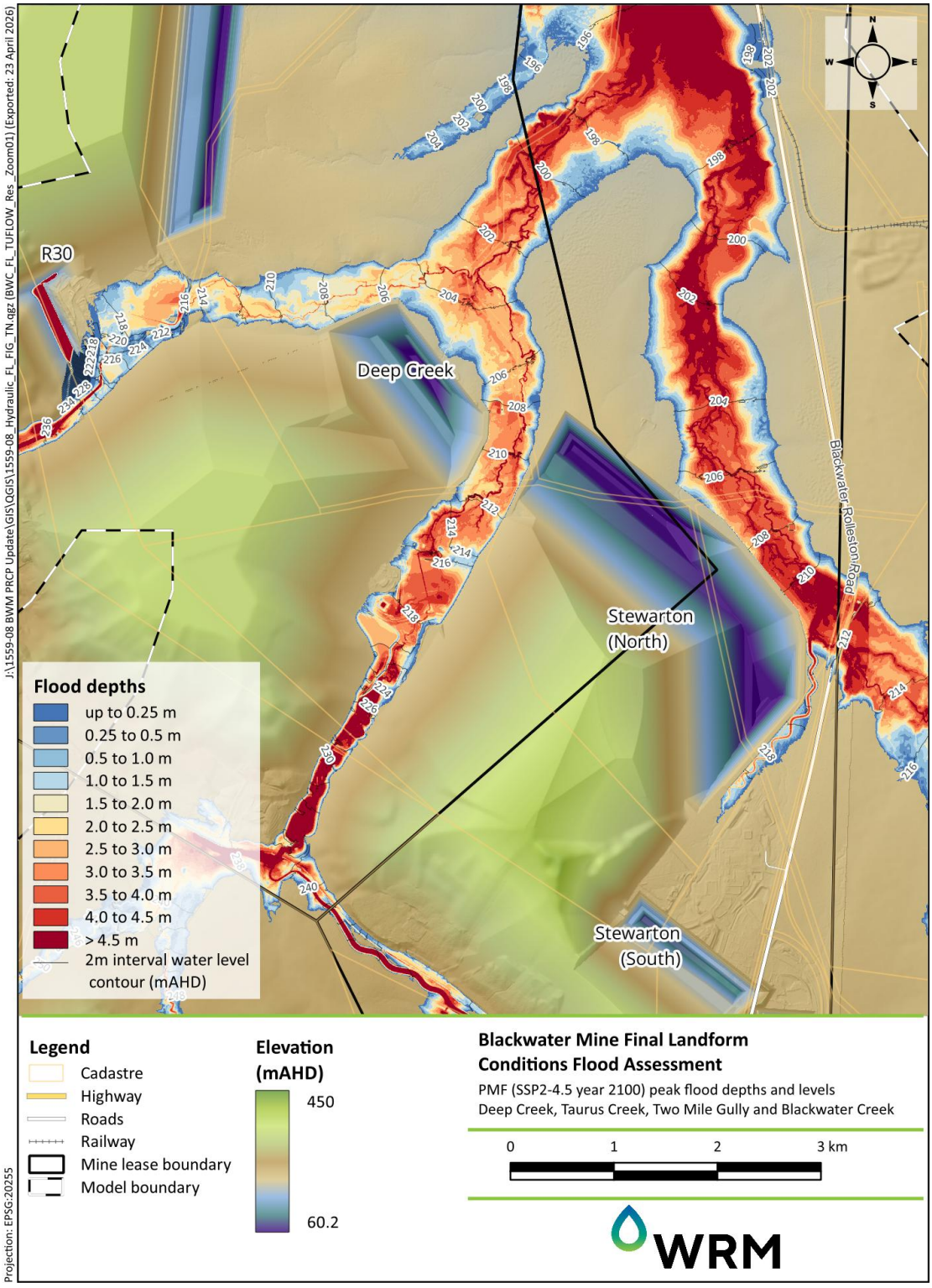


Figure C.15 Final landform conditions PMF peak flood depths, levels and extents, Deep Creek, Taurus Creek and Two Mile Gully (adjacent to the Stewarton North Void)

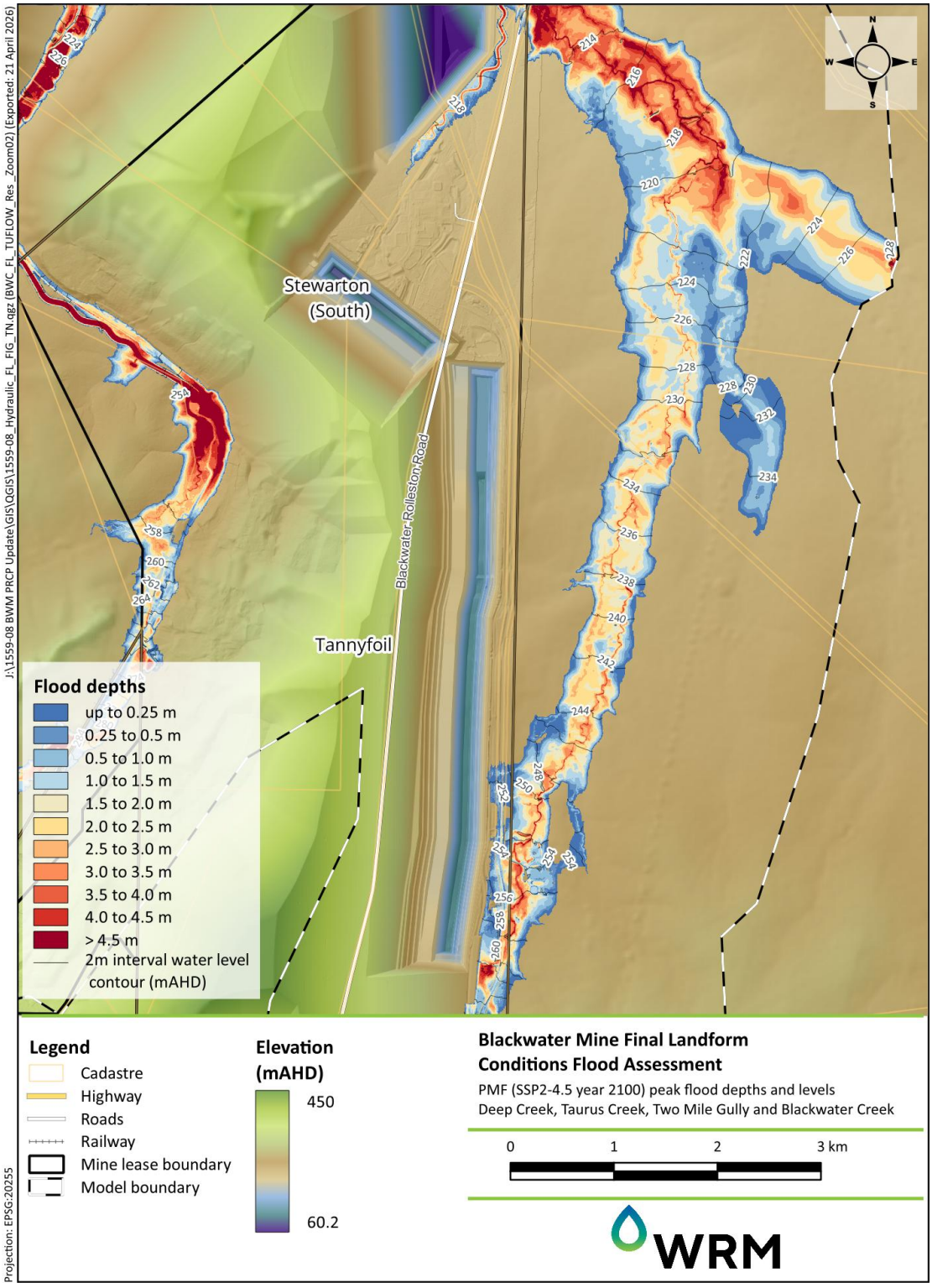


Figure C.16 Final landform conditions PMF peak flood depths, levels and extents, Two Mile Gully (adjacent to the Tannyfoil Void)

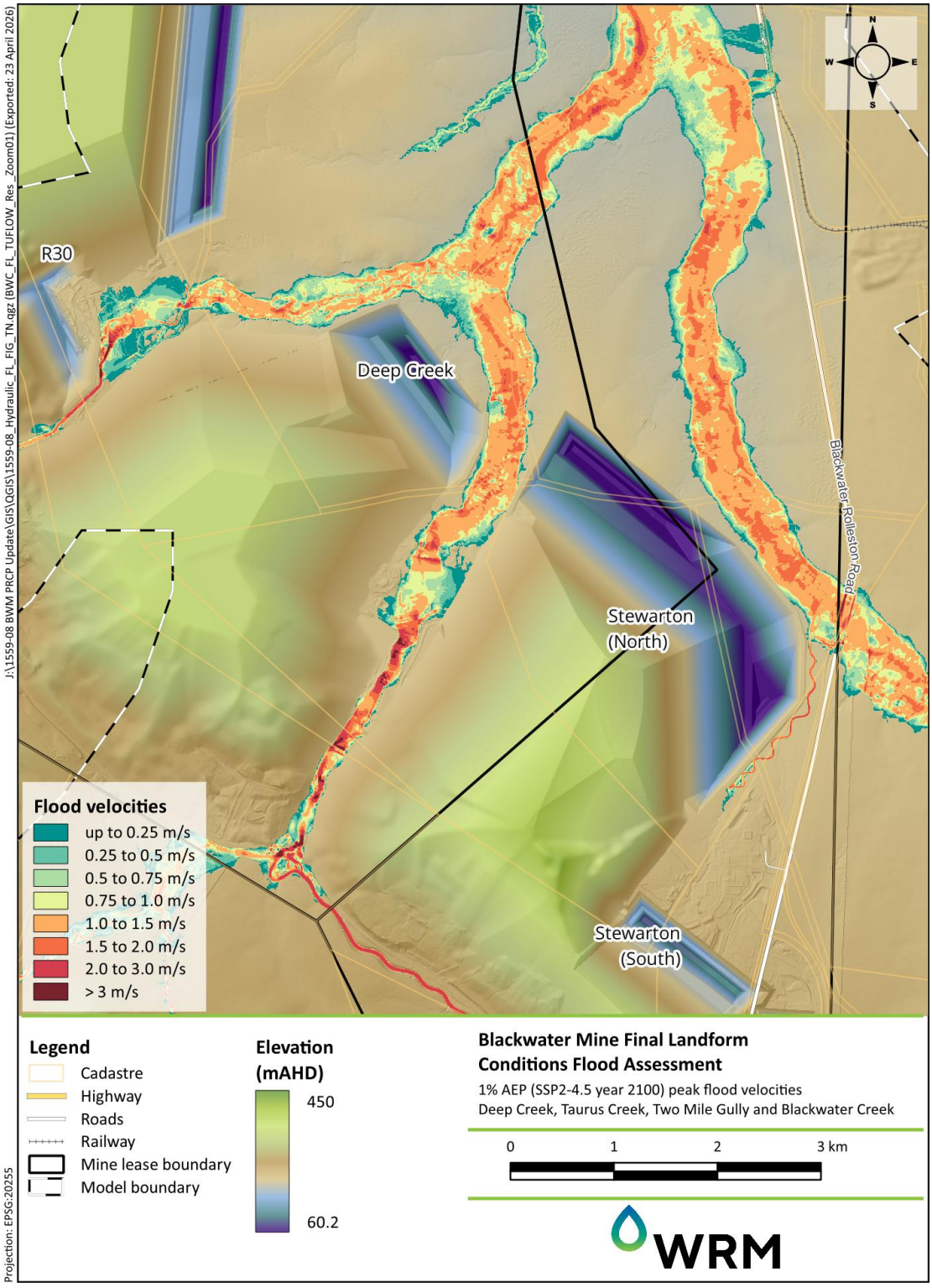


Figure C.17 Final landform conditions 1% AEP peak flood velocities, Deep Creek, Taurus Creek and Two Mile Gully (adjacent to the Stewarton North Void)

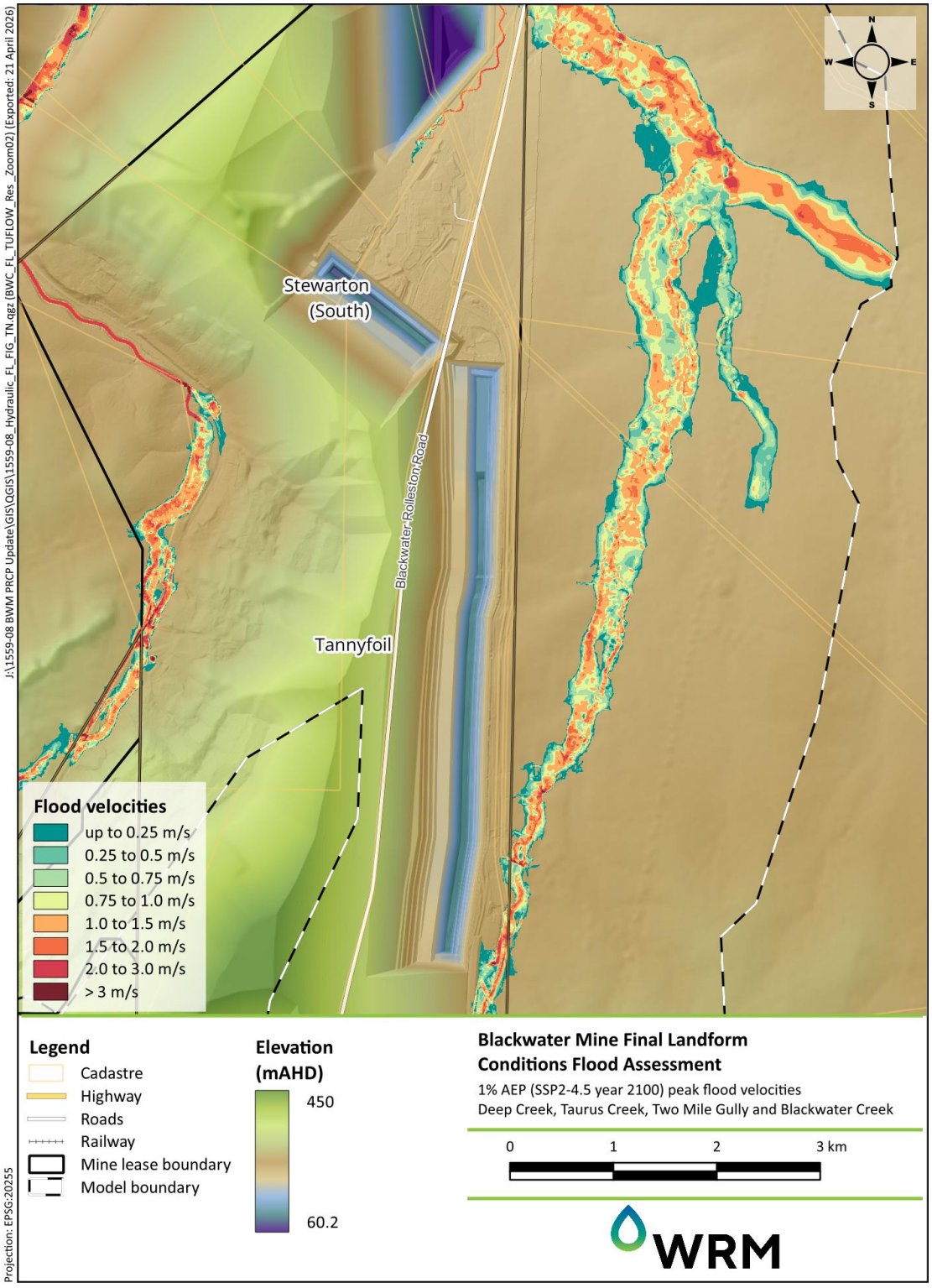


Figure C.18 Final landform conditions 1% AEP peak flood velocities, Two Mile Gully (adjacent to the Tannyfoil Void)

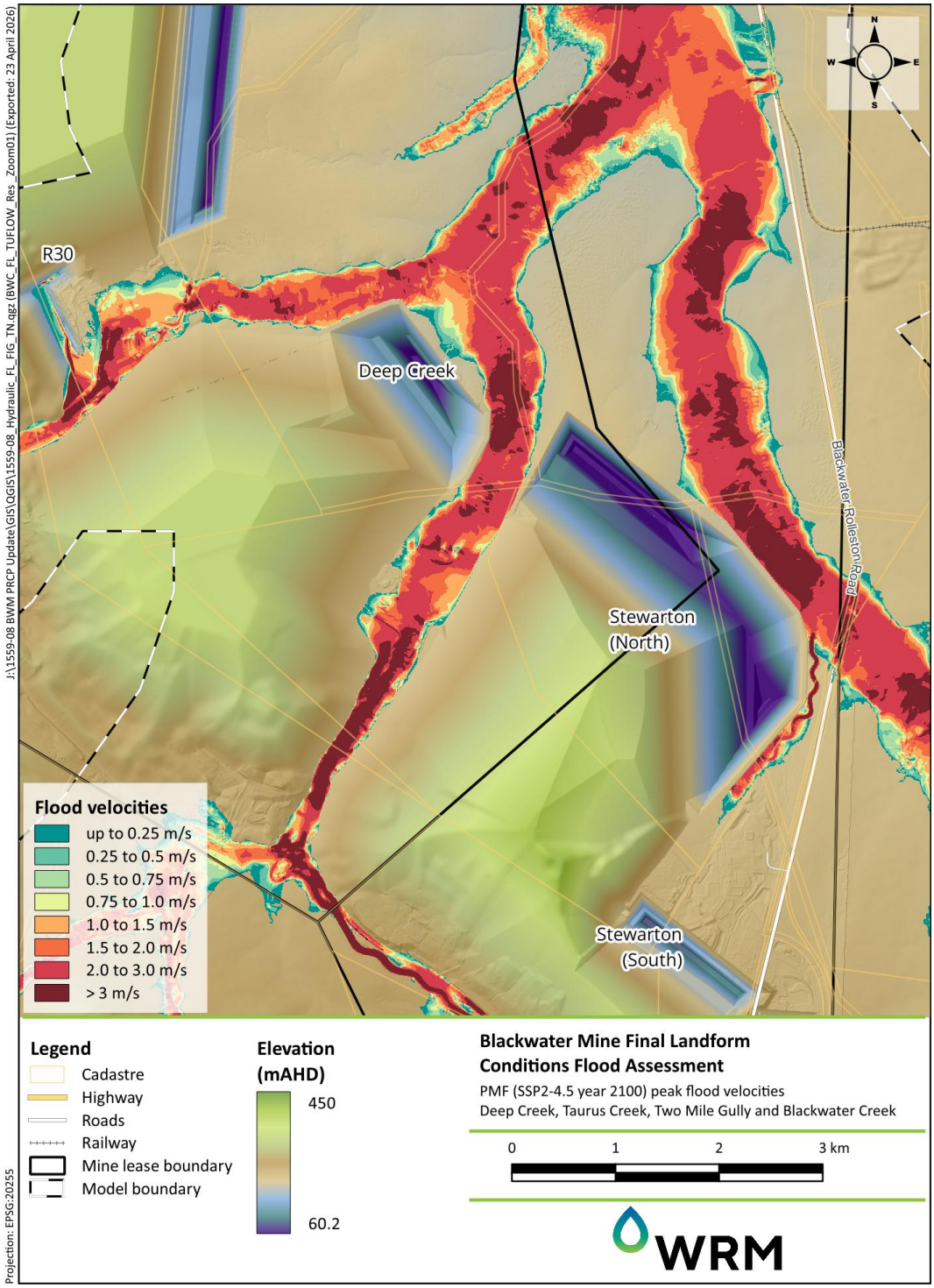


Figure C.19 Final landform conditions PMF peak flood velocities, Deep Creek, Taurus Creek and Two Mile Gully (adjacent to the Stewarton North Void)

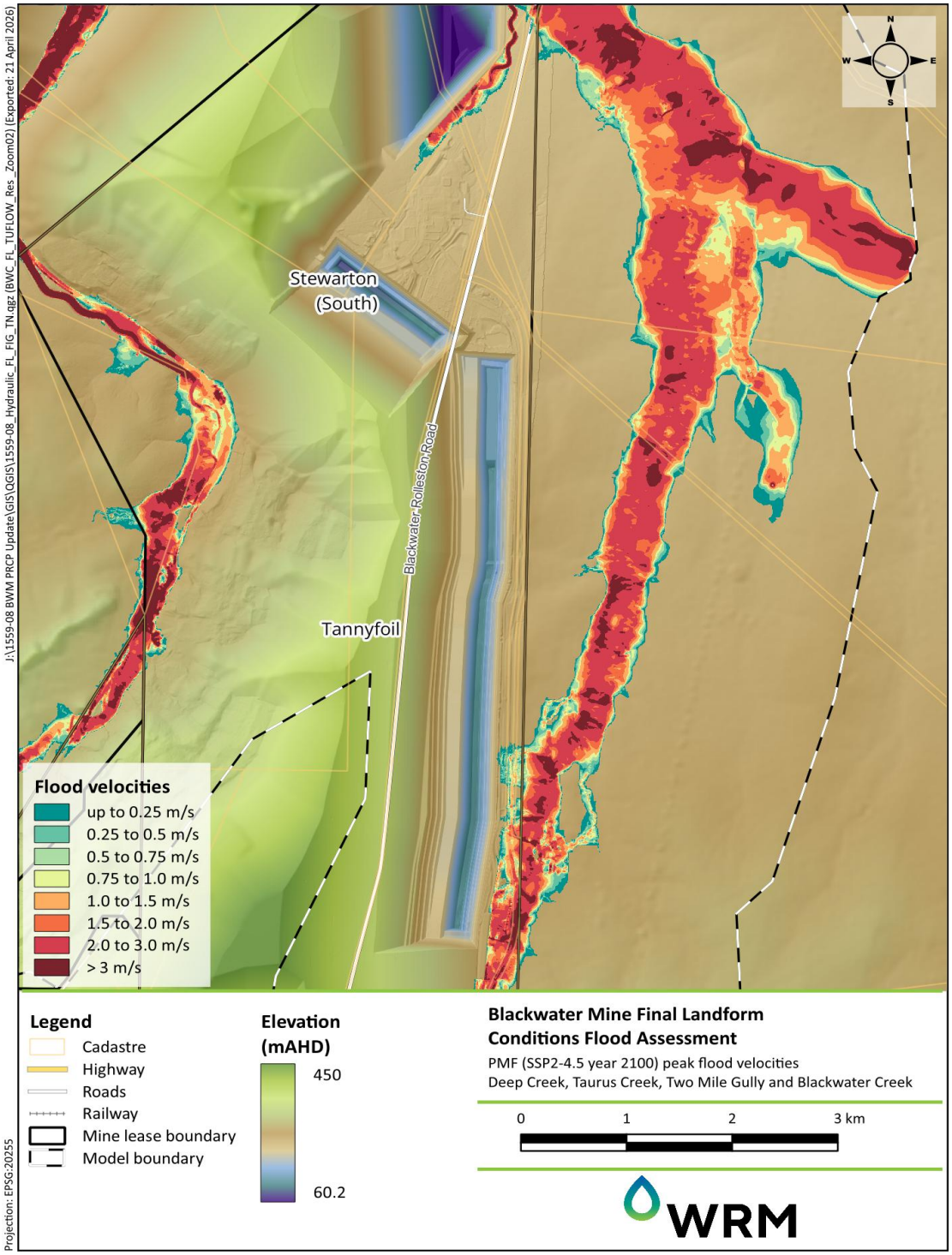


Figure C.20 Final landform conditions PMF peak flood velocities, Two Mile Gully (adjacent to the Tannyfoil Void)

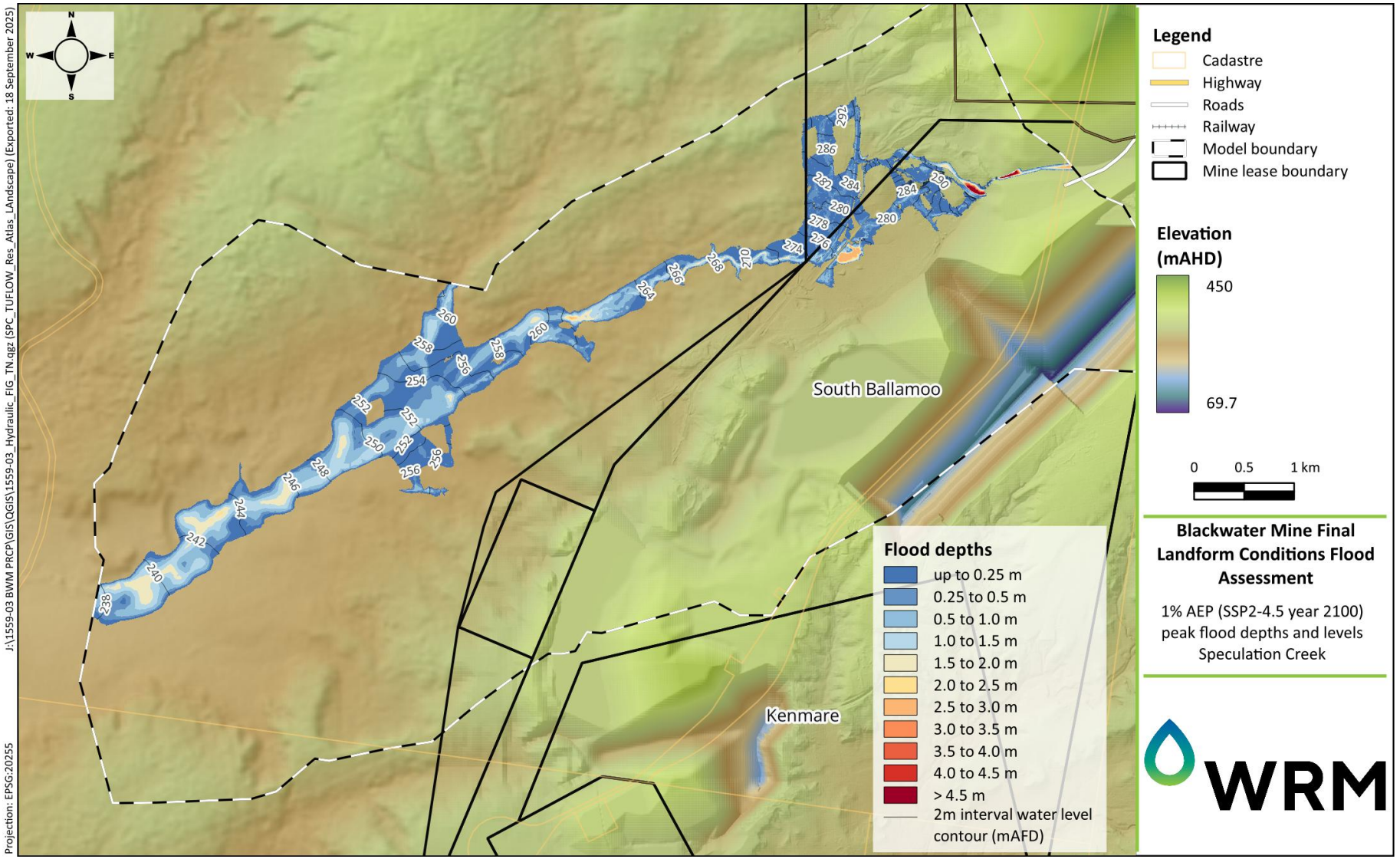


Figure C.21 **Final landform conditions 1% AEP peak flood depths, levels and extents, Speculation Creek**

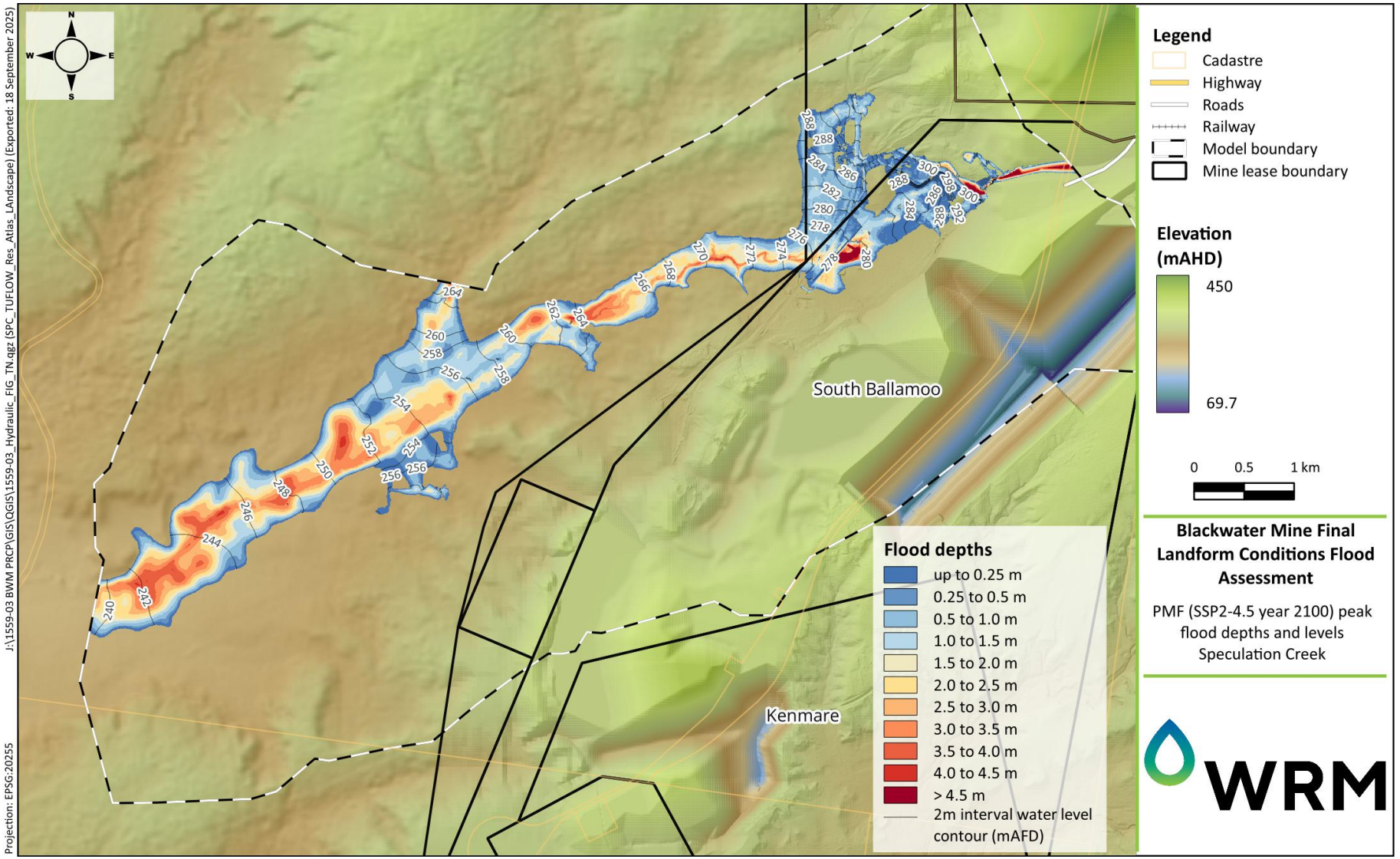


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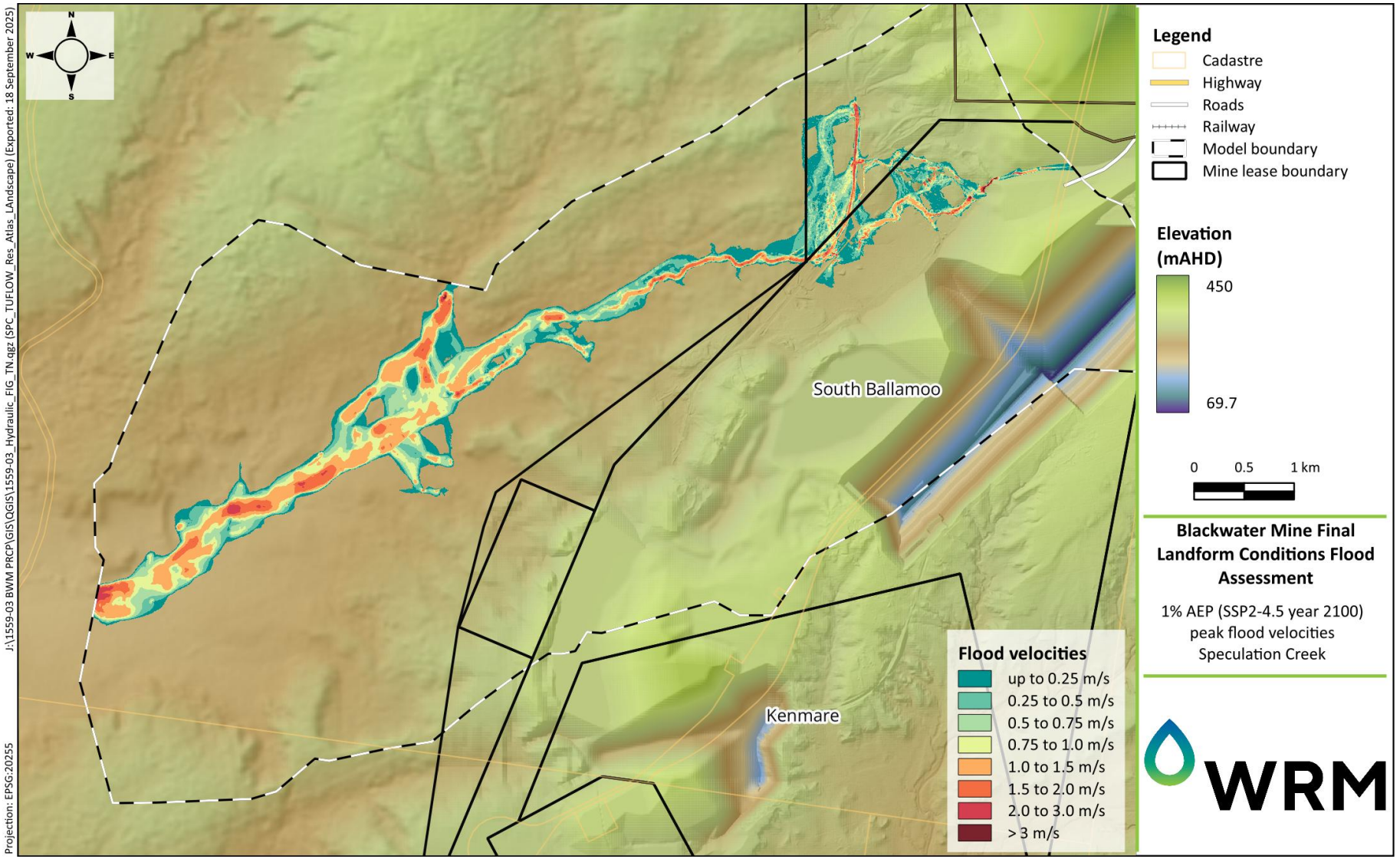


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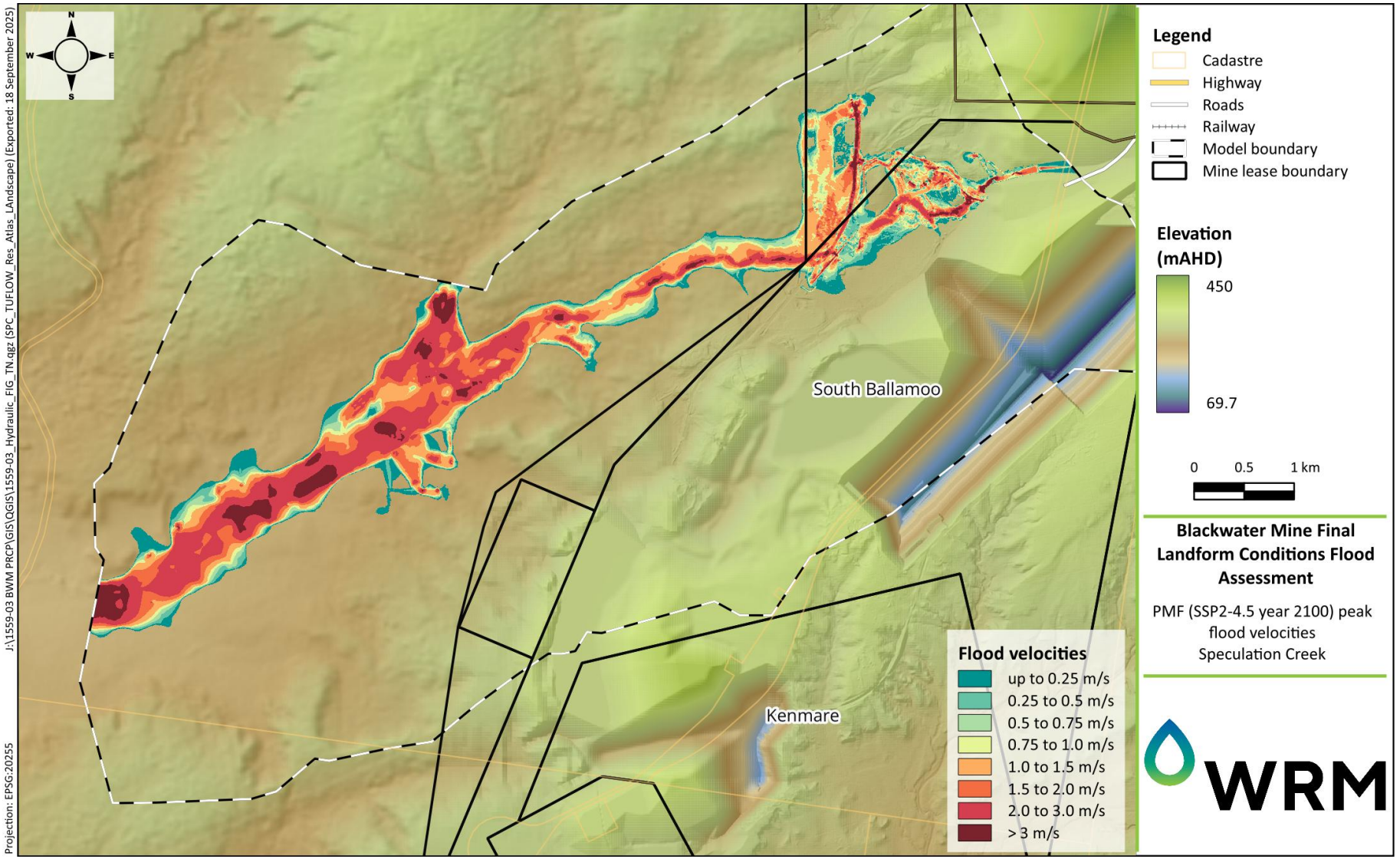


Figure C.24 **Final landform conditions PMF peak flood velocities, Speculation Creek**

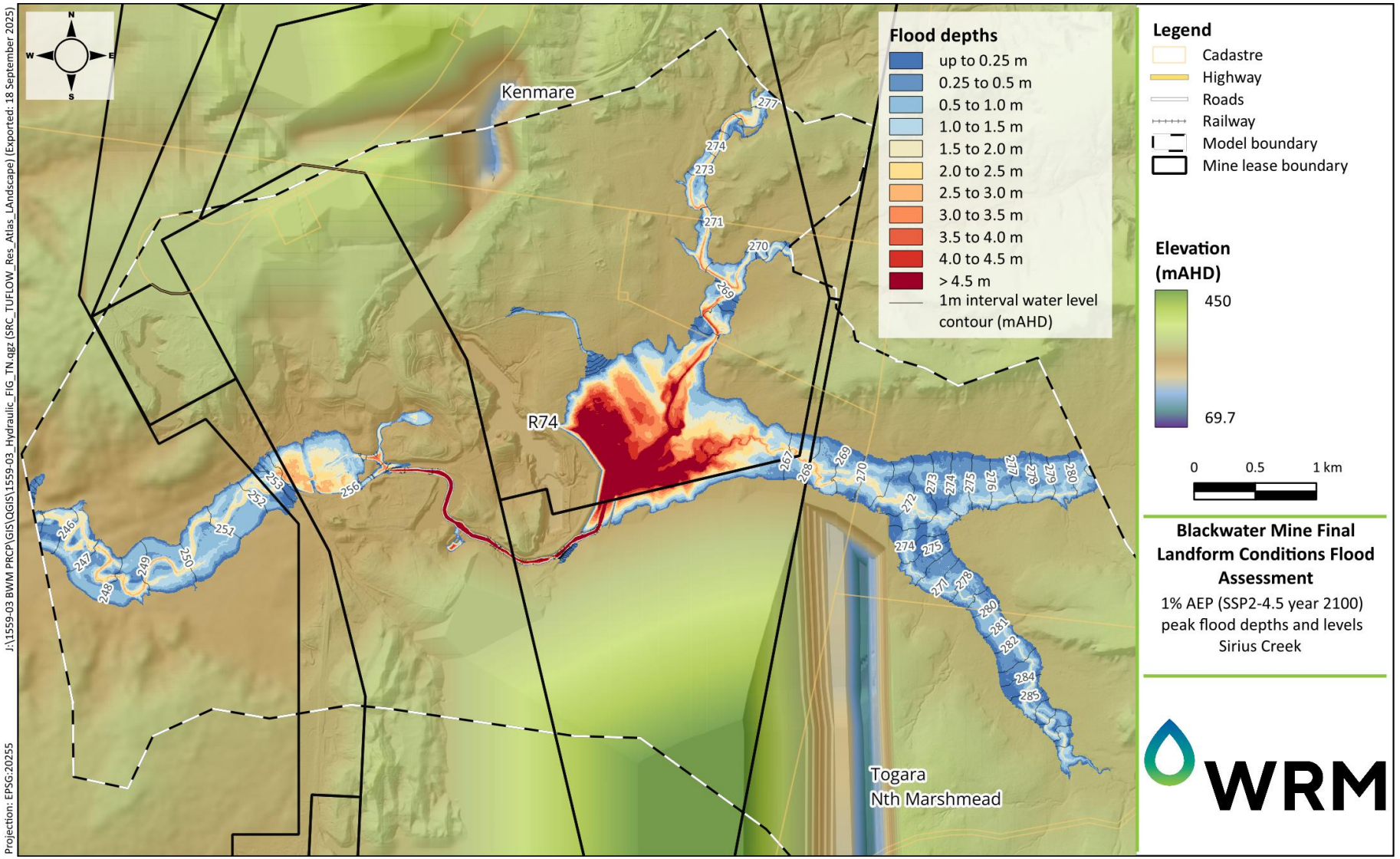


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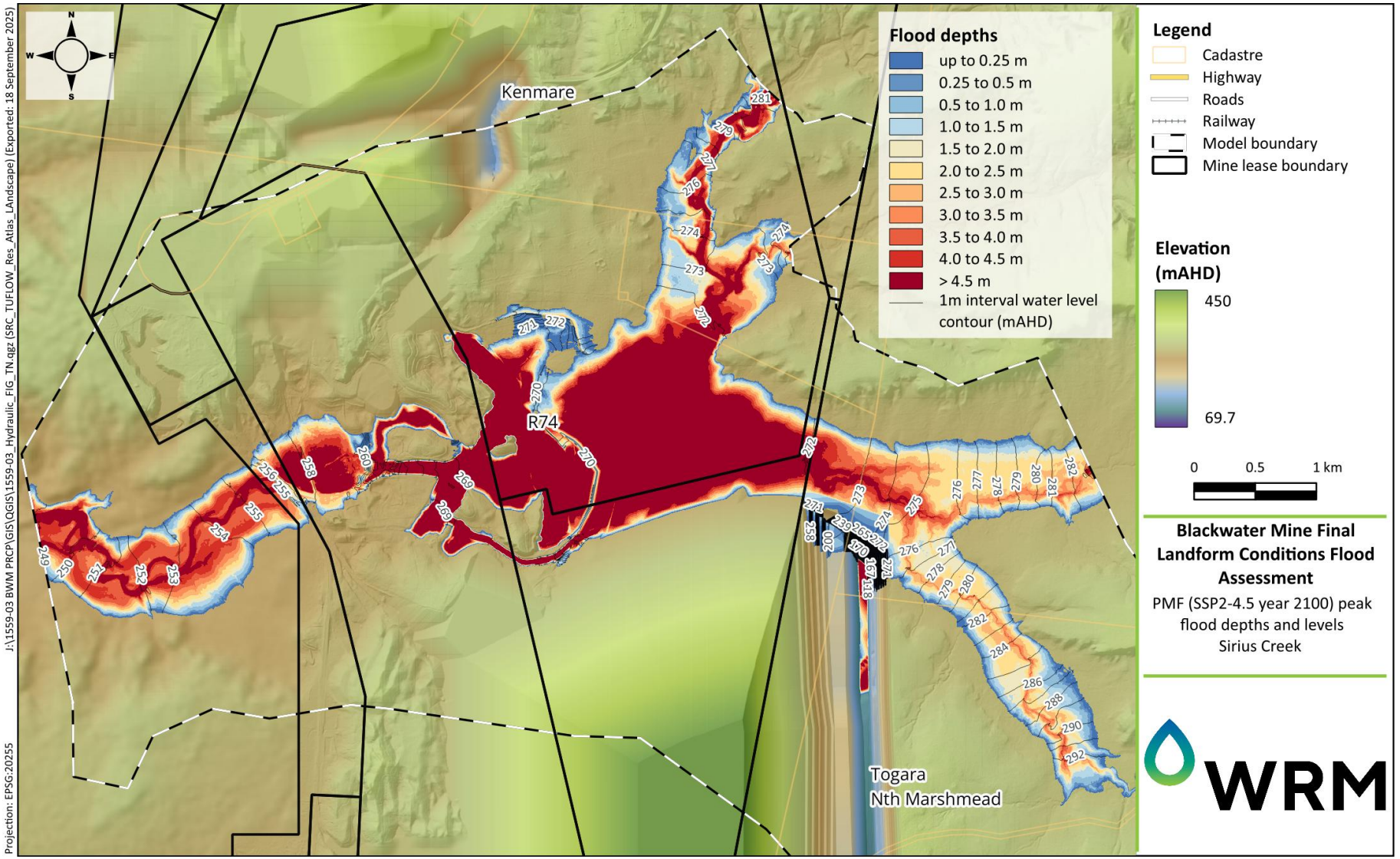


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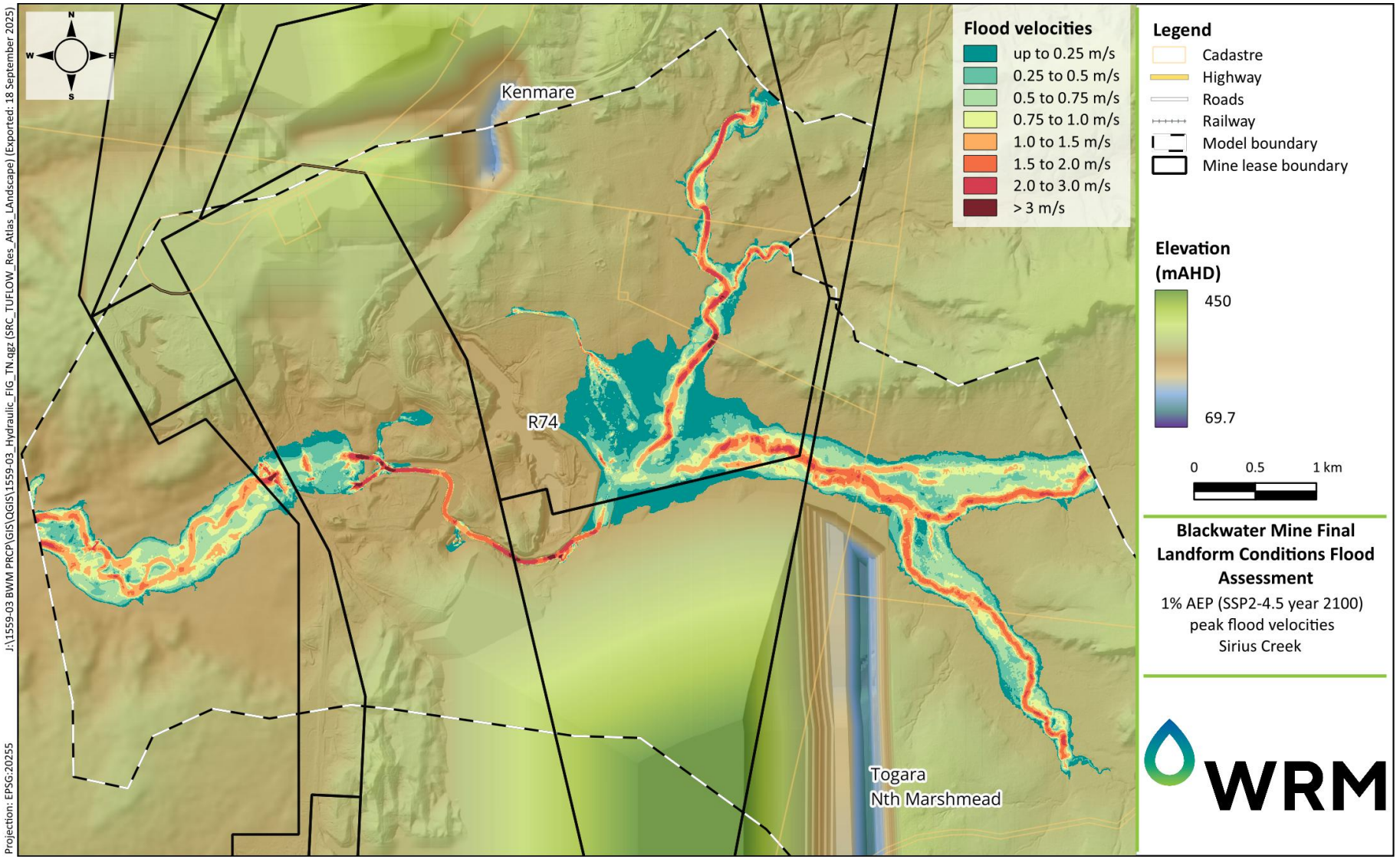


Figure C.27 **Final landform conditions 1% AEP peak flood velocities, Sirius Creek**

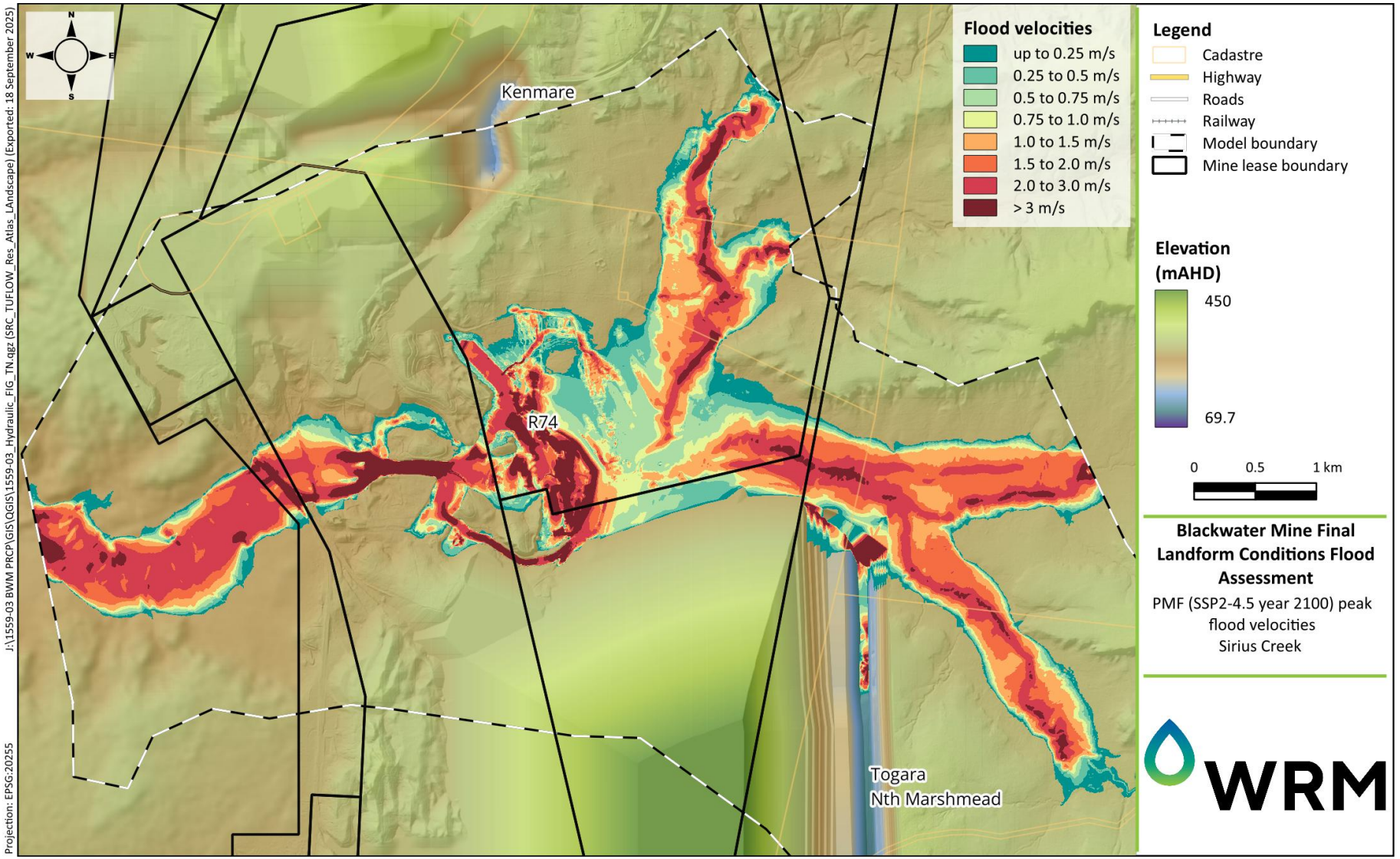


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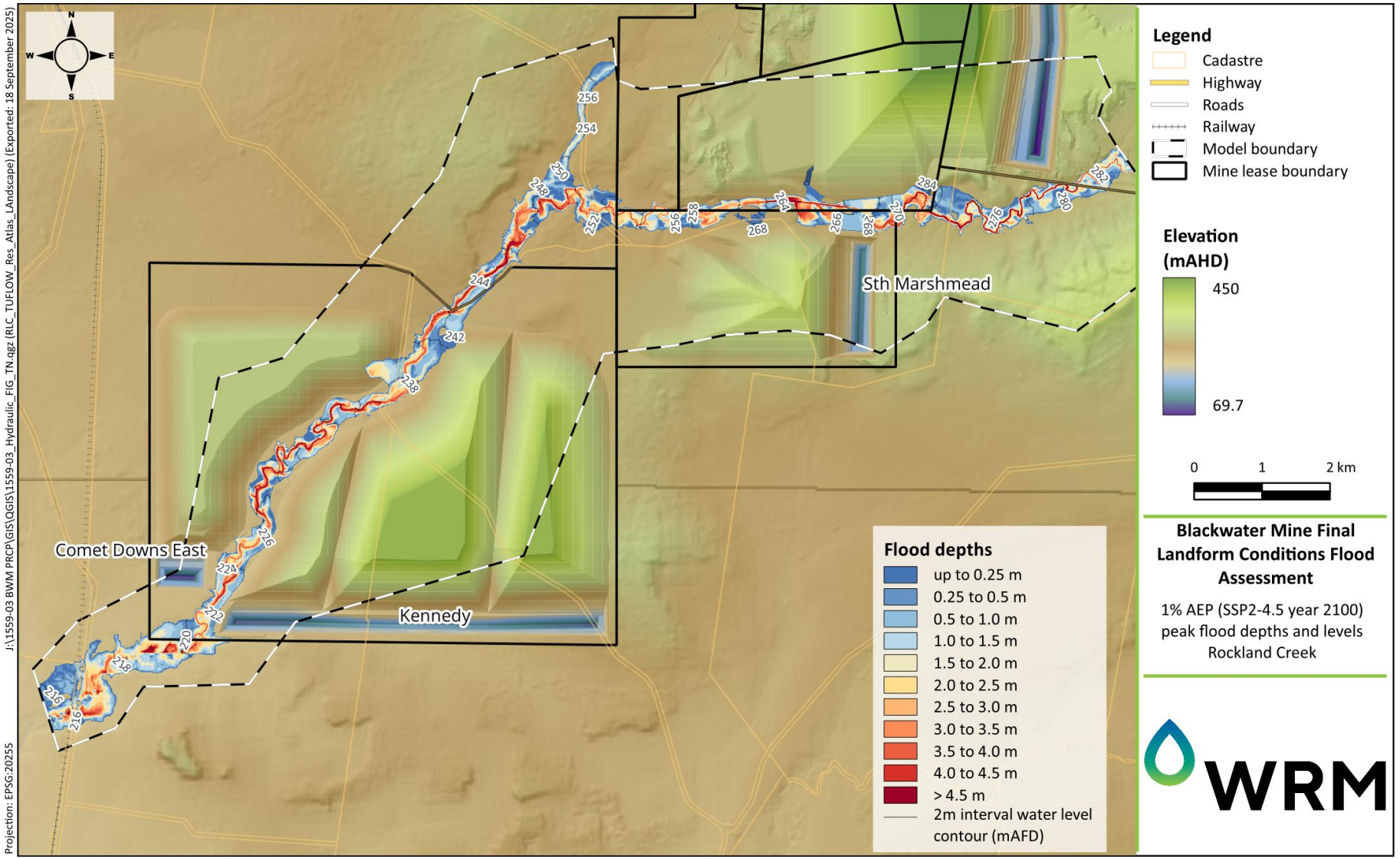


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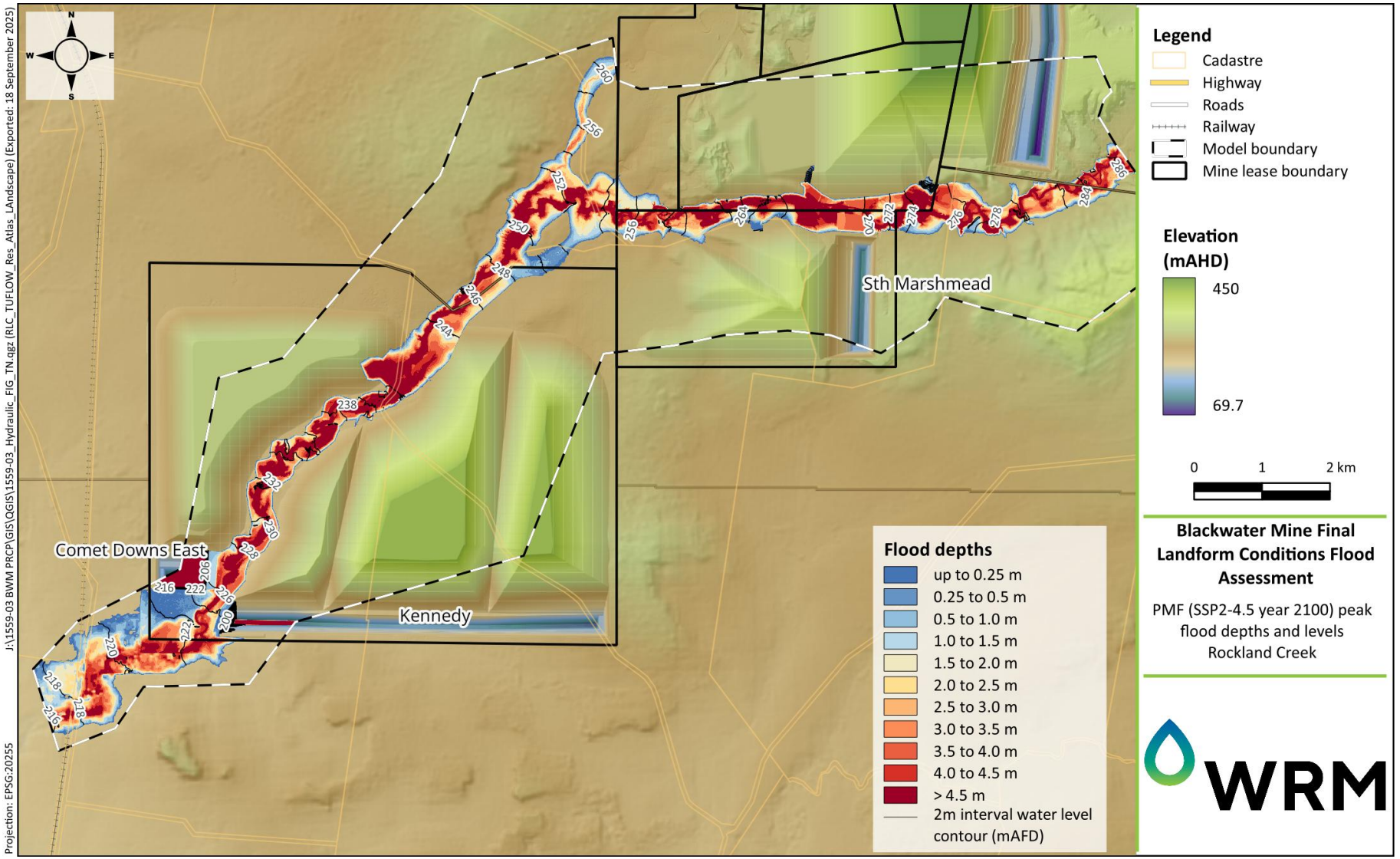


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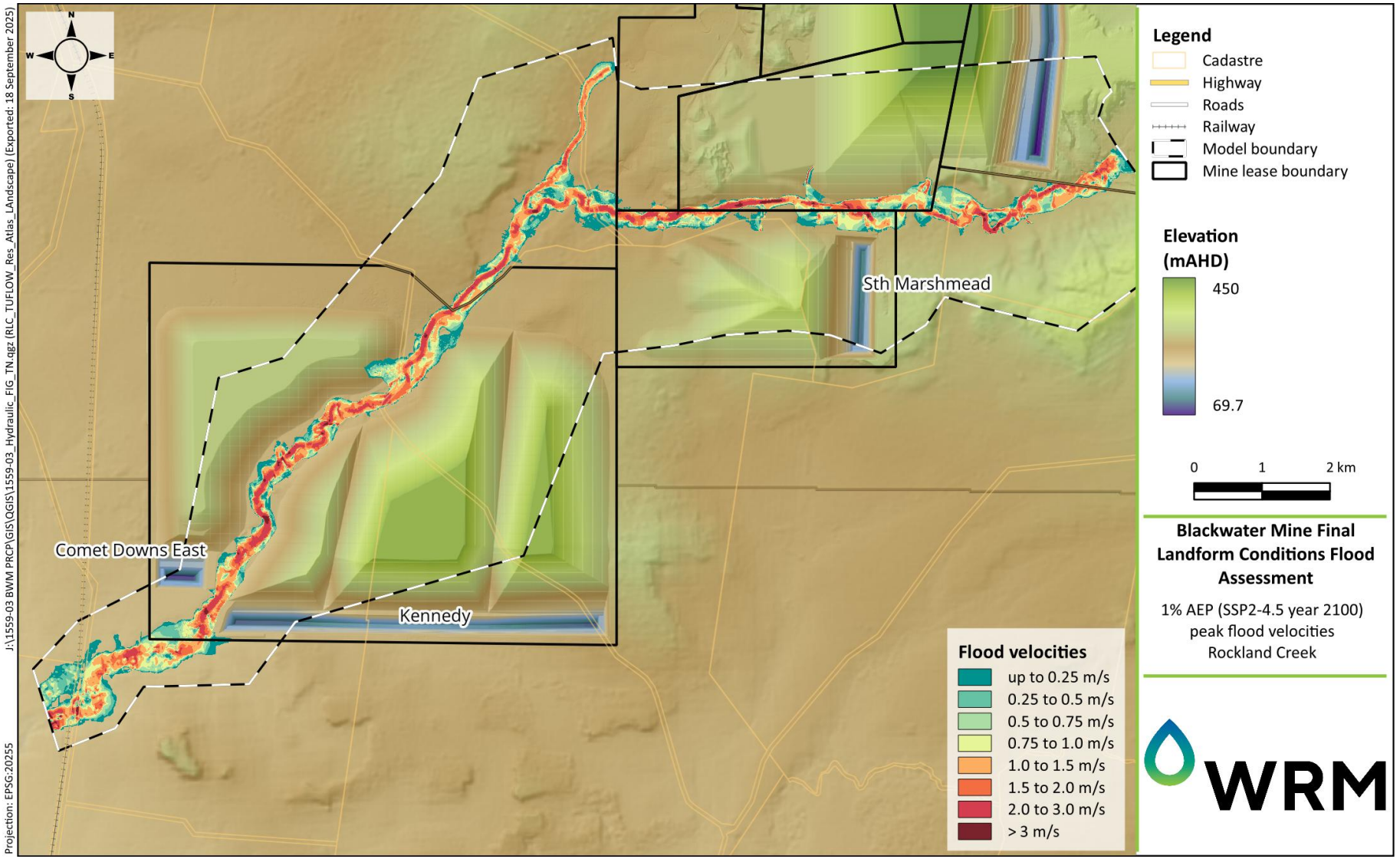


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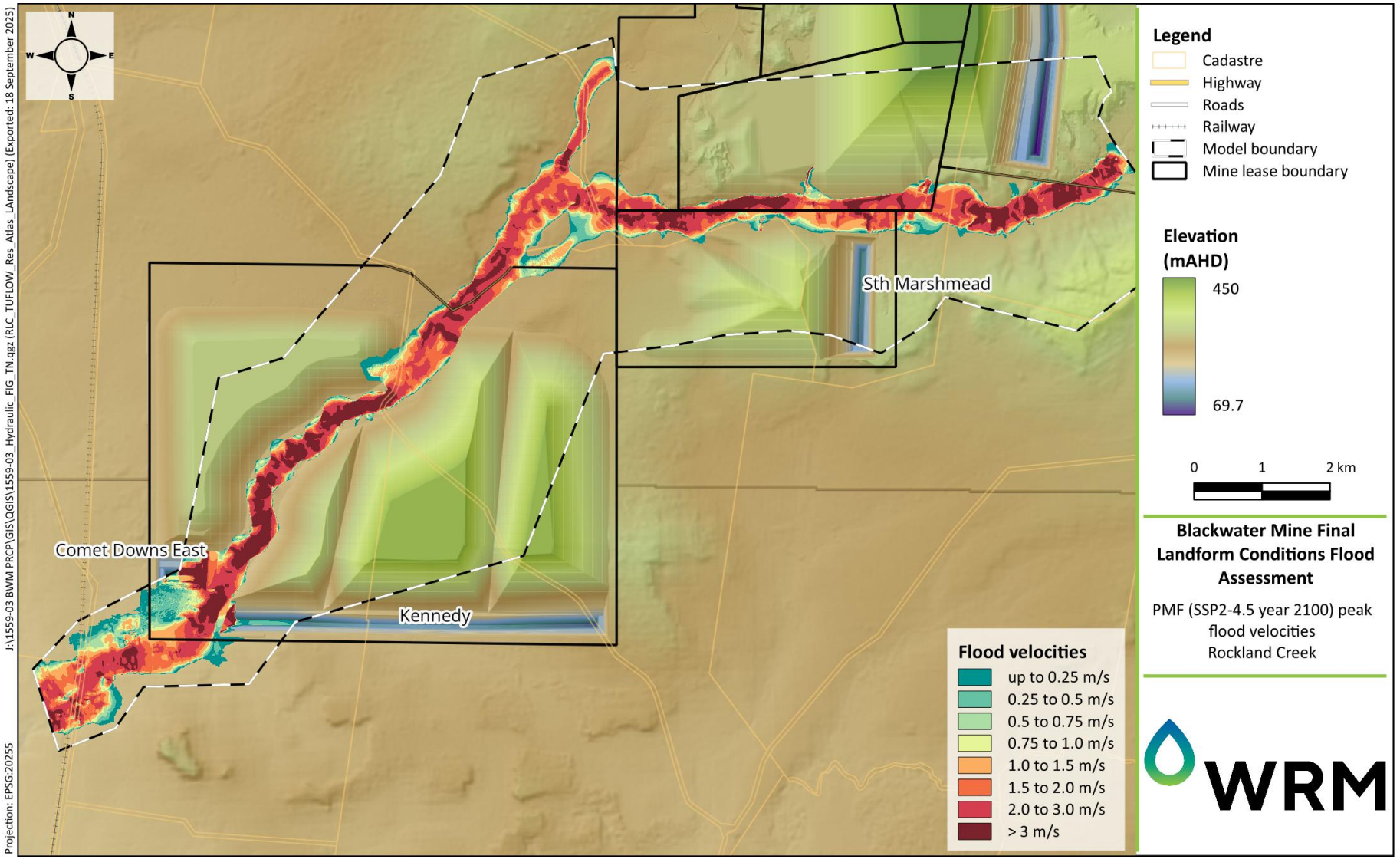


Figure C.32 **Final landform conditions PMF peak flood velocities, Rockland Creek**

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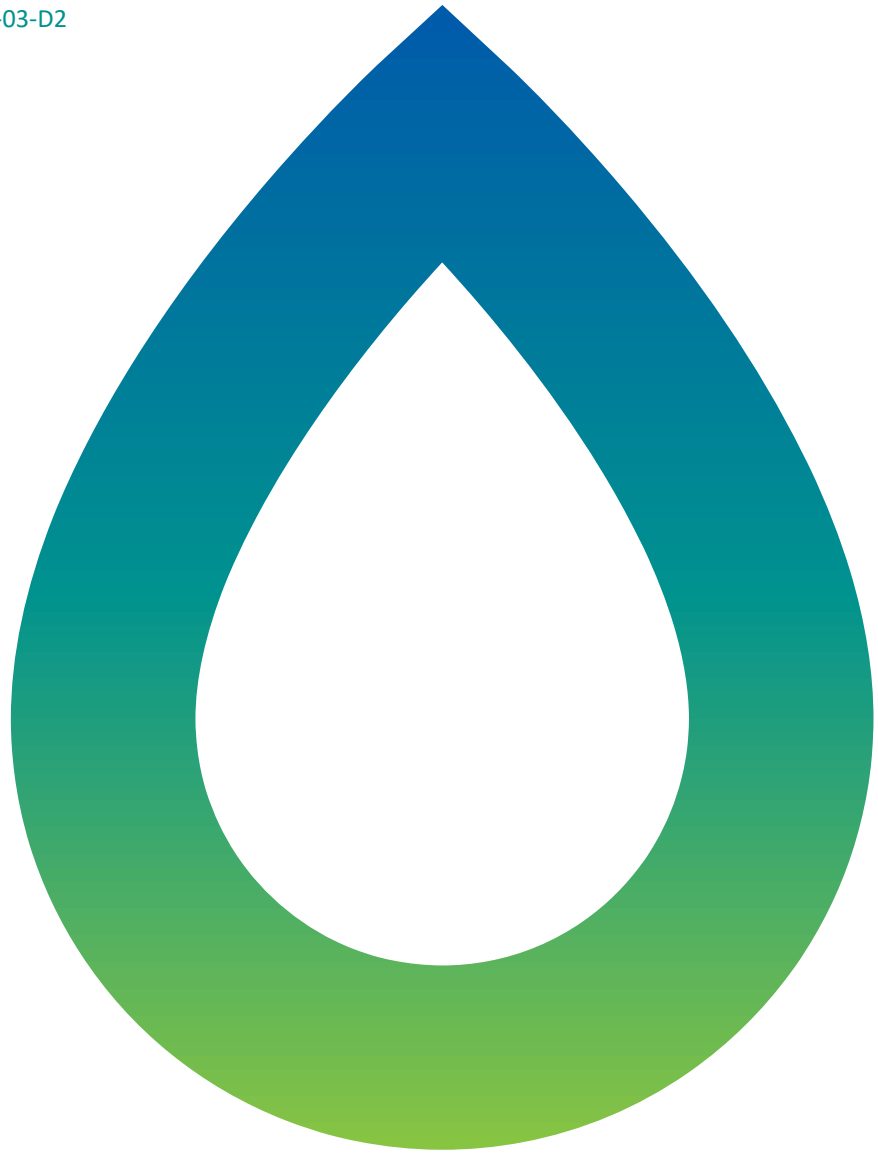
BLACKWATER MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN

Hydrologic Model Development, Calibration and Validation Report

Whitehaven Coal Limited

28 November 2025

1559-03-D2



DETAILS

Report Title	BLACKWATER MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN, Hydrologic Model Development, Calibration and Validation Report
Client	Whitehaven Coal Limited

THIS REVISION

Report Number	1559-03-D2
Date	28 November 2025
Author	Lorena Miranda
Reviewer	Ardianto Notodirdjo

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1 INTRODUCTION

1.1 OVERVIEW

Whitehaven, the owners of Blackwater Mine (BWM), has requested WRM Water & Environment Pty Ltd (WRM) to undertake hydrologic and hydraulic modelling for the BWM Progressive Rehabilitation and Closure Plan (PRCP) for Revision 2 (Rev 2) of the BWM final landform configuration.

New hydrologic models were developed using the URBS software package, which incorporates the latest climate change guidance from Australian Rainfall and Runoff 2019 Version 4.2 (ARR 2019 v4.2) (Ball et al, 2019). Additionally, URBS has increasingly become the industry standard (and preferred) software package for undertaking hydrologic modelling.

This "hydrologic model development report" presents the development, calibration and validation of seven (7) URBS hydrologic models for the catchments that drain across BWM. The modelled catchments are listed below and shown on Figure 1.1:

- Bonnie Doon Creek;
- Sagittarius Creek;
- Burngrove Creek;
- Blackwater Creek (including Deep Creek, Emu Creek, Taurus Creek and Two Mile Gully);
- Speculation Creek;
- Sirius Creek; and
- Rockland Creek.

This report provides the foundation for the following two flood assessments that inform the PRCP for Rev 2 of the BWM final landform:

- The Void in Floodplain Modelling assessment (WRM, 2025a); and
- The Final Landform Flood Modelling Assessment (WRM, 2025b).

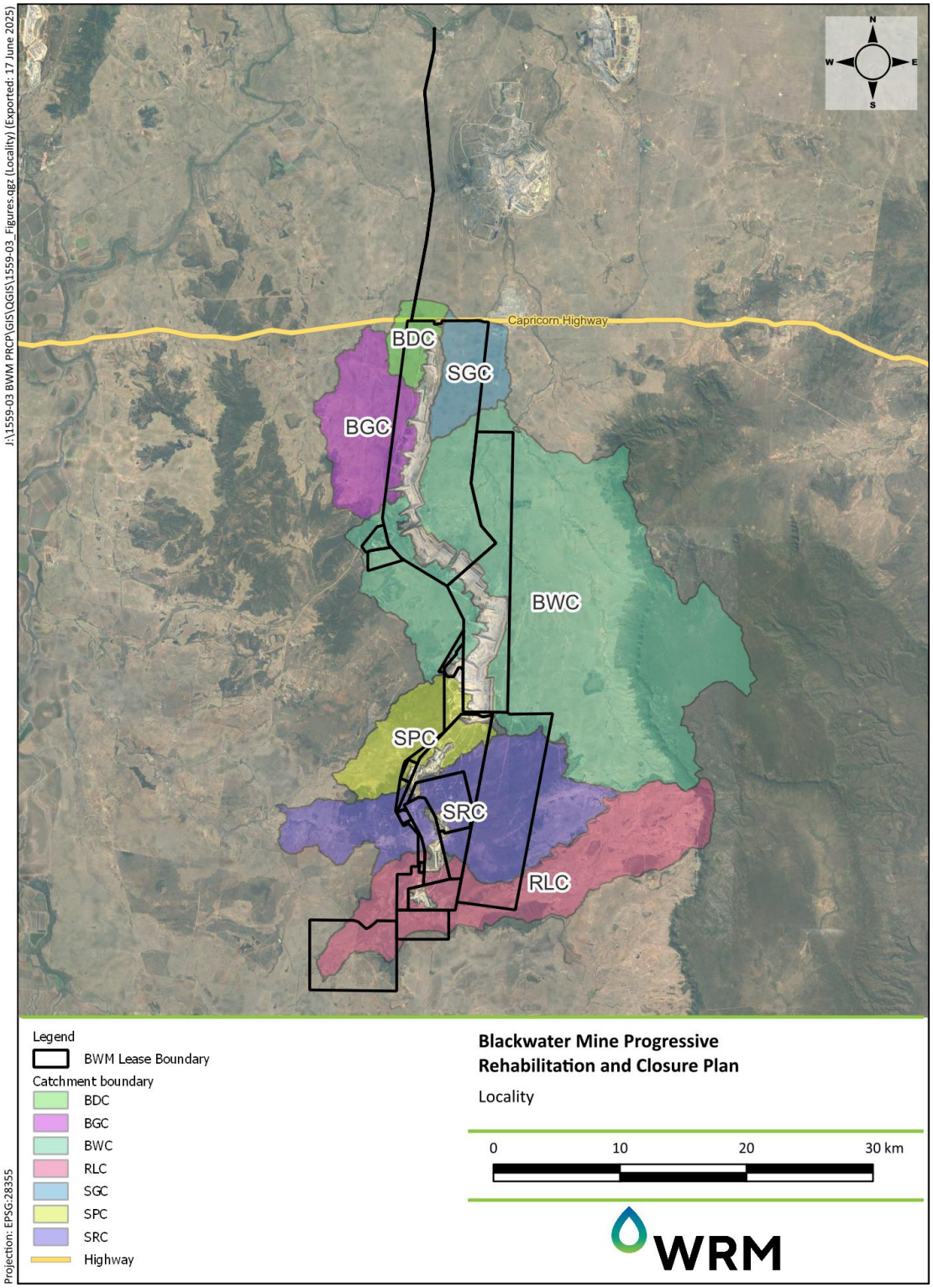


Figure 1.1 Study site locality

1.2 SCOPE OF STUDY

The proposed scope of works for this study included the following tasks:

- Development of a hydrologic model of the Burngrove Creek (BGC) catchment and calibration of the model using recorded water level data at the Burngrove Creek Upstream stream gauge (station 330127);
- Development of a hydrologic model of the Blackwater Creek (BWC) catchment and calibration of the model using recorded water level data at the Taurus Creek Downstream stream gauge (station 330101) and at the Two Mile Gully stream gauge (station 330124);
- Development of a hydrologic model of the Speculation Creek (SPC) catchment and calibration of the model using recorded water level data at the Speculation Creek stream gauge (station 330126);
- Development a hydrologic model of the Sirius Creek (SRC) catchment and calibration of the model using recorded water level data at the Sirius Creek Downstream stream gauge (station 330118), followed by validation of the model predicted 1% (1 in 100) annual exceedance probability (AEP) design discharges against discharge estimates from empirical methods.
- Development of hydrologic models of the Bonnie Doon Creek, Sagittarius Creek and Rockland Creek catchments and validation of the model predicted 1% AEP design discharges against discharge estimates from empirical methods.

1.3 REPORT STRUCTURE

The report is structured as follows:

- Section 2 is an overview of the data available for this study;
- Section 3 describes the development of the hydrologic model;
- Section 4 presents the hydrologic model calibration;
- Section 5 presents the hydrologic model validation;
- Section 6 is a list of references.

2 EXISTING DRAINAGE CHARACTERISTICS

Figure 2.1 shows the existing drainage characteristics in the vicinity of BWM, which are described as follows:

- Bonnie Doon Creek (BDC) drains in a northerly direction west of the BWM workings.
- Sagittarius Creek (SGC) drains in a northerly direction east of the BWM workings.
- The Burngrove Creek (BGC) catchment comprises the following three streams:
    - Burngrove Creek flows in a northeasterly direction west of the BWM workings. A 3 km section of the natural Burngrove Creek channel was removed by the BWM workings and replaced by a diversion channel that drains north between the railway and the BWM.
    - Cabbagetree Creek originates from the southwest of the catchment and drains in a northeasterly direction west of BWM before joining Burngrove Creek.
    - Tolmies Creek originates from the west of the catchment and drains in a northeasterly direction west of BWM before joining Burngrove Creek.
- The Blackwater Creek (BGC) catchment comprises the following five streams:
    - Blackwater Creek originates from the south of the catchment and flows in a northern direction. This creek does not interact with the BWM lease.
    - Taurus Creek, a major tributary of Blackwater Creek, originates from the east of BWM and drains in a northeasterly direction through BWM between the R38S and R42N open cut pits, eventually joining Blackwater Creek about 6 km east of BWM.
    - Deep Creek, a tributary of Taurus Creek, originates from the west of BWM and drains in a northeasterly direction through BWM via the temporary Deep Creek diversion between the R30S and R34S open cut pits, before joining Taurus Creek about 3 km east of BWM.
    - Two Mile Gully, a tributary of Taurus Creek, flows in a northerly direction east of BWM and joins Taurus Creek about 5 km east of BWM.
    - Emu Creek, a tributary of Taurus Creek, originates from the west (upstream) of BWM and flows in a northeasterly direction. It is then diverted in a northwesterly direction via the Emu Creek Diversion, which drains to Taurus Creek just upstream (west) of BWM.
- Speculation Creek (SPC) originates from the western extents of BWM and flows in a southwesterly direction away from BWM. The upper extents of the Speculation Creek catchment have been heavily disturbed by BWM mining operations.
- Sirius Creek originates from the east (upstream) of BWM. It flows in a westerly direction through BWM via the temporary Sirius Creek diversion between the R74 and R78N open cut pits. Downstream of the Sirius Creek Diversion, Sirius Creek continues to drain in a westerly direction away from BWM.
- Rockland Creek originates from the east (upstream) of the BWM. It flows in a westerly direction through BWM and south of the R82S open cut pit. Rockland Creek drains into Rockland Dam just upstream (east) of the mine.
    - Rockland Dam is formed by an earthen embankment across the Rockland Creek channel and floodplain. Rockland Dam is a free-draining structure, with a low-flow culvert outlet at the base of the dam and an overflow spillway weir and channel at the northern end of the dam.

- Table 2.1 shows the key characteristics of Rockland Dam obtained from the *Rockland Creek Diversion Construction Report* (PPK Consultants, 1994), the GHD (2021) report and the 2024 LiDAR data.

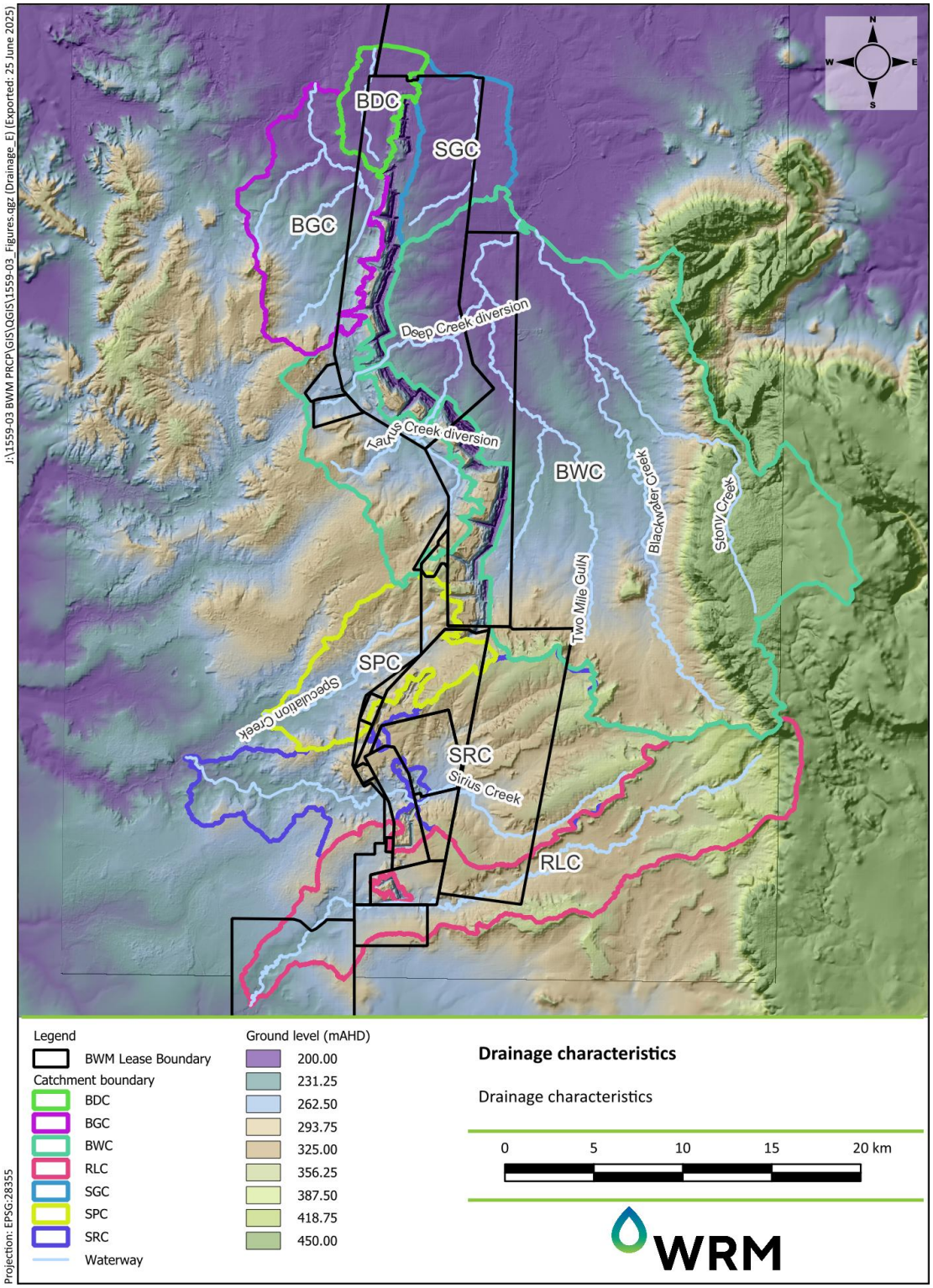


Figure 2.1 Study site drainage characteristics

- Figure 2.2 shows the stage-storage relationship for the dam derived from the LiDAR topographic data obtained in 2024. Figure 2.3 shows the stage-discharge relationship of the dam outlet derived from TUFLOW hydraulic model results.

Table 2.1 Rockland Dam key details

Dam feature	Value	Comment
Dam crest	281.2 mAHD	Based on 2024 LiDAR data
Dam crest width	8 m	Based on PPK (1994) construction report
Embankment height	16.1 m	Based on GHD (2021) report
Spillway invert	278.7 mAHD	Based on 2024 LiDAR data
Spillway width at crest	50 m	Based on GHD (2021) report
Outlet works	1.68 m wide and 1.95 m high box culverts Inlet invert = 263.4 mAHD Outlet invert = 262.8 mAHD	Based on GHD (2021) report
Storage volume at crest	20,310 ML	Based on PPK (1994) construction report

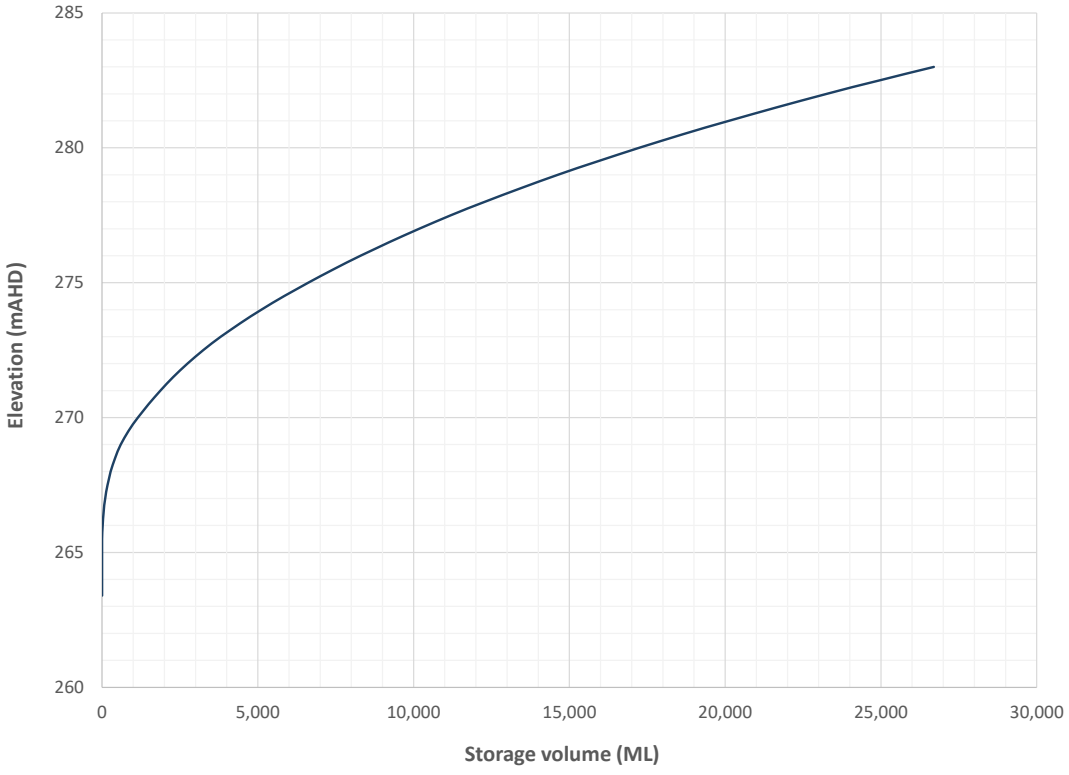


Figure 2.2 Stage-storage relationship for Rockland Dam

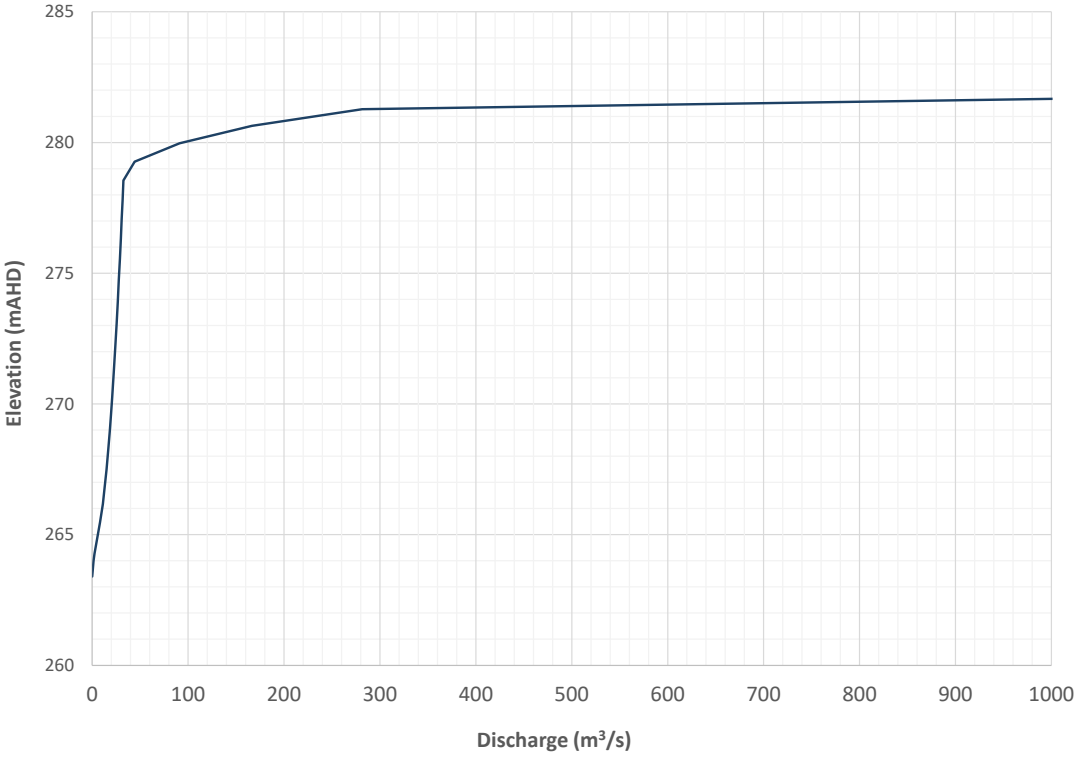


Figure 2.3 Stage-discharge relationship for the Rockland Dam outlet

3 AVAILABLE DATA

3.1 OVERVIEW

The following data was provided by Whitehaven for this study:

- Previous hydrologic and hydraulic studies;
- Recorded rainfall and water level data; and
- LiDAR topographic data.

3.2 PREVIOUS STUDIES

3.2.1 Blackwater Mine Flood Study (2021)

The Blackwater Mine Flood Study undertaken by GHD (2021) assessed existing flood risks across BWM. XP-RAFTS hydrologic and TUFLOW hydraulic models were developed for this study. In this study, the hydrologic models for Burngrove Creek and Speculation Creek were calibrated to recorded water level data. The GHD (2021) study report was provided for this study, but the XP-RAFTS and TUFLOW models were not available.

3.2.2 Blackwater Mine Progressive Rehabilitation and Closure Plan (2024)

The XP-RAFTS hydrologic and TUFLOW hydraulic models used by SLR (2024a and 2024b) for the Rev 1 PRCP flood assessment were provided for this study. These models appear to have been developed based on the GHD (2021) hydrologic and hydraulic models. Separate models were provided for the following catchments:

- Bonnie Doon Creek;
- Blackwater Creek;
- Burngrove Creek;
- Rockland Creek;
- Sagittarius Creek;
- Sirius Creek;
- Speculation Creek;
- Taurus Creek; and
- Two Mile Gully.

3.3 RAINFALL AND WATER LEVEL DATA

3.3.1 Rainfall and water level gauging stations

Figure 3.1 shows the location of three subdaily rainfall (pluviograph) stations and six stream gauging stations across BWM. Table 3.1 and Table 3.2 show details of these stations.

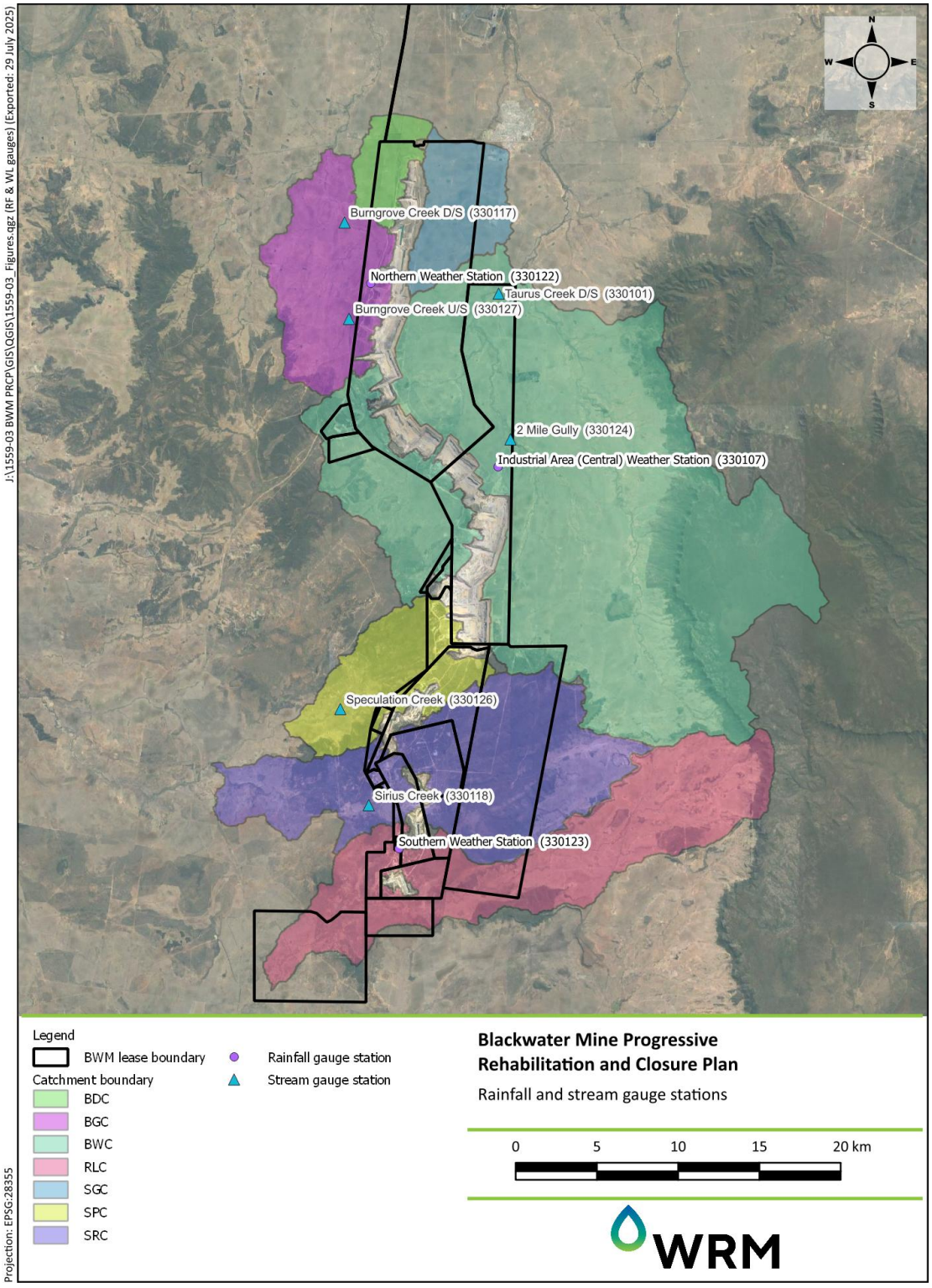


Figure 3.1 Location of rainfall and stream gauging stations

Table 3.1 Details of available subdaily rainfall (pluviograph) stations

Station Number	Station Name	Supplied data period
330122	Northern Weather Station	January 2016 – January 2025
330107	Industrial Areal (Central) Weather Station	January 2016 – January 2025
330123	Southern Weather Station	January 2016 – January 2025

Table 3.2 Details of available stream gauging stations

Station Number	Station Name	Supplied data period
330101	Taurus Creek D/S	January 2016 – January 2025
330118	Sirius Creek D/S	January 2016 – January 2025
330124	Two Mile Gully	January 2016 – January 2025
330126	Speculation Creek	January 2016 – January 2025
330127	Burngrove Creek U/S	January 2016 – January 2025
330117	Burngrove Creek D/S	January 2016 – January 2025

3.3.2 Rating curves

Whitehaven provided rating curves for the six gauges listed in Table 3.2 (referred to in this report as the Whitehaven rating curves). It was uncertain if the Whitehaven rating curves were derived from actual gaugings or from hydraulic modelling. For this study, the rating curves were verified and then modified and/or extended if necessary, using hydraulic modelling where detailed LiDAR data is available.

Figure 3.1 to Figure 3.4 compare the Whitehaven rating curves, the TUFLOW model generated rating curves and the final adopted rating curves for the Taurus Creek D/S, Two Mile Gully, Burngrove Creek U/S and Sirius Creek D/S gauges, respectively. For these four gauges, the “adopted” rating curves were used to convert recorded water levels into discharges for the hydrologic model calibration.

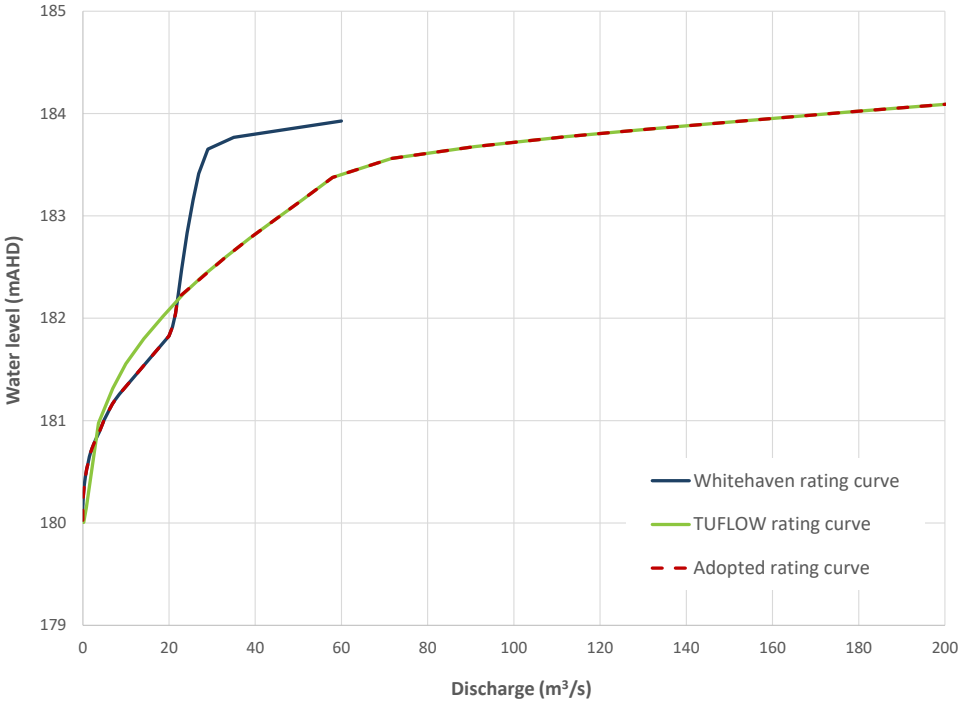


Figure 3.1 Comparison of Whitehaven-supplied, TUFLOW and adopted rating curves, Taurus Creek D/S gauging station

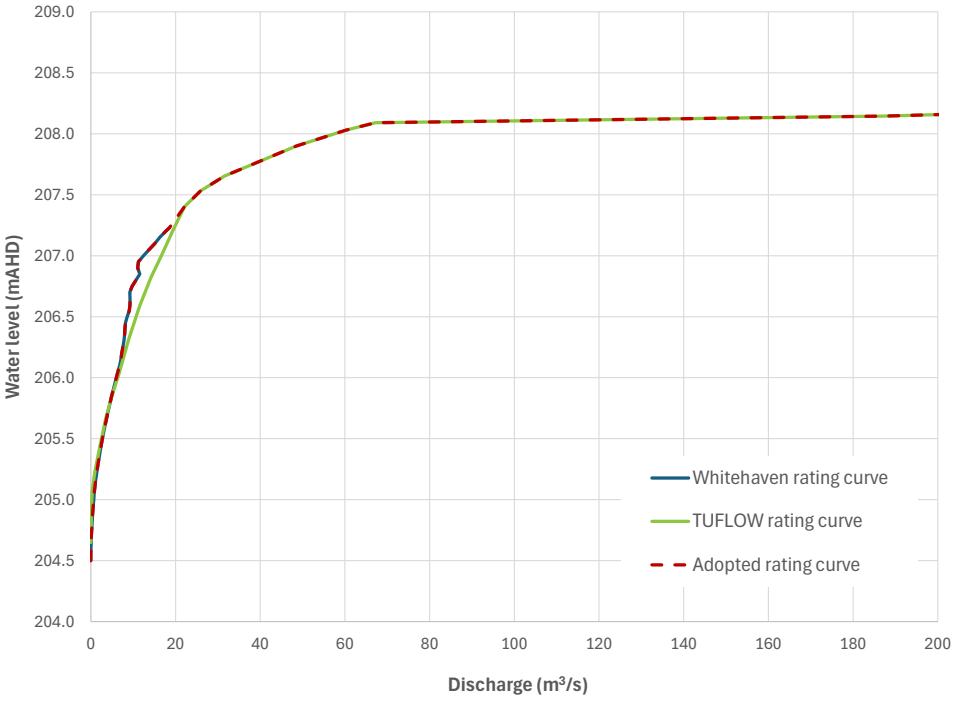


Figure 3.2 Comparison of Whitehaven-supplied, TUFLOW and adopted rating curves, Two Mile Gully gauging station

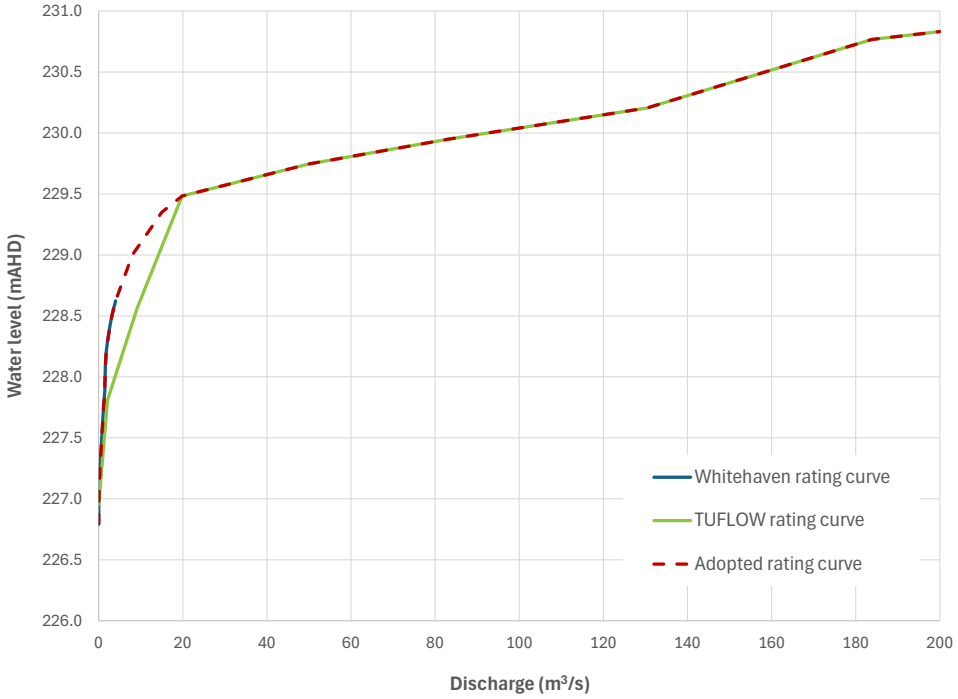


Figure 3.3 Comparison of Whitehaven-supplied, TUFLOW and adopted rating curves, Burngrove Creek U/S gauging station

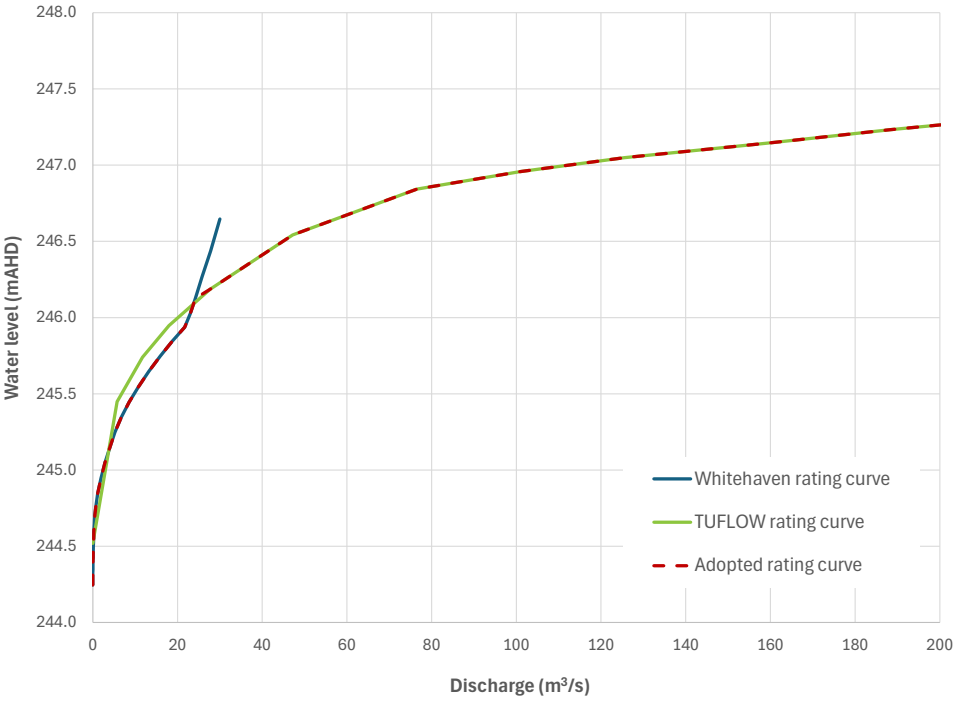


Figure 3.4 Comparison of Whitehaven-supplied, TUFLOW and adopted rating curves, Sirius Creek D/S gauging station

3.4 TOPOGRAPHIC DATA

The available topographic data used for this study is described as follows:

- A 1 m resolution LiDAR covering the BWM mine lease area captured in February 2024 (referred to as the 2024 LiDAR data);
- A 1 m resolution LiDAR covering the active mining pits of BWM captured in February 2025 (referred to as the 2025 LiDAR data); and
- A 30 m resolution Copernicus Digital Surface Model (DSM) satellite ground level observation data obtained from the European Space Programme on 31 January 2025 (referred to as the Copernicus DSM data).

4 HYDROLOGIC MODEL DEVELOPMENT

4.1 OVERVIEW

A total of seven URBS hydrologic models were developed for the following catchments:

- Bonnie Doon Creek;
- Blackwater Creek (including Taurus Creek and Two Mile Gully);
- Burngrove Creek;
- Rockland Creek;
- Sagittarius Creek;
- Sirius Creek;
- Speculation Creek.

URBS is a runoff-routing computer model that uses a network of conceptual storages to represent the routing of rainfall excess through a catchment. The URBS model was used in the "split mode" which enables the separate simulation of catchment and channel routing.

The initial and continuing loss method was adopted for this study. This model assumes that there is an initial loss (IL) in mm before any rainfall becomes runoff. After this, a continuing loss (CL) rate in mm per hour is applied to the rainfall.

Full details of the URBS model and its features are given in the URBS User Manual (Carroll, 2021).

The following three models were calibrated to recorded data for the March 2017 and January 2020 flood events:

- Burnrgrove Creek;
- Blackwater Creek (including Taurus Creek and Two Mile Gully);
- Sirius Creek.

The above three models were selected for calibration due to due to having stream gauging stations located in areas where detailed LiDAR data is available. This allowed for the rating curves to be verified using hydraulic model results.

The following is of note with regard to the remaining four models:

- Bonnie Doon Creek, Sagittarius Creek and Rockland Creek – There are no stream gauging stations within this catchment and hence, a model calibration cannot be undertaken for this catchment.
- Speculation Creek – The supplied rating curve for the Speculation Creek D/S gauge does not capture the peak flows that occurred in the March 2017 and January 2020 events. In addition, the Speculation Creek D/S gauging station is located outside of the detailed 2024 LiDAR data extent and as such, the supplied rating curve cannot be verified using hydraulic modelling.

The URBS models were then used to estimate design discharges for the 1% AEP event. The 1% AEP design discharge estimates were validated against estimates derived using the Rational Method, the Quantile Regression Technique (QRT) and the Regional Flood Frequency Estimation (RFFE) method.

4.2 MODEL CONFIGURATION

4.2.1 Subcatchment parameters

The URBS model subcatchments were assigned with area, slope, imperviousness, and PERN parameters. Subcatchment slopes were calculated using based on the available topographic data. The spatial configuration of the seven URBS models are summarised below.

4.2.1.1 Bonnie Doon Creek (BDC)

Figure A.1 in Appendix A shows the URBS model subcatchments adopted for the BDC model. The model covers an area of 21.6 km^2 and consists of 18 subcatchments, ranging in size from 0.17 km^2 to 2.46 km^2. Table A.1 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.2 Sagittarius Creek (SGC)

Figure A.2 in Appendix A shows the URBS model subcatchments adopted for the SGC model. The model covers a catchment area of 42.7 km^2 and consists of 28 subcatchments, ranging in size from 0.02 km^2 to 3.34 km^2. Table A.2 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.3 Burngrove Creek (BGC)

Figure A.3 in Appendix A shows the URBS model subcatchments adopted for the BGC model. The model covers an area of 79.2 km^2 and consists of 54 subcatchments, ranging in size from 0.06 km^2 to 5.72 km^2. Table A.3 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.4 Blackwater Creek (BWC)

Figure A.4 in Appendix A shows the URBS model subcatchments adopted for the BWC model. The model covers an area of 509.8 km^2 and consists of 226 subcatchments, ranging in size from 0.02 km^2 to 17.8 km^2. Table A.4 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.5 Speculation Creek (SPC)

Figure A.5 in Appendix A shows the URBS model subcatchments adopted for the SPC model. The model covers an area of 60.31 km^2 and consists of 39 subcatchments, ranging in size from 0.07 km^2 to 4 km^2. Table A.5 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.6 Sirius Creek (SRC)

Figure A.6 in Appendix A shows the URBS model subcatchments adopted for the SRC model. The model covers an area of 162 km^2 and consists of 85 subcatchments, ranging in size from 0.13 km^2 to 6.15 km^2. Table A.6 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.1.7 Rockland Creek (RLC)

Figure A.7 in Appendix A shows the URBS model subcatchments adopted for the SRC model. The model covers ant area of 158.6 km^2 and consists of 62 subcatchments, ranging in size from 0.14 km^2 to 8.5 km^2. Table A.7 in Appendix A shows the subcatchment parameters adopted in the model under existing land use conditions.

4.2.2 Adopted global URBS model parameters

The global URBS model parameters included channel lag parameter (alpha), catchment storage parameter (beta), catchment non-linearity (M) and channel routing exponent (N). The following global URBS parameters were adopted for all seven models:

- Channel routing “alpha” (α) = 0.1
- Catchment routing “beta” (β) = 1.0
- Catchment routing exponent (M) = 0.715
- Channel routing exponent (N) = 1.0

4.3 INITIAL AND CONTINUING LOSSES

The initial loss (IL) and continuing loss (CL) method of accounting for rainfall losses was adopted for this study. For the calibration events, different initial and continuing losses were derived for each calibration event to reflect different antecedent catchment conditions (refer to Section 5.3). Design event ILs and CLs were derived during the model validation process (refer to Section 6.2.2).

5 HYDROLOGIC MODEL CALIBRATION

5.1 METHODOLOGY

The URBS models for the Burngrove Creek, Blackwater Creek and Sirius Creek were calibrated for the March 2017 and January 2020 flood events. The purpose of the model calibration was to achieve the best possible match between URBS-modelled discharge hydrographs against the recorded discharge hydrographs, using a common set of model parameters between flood events.

5.2 SELECTION OF CALIBRATION EVENTS

5.2.1 Overview

The March 2017 and January 2020 flood events were selected for calibration due to the availability of data and because the rainfalls during these events triggered similar responses at all catchments for which data is available. The March 2017 and January 2020 events were also the selected calibration events in the GHD (2021) study.

Table 5.1 shows the adopted historical event simulation periods for the calibration events in the URBS model. Table 5.2 shows the recorded rainfall depths at each station for the calibration events. Table 5.3 shows the recorded peak discharges at each gauging station for the calibration events.

Table 5.1 Calibration event simulation periods

Calibration Event	Simulation period
March 2017	28 March (0000 hours) – 1 April (0000 hours) - 4 days
January 2020	24 January (0000 hours) – 27 January (0000 hours) - 3 days

Table 5.2 Total rainfall depths recorded during the 2017 and 2020 events

Station Number	Station Name	Rainfall depth (mm)	
		March 2017	January 2020
330107	Central WS	119.0	148.0
330122	Northern WS	139.5	78.5
330123	Southern WS	142.5	49.5

Table 5.3 Peak discharges recorded during calibration events

Station Number	Station Name	Peak discharge (m^3/s)	
		March 2017	January 2020
330127	Burngrove Creek U/S	78.5	22.2
330101	Taurus Creek D/S	117	156.8
330124	Two Mile Gully	16.2	50.4
330118	Sirius Creek D/S	15.9	8.6

5.2.2 March 2017 event

Figure B.1 to Figure B.3 (Appendix B) show the rainfall intensity recorded at each available rainfall station listed in Table 5.2 over the period 0000 hours on 28 March 2017 to 0000 hours on 1 April 2017 within and near the catchments of interest. The highest rainfall intensity of 29 mm/h was recorded in the at the Southern WS Station (330123).

Figure B.4 to Figure B.8 (Appendix B) shows the recorded water levels at the stations listed in Table 5.3 over the same period.

5.2.3 January 2020 event

Figure B.9 to Figure B.11 (Appendix B) show the rainfall intensity recorded at each available rainfall station listed in Table 5.2 over the period 0000 hours on 24 January 2020 to 0000 hours on 27 January 2020 within and near the catchments of interest. The highest rainfall intensity of 46 mm/h was recorded at the Central WS Station (330107).

Figure B.12 to Figure B.16 (Appendix B) shows the recorded water levels at the stations listed in Table 5.3 over the same period.

5.2.4 Assignment of subcatchment rainfalls

Each URBS subcatchment was assigned a rainfall hyetograph based on the three nearest pluviograph stations, using the URBS SUBRAIN utility. The SUBRAIN utility calculates the weighted average rainfall depth for each subcatchment using an inverse distance squared method based on the relative distance between the rainfall station location and the subcatchment centroid.

5.3 INITIAL AND CONTINUING LOSSES

Table 5.4 shows the IL and CL adopted for the Blackwater Creek, Burngrove Creek and Sirius Creek catchments for the two calibration events. A CL of 3.5 mm/h was adopted for all three models and for all events. Different ILs were adopted for each model and for each event which reflect the different antecedent conditions prior to each event.

Table 5.4 Adopted initial and continuing losses

Model	March 2017		January 2020	
	IL (mm)	CL (mm/h)	IL (mm)	CL (mm/h)
BGC	52	3.5	53	3.5
BWC	82	3.5	75	3.5
SRC	125	3.5	73	3.5

5.4 MODEL CALIBRATION RESULTS

5.4.1 Overview

Table 5.5 shows the comparison of the calculated and recorded peak discharges at the four gauging stations for the 2017 and 2020 events.

Table 5.5 Summary of calibration results

Station Number	Station Name	Peak discharge (m^3/s)					
		March 2017			January 2020		
		Calculated	Recorded	Difference (%)	Calculated	Recorded	Difference (%)
330127	Burngrove Creek U/S	57.4	56.5	1.5%	22.5	22.2	1%
330101	Taurus Creek D/S	116.6	117.0	-0.3%	155.6	156.8	-1%
330124	Two Mile Gully	46.9	16.2	189.4%	79.1	50.4	57%
330118	Sirius Creek D/S	12.2	11.9	2.3%	9.0	8.6	4%

5.4.2 March 2017 event calibration results

Figure 5.1 to Figure 5.4 compare the modelled / calculated (C) and recorded (R) discharge hydrographs for the March 2017. The calibration results for the March 2017 event are summarised below.

- In Burngrove Creek, the calibration is considered good, with the modelled (calculated) hydrograph matching well with the recorded hydrograph peak, shape and timing at the Burngrove Creek U/S gauge.
- In Taurus Creek and Two Mile Gully:
  - The modelled (calculated) hydrograph matches well with the recorded hydrograph peak and shape at the Taurus Creek D/S gauge. However, the URBS model could not reproduce the recorded hydrograph shape, peak or timing further upstream at the Two Mile Gully gauge.
  - The recorded data suggests that the Two Mile Gully gauge appears to have malfunctioned during the event, as indicated by the following:

- The recorded water level hydrograph shape at the Two Mile Gully gauge is inconsistent with the recorded water levels at the Taurus Creek gauge (refer to Figure B.5 and B.6 in Appendix B).
- The catchment area to Two Mile Gully is around 27% of the catchment area to the Taurus Creek D/S gauge. Despite this, the recorded peak discharge at Two Mile Gully D/S is only 14% of the recorded peak discharge at Taurus Creek D/S. This indicates that the Two Mile Gully gauge likely did not capture the peak water level (and hence the peak discharge) during this event.
- In consideration of the above, the calibration in Two Mile Gully and Taurus Creek is considered acceptable.

- In Sirius Creek:
  - The modelled (calculated) hydrograph generally matches the recorded hydrograph shape and peak, but the timing of the modelled flood peak is significantly delayed compared to the recorded peak.
  - The reason for the discrepancy in timing between the modelled and recorded flood peak is uncertain. The catchment area to the Sirius Creek gauge is around 120 km^2 and on this basis, the flood peak is expected to occur much later than what the data is suggesting, similar to observations at the Taurus Creek and Two Mile Gully gauges for this event. This suggests that there could be an issue with the timing of the recorded water levels at the Sirius Creek gauge, but further investigation is required to confirm this.
  - In consideration of the above, the calibration in Sirius Creek is considered acceptable.

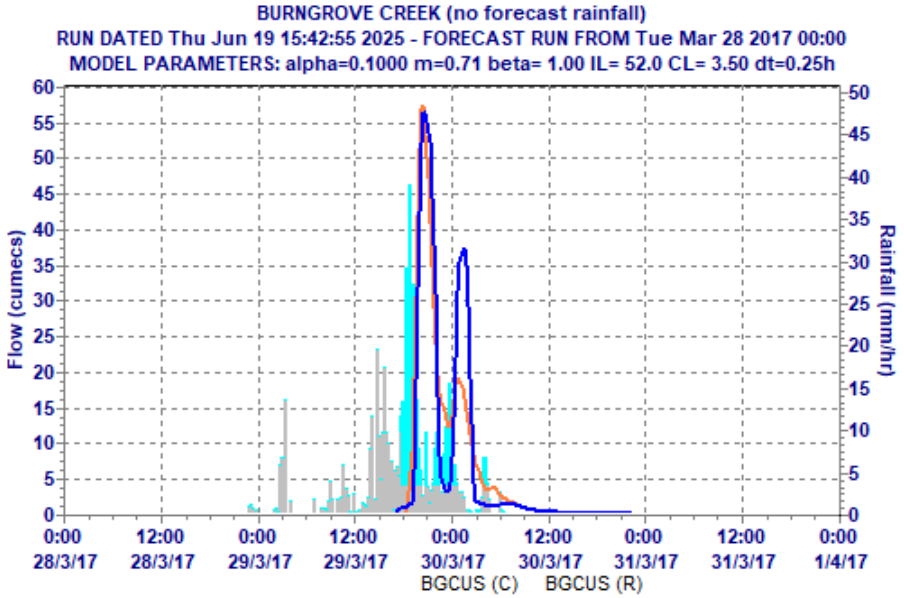


Figure 5.1 Calculated (C) and recorded (R) discharge hydrographs for March 2017 event at Burngrove Creek

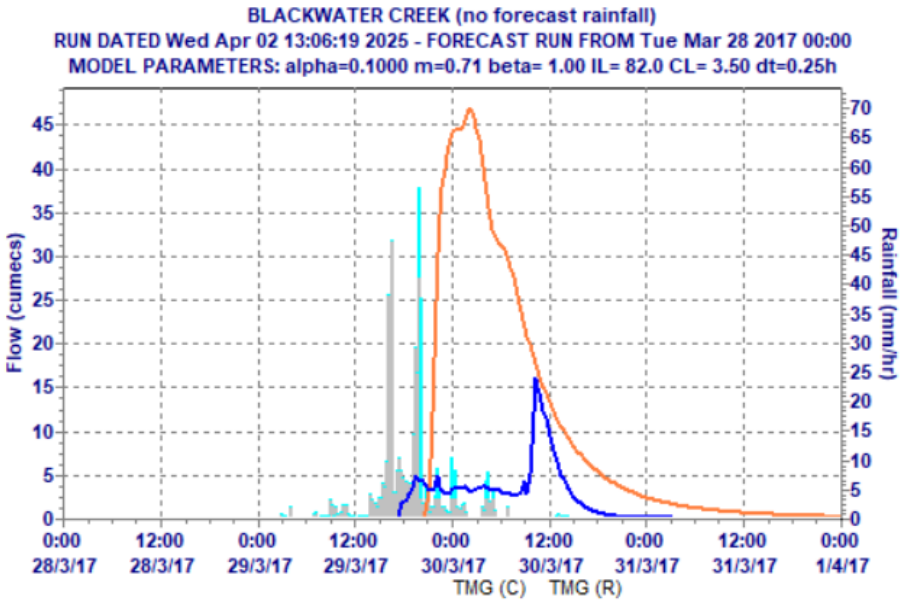


Figure 5.2 Calculated (C) and recorded (R) discharge hydrographs for March 2017 event at Two Mile Gully

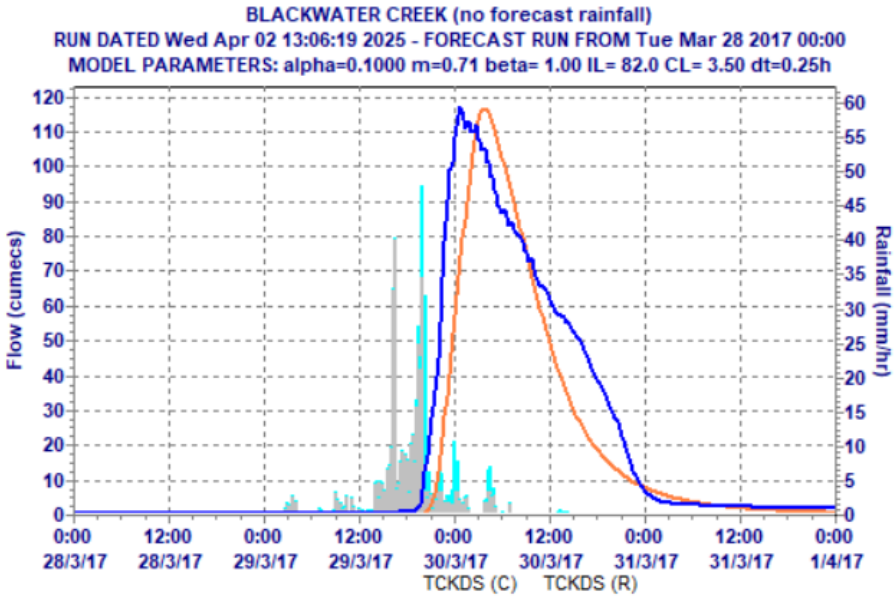


Figure 5.3 Calculated (C) and recorded (R) discharge hydrographs for March 2017 event at Taurus Creek

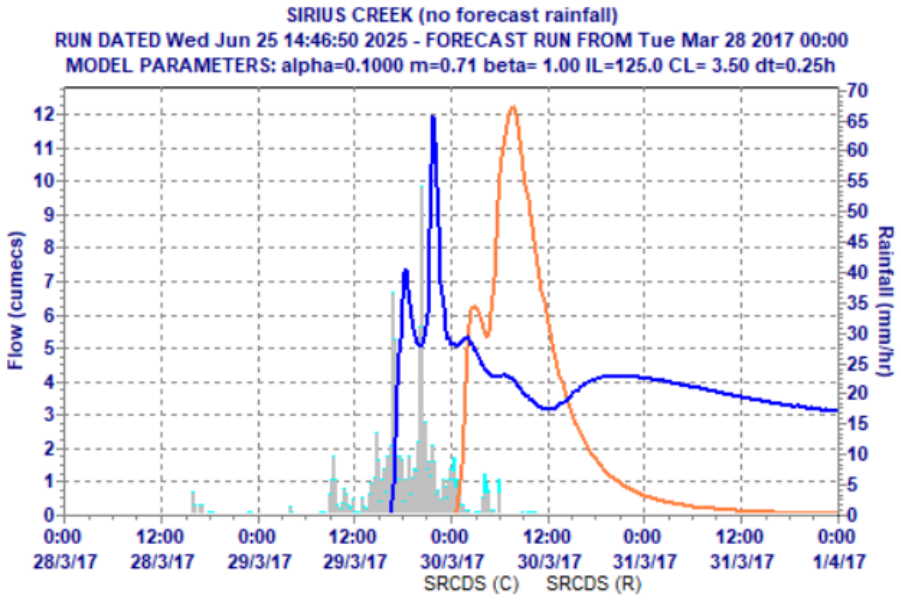


Figure 5.4 Calculated (C) and recorded (R) discharge hydrographs for March 2017 event at Sirius Creek

5.4.3 January 2020 event calibration results

Figure 5.5 to Figure 5.4 compare the modelled / calculated (C) and recorded (R) discharge hydrographs for the March 2017. The calibration results for the March 2017 event are summarised below

- In Burngrove Creek, the calibration is considered good, with the modelled (calculated) hydrograph matching well with the recorded hydrograph peak, shape and timing at the Burngrove Creek U/S gauge.
- In Taurus Creek and Two Mile Gully:
  - The modelled (calculated) hydrograph matches well with the recorded hydrograph peak and shape at the Taurus Creek D/S gauge. However, the URBS model could not reproduce the recorded hydrograph shape, peak or timing further upstream at the Two Mile Gully gauge.
  - Compared to the March 2017 event, there are similar discrepancies observed between the recorded water level hydrographs at Two Mile Gully and Taurus Creek D/S for the January 2020 event. This suggests that the Two Mile Gully gauge may not have accurately captured the peak flood level (and hence the peak discharge) during the January 2020 event, due to similar reasons described in Section 5.4.2 for the March 2017 event.
  - In consideration of the above, the calibration in Two Mile Gully and Taurus Creek is considered acceptable.
- In Sirius Creek:
  - The modelled (calculated) hydrograph generally matches the recorded hydrograph shape and peak, but the timing of the modelled flood peak is significantly delayed compared to the recorded peak.
  - The reason for the discrepancy in timing between the modelled and recorded flood peak is uncertain, but it is similar to the calibration results for the March 2017 event at this gauge

(refer to Section 5.4.2). This further suggests that there could be an issue with the timing of the recorded water levels at the Sirius Creek gauge, but further investigation is required to confirm this.

- In consideration of the above, the calibration in Sirius Creek is considered acceptable.

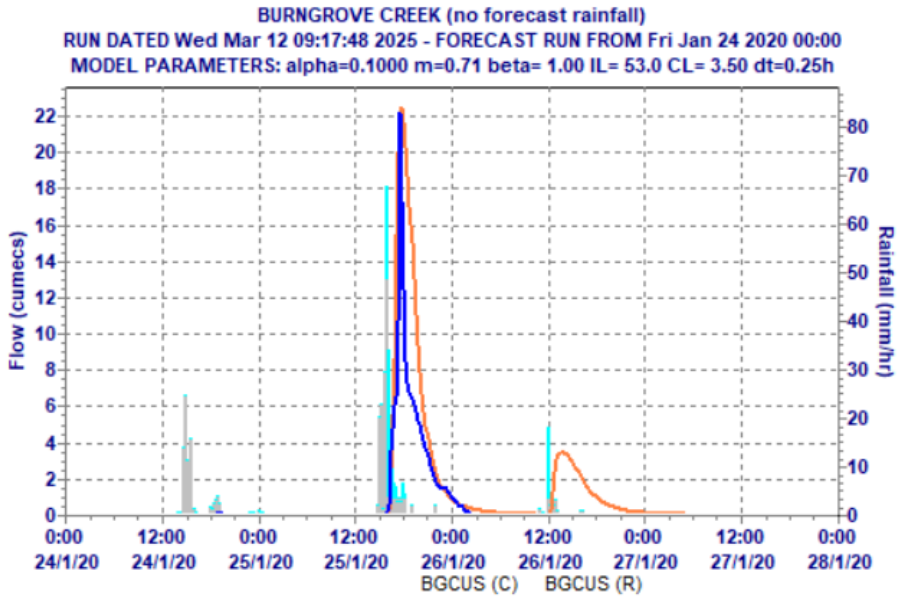


Figure 5.5 Calculated (C) and recorded (R) discharge hydrographs for January 2020 event at Burngrove Creek

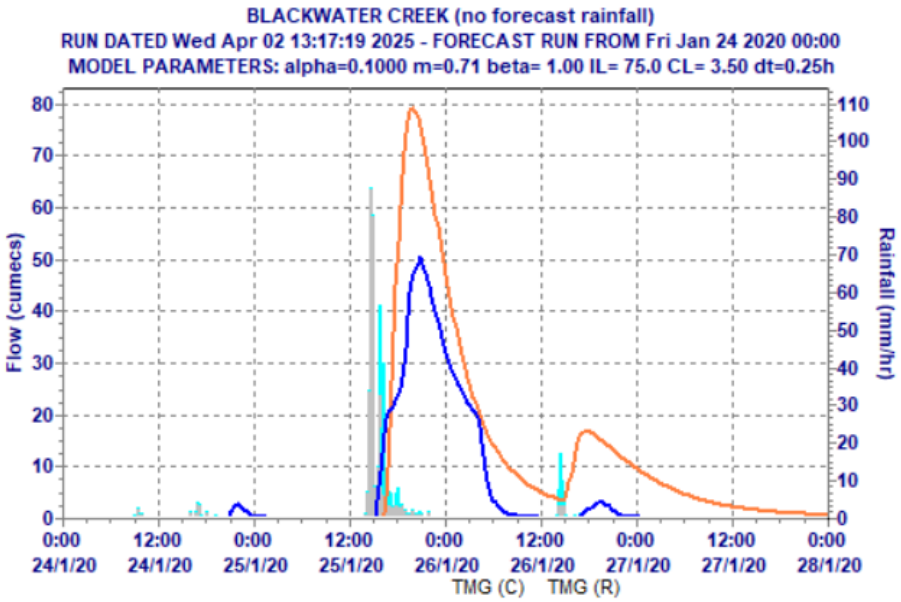


Figure 5.6 Calculated (C) and recorded (R) discharge hydrographs for January 2020 event at Two Mile Gully

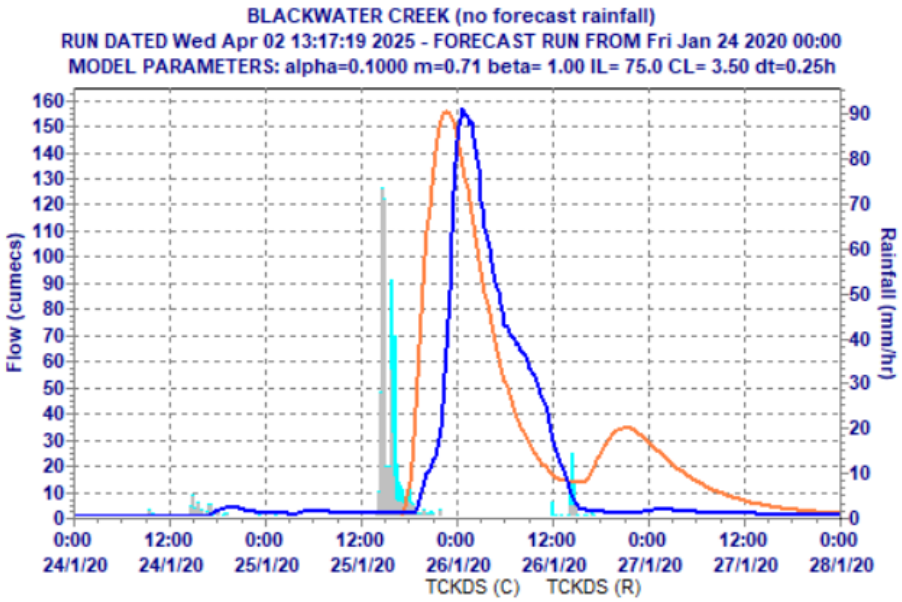


Figure 5.7 Calculated (C) and recorded (R) discharge hydrographs for January 2020 event at Taurus Creek

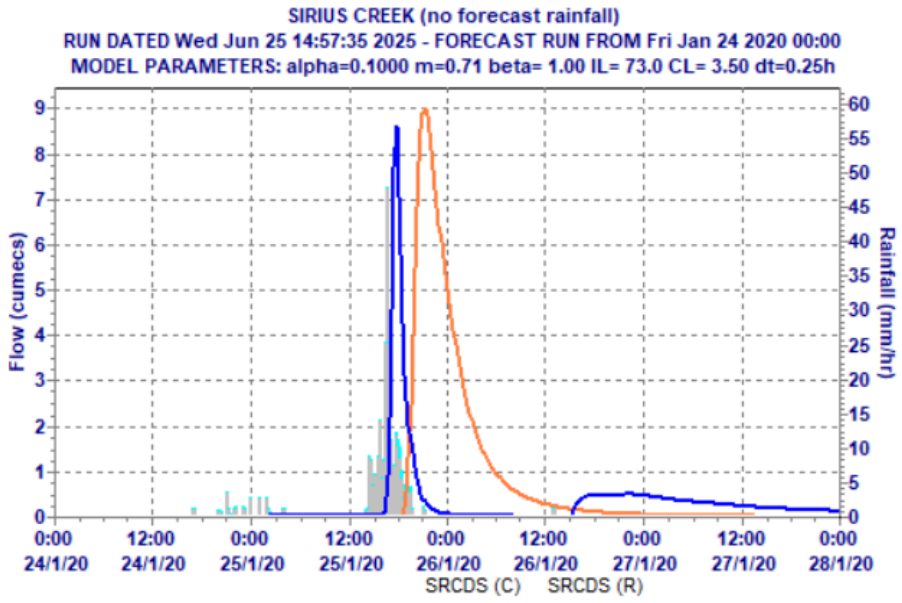


Figure 5.8 Calculated (C) and recorded (R) discharge hydrographs for January 2020 event at Sirius Creek

6 DESIGN DISCHARGE ESTIMATION AND VALIDATION

6.1 METHODOLOGY

URBS model design discharge estimates for all seven models were validated against discharge estimates derived using the Rational Method (RM), the Quantile Regression Technique (QRT) (Palmen and Weeks, 2015) and the Regional Flood Frequency Analysis (RFFE) method. Design peak discharges were validated for the 1% AEP event only, at key validation locations shown in Figure 6.1, which were selected to allow comparison of design discharges from all of the above-mentioned methods at the same location.

6.2 URBS MODEL PARAMETERS

6.2.1 Global model parameters

The global URBS model parameters (alpha, beta, M and N) given in Section 4.2.2 were adopted for design event modelling for all models.

6.2.2 Initial and continuing losses

Table 6.1 shows the ILs and CLs adopted for 1% AEP design event in each model.

The design event ILs are generally lower than those adopted for the calibration events (refer to Section 5.3). This reflects the high degree of catchment saturation that is expected prior to the main rainfall burst during rare events such as the 1% AEP. In comparison, the March 2017 and January 2020 calibration events were much smaller and more frequent events than a 1% AEP design event.

The adopted CLs for the seven models are generally consistent with the calibration event CLs (3.5 mm/h) except for the Rockland Creek and Sagittarius Creek models. Lower CLs were adopted for these models to achieve a better match between URBS model peak discharges and those derived from empirical methods.

Table 6.1 Adopted design event initial and continuing losses for the 1% AEP event

URBS Model	1% AEP losses	
	IL (mm)	CL (mm/h)
Bonnie Doon Creek (BDC)	5	3.5
Burngrove Creek (BGC)	35	3.5
Sagittarius Creek (SGC)	0	2
Blackwater Creek (BWC)	0	3.5
Speculation Creek (SPC)	0	3.5
Sirius Creek (SRC)	50	3.5
Rockland Creek (RLC)	0	2

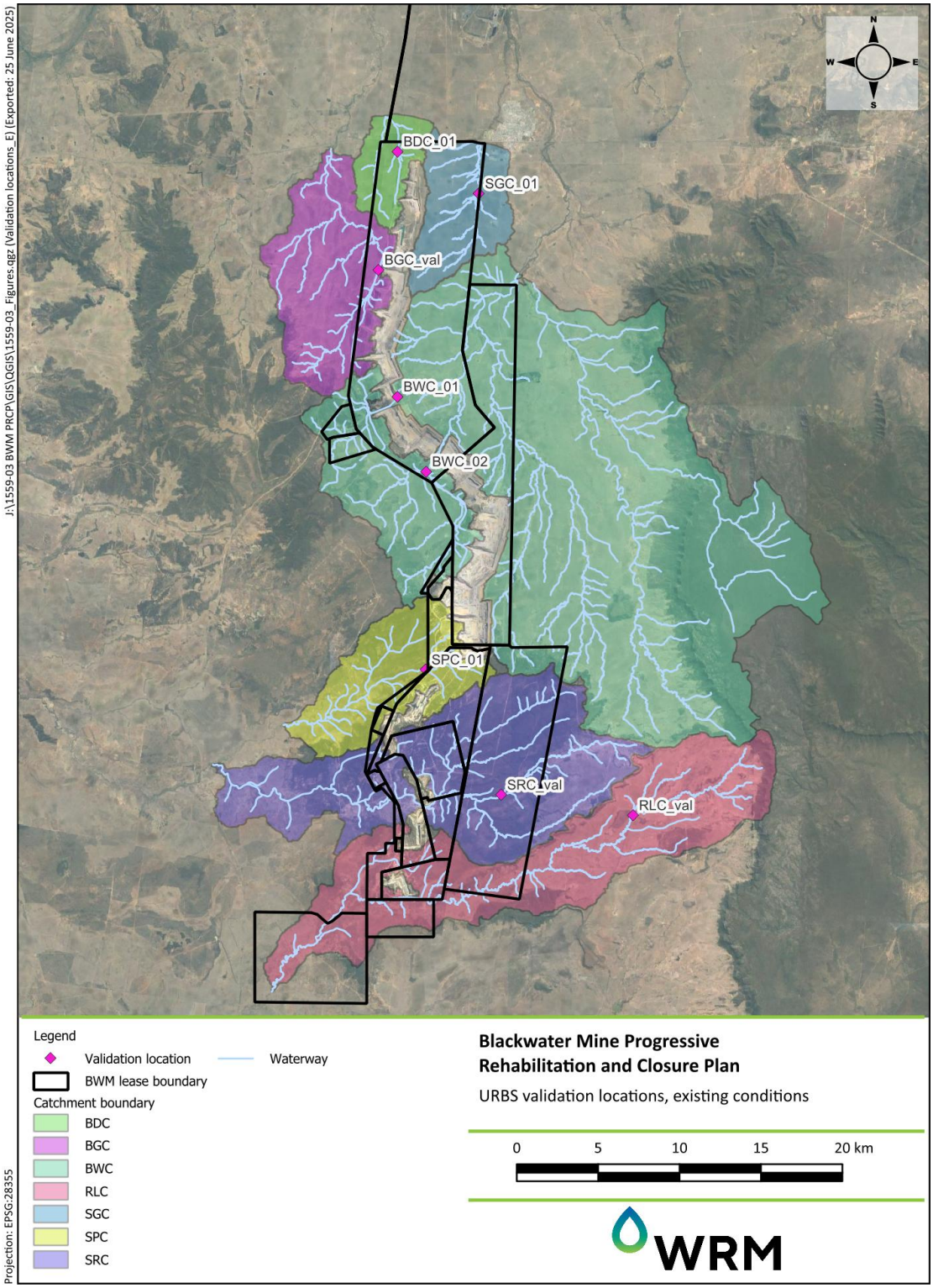


Figure 6.1 URBS validation locations

6.3 ADJUSTMENT FOR CLIMATE CHANGE

Based on the latest guidance on climate change provided in ARR 2019 v4.2, global temperatures have already risen since the baseline historical rainfall data midpoint of 1961-1990. Therefore, to assess current (2025) flood risks, design rainfall estimates require factoring up to account for this temperature increase that has already occurred.

Design Intensity-Frequency-Duration (IFD) design rainfall intensities were scaled up using uplift factors obtained from ARR datahub[1], corresponding to the SSP5-8.5 (year 2030) climate scenario. The associated pre-burst rainfalls were also scaled up accordingly.

The SSP5-8.5 climate adjustments account for approximately 1.3°C of global warming up to 2025 since the historical baseline period of 1961-1990. Table 6.2 shows the corresponding 1% AEP design rainfall uplift factors for various storm durations (as percentage increases compared to the baseline).

Table 6.2 Adopted design rainfall uplift factors (SSP5-8.5 year 2030)

Storm duration	Rainfall uplift factor
<1 hour	20%
1.5 Hours	18%
2 Hours	17%
3 Hours	16%
4.5 Hours	14%
6 Hours	13%
9 Hours	13%
12 Hours	12%
18 Hours	11%
>24 Hours	11%

6.4 MODEL VALIDATION RESULTS

Table 6.3 compares the URBS peak discharges for the 1% AEP design events against discharges estimated using the Rational Method, QRT and RFFE methods. For the RFFE, design peak discharges were estimated using both the 2016 and 2021 versions of the RFFE.

The validation results show that the URBS model predicted design peak discharges generally correspond well (within 20%) to the Rational Method and QRT design peak discharge estimates. However, the differences between URBS and RFFE peak discharges are greater.

There is considerable uncertainty in the RFFE design peak discharges, which are reliant upon the accuracy of Flood Frequency Analysis results from nearby gauged catchments. However, the URBS model predicted design peak discharges are generally within the range of uncertainty (i.e. 5th to 95th percentile) of the RFFE peak discharge estimates.

[1] https://data.arr-software.org/

Table 6.3 Model validation results for the 1% AEP event

Location (Figure 6.1)	1% AEP design peak discharge (m^3/s)					
	URBS	QRT	Rational Method	RFFE		
				Flow	5%ile	95%ile
BDC	78	77	73	316	83	1,102
BGC	259	203	222	493	144	1,550
BWC_L1	172	174	191	520	140	1,796
BWC_L2	190	189	176	471	130	1,596
RLC	110	176	119	785	212	2,758
SGC	147	182	170	535	141	1,868
SPC	117	116	133	583	155	2,049
SRC	203	190	168	1,084	304	3,672

7 REFERENCES

Ball et al, 2019	Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I (Editors), 2019, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia.
GHD, 2021	GHD Pty Ltd, June 2021, *Blackwater Mine Flood Study*
PPK, 1994	PPK Consultants Pty Ltd, March 1994, *Rockland Creek Diversion Construction Report*
SLR, 2024a	SLR Consulting Australia Pty Ltd, 10 October 2024, *Blackwater Mine Progressive Rehabilitation and Closure Plan – Voids in Floodplain Modelling*
SLR, 2024b	SLR Consulting Australia Pty Ltd, 10 October 2024, *Blackwater Mine Progressive Rehabilitation and Closure Plan – Rehabilitation Flood Assessments*
WRM, 2025a	WRM Water & Environment Pty Ltd, November 2025, *Blackwater Mine Progressive Rehabilitation and Closure Plan – Void in Floodplain Modelling*
WRM, 2025b	WRM Water & Environment Pty Ltd, November 2025, *Blackwater Mine Progressive Rehabilitation and Closure Plan – Final Landform Flood Modelling*

APPENDIX A URBS MODEL CONFIGURATION

A.1 BDC CATCHMENT

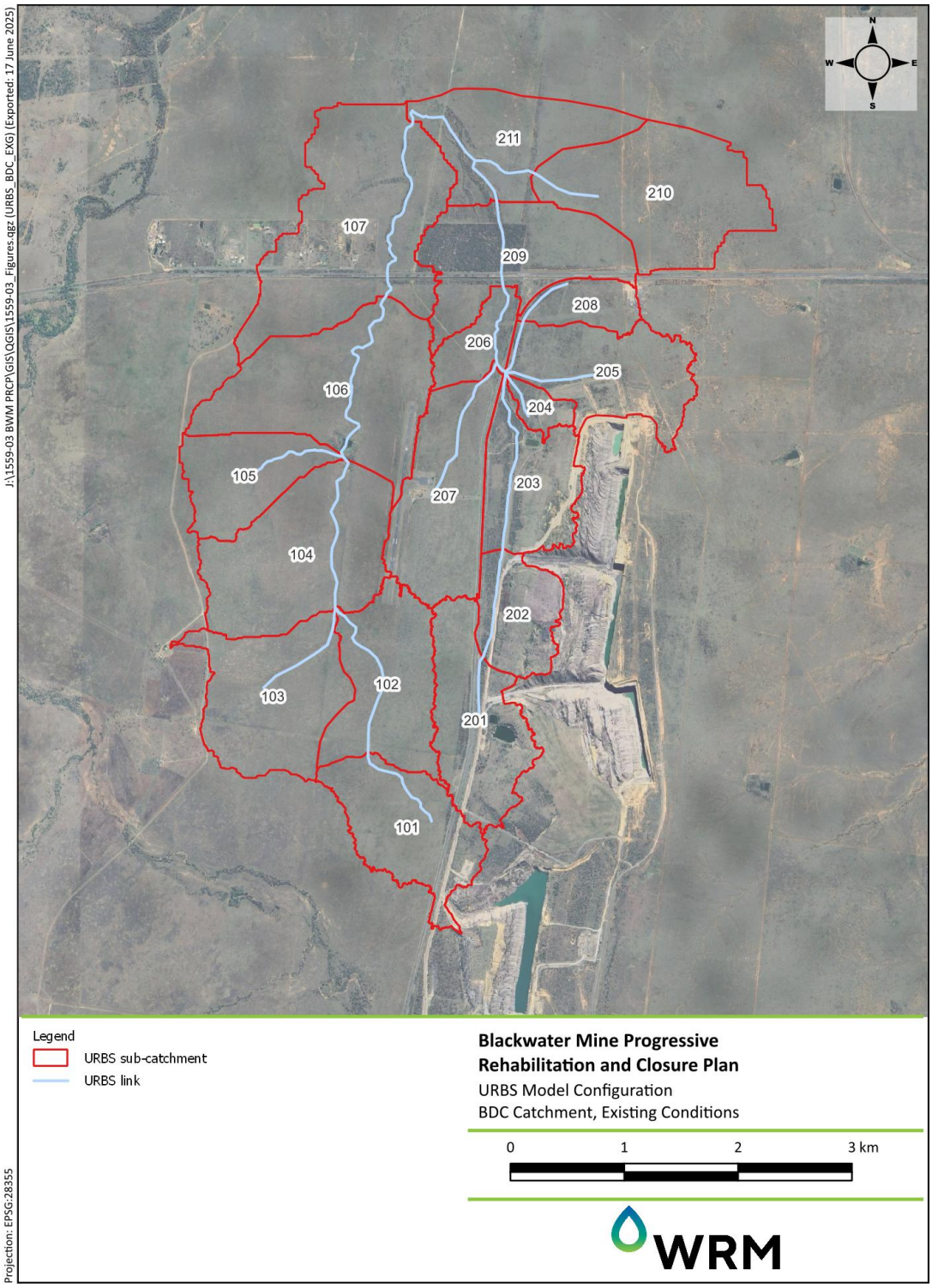


Figure A.1 URBS model configuration of the BDC catchment

Table A.1 URBS catchment parameters of the BDC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.15	0	0.07	0.007
102	1.26	0	0.07	0.006
103	1.46	0	0.07	0.010
104	1.83	0	0.07	0.007
105	0.83	0	0.07	0.011
106	2.02	0	0.07	0.005
107	2.46	0	0.07	0.007
201	1.20	0	0.07	0.009
202	0.68	0	0.07	0.015
203	0.95	0	0.07	0.009
204	0.17	0	0.07	0.012
205	1.16	0	0.07	0.006
206	0.39	0	0.07	0.005
207	1.36	0	0.07	0.007
208	0.38	0	0.07	0.006
209	1.39	0	0.07	0.007
210	1.72	0	0.07	0.006
211	1.19	0	0.07	0.005

A.2 SGC CATCHMENT

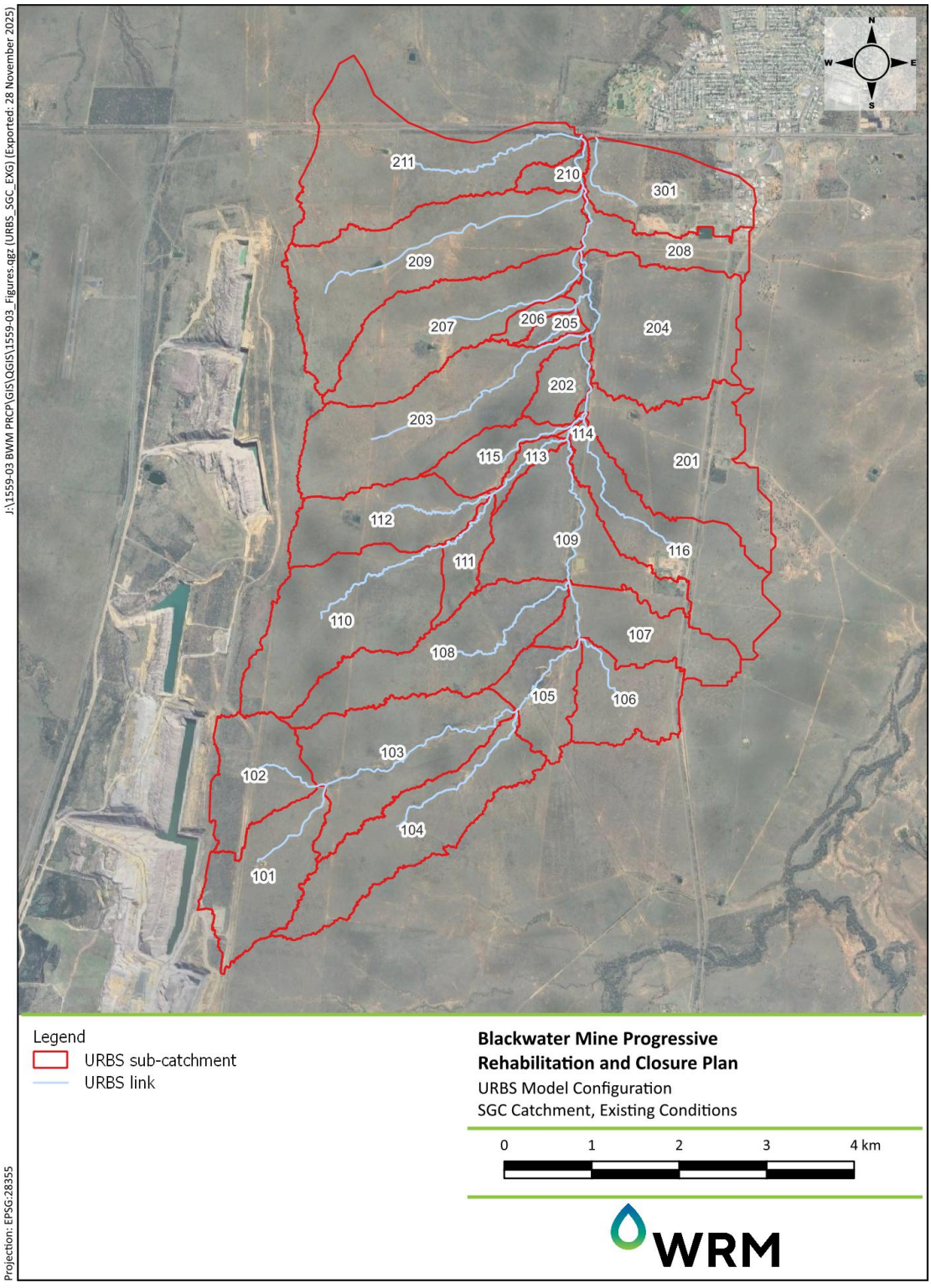


Figure A.2 URBS model configuration of the SGC catchment

Table A.2 URBS catchment parameters of the SGC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.58	0	0.07	0.009
102	1.29	0	0.07	0.008
103	2.37	0	0.07	0.007
104	2.19	0	0.07	0.007
105	0.87	0	0.07	0.007
106	1.14	0	0.07	0.008
107	1.37	0	0.07	0.009
108	2.2	0	0.07	0.008
109	2.02	0	0.07	0.007
110	2.69	0	0.07	0.008
111	0.46	0	0.07	0.009
112	1.46	0	0.07	0.009
113	0.19	0	0.07	0.007
114	0.02	0	0.07	0.005
115	0.63	0	0.07	0.007
116	2.12	0	0.07	0.007
201	2.44	0	0.07	0.01
202	0.51	0	0.07	0.004
203	2.72	0	0.07	0.007
204	2.69	0	0.07	0.01
205	0.17	0	0.07	0.007
206	0.2	0	0.07	0.007
207	2.22	0	0.07	0.008
208	0.81	0	0.07	0.008
209	3.34	0	0.07	0.007

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
210	0.27	0	0.07	0.003
211	3.14	0	0.07	0.005
301	1.58	0	0.07	0.008

A.3 BGC CATCHMENT

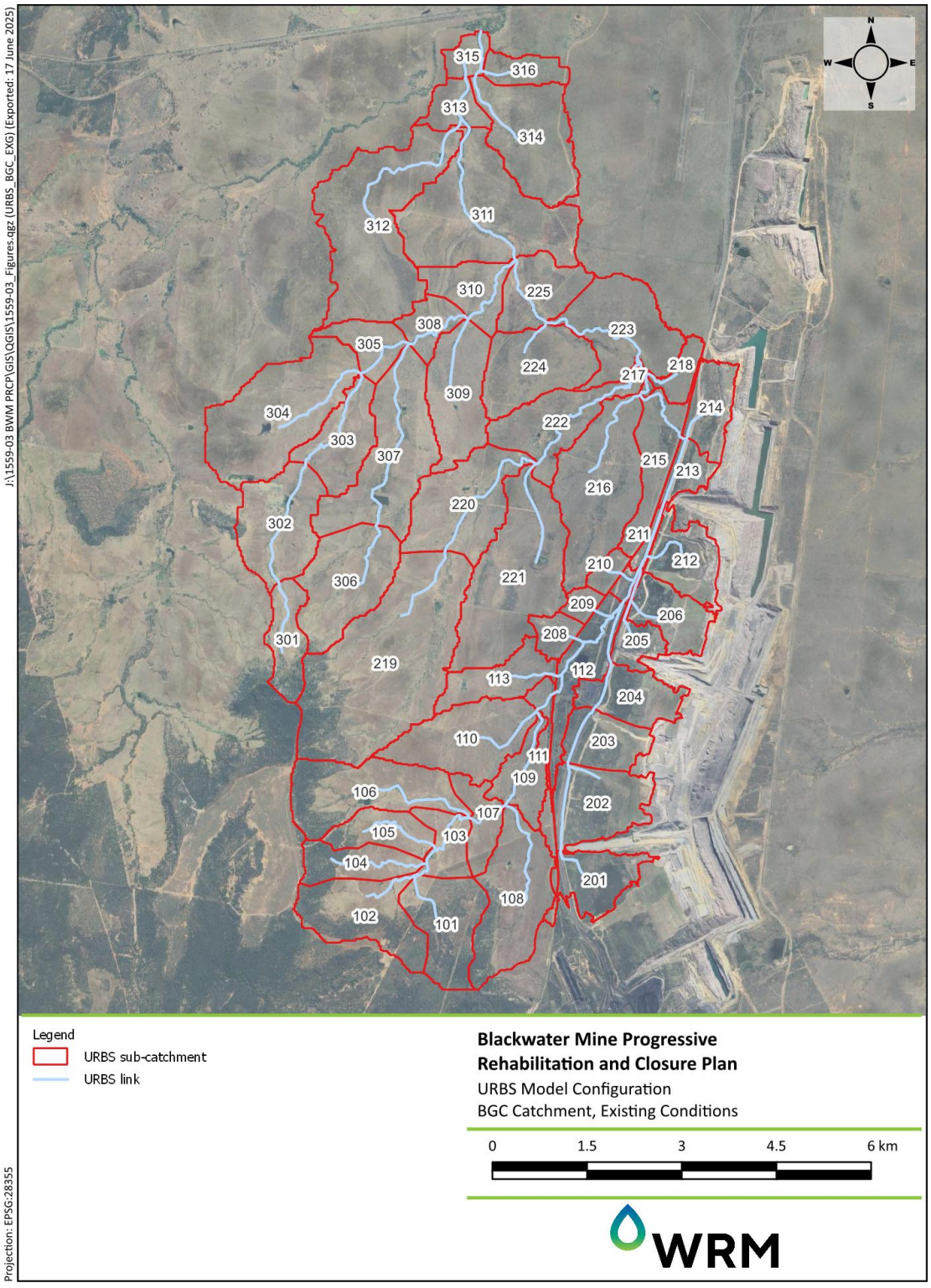


Figure A.3 URBS model configuration of the BGC catchment

Table A.3 URBS catchment parameters of the BGC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.66	0	0.035	0.017
102	1.90	0	0.035	0.019
103	0.72	0	0.035	0.007
104	0.96	0	0.035	0.010
105	0.89	0	0.035	0.009
106	2.25	0	0.035	0.023
107	0.72	0	0.035	0.007
108	2.37	0	0.035	0.024
109	0.87	0	0.035	0.009
110	2.07	0	0.035	0.021
111	0.54	0	0.035	0.005
112	1.22	0	0.035	0.012
113	1.04	0	0.035	0.010
201	1.10	0	0.035	0.011
202	1.63	0	0.035	0.016
203	1.06	0	0.035	0.011
204	1.14	0	0.035	0.011
205	0.55	0	0.035	0.006
206	1.03	0	0.035	0.010
207	0.15	0	0.035	0.002
208	0.41	0	0.035	0.004
209	0.25	0	0.035	0.003
210	0.27	0	0.035	0.003
211	0.17	0	0.035	0.002
212	1.16	0	0.035	0.012

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
213	0.50	0	0.035	0.005
214	0.93	0	0.035	0.009
215	1.26	0	0.035	0.013
216	2.89	0	0.035	0.029
217	0.06	0	0.035	0.001
218	0.42	0	0.035	0.004
219	5.72	0	0.035	0.057
220	2.24	0	0.035	0.022
221	3.52	0	0.035	0.035
222	1.69	0	0.035	0.017
223	2.17	0	0.035	0.022
224	1.87	0	0.035	0.019
225	1.26	0	0.035	0.013
301	0.93	0	0.035	0.009
302	2.00	0	0.035	0.020
303	1.33	0	0.035	0.013
304	3.27	0	0.035	0.033
305	0.76	0	0.035	0.008
306	2.17	0	0.035	0.022
307	2.89	0	0.035	0.029
308	0.63	0	0.035	0.006
309	1.81	0	0.035	0.018
310	1.00	0	0.035	0.010
311	3.79	0	0.035	0.038
312	4.12	0	0.035	0.041

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
313	0.61	0	0.035	0.006
314	2.26	0	0.035	0.023
315	0.40	0	0.035	0.010
316	0.58	0	0.035	0.010

A.4 BWC CATCHMENT

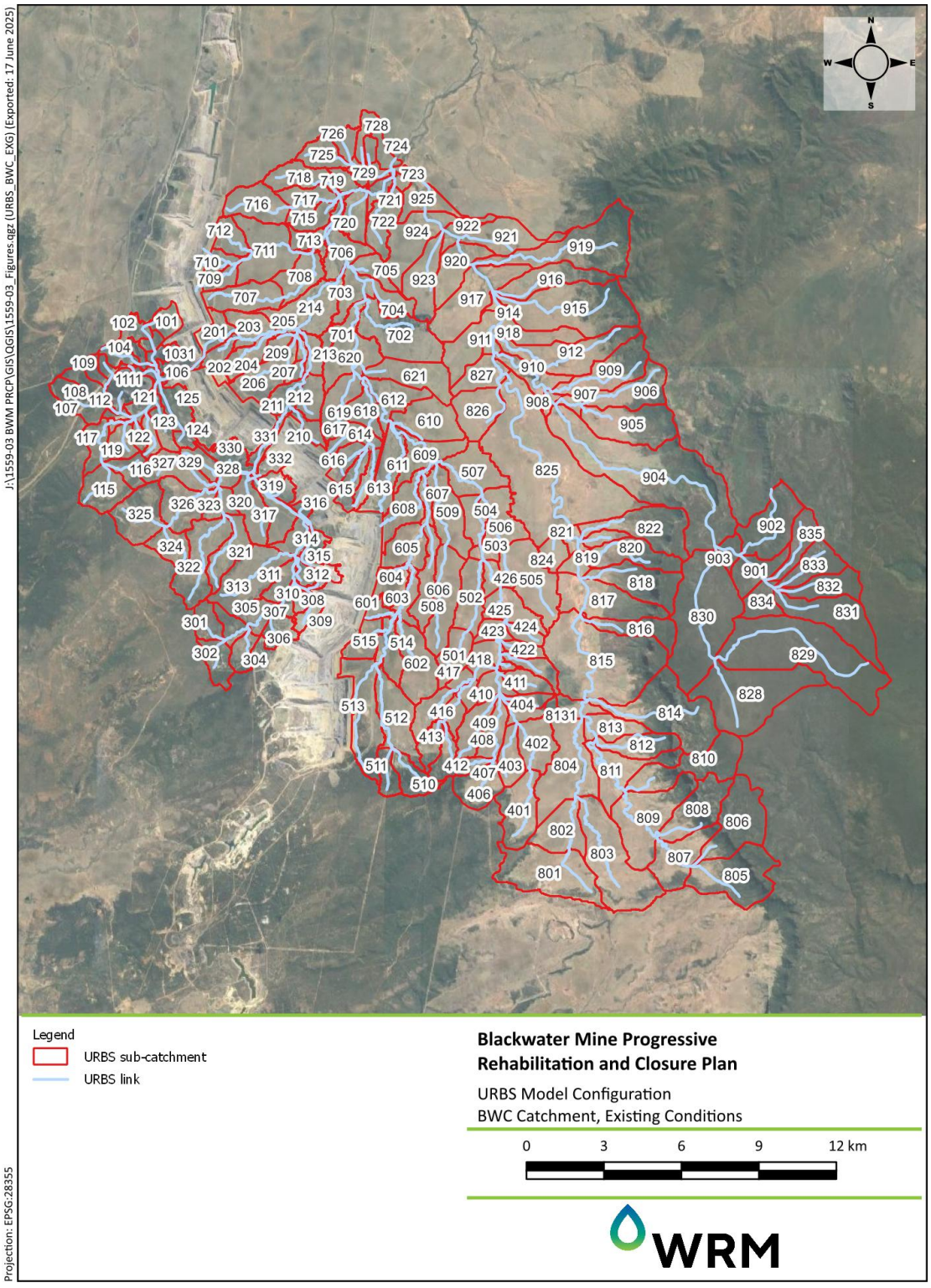


Figure A.4 URBS model configuration of the BWC catchment

Table A.4 URBS catchment parameters of the BWC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.11	0	0.07	0.019
102	0.88	0	0.07	0.009
103	0.47	0	0.07	0.022
104	0.97	0	0.07	0.028
105	0.51	0	0.07	0.021
106	0.37	0	0.07	0.004
107	2.02	0	0.07	0.030
108	1.10	0	0.04	0.070
109	0.65	0	0.07	0.028
110	0.42	0	0.07	0.044
111	0.02	0	0.07	0.006
112	0.10	0	0.07	0.009
113	1.94	0	0.07	0.005
114	0.33	0	0.07	0.020
115	2.55	0	0.07	0.017
116	1.21	0	0.07	0.015
117	1.61	0	0.07	0.012
118	0.28	0	0.07	0.010
119	1.14	0	0.07	0.036
120	0.50	0	0.07	0.029
121	0.95	0	0.07	0.009
122	0.79	0	0.07	0.023
123	1.05	0	0.07	0.018
124	0.60	0	0.07	0.027
125	1.72	0	0.07	0.013

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
201	1.45	0	0.07	0.006
202	1.26	0	0.07	0.012
203	1.77	0	0.07	0.007
204	1.65	0	0.07	0.008
205	0.32	0	0.07	0.002
206	2.94	0	0.07	0.008
207	0.46	0	0.07	0.007
208	0.39	0	0.07	0.003
209	0.67	0	0.07	0.008
210	0.83	0	0.07	0.010
211	1.36	0	0.07	0.006
212	1.54	0	0.07	0.011
213	1.04	0	0.07	0.004
214	3.78	0	0.07	0.004
301	1.34	0	0.07	0.033
302	1.71	0	0.07	0.018
303	1.05	0	0.07	0.026
304	1.20	0	0.07	0.026
305	1.23	0	0.07	0.009
306	1.29	0	0.07	0.019
307	0.62	0	0.07	0.019
308	0.56	0	0.07	0.037
309	0.83	0	0.07	0.044
310	0.10	0	0.07	0.016
311	1.08	0	0.07	0.015

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
312	0.69	0	0.07	0.030
313	4.53	0	0.07	0.017
314	1.21	0	0.07	0.004
315	1.44	0	0.07	0.007
316	0.39	0	0.07	0.074
317	1.80	0	0.07	0.009
318	0.78	0	0.07	0.053
319	0.35	0	0.07	0.085
320	2.47	0	0.07	0.013
321	2.35	0	0.07	0.017
322	4.18	0	0.07	0.016
323	1.05	0	0.07	0.013
324	1.70	0	0.07	0.019
325	3.44	0	0.07	0.023
326	3.05	0	0.07	0.013
327	2.58	0	0.07	0.013
328	0.66	0	0.07	0.004
329	1.04	0	0.07	0.015
330	1.44	0	0.07	0.018
331	0.80	0	0.07	0.006
332	0.57	0	0.07	0.029
401	3.50	0	0.07	0.015
402	2.59	0	0.07	0.011
403	1.73	0	0.07	0.012
404	0.92	0	0.07	0.017

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
405	0.74	0	0.07	0.032
406	2.38	0	0.07	0.018
407	0.62	0	0.07	0.027
408	1.72	0	0.07	0.012
409	2.13	0	0.07	0.015
410	1.21	0	0.07	0.007
411	1.35	0	0.07	0.030
412	1.33	0	0.07	0.022
413	1.28	0	0.07	0.024
414	0.97	0	0.07	0.016
415	0.66	0	0.07	0.015
416	1.65	0	0.07	0.013
417	0.55	0	0.07	0.011
418	0.57	0	0.07	0.011
419	0.21	0	0.07	0.018
420	1.00	0	0.07	0.015
421	1.25	0	0.07	0.026
422	0.87	0	0.07	0.015
423	1.00	0	0.07	0.008
424	0.79	0	0.07	0.016
425	2.31	0	0.07	0.009
426	1.00	0	0.07	0.005
501	2.03	0	0.07	0.010
502	2.62	0	0.07	0.006
503	0.56	0	0.07	0.005

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
504	1.46	0	0.07	0.005
505	4.78	0	0.07	0.007
506	2.93	0	0.07	0.006
507	3.35	0	0.07	0.004
508	3.88	0	0.07	0.006
509	3.46	0	0.07	0.006
510	1.80	0	0.07	0.032
511	1.23	0	0.07	0.031
512	3.76	0	0.07	0.015
513	4.77	0	0.07	0.013
514	1.85	0	0.07	0.007
515	1.57	0	0.07	0.012
601	0.63	0	0.07	0.012
602	3.63	0	0.07	0.008
603	1.13	0	0.07	0.005
604	1.69	0	0.07	0.011
605	2.43	0	0.07	0.006
606	2.29	0	0.07	0.007
607	0.69	0	0.07	0.004
608	2.44	0	0.07	0.005
609	2.66	0	0.07	0.006
610	3.38	0	0.07	0.006
611	2.97	0	0.07	0.007
612	2.44	0	0.07	0.006
613	1.09	0	0.07	0.009

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
614	0.38	0	0.07	0.006
615	1.36	0	0.07	0.007
616	1.19	0	0.07	0.010
617	1.02	0	0.07	0.013
618	1.58	0	0.07	0.003
619	2.57	0	0.07	0.009
620	3.14	0	0.07	0.008
621	3.18	0	0.07	0.009
701	1.23	0	0.07	0.005
702	4.86	0	0.07	0.007
703	1.79	0	0.07	0.005
704	1.35	0	0.07	0.006
705	1.22	0	0.07	0.012
706	2.13	0	0.07	0.005
707	2.90	0	0.07	0.008
708	2.27	0	0.07	0.007
709	0.93	0	0.07	0.010
710	0.89	0	0.07	0.012
711	4.49	0	0.07	0.008
712	1.47	0	0.07	0.012
713	1.27	0	0.07	0.004
714	0.55	0	0.07	0.002
715	1.15	0	0.07	0.006
716	2.84	0	0.07	0.011
717	1.89	0	0.07	0.009

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
718	2.25	0	0.07	0.008
719	0.73	0	0.07	0.007
720	1.69	0	0.07	0.005
721	0.77	0	0.07	0.004
722	2.29	0	0.07	0.009
723	0.36	0	0.07	0.002
724	0.88	0	0.07	0.008
725	1.67	0	0.07	0.007
726	1.07	0	0.07	0.007
727	0.61	0	0.07	0.008
728	0.92	0	0.07	0.012
729	0.52	0	0.07	0.004
730	0.46	0	0.07	0.012
801	6.29	0	0.07	0.011
802	3.02	0	0.07	0.013
803	7.28	0	0.07	0.009
804	6.31	0	0.07	0.009
805	5.39	0	0.07	0.075
806	4.86	0	0.07	0.108
807	3.45	0	0.07	0.040
808	3.68	0	0.07	0.107
809	5.80	0	0.07	0.044
810	4.62	0	0.07	0.106
811	3.55	0	0.07	0.008
812	2.30	0	0.07	0.059

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
813	1.92	0	0.07	0.021
814	7.10	0	0.07	0.074
815	11.57	0	0.07	0.015
816	2.31	0	0.07	0.104
817	4.75	0	0.07	0.072
818	3.83	0	0.07	0.076
819	0.74	0	0.07	0.010
820	3.15	0	0.07	0.039
821	0.75	0	0.07	0.005
822	4.47	0	0.07	0.062
824	1.24	0	0.07	0.010
825	17.80	0	0.07	0.004
826	2.94	0	0.07	0.014
827	2.01	0	0.07	0.008
828	8.08	0	0.07	0.019
829	12.06	0	0.07	0.015
830	10.24	0	0.07	0.009
831	4.87	0	0.07	0.030
832	2.36	0	0.07	0.039
833	2.38	0	0.07	0.070
834	1.62	0	0.07	0.034
835	2.01	0	0.07	0.045
901	2.16	0	0.07	0.037
902	4.27	0	0.07	0.034
903	0.86	0	0.07	0.031

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
904	15.68	0	0.07	0.028
905	4.65	0	0.07	0.041
906	3.15	0	0.07	0.034
907	0.56	0	0.07	0.006
908	0.42	0	0.07	0.010
909	3.92	0	0.07	0.027
910	2.02	0	0.07	0.005
911	0.34	0	0.07	0.005
912	4.87	0	0.07	0.022
914	0.39	0	0.07	0.004
915	8.00	0	0.07	0.022
916	3.12	0	0.07	0.022
917	5.05	0	0.07	0.006
918	5.11	0	0.07	0.005
919	7.07	0	0.07	0.030
920	2.75	0	0.07	0.007
921	3.07	0	0.07	0.011
922	0.80	0	0.07	0.002
923	3.09	0	0.07	0.007
924	4.33	0	0.07	0.005
925	2.19	0	0.07	0.002
1031	0.72	0	0.07	0.012
1111	0.44	0	0.07	0.021
3091	0.20	0	0.07	0.036
8131	1.06	0	0.07	0.021

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
8211	0.76	0	0.07	0.026

A.5 SPC CATCHMENT

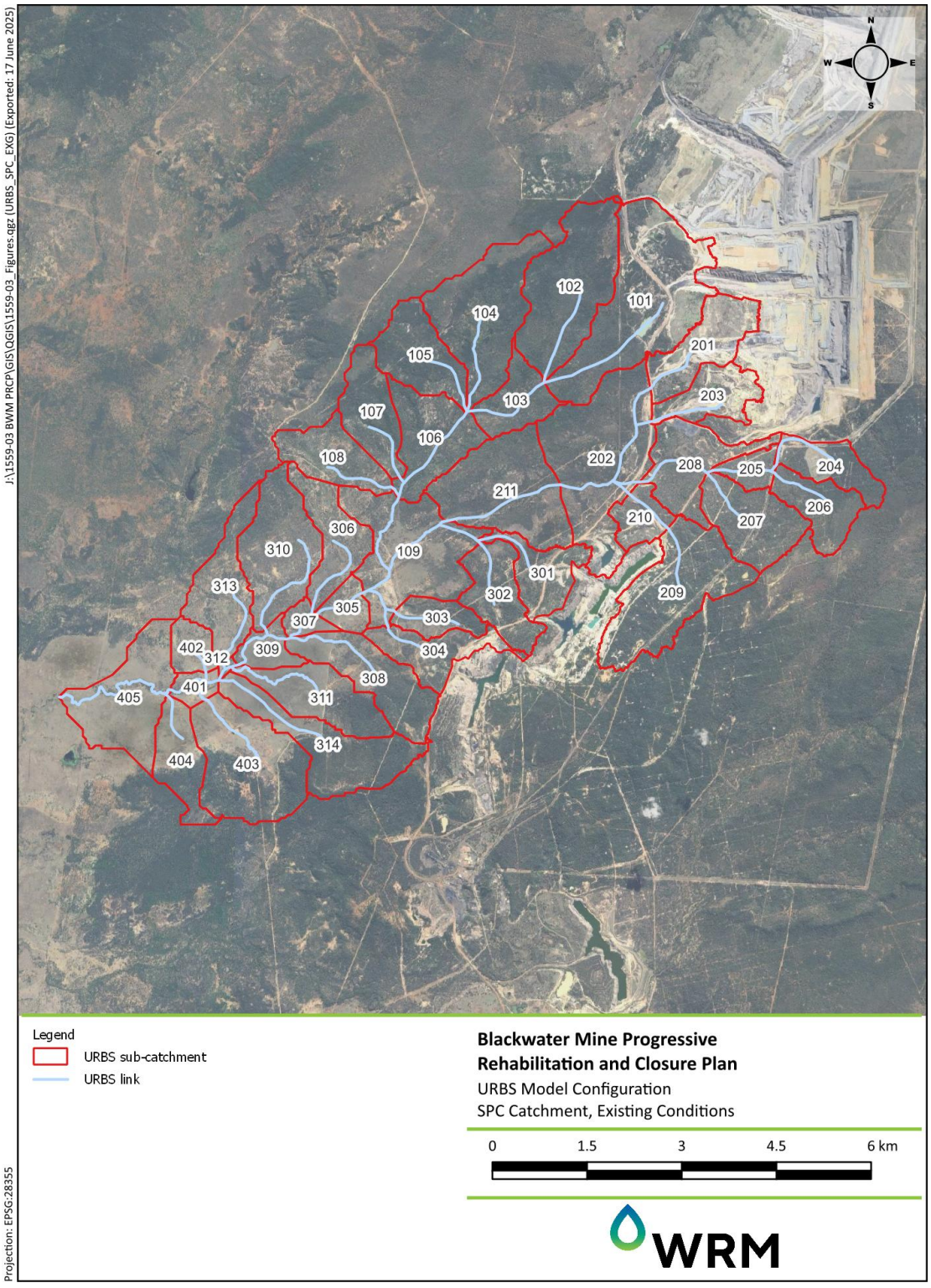


Figure A.5 URBS model configuration of the SPC catchment

Table A.5 URBS catchment parameters of the SPC catchment model

ID	Total Area (km2)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	4.00	0	0.07	0.012
102	2.89	0	0.07	0.018
103	1.00	0	0.07	0.016
104	2.70	0	0.07	0.016
105	1.47	0	0.07	0.028
106	1.69	0	0.07	0.017
107	1.31	0	0.07	0.027
108	1.27	0	0.07	0.027
109	2.90	0	0.07	0.009
201	1.45	0	0.07	0.019
202	3.63	0	0.07	0.007
203	1.05	0	0.07	0.025
204	0.98	0	0.07	0.032
205	0.45	0	0.07	0.029
206	1.07	0	0.07	0.032
207	1.60	0	0.07	0.029
208	1.55	0	0.07	0.011
209	2.80	0	0.07	0.038
210	0.66	0	0.07	0.027
211	2.77	0	0.07	0.011
301	1.06	0	0.07	0.017
302	1.30	0	0.07	0.022
303	0.69	0	0.07	0.024
304	1.12	0	0.07	0.022
305	0.49	0	0.07	0.009

ID	Total Area (km2)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
306	1.32	0	0.07	0.010
307	0.31	0	0.07	0.009
308	1.77	0	0.07	0.019
309	0.53	0	0.07	0.005
310	2.18	0	0.07	0.017
311	1.56	0	0.07	0.015
312	0.07	0	0.07	0.006
313	1.57	0	0.07	0.013
314	2.15	0	0.07	0.012
401	0.33	0	0.07	0.014
402	0.52	0	0.07	0.024
403	2.73	0	0.07	0.019
404	1.13	0	0.07	0.025
405	2.24	0	0.07	0.007

A.6 SRC CATCHMENT

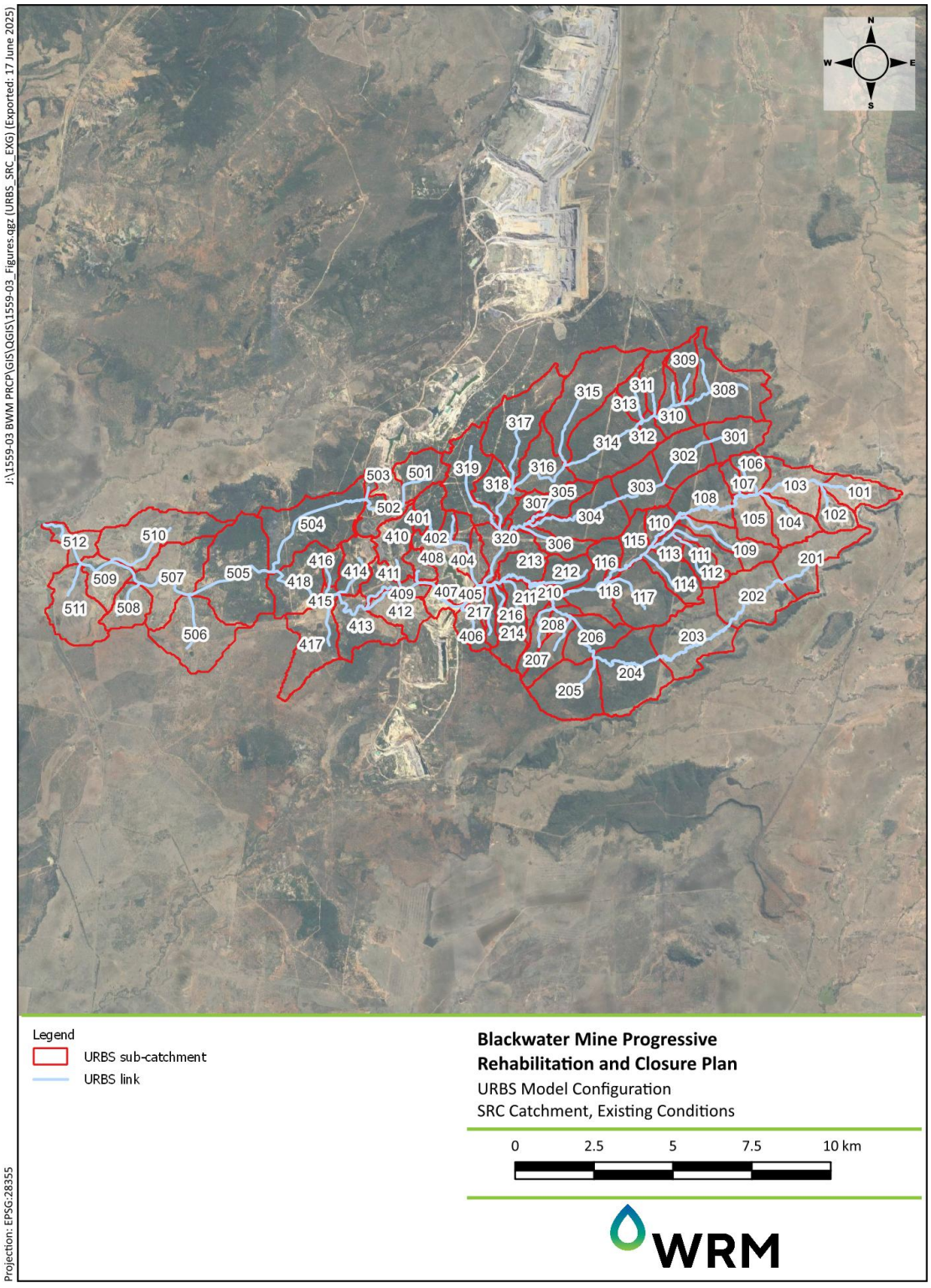


Figure A.6 URBS model configuration of the SRC catchment

Table A.6 URBS catchment parameters of the SRC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	1.70	0	0.045	0.016
102	1.18	0	0.045	0.016
103	2.37	0	0.045	0.016
104	1.66	0	0.045	0.024
105	1.75	0	0.045	0.027
106	1.13	0	0.045	0.039
107	0.48	0	0.045	0.048
108	2.73	0	0.045	0.019
109	1.92	0	0.045	0.017
110	0.88	0	0.045	0.010
111	1.09	0	0.045	0.022
112	1.22	0	0.045	0.030
113	0.56	0	0.045	0.013
114	1.67	0	0.045	0.025
115	1.17	0	0.045	0.009
116	0.22	0	0.045	0.015
117	3.37	0	0.045	0.025
118	2.75	0	0.045	0.013
201	2.99	0	0.045	0.015
202	3.56	0	0.045	0.010
203	4.26	0	0.045	0.016
204	4.50	0	0.045	0.017
205	3.45	0	0.045	0.022
206	2.04	0	0.045	0.017
207	1.33	0	0.045	0.028

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
208	0.50	0	0.045	0.028
209	0.97	0	0.045	0.031
210	0.21	0	0.045	0.014
211	0.93	0	0.045	0.016
212	1.40	0	0.045	0.020
213	1.11	0	0.045	0.016
214	2.08	0	0.045	0.026
215	0.13	0	0.045	0.005
216	0.40	0	0.045	0.042
217	0.58	0	0.045	0.044
301	2.00	0	0.045	0.015
302	2.56	0	0.045	0.014
303	2.28	0	0.045	0.031
304	3.32	0	0.045	0.011
305	1.21	0	0.045	0.013
306	1.09	0	0.045	0.022
307	0.88	0	0.045	0.015
308	4.36	0	0.045	0.012
309	1.31	0	0.045	0.028
310	1.47	0	0.045	0.024
311	1.18	0	0.045	0.032
312	0.45	0	0.045	0.053
313	0.99	0	0.045	0.033
314	4.85	0	0.045	0.014
315	4.84	0	0.045	0.019

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
316	2.33	0	0.045	0.021
317	4.29	0	0.045	0.018
318	1.76	0	0.045	0.012
319	3.29	0	0.045	0.016
320	1.98	0	0.045	0.008
401	1.30	0	0.045	0.039
402	0.52	0	0.045	0.022
403	0.50	0	0.045	0.023
404	0.91	0	0.045	0.004
405	0.46	0	0.045	0.015
406	1.07	0	0.045	0.044
407	0.73	0	0.045	0.010
408	0.63	0	0.045	0.007
409	0.43	0	0.045	0.017
410	1.99	0	0.045	0.018
411	0.90	0	0.045	0.011
412	1.82	0	0.045	0.010
413	2.61	0	0.045	0.005
414	1.77	0	0.045	0.016
415	0.22	0	0.045	0.032
416	0.59	0	0.045	0.037
417	3.27	0	0.045	0.020
418	2.92	0	0.045	0.021
501	1.80	0	0.045	0.015
502	1.17	0	0.045	0.019

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
503	0.23	0	0.045	0.032
504	5.17	0	0.045	0.012
505	6.15	0	0.045	0.006
506	4.05	0	0.045	0.017
507	3.90	0	0.045	0.007
508	1.60	0	0.045	0.034
509	1.75	0	0.045	0.019
510	4.43	0	0.045	0.008
511	3.38	0	0.045	0.015
512	1.25	0	0.045	0.003

A.7 RLC CATCHMENT

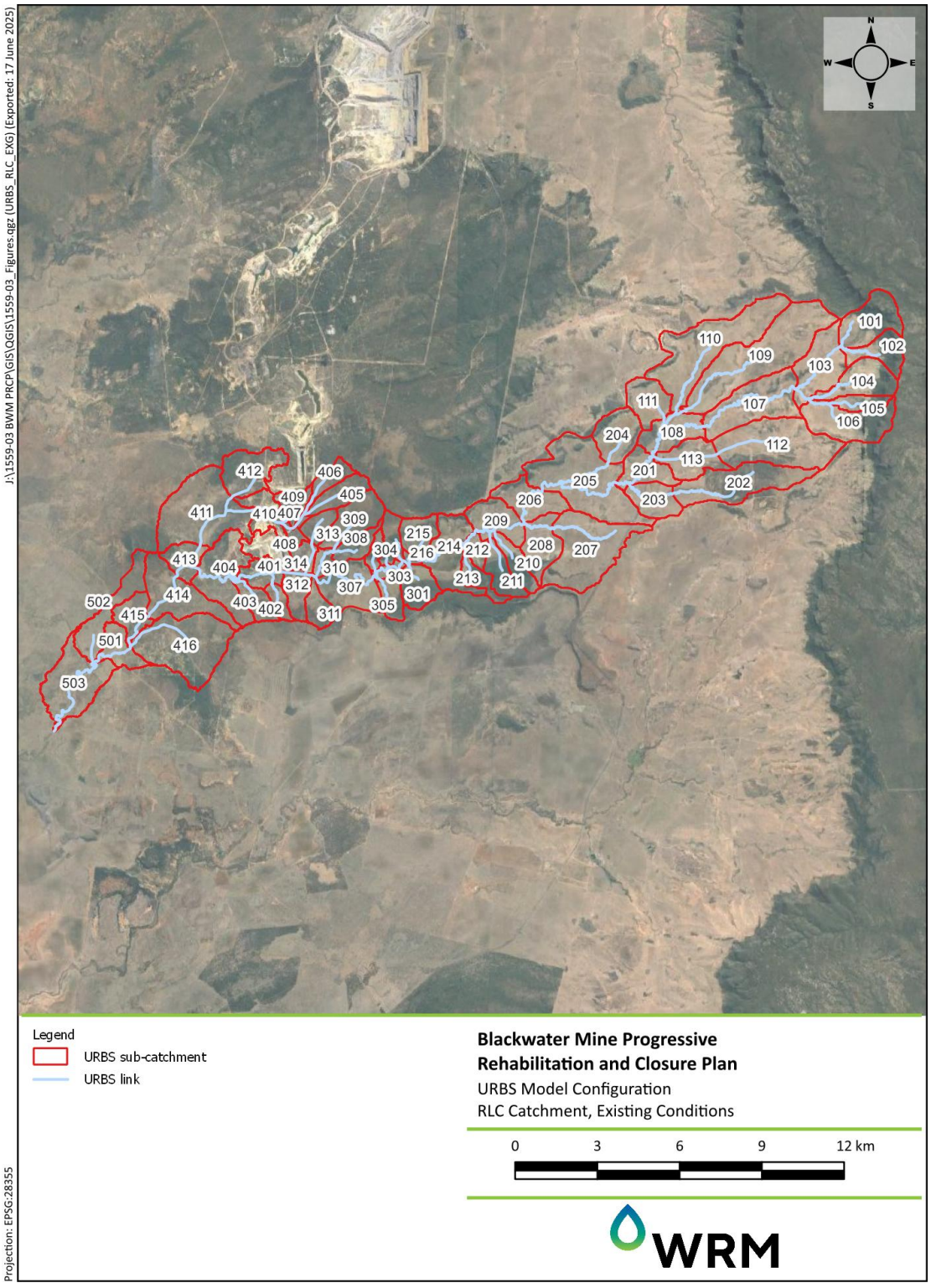


Figure A.7 URBS model configuration of the RLC catchment

Table A.7 URBS catchment parameters of the RLC catchment model

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
101	8.50	0	0.07	0.085
102	7.98	0	0.07	0.080
103	7.54	0	0.07	0.075
104	6.86	0	0.07	0.069
105	6.46	0	0.07	0.065
106	6.42	0	0.07	0.064
107	6.24	0	0.07	0.062
108	4.87	0	0.07	0.049
109	4.84	0	0.07	0.048
110	4.63	0	0.07	0.046
111	4.16	0	0.07	0.042
112	4.10	0	0.07	0.041
113	3.77	0	0.07	0.038
201	3.65	0	0.07	0.037
202	3.55	0	0.07	0.036
203	3.29	0	0.07	0.033
204	3.11	0	0.07	0.031
205	2.99	0	0.07	0.030
206	2.96	0	0.07	0.030
207	2.73	0	0.07	0.027
208	2.60	0	0.07	0.026
209	2.57	0	0.07	0.026
210	2.55	0	0.07	0.026
211	2.49	0	0.07	0.025
212	2.48	0	0.07	0.025

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
213	2.46	0	0.07	0.025
214	2.46	0	0.07	0.025
215	2.19	0	0.07	0.022
216	2.00	0	0.07	0.020
301	1.99	0	0.07	0.020
302	1.89	0	0.07	0.019
303	1.82	0	0.07	0.018
304	1.79	0	0.07	0.018
305	1.69	0	0.07	0.017
306	1.67	0	0.07	0.017
307	1.66	0	0.07	0.017
308	1.61	0	0.07	0.016
309	1.56	0	0.07	0.016
310	1.56	0	0.07	0.016
311	1.46	0	0.07	0.015
312	1.37	0	0.07	0.014
313	1.31	0	0.07	0.013
314	1.29	0	0.07	0.013
401	1.29	0	0.07	0.013
402	1.24	0	0.07	0.012
403	1.23	0	0.07	0.012
404	1.16	0	0.07	0.012
405	1.16	0	0.07	0.012
406	1.12	0	0.07	0.011
407	1.07	0	0.07	0.011

ID	Total Area (km²)	Percentage Impervious (%)	PERN 'n'	Catchment Slope (m/m)
408	1.05	0	0.07	0.011
409	1.00	0	0.07	0.010
410	0.76	0	0.07	0.008
411	0.75	0	0.07	0.008
412	0.75	0	0.07	0.008
413	0.66	0	0.07	0.007
414	0.60	0	0.07	0.006
415	0.51	0	0.07	0.005
416	0.49	0	0.07	0.005
501	0.29	0	0.07	0.003
502	0.23	0	0.07	0.002
503	0.14	0	0.07	0.001

APPENDIX B CALIBRATION EVENTS

B.1 2017 EVENT

B.1.1 Recorded rainfall

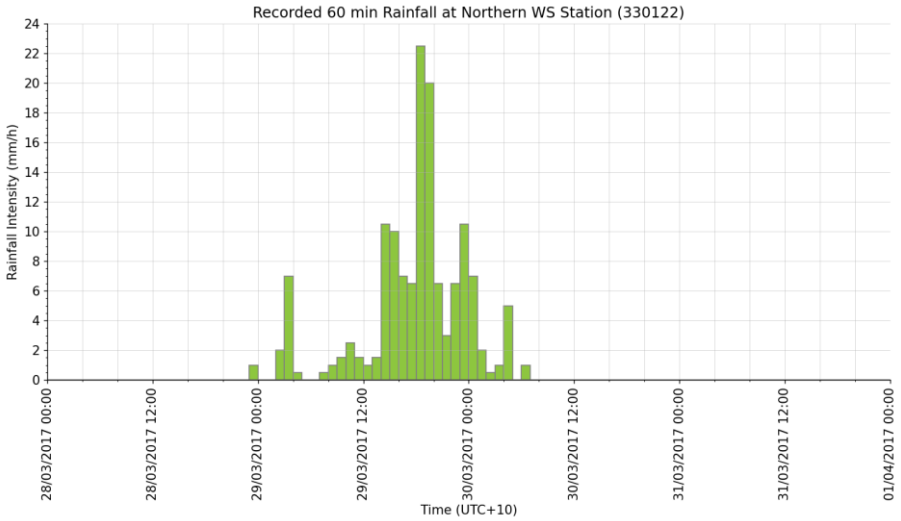


Figure B.1 Recorded rainfall at Northern WS Station (330122), 2017 event

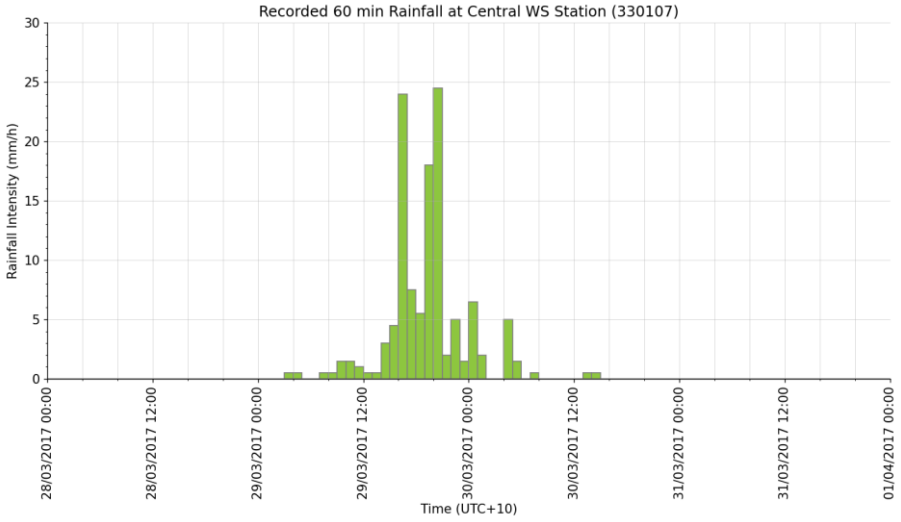


Figure B.2 Recorded rainfall at Central WS Station (330107), 2017 event

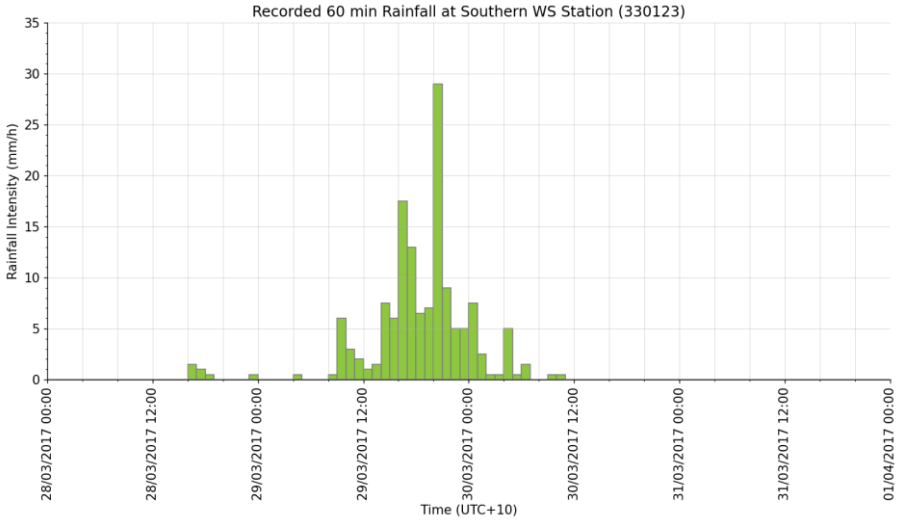


Figure B.3 Recorded rainfall at Southern WS Station (330123), 2017 event

B.1.2 Recorded water levels

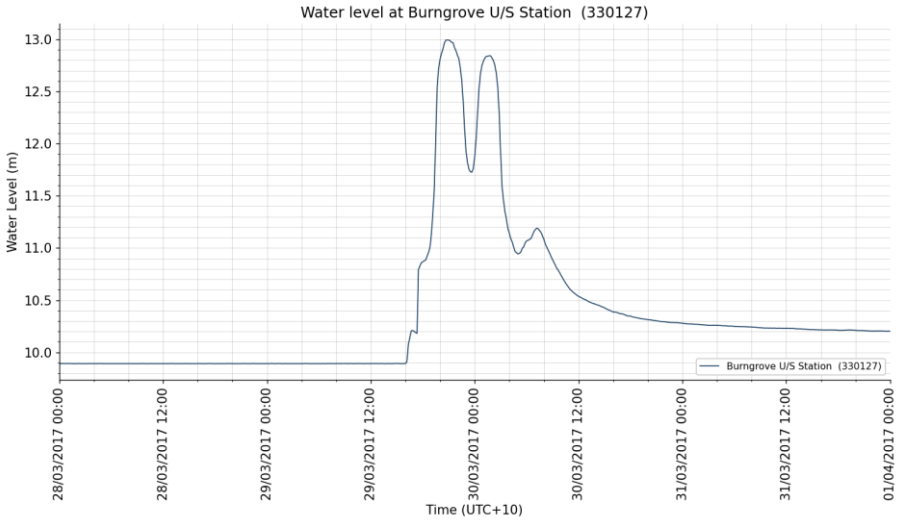


Figure B.4 Recorded water level at Burngrove D/S Station (330117), 2017 event

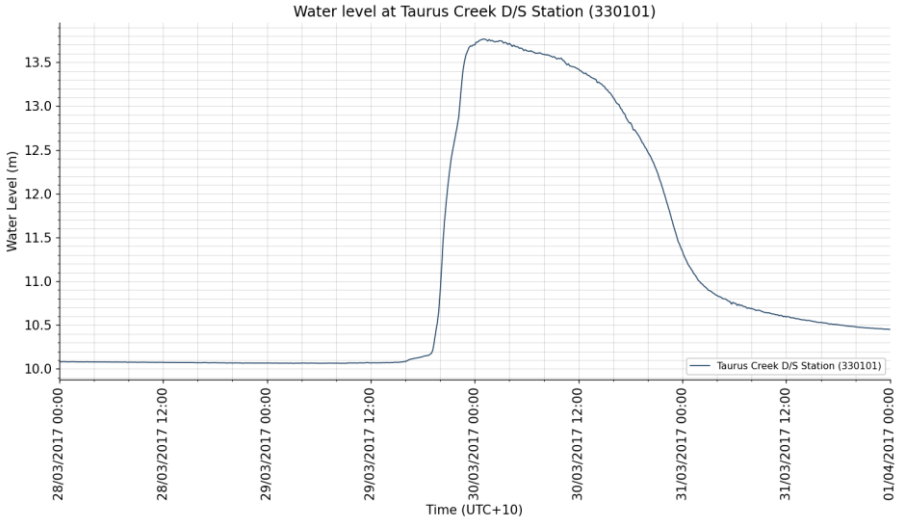


Figure B.5 Recorded water level at Taurus Creek D/S Station (330101), 2017 event

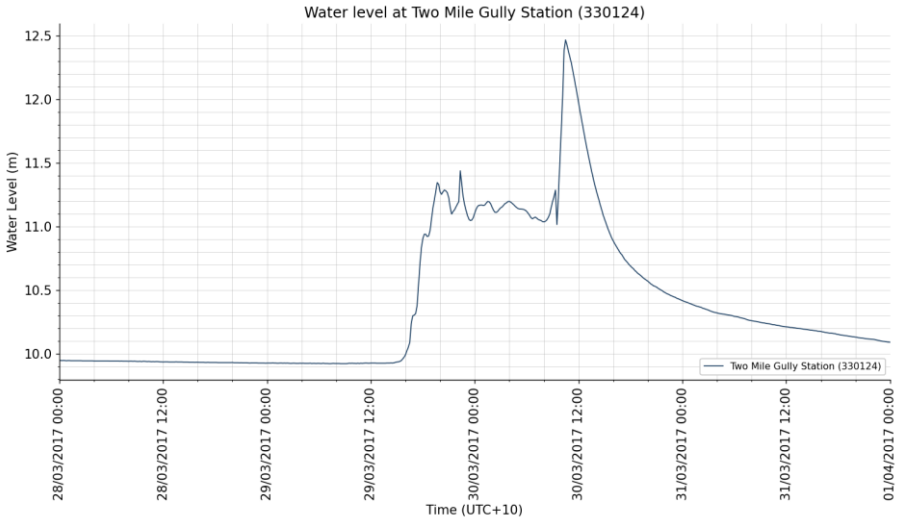


Figure B.6 Recorded water level at Two Mile Gully Station (330124), 2017 event

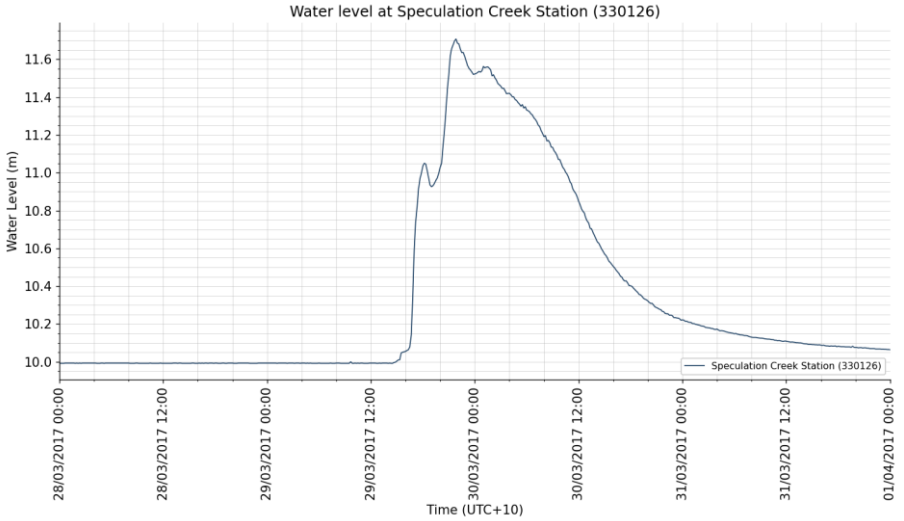


Figure B.7 Recorded water level at Speculation Creek Station (330126), 2017 event

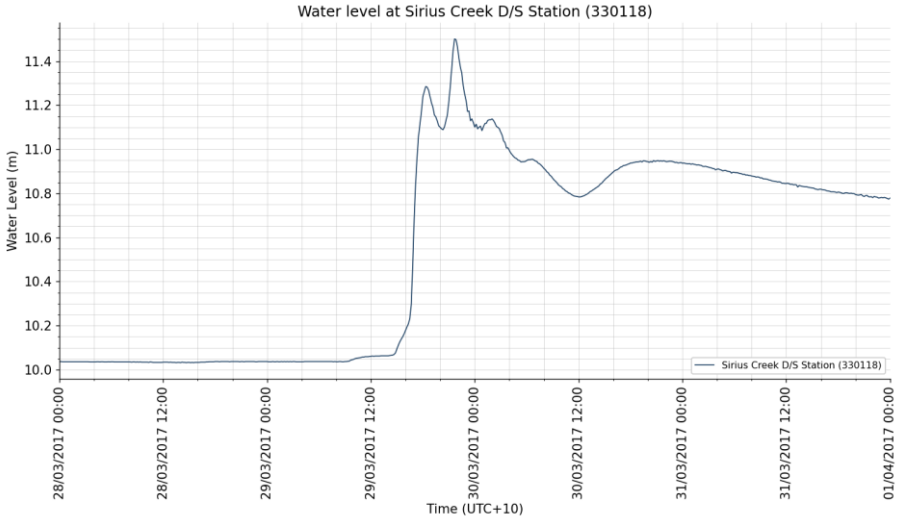


Figure B.8 Recorded water level at Sirius Creek Station (330118), 2017 event

B.2 2020 EVENT

B.2.1 Recorded rainfall

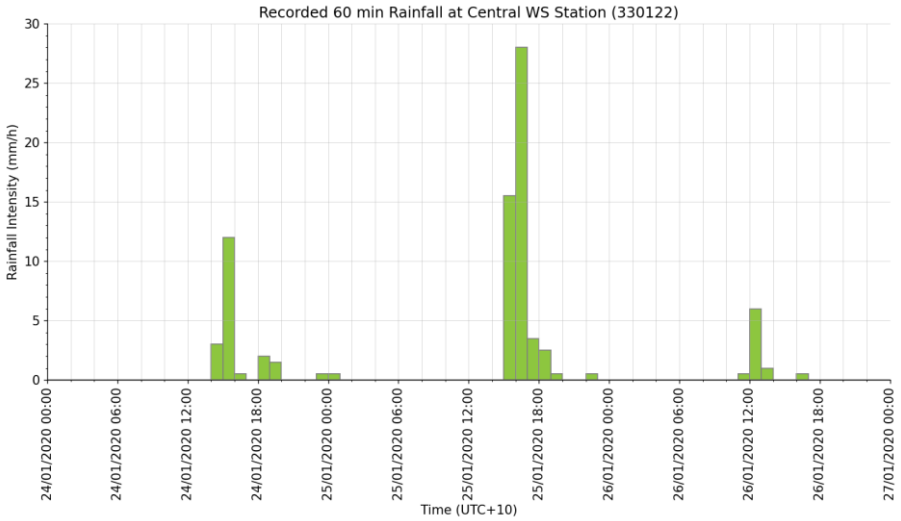


Figure B.9 Recorded rainfall at Northern WS Station (330122), 2020 event

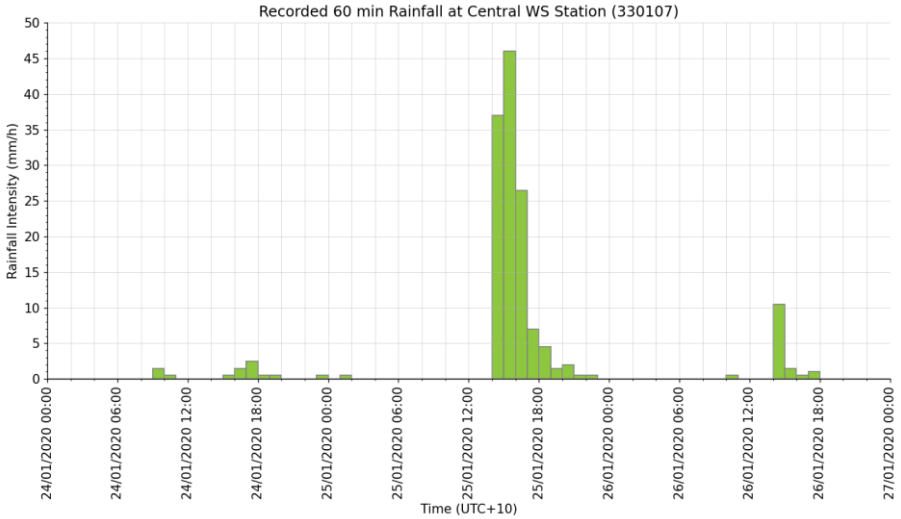


Figure B.10 Recorded rainfall at Central WS Station (330107), 2020 event

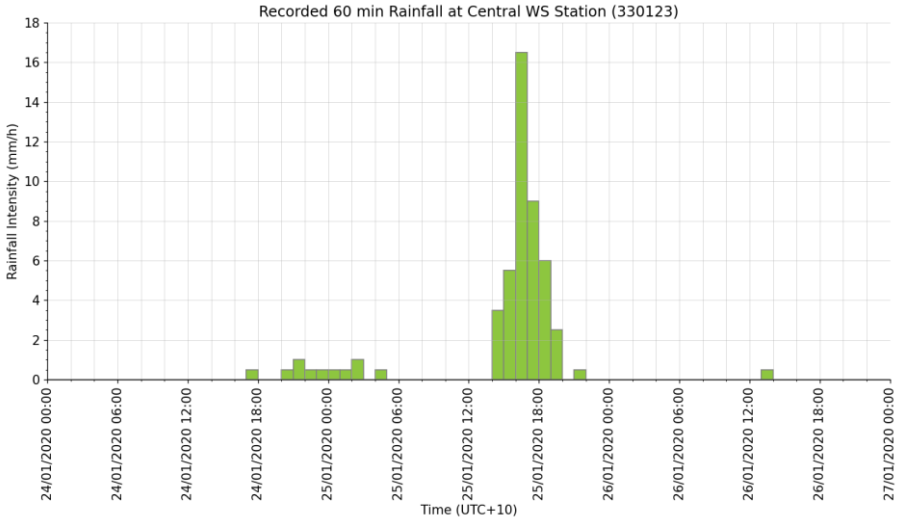


Figure B.11 **Recorded rainfall at Southern WS Station (330123), 2020 event**

B.2.2 Recorded water level

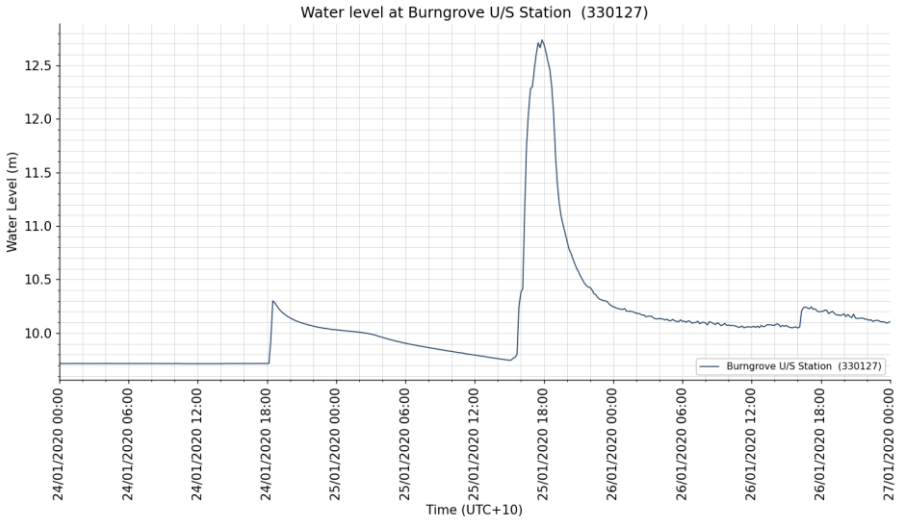


Figure B.12 **Recorded water level at Burngrove U/S Station (330127), 2020 event**

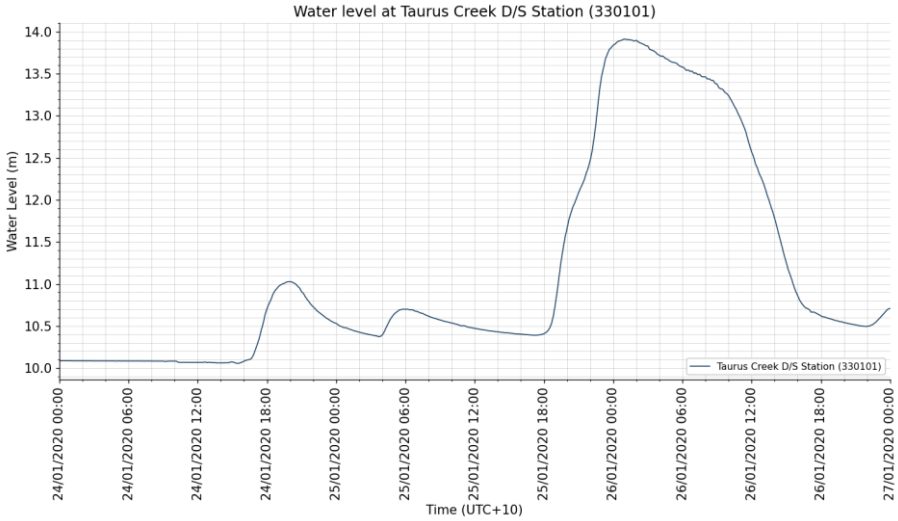


Figure B.13 **Recorded water level at Taurus Creek D/S Station (330101), 2020 event**

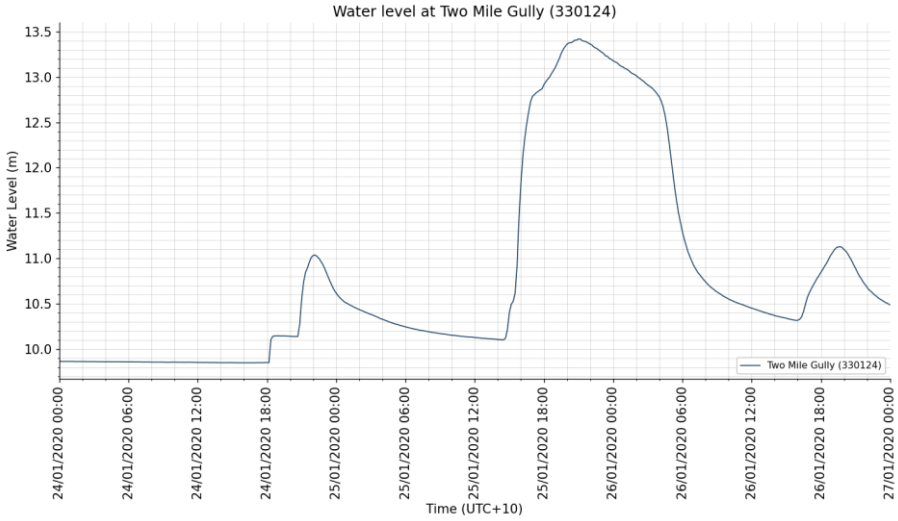


Figure B.14 **Recorded water level at Two Mile Gully Station (330124), 2020 event**

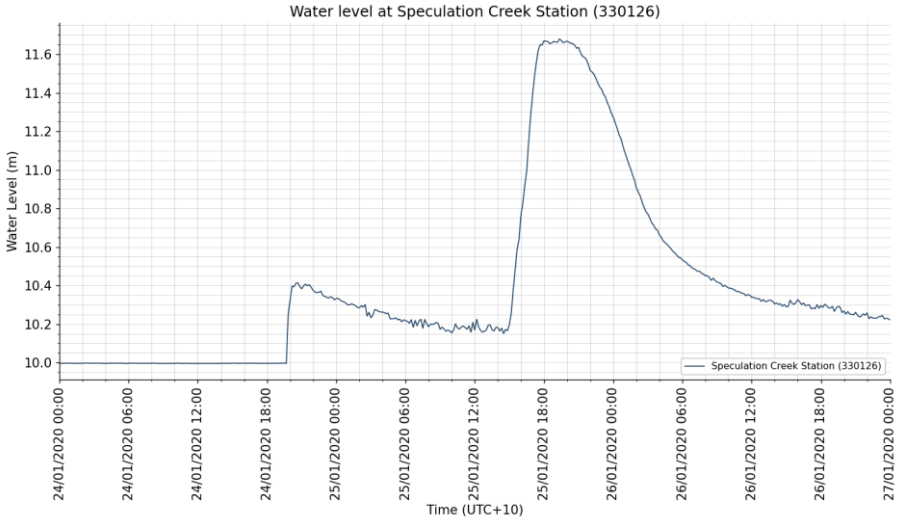


Figure B.15 **Recorded water level at Speculation Creek Station (330126), 2020 event**

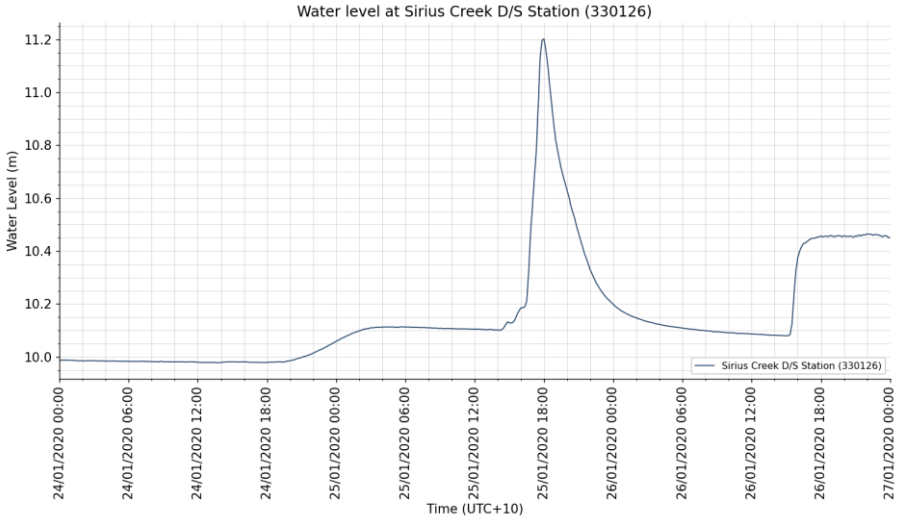


Figure B.16 **Recorded water level at Sirius Creek Station (330118), 2020 event**



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