# Technical Memorandum

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| **Date** | 02 July 2025 |
| **To** | Water Planning (Eastern) |
| **From** | Kelly Lavell, Nicole McAlinden – Approvals |
| **CC** | Johanna Richards, Iain Rea, Dadang Saepulloh, James Jordan – Water Planning |
| **Subject** | **Ore Body 32 Below Water Table Surplus Water Study – Summary of Creek Discharge Modelling Report** |

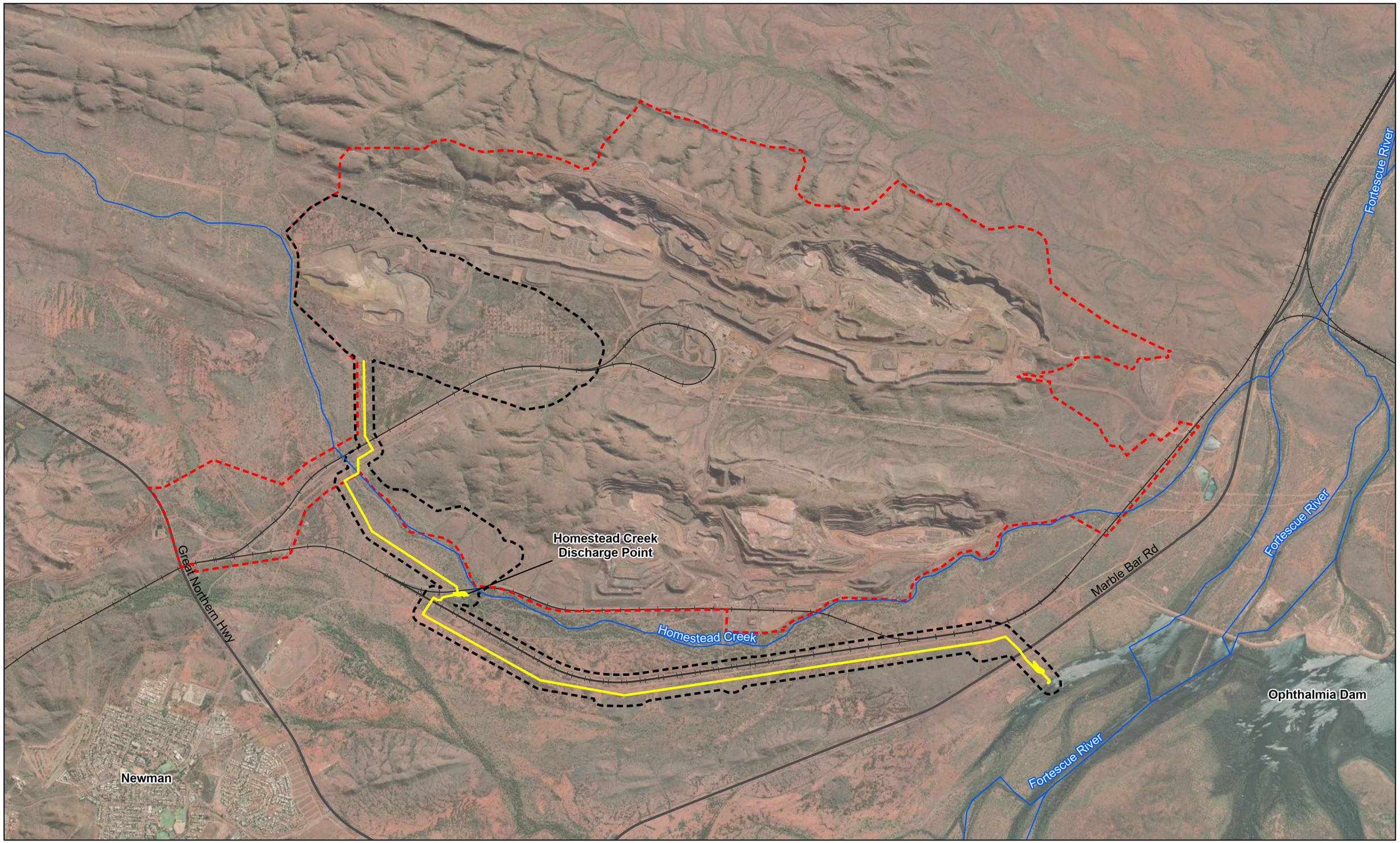
## 1 Introduction

BHP operates the Eastern Ridge (ER) Mine in the Pilbara region of Western Australia. Surplus water generated from below water table (BWT) mining activities at ER are managed via the integrated Eastern Pilbara Surplus Water Management System servicing ER, Mt Whaleback, Ore Body 18, Ore Body 31, and Jimblebar.

Ore Body 32 (OB32) is an existing deposit in the ER mine. Dewatering of the ore body is anticipated to commence in FY26 and produce up to 60 ML/day of surplus mine dewater. The discharge of surplus water to Ophthalmia Dam via a new pipeline was identified as the preferred discharge location for OB32 BWT and was included in the OB32 BWT Derived Proposal, approved by the EPA in September 2023 (EPA reference APP-0025015).

The discharge of surplus mine dewater to Homestead Creek was also identified as an alternate surplus water management option for OB32 BWT, and a contingency option for when Ophthalmia Dam is nearing capacity, or the pipeline to the Dam is undergoing maintenance. Figure **8** 1 illustrates the surplus water management arrangements for OB32 BWT.

A Homestead Creek Discharge Modelling Report (Advisian, 2023) was prepared to support the environmental approvals required to discharge surplus water to Homestead Creek by assessing the wetting front behaviour corresponding to various discharge scenarios to Homestead Creek. This memorandum has been prepared to provide a summary of the modelling outcomes.




- Watercourse
- Roads
- Rail
- OB32 BWT Surplus Water Disposal Pipeline
- Eastern Ridge Development Envelope (MS1037)
- OB32 Below Water Table Developement Envelope

N

0 0.5 1 1.5 2

KILOMETRES

GDA 1994 MGA ZONE 50

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# OREBODY 32 BWT CREEK DISCHARGE WETTING FRONT SUMMARY REPORT

General Arrangement for OB32 BWT Surplus Water Discharge

WAIO - PLANNING, TECHNICAL & ENVIRONMENT

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| DATE: | 2/07/2025 | PREPARED: | Geomatics | NO: | A1079_102_RevD |
| | | REVIEWED: | K. Lavell | | |

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# 2 Wetting Front Assessment

A wetting front assessment (Advisian, 2023) was initially undertaken to evaluate the wetting front behaviour corresponding to various creek discharge scenarios. The modelled discharge rates ranged from 82 ML/day to 47.5 ML/day of continuous discharge, and a range of pulsed scenarios were modelled where the creek discharge would operate under a range of regular intervals such as 80 days on, 30 days off.

The wetting front assessment was undertaken through a combination of 2D surface water and groundwater balance modelling using two advanced software packages TUFLOW[1] and GoldSim[2]. TUFLOW was used to model flows through Homestead Creek and Fortescue River based on the natural creek terrain and estimated infiltration rates, while the GoldSim analytical water balance model was used to conceptualise groundwater levels and movement within the aquifers which receive infiltration from Homestead Creek and Fortescue River.

Homestead Creek is a tributary of the Fortescue River, surplus water discharged to Homestead Creek will enter the Fortescue River and travel in a northerly direction. The study extent included two downstream points of interest along the Fortescue River, being Jigalong Road crossing and the crossing at Marble Bar Road, immediately upstream of Fortescue Marsh, located approximately 75 km and 130 km respectively from the proposed Homestead Creek discharge location (Figure 2). The downstream boundary of the surface water model was the opening to Fortescue Marsh.

Rio Tinto have approval to continuously discharge surplus water to Kalgan Creek, another tributary of the Fortescue River located approximately 15 km downstream of the confluence of Homestead Creek and Fortescue River. This creek discharge was included to assess the cumulative flow and extent of the wetting front which may occur from the continuous discharge of 60 ML/day to Homestead Creek plus Rio Tinto's discharge of 27 ML/day to Kalgan Creek, and three months of controlled release from Ophthalmia Dam at 120 ML/day.

[1] TUFLOW HPC software package (Version 2020-10-AD; BMT, 2022)
[2] GoldSim version 14.0 (GoldSim Technology Group LLC, 2021)

775000mE
800000mE
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Marble Bar Road crossing prior to Fortescue Marsh

Jigaling Road crossing

Ethel Creek / Jigalong Road

Marble Bar Rd

Homestead Creek Discharge Location

Great Northern Hwy

Ophthalmia Dam

Roads
Wetting Front Model Extent

N
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KILOMETRES
GDA 1994 MGA ZONE 50

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# OB32 BWT CREEK DISCHARGE WETTING FRONT SUMMARY REPORT

## Model Extent

WAIO- PLANNING, TECHNICAL & ENVIRONMENT

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| DATE: | 2/07/2025 | PREPARED: | Geomatics | NO: | A1079_126_RevB |
| | | REVIEWED: | K. Lavell | | |

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## 2.1 Model Inputs, Assumptions and Limitations

Key inputs to the modelling exercise were as follows:

- Aerial Imagery
- Topography (Digital Elevation Model) for the Homestead Creek, Ophthalmia Dam, and the Fortescue River areas
- Available groundwater elevations
- A range of surplus water discharge rates and scenarios
- Alluvial material coverage for the area adjacent to Ophthalmia Dam
- Infiltration rates in the Fortescue River (calculated based on previous discharges into the Fortescue River from Ophthalmia Dam); and
- Results from previous hydrogeological investigations undertaken by BHP.

Key Assumptions applied to the wetting front assessment included:

- The depth to groundwater for a considerable area of the Fortescue River is outside the coverage of available groundwater level information. Interpolation between the area of coverage where groundwater depths were available and the Fortescue Marsh region (where the water table is understood to be approximately 2 m below ground level) was used for the area where data was not available.
- A constant evapotranspiration rate of 8.5 mm/day was applied to the model, based on point potential evapotranspiration data obtained from the Bureau of Meteorology (BoM).
- A single Manning's n of 0.04 was applied throughout the model domain to account for the mixture of heavily and sparsely vegetation areas.

Key limitations of the wetting front assessment were as follows:

- The TUFLOW model was run for consecutive years to determine the time it took for the wetting front to reach Jigalong Road when continuously discharging 60 ML/day to Homestead Creek. For all other modelled scenarios, the TUFLOW model was run for 365 days (1 year).
- The TUFLOW model grid cell size was initially set to 25 m (with sub grid sampling of 5 m) to strike a balance between practical model run times whilst still providing meaningful results. Sub-grid sampling (SGS) stores and uses curves representing the sub-2D-cell terrain data of the DEMs and terrain modification shapes instead of each 2D cell and each 2D face having only one elevation.
- There is no method in TUFLOW for removing groundwater once the surface water has infiltrated into the subsurface. It is for this reason that the GoldSim modelling was required to capture the potential lateral groundwater migration based on the transmissivity of the local geology. The total lateral groundwater flux was then added to the evapotranspiration to simulate the loss of groundwater from the subsurface to the surrounding areas.
- For scenarios requiring steady state conditions, the depth to groundwater in the TUFLOW model was reduced to zero. This enabled the model to reach steady state in days rather than years. Therefore, respective results in these scenarios do not include losses to infiltration and provide conservative values.
- Hydraulic conductivity is a key parameter in determining the timing of the wetting front. Variations in the hydraulic conductivity affect the infiltration rate and therefore the time taken to fill the alluvial storage. The hydraulic conductivity will naturally vary within Homestead Creek and Fortescue River.
- Antecedent conditions within a catchment and waterway will influence the behaviour of a wetting front following the controlled release of surplus water to a waterway. The best available data and software has been used to complete the wetting front assessment; however, the modelling of real-world environments is complex. The modelling results are intended to provide a guide as to how the wetting

front is likely to behave. Further operational controls, including the installation of flow gauge monitoring sites is required to ensure the wetting front is managed appropriately.

## 2.2 Modelling Approach

### *2.2.1 Model Conceptualisation*

Given the variability in subsurface geology, Homestead Creek and Fortescue Rivers were split into fifty-five discrete reaches, based on their hydrological and hydrogeological features. These reaches were used to represent interactions between the TUFLOW and GoldSim models. Each reach in the water balance model is based on a cross-section of the main water way and its bulk groundwater flow properties.

### *2.2.2 Model Calibration*

The calibration of the TUFLOW model centred around matching the timing of the wetting front associated with the 2020 Ophthalmia Dam discharge trial (BHP 2019).

Surplus water from several of BHP mining operations is piped to Ophthalmia Dam where the water infiltrates to replenish the groundwater aquifer beneath the Dam. This aquifer has historically been used to provide potable water to Newman Town.

Controlled releases of water from the Dam occur following the wet season, when required to ensure sufficient capacity remains to store rainfall and surplus mine dewater during the year ahead.

A discharge test trial was conducted between August to November 2017 (BHP, 2019), in which 9.4 GL (approximately 116 ML/day) of water was released from Ophthalmia Dam to the Fortescue River. It was reported that following the discharge, the wetting front arrived at Jigalong Road. Rainfall data recorded at the Bureau of Meteorology's Newman Aero Station (Station ID 007176) indicates that 40 mm of rainfall was received during the discharge, however no flows were recorded in the Fortescue River upstream of the dam at the Department of Water and Environmental Regulation's (DWER) stream gauge 708011 (DWER Site 708011).

Rainfall data from Station ID 007176 also indicates that a higher-than-average wet season was experienced in Newman prior to the discharge trial, with 390 mm of rain received between November 2016 through March 2017, and a further 117mm of rain received in April and May 2017.

Stream flow data from DWER stream gauge 708011 indicates that flows were recorded in the Fortescue River between January and June 2017. As such, wet antecedent conditions were present prior to the discharge trial which may have resulted in the wetting front traveling faster than would occur during dry conditions. Although no flow was recorded in DWER's stream gauge upstream of the dam (708011), the alluvial material in the creek bed would still have been reasonably saturated, reducing the infiltration capacity of the river.

The modelling work undertaken in support of the wetting front assessment accounts for theoretical conditions and provides a robust base on which to plan operational schemes. However, operational controls, including the monitoring of the wetting front with strategically placed stream gauges, will be important for reducing the risk of the wetting front going beyond Jigalong Road during natural no-flow conditions.

### *2.2.3 Model Cross Section Locations*

Following the initial wetting front assessment (Advisian, 2023), the TUFLOW model was rerun with a finer cell size resolution of 6 m (from 25 m) to provide more accurate representation of the wetting front within the channel of Homestead Creek and Fortescue River (Worley, 2024). Several cross sections were taken at points of interest along both waterways to estimate the width and depth of the wetting front which is likely to be experienced during the discharge of surplus water to Homestead Creek. The modelled cross section locations are provided in Figure 3.

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825000mE

7450000mN

7425000mN

60ML/day Continuous Discharge Wetting Front

Ethel Creek / Jigalong Road

Marble Bar Rd

Kalgan Creek

Fortescue River

Jimblebar Creek

Homestead Creek Discharge Location

Homestead Creek

Ophthalmia Dam

Fortescue River

Shovelanna Creek

Great Northern Hwy

Warrawanda Creek

Jimblebar Creek

Roads
Watercourse
Model Cross Section
Wetting Front

N

0 1 2 3 4 5
KILOMETRES

GDA 1994 MGA ZONE 50

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# OB32 BWT CREEK DISCHARGE WETTING FRONT SUMMARY REPORT

## Model Cross Section Location

WAIO- PLANNING, TECHNICAL & ENVIRONMENT

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| | | REVIEWED: | K. Lavell | | |

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## 2.3 Key Outcomes

The key outcomes from the assessment and modelling are as follows:

- A continuous discharge of 60 ML/day to Homestead Creek will travel 76 km and arrive at the Jigalong Road crossing over the Fortescue River in 5 years (1,806 days) (Figure 8).
- The pulsed discharge of 60 ML/day (60 ML/day for 4 months, off for 2 months, repeat) will travel 41 km and will not reach the Jigalong Road crossing after 1 year (Figure 5)
- A continuous discharge of 47.5 ML/d to Homestead Creek can be sustained without the wetting front arriving at the Jigalong Road crossing (Figure 6)
- The continuous combined discharge to Homestead Creek (60 ML/day), Kalgan Creek (27 ML/day) and 3-month release of water from Ophthalmia Dam (120 ML/day) will likely reach Jigalong Road crossing within two years (Figure 7)
- Significant variability in the width of the wetting front is expected which is governed by channel morphology and antecedent conditions
- The width of the wetting front in Homestead Creek when continuously discharging 60 ML/day is predicted to range from 6 m to 40 m
- The width of the wetting front in Fortescue River when continuously discharging 60 ML/day to Homestead Creek is predicted to range from 21 m to 37 m
- The width of the wetting front in Fortescue River during the cumulative discharge of water to Homestead Creek, Kalgan Creek and from Ophthalmia Dam is predicted to range from 23 m to 43 m.

As a result of the modelling undertaken, the Part IV OB32 BWT Creek Discharge proposal is seeking to discharge up to 60 ML/day of surplus water to Homestead Creek, when required. The creek discharge will however operate for a maximum of 9 months per year to maintain a drying pattern of both Homestead Creek and Fortescue River.

No culverts exist beneath the Jigalong Road crossing which creates a damning effect on river flow, resulting in a deep pool of water being able to form upstream of the road. In addition, the Jigalong Road crossing provides existing access to install water monitoring equipment and will provide greater protection to the Fortescue Marsh, which is located a further 55 km downstream of the Jigalong Road crossing. The Jigalong Road crossing over the Fortescue River was strategically chosen as the downstream wetting front threshold as it is located midway between the discharge point and the Fortescue Marsh. It offers a practical and effective location for monitoring and managing discharge to avoid impacts to the Fortescue Marsh.

800000mE

825000mE

7450000mN

7425000mN

60ML/day Continuous Discharge Wetting Front

Ethel Creek / Jigalong Road

Marble Bar Rd

Kalgan Creek

Fortescue River

Jimblebar Creek

Homestead Creek Discharge Location

Homestead Creek

Ophthalmia Dam

Fortescue River

Shovelanna Creek

Great Northern Hwy

Warrawanda Creek

Roads

Watercourse

Wetting Front

N

0 1 2 3 4 5

KILOMETRES

GDA 1994 MGA ZONE 50

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# OB32 BWT CREEK DISCHARGE WETTING FRONT SUMMARY REPORT

## 60 ML/day Continuous Discharge

WAIO- PLANNING, TECHNICAL & ENVIRONMENT

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800000mE

825000mE

7450000mN

7425000mN

Ethel Creek / Jigalong Road

Marble Bar Rd

60ML/day Pulsed
Discharge
Wetting Front

Fortescue River

Kalgan Creek

Jimblebar Creek

Homestead
Creek Discharge
Location

Homestead Creek

Ophthalmia
Dam

Shovelanna Creek

Great
Northern Hwy

Warrawanda Creek

Roads
Watercourse
Wetting Front

N

0 1 2 3 4 5
KILOMETRES

GDA 1994 MGA ZONE 50

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# OB32 BWT CREEK DISCHARGE WETTING FRONT SUMMARY REPORT

## 60 ML/day Pulsed Discharge

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800000mE

825000mE

7450000mN

7425000mN

47.5ML/day Continuous Discharge Wetting Front

Ethel Creek / Jigalong Road

Marble Bar Rd

Kalgan Creek

Fortescue River

Jimblebar Creek

Homestead Creek Discharge Location

Homestead Creek

Ophthalmia Dam

Fortescue River

Great Northern Hwy

Warrawanda Creek

Shovelanna Creek

Jimblebar Creek

Roads

Watercourse

Wetting Front

N

0 1 2 3 4 5

KILOMETRES

GDA 1994 MGA ZONE 50

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# OB32 BWT CREEK DISCHARGE WETTING FRONT SUMMARY REPORT

## 47.5 ML/day Continuous Discharge

WAIO- PLANNING, TECHNICAL & ENVIRONMENT

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800000mE

825000mE

7450000mN

7425000mN

Ethel Creek / Jigalong Road

Cumulative Wetting Front

Jimblebar Creek

Marble Bar Rd

Kalgan Creek

Fortescue River

Homestead Creek Discharge Point

Homestead Creek

Ophthalmia Dam

Fortescue River

Great Northern Hwy

Warrawanda Creek

Shovelanna Creek

Jimblebar Creek

- Homestead Creek discharge point
- Roads
- Watercourse
- Wetting Front

N

0 2 4 6 8 10

KILOMETRES

GDA 1994 MGA ZONE 50

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**OB32 BWT CREEK DISCHARGE**
**WETTING FRONT SUMMARY REPORT**

Cumulative Wetting Front - Homestead Creek Continuous 60ML/day, Kalgan Creek 27ML/day and Ophthalmia Dam 120ML/day for three months

WAIO- PLANNING, TECHNICAL & ENVIRONMENT

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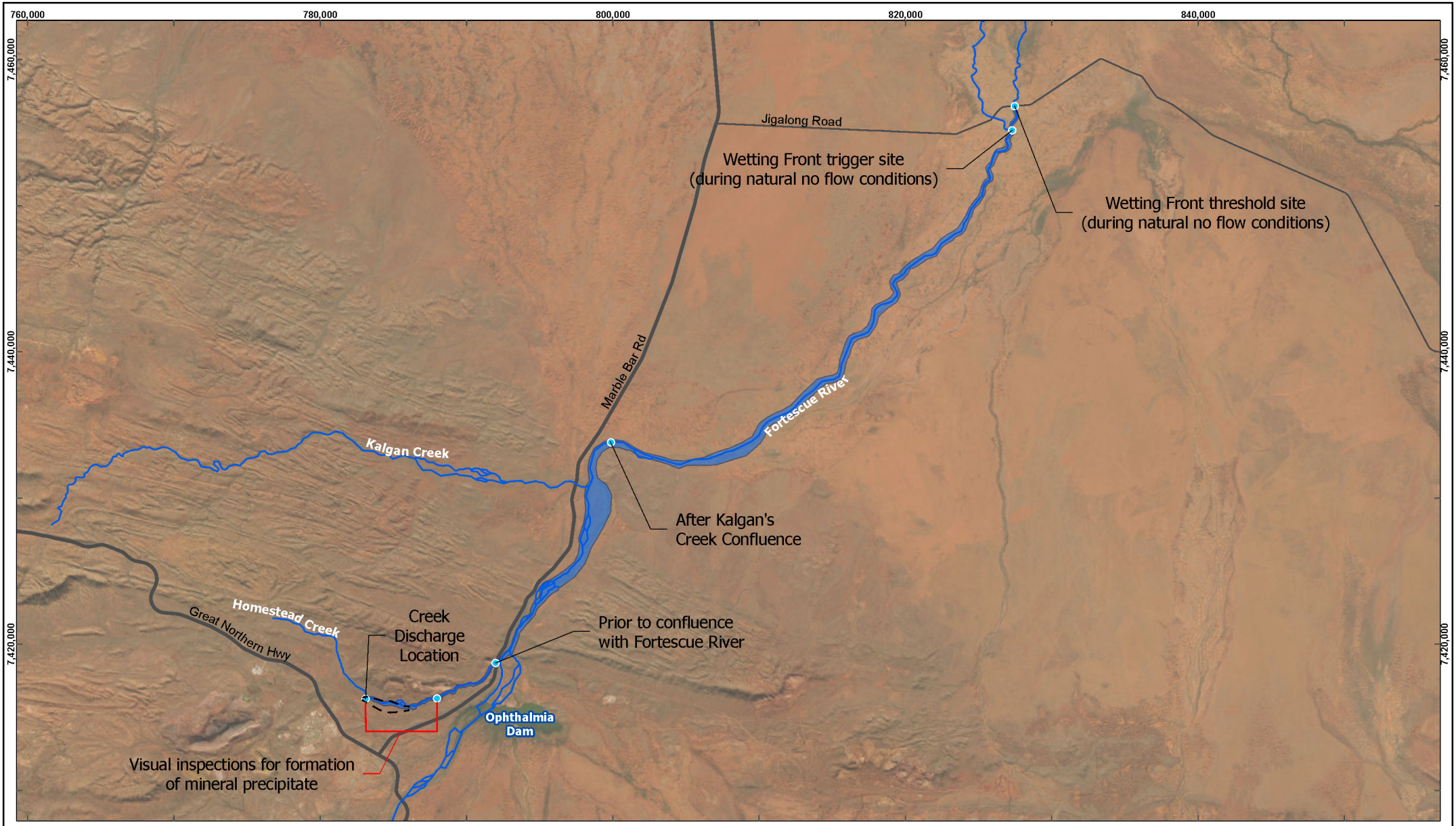
# 3 Proposed Monitoring System

### *3.1.1 Identification of Suitable Stream Gauge Locations*

Six locations have been identified as being suitable for the installation of water monitoring locations (Figure 8) including.

- A flow meter at the Homestead Creek discharge location
- Visual inspections being completed up to 5 km downstream of the Homestead Creek discharge location to inspect for mineral precipitate formation.
- New stream gauges being installed
    - Immediately upstream of the Homestead Creek and Fortescue River confluence
    - 2 km downstream of Kalgan Creek and Fortescue River confluence
    - 2 km upstream of the Jigalong Road crossing (wetting front trigger site)
    - Immediately upstream of Jigalong Road crossing (wetting front threshold site)

These locations were selected based on their proximity to already established public access routes, thereby eliminating the need for environmental disturbance and clearing of native vegetation through the creation of new access tracks. Figure 9 provides a photo of the Jigalong Road crossing and Figure 10 the low flow channel of the Fortescue River looking south (upstream) of Jigalong Road crossing.




OB32 BWT Creek Discharge Development Envelope
Wetting Front
Roads
Watercourse
Water Monitoring Locations

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KILOMETRES

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# OB32 BWT CREEK DISCHARGE WETTING FRONT SUMMARY REPORT

Proposed Surface Water Monitoring Stations

WAIO - PLANNING, TECHNICAL & ENVIRONMENT

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| DATE: | 19/09/2025 | REQUESTOR: | ENV APPROVALS | NO: | A1079-103_RevF |

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**Figure 9: Jigalong Road crossing through Fortescue River**

**Figure 10: Fortescue River low flow channel looking immediately upstream (south) of Jigalong Road crossing**

# 4 Conclusion

Dewatering of OB32 BWT is anticipated to commence in FY26 and produce up to 60 ML/day of surplus mine dewater. Discharge directly into Ophthalmia Dam is the existing approved and preferred discharge location for OB32 surplus water, with contingency discharge to Homestead Creek. A wetting front assessment was undertaken to assess the travel times and distances the wetting front will travel under various creek discharge scenarios. The key outcomes of this assessment are that the continuous discharge of 60 ML/d to Homestead Creek will arrive at the Jigalong Road crossing over the Fortescue River in approximately 5 years; and the continuous discharge of 47.5 ML/d can be sustained without the wetting front going beyond the Jigalong Road crossing.

Operational controls including the installation of stream gauges along Homestead Creek and the Fortescue River to track the progress of the wetting front and operating the creek discharge for a maximum of nine months a year will assist with ensuring the wetting front does not go beyond the Jigalong Road crossing during natural no flow conditions.

# 5 References

Advisian (2023). *Surplus Water Management Definition Phase Study Creek Discharge Modelling Report.* Unpublished report prepared for BHP

BHP (2019). Ophthalmia Dam Discharge Hydrology Study 2019. Internal Memo. BHP Iron Ore, Perth Australia

Worley (2024). *OB32 Stage 2 Technical Support*. Unpublished memo prepared for BHP.