WINCHESTER SOUTH PROJECT

WATER AND FINAL LANDFORM ADDENDUM

JUNE 2023
Project No. WHC-18-62
Document No. 01185344-006.docx

TABLE OF CONTENTS

LIST OF ATTACHMENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF CHARTS

LIST OF PLATES

1 INTRODUCTION

The Winchester South Project (the Project) is located approximately 30 kilometres (km) south-east of Moranbah, in the Isaac Regional Council (IRC) Local Government Area (LGA) (Figure 1), within the Bowen Basin Coalfield, in Queensland.

The Project involves the development of an open cut metallurgical coal mine in an existing mining precinct.

Whitehaven WS Pty Ltd (Whitehaven WS) is the proponent for the Project and is a wholly owned subsidiary of Whitehaven Coal Limited (Whitehaven).

In 2021, Whitehaven WS submitted the *Winchester South Project Environmental Impact Statement* (the Draft EIS) for assessment under the *State Development and Public Works Organisation Act 1971* (SDPWO Act).

The Draft EIS was placed on public notification by the Office of the Coordinator-General (OCG) from 4 August 2021 until 15 September 2021. During and following this period, government advisory agencies, organisations and members of the public provided submissions on the Draft EIS to the OCG.

Subsequent to the public notification of the Draft EIS in 2021 and in response to comments raised in submission, Whitehaven WS reviewed the mine plan and mine schedule with the aim of reducing environmental impacts of the Project and modifying the proposed Project final landform. This review also considered new geological data, coal quality data and the outcomes of processing trials to further refine the mine plan.

On 3 December 2021, the OCG formally requested (in accordance with section 34B of the SDPWO Act) Additional Information on the environmental effects of the Project and other matters relating to the Project. Subsequently, Whitehaven WS prepared and provided the Additional Information in consideration of the OCG's request for Additional Information.

The Revised Draft EIS was placed on public notification by the OCG from 21 November 2022 until 19 December 2022. During and following this period, government advisory agencies, organisations and members of the public provided submissions on the Revised Draft EIS to the OCG.

A Response to Submissions was provided to the OCG in March 2023 with Whitehaven WS' response to government agencies, organisations and members of the public submissions. Following provision of the Response to Submissions, the OCG provided information requests, referred to as the Surface Water, Groundwater and Final Landform and Residual Voids Requests for Information (RFIs), for some residual matters for the Coordinator-General's Evaluation Report. This Water and Final Landform Addendum provides responses to the information requested by the OCG and Table 1-1A provides a reconciliation of where each item in the RFIs have been addressed. Copies of the information requests are provided in Attachments 1, 2 and 3.

This Water and Final Landform Addendum is structured as follows:

- Section 2 – provides a summary of the credentials and experience of the technical specialists involved with the Environmental Impact Statement process and for the Project.
- Section 3 – provides a response to the Surface Water RFI, including specific references that align with the numbering convention provided in the RFI.
- Section 4 – provides a response to the Groundwater RFI, including specific references that align with the numbering convention provided in the RFI.
- Section 5 – provides a response to the Final Landform and Residual Voids RFI (also referred to as the Rehabilitation RFI), including specific references that align with the numbering convention provided in the RFI.
- Section 6 – provides a consolidated impact assessment for water-related matters relevant to the Project.

Table 1-1A
Reconciliation Table for the Surface Water, Groundwater and Final Landform and Residual Voids RFIs

Item	Description of Request for Information Description	Section
Surface Water RFI		
1.	Inconsistencies with the surface water management system, including clean water diversions and overland flow capture	Section 3.1
2.	Lack of information on how waterway diversions will be managed to minimise potential impacts to environmental values	Section 3.2
3.	Lack of information on how coal rejects and associated runoff will be managed to minimise potential impacts to environmental values (OWS 13, 15 and IESC 7, 23a, 24, 46)	Section 3.3
4.	Proposed alternative approach to manage surface water runoff in sediment dams (IESC 7, 25, 26, 27, 39)	Section 3.4
5.	Use of Isaac River flows to determine discharge rates of controlled releases of mine-affected water (OWS 15, 16 and IESC 7, 32, 33)	Section 3.5
6.	Updated and consolidated impact assessment for controlled releases of mine-affected water	Section 3.6
7.	Inadequacy of proposed management measures to minimise potential erosion risks (OWS 15, 22 and IESC 7, 25, 26, 27, 39, 40, 46)	Section 3.7
Groundwater RFI		
1.	Site-specific data for alluvium and regolith to support the conclusions that GDEs will not be impacted by the project (OWS 4a, 5a, 5b, 5c, 6, 7, 8 and IESC 13, 14a, 19, 21b)	Section 4.1
2.	Lack of site-specific data for the regolith to support hydraulic parameters used in the groundwater model (OWS 5a)	Section 4.2
3.	Inconsistencies between groundwater levels and saturation parameters used in the groundwater model and monitoring records (OWS 5b)	Section 4.3
4.	Inconsistencies in conceptualisation of regolith (OWS 5b)	Section 4.4
5.	Lack of site-specific data to characterise water quality parameters in the regolith (OWS 5d, 11, 12, 13)	Section 4.5
6.	Lack of site-specific data to confirm the presence and extent of impermeable layers to interrupt movement of groundwater (IESC 28, 29)	Section 4.6
7.	Lack of site-specific data to confirm the presence and extent of impermeable layers to prevent seepage from waste rock emplacements (OWS 4)	Section 4.7
8.	Geochemical data to further characterise the geochemical reactivity of waste rock and coal rejects (OWS 13, IESC 24)	Section 4.8
9.	Inconsistent conceptualisation of the Isaac River (OWS 10 and IESC 13)	Section 4.9
10.	Cumulative impacts – exclusion of other projects (OWS 8, 9 and IESC 14b, 14c and 48)	Section 4.10
11.	Sensitivity and uncertainty analysis (OWS 5c and IESC 14a)	Section 4.11
12.	Exclusion of excised or diverted waterways from the groundwater model (IESC 5, 9, 10, 11, 14e, 27, 48)	Section 4.12
13.	Other groundwater characterisation and modelling issues raised by IESC and OWS	Section 4.13
14.	Disproportionate significance of GDEs providing habitat for MNES (OWS 18, 20 and IESC 3, 11, 32, 33, 42, 43, 44, 50)	Section 4.14
15.	Ground-truthing of GDEs (OWS 17, 18a, 18b and IESC 2, 9, 28, 29, 30, 45)	Section 4.15
16.	Monitoring of GDEs and Wynette offset area	Section 4.16
17.	Bores in the alluvium and regolith	Section 4.17
18.	Other bores	Section 4.18
19.	Baseline water level data	Section 4.19
20.	Assumptions for residual void modelling (IESC 4, 16)	Section 4.20
21.	Behaviour of voids as sinks or sources (IESC 4, 15, 16 and DES issue 584.23)	Section 4.21
22.	Hydraulic properties of backfilled pits (OWS 5h and IESC 17, 23a)	Section 4.22
23.	Modelling of scenarios for climate change and potential differences in cumulative drawdown (OWS 5i, IESC 15)	Section 4.23
24.	Impacts of void water on biota in the surrounding area (IESC 9)	Section 4.24
Final Landform and Residual Voids RFI		
-	Final Landform and Residual Voids	Section 5.1
-	Existing Winchester Quarry	Section 5.2

2 TECHNICAL SPECIALISTS

The Environmental Impact Statement, and subsequent additional information and responses, were prepared by Whitehaven WS and Resource Strategies Pty Ltd with supporting assessments prepared by highly qualified and experienced technical specialists. These specialists have with extensive knowledge and experience with environmental impact assessments, approval processes and operational management/monitoring associated with large-scale mining and resource projects in the Bowen Basin, as well as throughout Queensland and the rest of Australia.

Sections 2.1 to 2.5 outline the particular relevant knowledge and extensive experience of the technical specialists involved with the preparation of this Water and Final Landform Addendum, as well as the prior components of the Draft EIS.

2.1 Groundwater Modelling and Assessment

Derwin Lyons (Technical Director at SLR Consulting Australia Pty Ltd [SLR])
BSc (Hydrogeology) (Hons), BSc (Hydrology and Water Resource Science).

Over 17 years' experience in groundwater resource development and management at multiple consultancies in a variety of mining, coal seam gas and underground water resource management projects in Queensland, South Australia, New South Wales (NSW) and the Northern Territory. Key experience includes:

- conceptual hydrogeological model development;
- mining impact assessment;
- water supply development;
- monitoring network design;
- production and monitoring well design and construction;
- field program design and implementation; and
- aquifer testing and analysis.

Brian Rask (Technical Director at SLR)
BSc (Watershed Science), MBA.

Over 30 years' extensive experience in hydrogeology in the United States and Australia, including:

- surface and groundwater assessments and environmental impact statements;
- groundwater modelling programs including, MODFLOW (Visual and Groundwater Vistas), MODFLOW-SURFACT, MODFLOW_USG, FEFLOW, HEC-RAS, Quickflow, WinFlow, WinTrans, and GoldSim;
- mine site water supply management;
- conceptual hydrogeological model development;
- mining impact assessment;
- water supply, storage and operational management programs;
- contaminated site/surface and groundwater transport assessments/modelling;
- remedial action plans; and
- drilling and well design/construction management.

Dr Noel Merrick (Principal at HydroAlgorithmics Pty Ltd) – Peer Reviewer
BSc, MSc (Geophysics), PhD (Hydrogeology), GradDip (DataProc).

Over 50 years' experience in hydrogeology, geophysics and groundwater modelling in all Australian States:

- Co-author of modelling guidelines.
- Authoring and/or peer review of groundwater models and assessments for numerous mining projects across Queensland and NSW.
- Extensive knowledge of Bowen Basin (e.g. Olive Downs Project Environmental Impact Statement [EIS] and Land Court Case).
- Long-term Technical Advisory Panel member for Office of Groundwater Impact Assessment (Surat Basin).
- Former Associate Professor and Research Scientist.
- Former membership of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Burdekin Research Steering Committee, and the DERM-led Modelling Reference Group for the Lower Burdekin Groundwater Modelling Project.
- Former membership of the Technical Audit Panel and Wetlands Technical Panel for Government of Victoria.
- Former membership of Strategic Inquiry Panel into Coal Mining (Wyong), and Independent Hearing and Assessment Panel (Somersby) for NSW Government.
- Long-term member of the Independent Audit Group for Salinity in the Murray-Darling Basin.
- Inaugural recipient of the International Association of Hydrogeologists (Australia) Groundwater Professional Award for lifetime service to the groundwater industry.
- Over 300 peer reviews for water supply, mine and quarry groundwater assessments.

2.2 *Surface Water and Flooding Modelling and Assessment*

Dr David Newton (Director/Senior Principal Engineer at WRM Water & Environment Pty Ltd [WRM])
BEng (Hons), MEngSt, PhD (Urban Stormwater), CPEng, RPEQ.

Over 30 years' experience in water resource management, including:

- Extensive experience in surface water assessment and infrastructure design for mining projects in Queensland and NSW.
- Provision of advice on numerous Queensland projects including Middlemount, Curragh, Central Queensland Coal, Baralaba and Ensham.
- Project manager for mine EIS studies throughout New South Wales, including Maules Creek, Watermark, Moolarben and Bengalla.
- Engaged by the Office of the Queensland Mine Rehabilitation Commissioner to provide advice on leading practices for mine void modelling used to support rehabilitation planning (co-author of three technical papers).

Matthew Briody (Principal Engineer at WRM)
BEng (Civil) (Hons), RPEQ.

Over 20 years' experience in water resource management, primarily in the Queensland and NSW mining sector, recent experience includes:

- Preparation of the Surface Water Assessment for the neighbouring Olive Downs Project EIS and nearby Isaac Downs Project EIS.
- Project manager and technical specialist for numerous water management studies (approvals, operational and closure planning) for many operations within the Bowen Basin, including: Isaac Plains; Isaac Downs, Lake Vermont; Millennium; Moranbah North; Burton; Saraji; Norwich Park; and Middlemount.
- Engaged by the Office of the Queensland Mine Rehabilitation Commissioner to provide advice on leading practices for mine void modelling used to support rehabilitation planning (co-author of three technical papers).

Tony Marszalek (Director at Hydro Engineering & Consulting Pty Ltd) – Peer Reviewer
BEng (Civil) (Hons), M (EngSc).

Over 30 years' experience in water resource management, working on projects relating to water resources, mining and civil and environmental engineering. Provision of expert advice for legal proceedings as well as to government agencies in regard to water resource assessments.

2.3 Baseline Groundwater and Surface Water Monitoring and Investigations

Daniel Barclay (Principal Hydrogeologist at hydrogeologist.com.au)
BAppSc (Hons), BAppSc (Geology), International Association of Hydrogeologists.

Over 20 years' experience as a hydrogeologist within the consulting, government and mining sectors, with hydrogeological exposure within the mining environment in Australia, Asia and North America including:

- Groundwater resource assessments, including desktop assessments, program design and conceptualisation studies for a number of projects in Queensland (Vulcan Complex Project, Bauxite Mine, Clarence Moreton Basin, Surat Basin, Lady Annie, Great Artesian Basin Recharge Project), South Australia and Papua New Guinea.
- Conceptual model development, design and installation of bores and hydrochemical assessments, groundwater sampling and mine activity simulations for a number of projects in Queensland (Wilson Creek Project, Dawson Mine, Surat Basin, Gregory-Crinum Mine, Isis and Gordon Mines), South Australia and Canada.
- Groundwater impact assessments for mining projects in Queensland (Aurukun Bauxite, Moranbah South, Taroborah, Broughton), NSW, South Australia and Papa New Guinea.
- Annual groundwater monitoring reviews, borefield performance reports and exceedance investigation reports to assist mining companies with regulatory conditions and reporting obligations in Queensland (Meteor Downs South, Callide Mine, Norwich Park Mine, Oaky Creek Mine, Gregory Crinum Mine, Cameby Downs, Surat Basin, Grassdale Feedlot, Ernest Henry Mine, Lady Loretta Mine) and NSW.
- Mine site dewatering and depressurisation projects in Queensland (Burton Widening Project, Ernest Henry Mine), Papua New Guinea and Laos.
- Development of numerical flow models for mines and development activities in Queensland (Vulcan Complex Project, Ernest Henry Mine, King Vol Mine, Mt Dromedary, Surat Basin, Lady Annie), South Australia, Western Australia, Papua New Guinea and Laos.
- Co-authoring Groundwater Recharge in the Great Artesian Basin Intake Beds, Queensland.

2.4 Geochemistry Investigations and Assessment

Dr Ian Swane (Principal Geochemist and Director at Terrenus Earth Sciences [Terrenus])
BEnvSc (Geology) (Hons), PhD (Hydrogeochemistry).

Environmental geochemist with over 25 years' experience in consulting, technical and project management in the mining sector. Extensive Bowen Basin coal experience, having completed (or currently working on) dozens of environmental geochemical assessments for Bowen Basin coal projects. Recent examples include:

- Expansion of Blackwater Mine (BMA).
- Expansion of Caval Ridge Mine (BMA).
- Expansion of South Walker Creek Mine (BMC, now Stanmore).
- Expansion of Daunia Mine (BMA).
- Isaac Downs Project (Stanmore).
- Isaac Plains Mine and Isaac Plains East Project (Stanmore).
- Olive Downs Project (Pembroke Resources).
- Star Project (QCoal).
- Geochemical Acid and Metalliferous Drainage (AMD) Risk Assessments at all of BHP Coal's Australian operations, including geochemical assessments underway for PRC Plans for all BHP Queensland coal operations.

The Geochemistry Assessment prepared by Terrenus (Dr Ian Swane) was also subject to a Technical Review by Dr. Alan Robertson at RGS Environmental Pty Ltd.

2.5 Terrestrial and Aquatic Ecology Investigations and Assessment

Brad Dreis (Principal Ecologist at E2M)
BEnvMgmt, MEIANZ, MESA.

Over 15 years' experience as an ecologist through Queensland, NSW, Northern Territory and South Australia:

- Recent projects include the Caval Ridge Mine, Grasstree Mine, Australian Pacific LNG Project, Granite Belt Irrigation Scheme and Carmichael Coal Mine.
- Provision of expert advice to court relating to ecological assessment and impacts in Assessment of Ecology Issues in the Matter of Conway v Origin and Malcolm Burke v Moreton Bay Regional Council & The Village at Redcliffe Pty Ltd & Department of Main Roads.
- Peer review of ecological assessments, ecological management plans and ecological impact assessments.

Lauren Thorburn (Principal Ecologist at Ecological Service Professionals Pty Ltd [ESP])
BSc (Ecology and Marine Biology), BSc (Hons).

Over 15 years' experience as an aquatic ecologist, including:

- Provision of expert evidence to the Planning and Environment Court relating to aquatic ecology (freshwater and marine).
- Preparation of aquatic ecology assessments for a variety of water resource projects, tourism projects and various coal mine developments and expansions including (but not limited to) the Baralaba South Project and the Poitrel, Caval Ridge, Saraji and Oaky Creek Mines.

3 SURFACE WATER REQUEST FOR INFORMATION

The following section have been prepared using information from the Revised Draft EIS (e.g. the Draft EIS, Additional Information and Response to Submissions) as well as other information prepared by the technical specialists and incorporated into the Water and Final Landform Addendum:

- Response to Submissions (March 2023):
  - Attachment 1 – Proposed Conditions and Commitments (Whitehaven WS, 2023).
  - Attachment 2 – Consolidated Project Description (Whitehaven WS, 2023).
  - Attachment 3 – Groundwater Responses (SLR, 2023).
  - Attachment 4 – Surface Water and Flooding Responses (WRM, 2023).
  - Attachment 5 – Aquatic Ecology Responses (ESP, 2023).
- Revised Draft EIS (November 2022):
  - Additional Information – Attachment 5 –Groundwater (SLR, 2022).
  - Additional Information – Attachment 6 –Surface Water and Flooding (WRM, 2022).
  - Additional Information – Attachment 7 –Offset Management Strategy (Whitehaven WS, 2022).
  - Additional Information – Attachment 9 –Aquatic Ecology and Stygofauna (ESP, 2022a).
  - Additional Information – Attachment 10 –Aquatic Ecology and Stygofauna Assessment Addendum (ESP, 2022b).
- Draft EIS (August 2021):
  - Appendix B – Appendix F – Geomorphology Technical Study (Fluvial Systems, 2020).
  - Appendix D – Terrestrial Ecology Assessment (E2M, 2021).
  - Appendix E – Aquatic Ecology and Stygofauna Assessment (ESP, 2021).
  - Appendix M – Geochemistry Assessment (Terrenus, 2021).

3.1 1. Inconsistencies with the surface water management system, including clean water diversions and overland flow capture

Information Request

1. Inconsistencies with the surface water management system, including clean water diversions and overland flow capture

It is not clear from the DEIS, RDEIS and additional information how the surface water management system, particularly clean water diversions and the capture of overland flow for use on site, will operate.

DEIS:

Section 2.4.11 (Site up-catchment water management infrastructure) of the DEIS project description states: A permanent up-catchment diversion system would be progressively constructed to divert up-catchment runoff around the advancing open cut. The diversion system would consist of a diversion dam of approximately 1,000 megalitres (ML) capacity, two temporary diversions (one located north of the mine access road, near the Railway Pit, which would be constructed initially and the other further downslope and constructed before operations commence in the Main Pit North) and a permanent eastern diversion. Both temporary diversions would run in an easterly direction and ultimately join a drainage line of the Isaac River.

Section 2.7 (water management) of the project description lists CWD 1 and 2 as proposed water storages, and shows CWD 1 on Figure 2-5.

The impoundments for CWD 1 and 2, and the diversion dam referred to in section 2.4.11 (if this is separate to CWD 1 and 2) are not shown on any figures or discussed further in the additional information, other than the inclusion of two linear 'clean water dam embankments' on figures 2-3 and 2-4 of the project description, and their associated spatial files submitted with the additional information.

Section 5.6.1 (Catchment runoff water management - clean water diversions) of DEIS Appendix B (surface water and flooding assessment (SWFA)) in the DEIS states: Two clean water dams would be constructed upstream of the Main Pit to prevent upslope catchment runoff entering the areas disturbed by mining and would include erosion and drainage controls as required. Upslope catchment runoff collected by the clean water dams would be pumped into the up-catchment diversions at a rate of 100 L/s allowing flow to the Isaac River. The clean water dams would be in place by Phase 3 and would be progressively decommissioned and removed as West Pit expands.

Clean Water Dams (CWD) 1 and 2 are shown in the DEIS SWFA on figures 5.3, 5.4 (proposed water management system) and Figure 6.2 (water management system schematic), and Table 6.5 where CWD 1 has a design storage volume (DSV) of 26ML and a total storage volume (TSV) of 523ML, and CWD has a DSV of 56ML and TSV of 1,121ML. CWD 1 and 2 will impound flows related to the unnamed central waterway.

Neither the aquatic ecology and stygofauna assessment nor the terrestrial ecology assessment describe how the diversions will be managed to minimise potential impacts to environmental values, other than brief references to erosion and sediment control measures.

The size and operation of the clean water dams was raised in a submission on the DEIS from DRDMW (DEIS issue 452.03). The submission noted that the dams proposed to capture overland flow had a maximum capacity greater than 50ML, and under section 110, 2(b) of the Water Plan (Fitzroy Basin) 2011 would require a water licence under the Water Act 2000.

RDEIS:

Section 5.6.1 of RDEIS Attachment 6 (SWFA) has removed reference to CWD 1 and 2 in text and figures and now states: Whitehaven WS may implement alternative clean water diversions over the life of the Project to divert water around active operations. This could potentially include diversions/embankments that are located further upslope than the indicative locations shown on Figure 5.1 to Figure 5.6 (within the proposed Project footprint) and/or clean water dams and associated pumping infrastructure.

March 2023 additional information:

Sections 2.4.11 and 2.7 of the updated project description still reference CWD 1 and 2, and figures 2-3 and 2-4 of the project description refer to two linear 'clean water dam embankments'. These embankments were also included in the spatial files submitted with the additional information.

Proposed condition F26 states: The environmental authority holder may take overland flow water to satisfy the requirements for the activities authorised under this environmental authority.

In response to DES issue 584.32 on the RDEIS, the following direction to the proponent was given: Provide a detailed description of the design and location of clean water management system (including waterway diversions) to ensure all relevant potential impacts are identified and adequately assessed.

Whitehaven's response to this issue referred to four dams in the MIA (in the context of another section of the direction to proponent around MAW storage capacities) and conditions F29 and F30 which relate to the water management plan. No further details of the clean water management systems are provided.

In response to DES issue 584.83 the following direction to the proponent was given: Provide a revised list of draft EA conditions and the required management approach that includes details of temporary and permanent disturbance of water flow paths/patterns, including levees, regulated structures and other water management infrastructures such as diversions. Provide maps at suitable scale for all locations.

Whitehaven's response to this issue referred again to proposed conditions F29 and F30 which relate to the water management plan, and Schedule I which relates to regulated structures. No further details of temporary and permanent disturbance of water flow paths/patterns or water management infrastructure have been provided in this response.

In submission issue 614.1 on the RDEIS, DRDMW strongly encouraged Whitehaven to contact them regarding the proposed CWDs and approvals under the Water Act 2000. OCG reiterates this advice and recommends Whitehaven contacts DRDMW to discuss any other approvals that may be required. OCG is happy to facilitate this discussion.

OCG notes that item 7.12 of the TOR requires the EIS to identify all government approvals required for the proposed project to proceed, and all approvals sought through the EIS process. The assessment and supporting information should be sufficient for the administering authority to decide whether an approval should be granted.

OCG also notes that items 10.14 and 10.16 of the TOR require the proponent to describe new infrastructure necessary for the project at all stages of its development. Item 10.19 of the TOR requires the proponent to describe the purpose of all dams or levees proposed on the site, and that their locations be shown on appropriately scaled maps.

A consolidated, consistent description of the surface water management system is required to understand potential impacts to environmental values.

Response

The proposed strategy for the management of surface water at the Project is based on the separation of water from different sources in consideration of predicted water quality. Clean water would be separated from the mine-affected and sediment water systems and allowed to pass to the downstream receiving environment. The clean water management system would comprise clean water drains and may include clean water dams, if required. No watercourse diversions are required or proposed for the Project. Although clean water drains have previously been referred to as clean water diversions, the terminology has been revised in this Water and Final Landform Addendum to consistently use "clean water drains" for clarity.

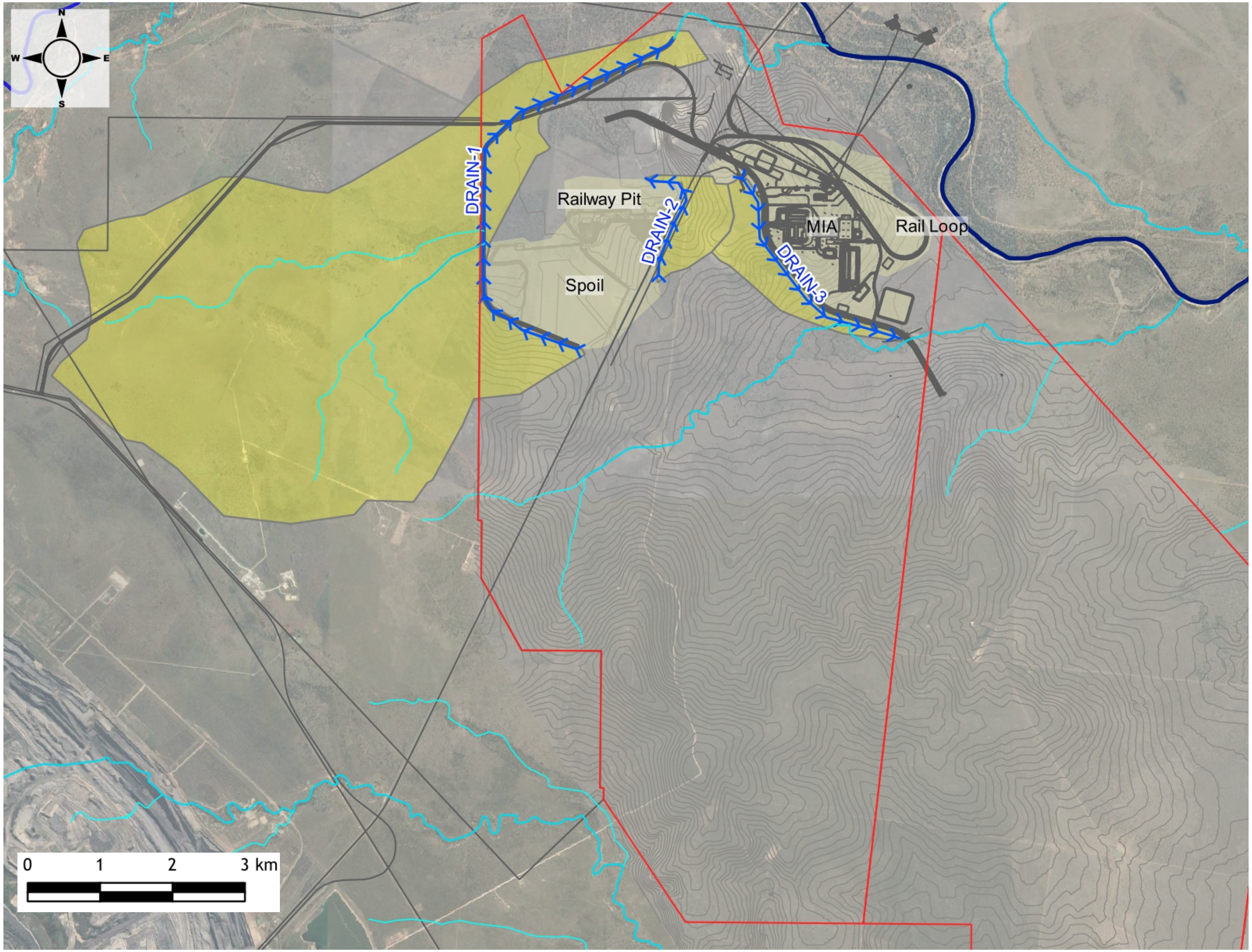
A series of up-catchment clean water drains are proposed to temporarily divert clean runoff water around the active mining areas. The indicative locations of the clean water drains for the various phases of the Project are shown on Figure 3-1A to Figure 3-1F. Diverting clean water around the mining areas has multiple benefits to operations and the receiving environment (compared with capturing all up-catchment runoff), namely:

- minimising the volume of runoff that enters the water management system for the Project, which minimises generation of mine-affected water; and
- minimising the catchment area excised during mining operations, thereby maximising the background flows into the receiving waters (i.e. local drainage features and ultimately the Isaac River).

The proposed design criteria for the clean water drains have been set to minimise the risk of overflows into the water management system and minimise the risk of scour and erosion within the drains during flow events. The configuration, alignment and geometry of the proposed clean water drains will be finalised as part of the detailed design process consistent with standard and best practice so that the water management design best reflects the detailed mine design. The adopted design criteria are as follows:

- 1% AEP design event discharge;
- batter slopes of 1 vertical to 3 horizontal (1V:3H);
- bed width of 10 metres (m); and
- scour protection at appropriate locations.

Alternative clean water management strategies and infrastructure may be implemented over the life of the Project to divert water around active operations. This could potentially include development of additional drains/embankments as required. Detailed design of water management infrastructure would be outlined in the Water Management Plan for the Project and updated over the life of the Project. As described above, the indicative locations of clean water drains are shown in Figure 3-1A to Figure 3-1F. The drainage pathways for the rehabilitated final landform are shown on Figure 3-1G.



LEGEND

- Project Mining Lease Boundary
- Infrastructure
- Diverted (Clean) Catchment
- Internally Draining Catchment
- Proposed Clean Water Drain
- Proposed Ground Contour (1 m)

Watercourses

- First Order
- Second Order
- Third Order
- Forth Order
- Fifth Order
- Sixth Order

Source: WRM (2023)

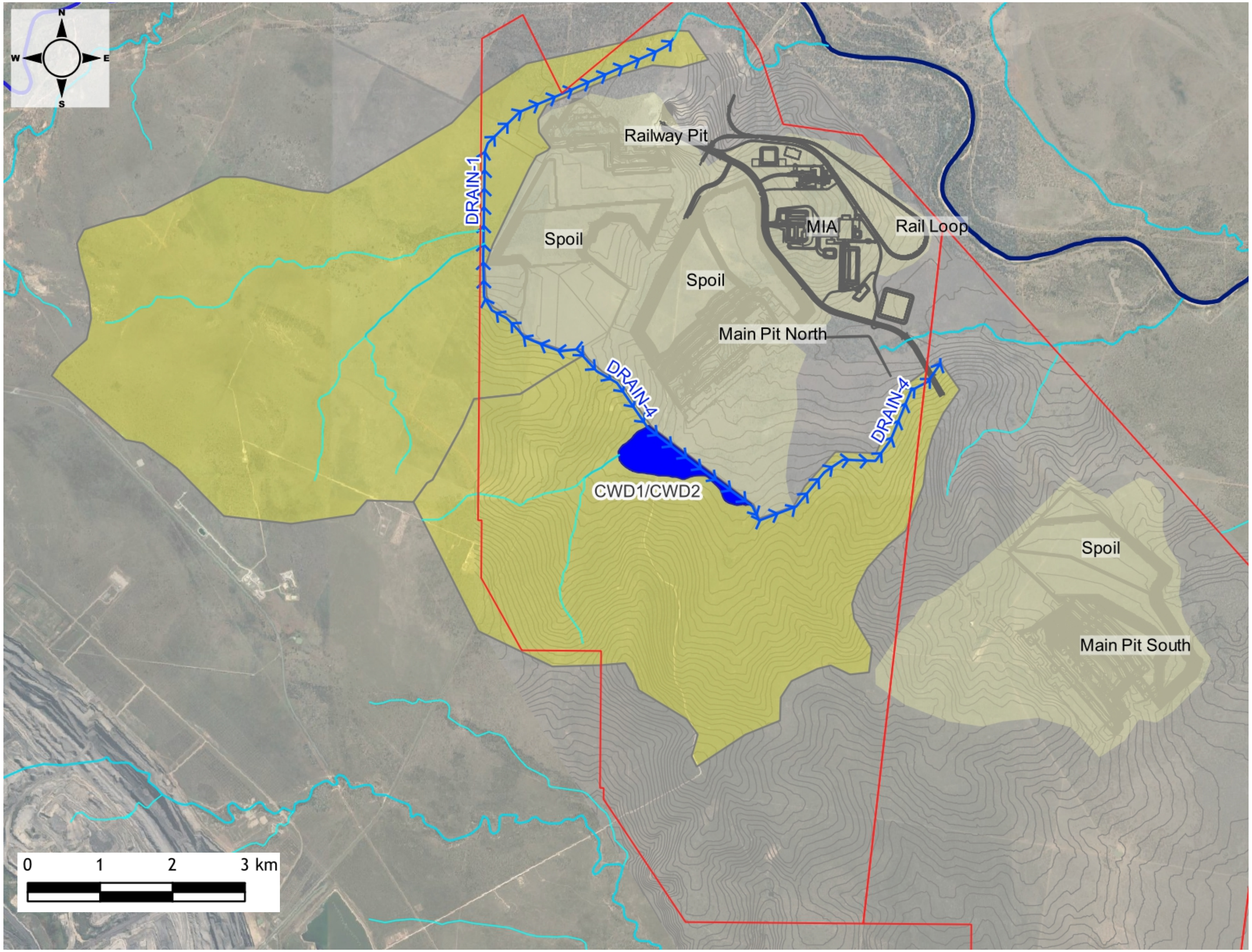
WHC-18-62_IR_002A

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Clean Water Infrastructure for the Project (Phase 1)

Figure 3-1A



LEGEND

- Project Mining Lease Boundary
- Infrastructure
- Diverted (Clean) Catchment
- Internally Draining Catchment
- Proposed Clean Water Drain
- Proposed Clean Water Dam (If Required)
- Proposed Ground Contour (1 m)

Watercourses

- First Order
- Second Order
- Third Order
- Forth Order
- Fifth Order
- Sixth Order

Source: WRM (2023)

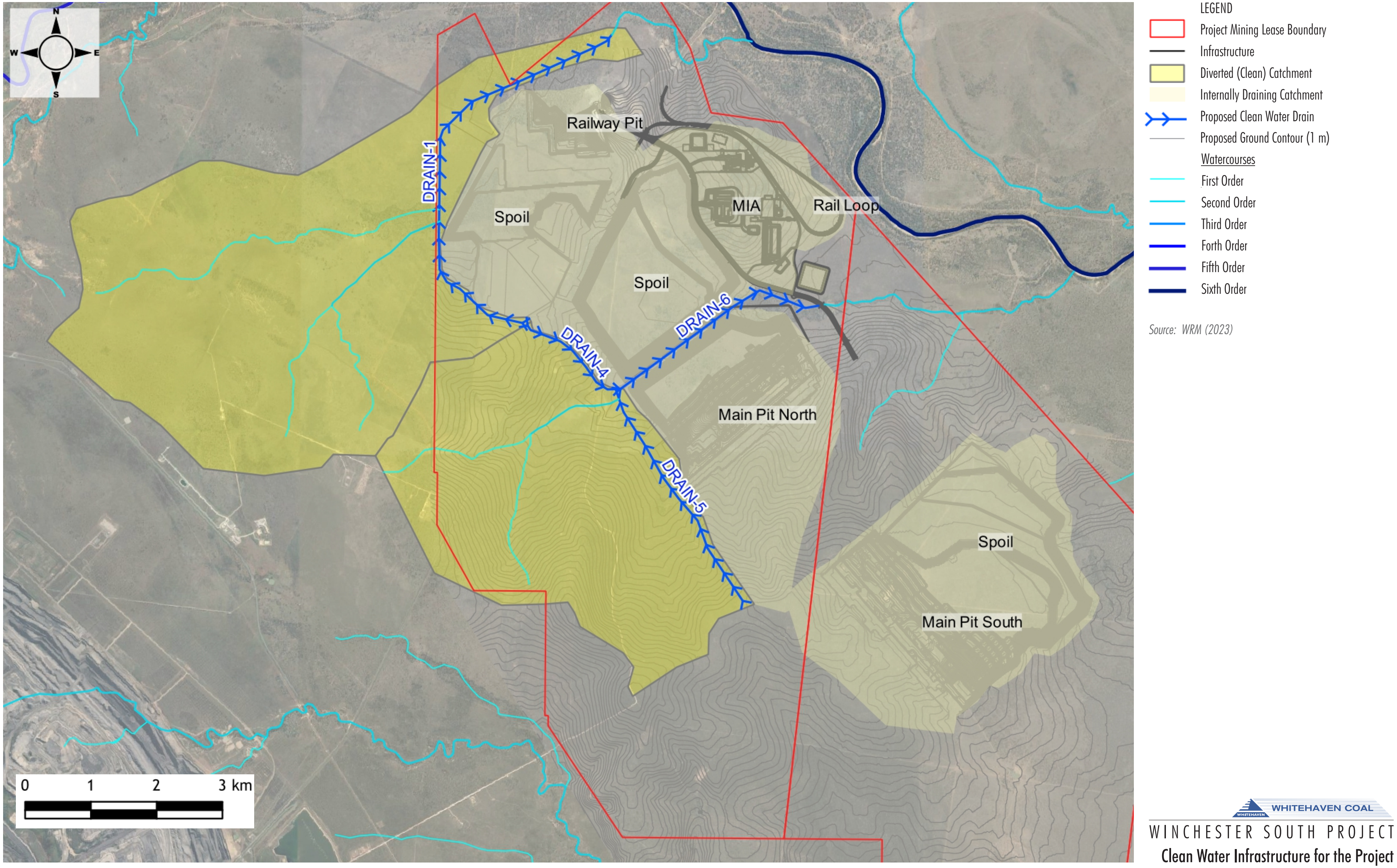
WHC-18-62_IR_003A

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Clean Water Infrastructure for the Project (Phase 2)

Figure 3-1B



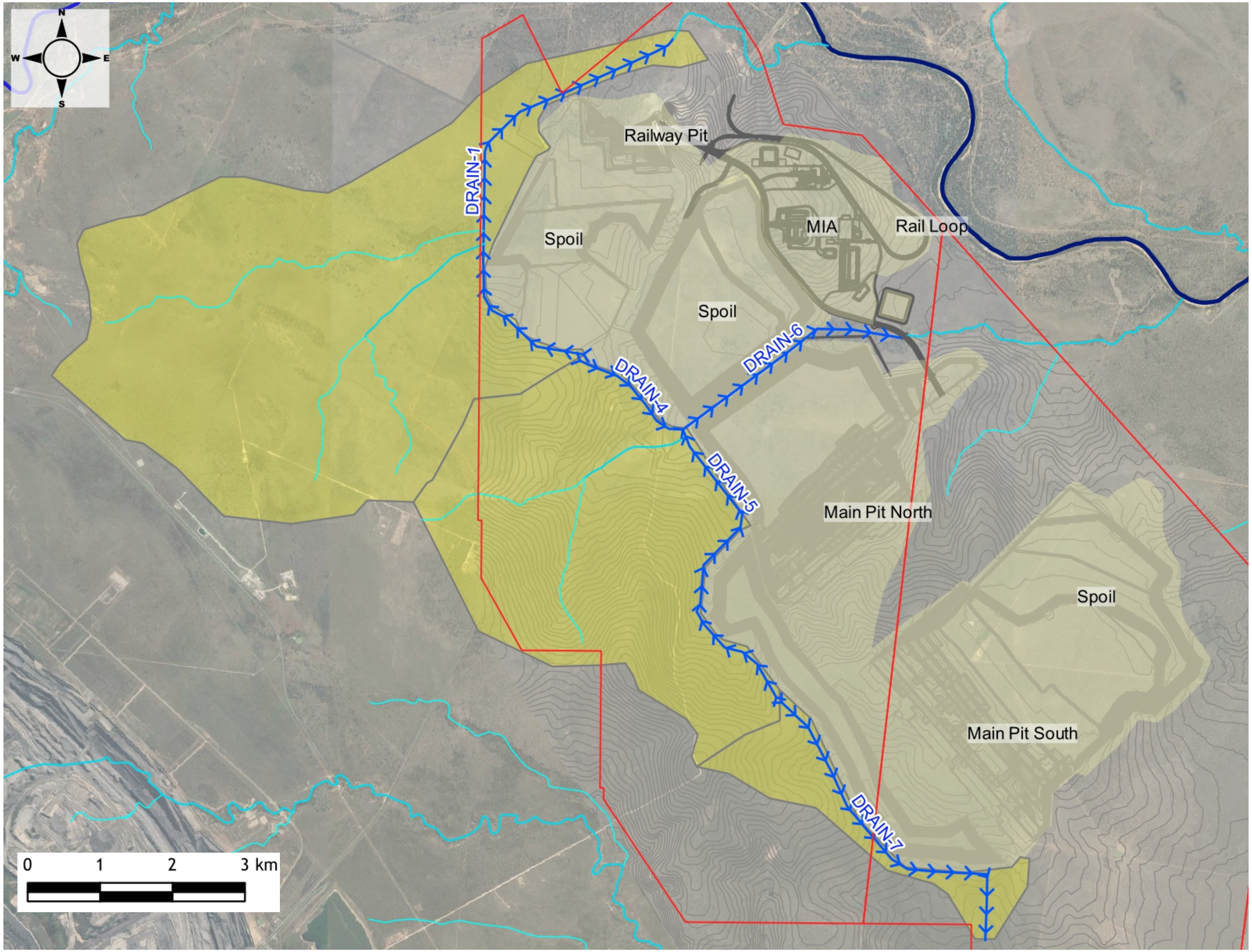
WHC-18-62_IR_004B

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Clean Water Infrastructure for the Project (Phase 3)

Figure 3-1C



WHC-18-62_IR_005A

LEGEND

- Project Mining Lease Boundary
- Infrastructure
- Diverted (Clean) Catchment
- Internally Draining Catchment
- Proposed Clean Water Drain
- Proposed Ground Contour (1 m)
- Watercourses
  - First Order
  - Second Order
  - Third Order
  - Forth Order
  - Fifth Order
  - Sixth Order

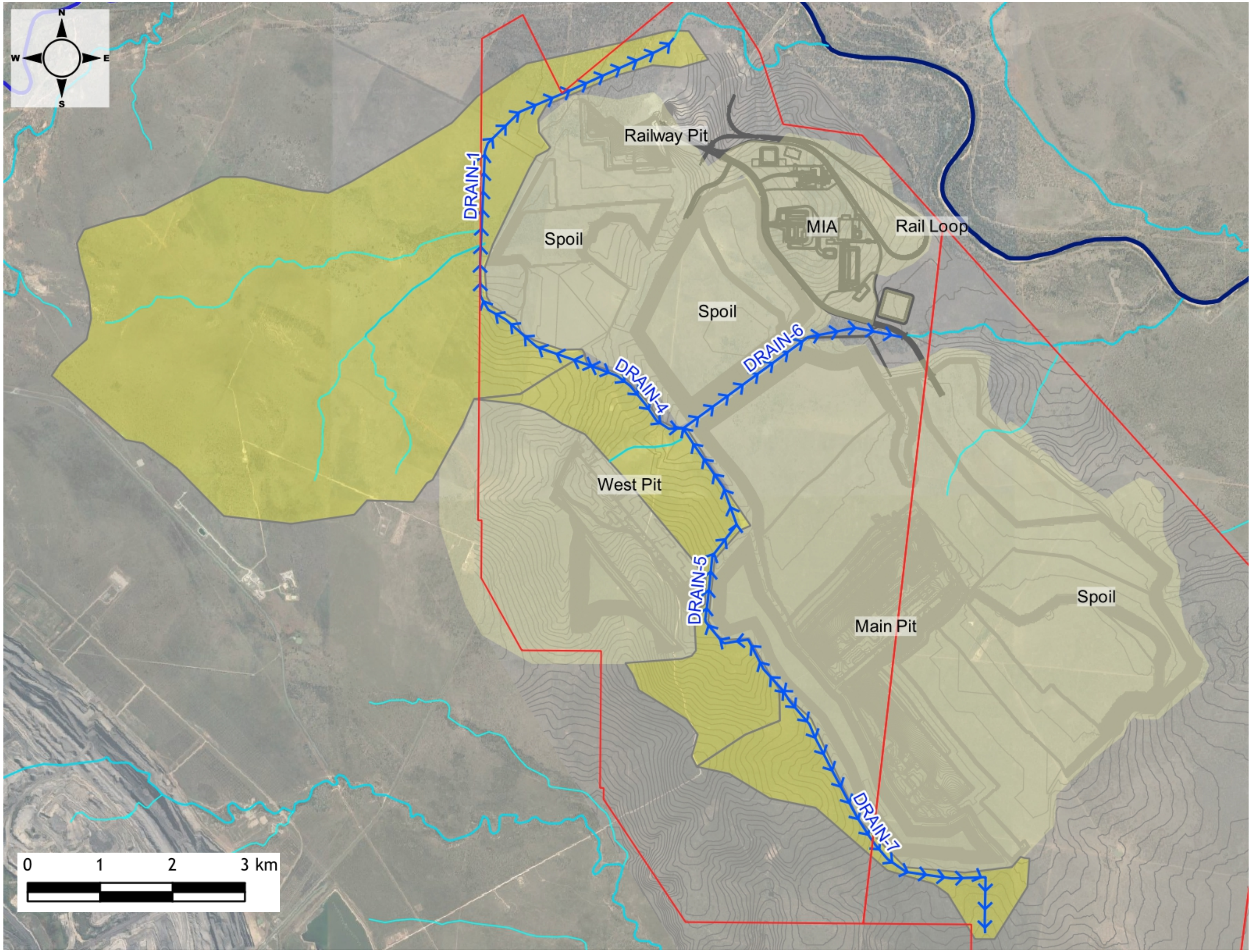
Source: WRM (2023)

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Clean Water Infrastructure for the Project (Phase 4)

Figure 3-1D



LEGEND

- Project Mining Lease Boundary
- Infrastructure
- Diverted (Clean) Catchment
- Internally Draining Catchment
- Proposed Clean Water Drain
- Proposed Ground Contour (1 m)

Watercourses

- First Order
- Second Order
- Third Order
- Forth Order
- Fifth Order
- Sixth Order

Source: WRM (2023)

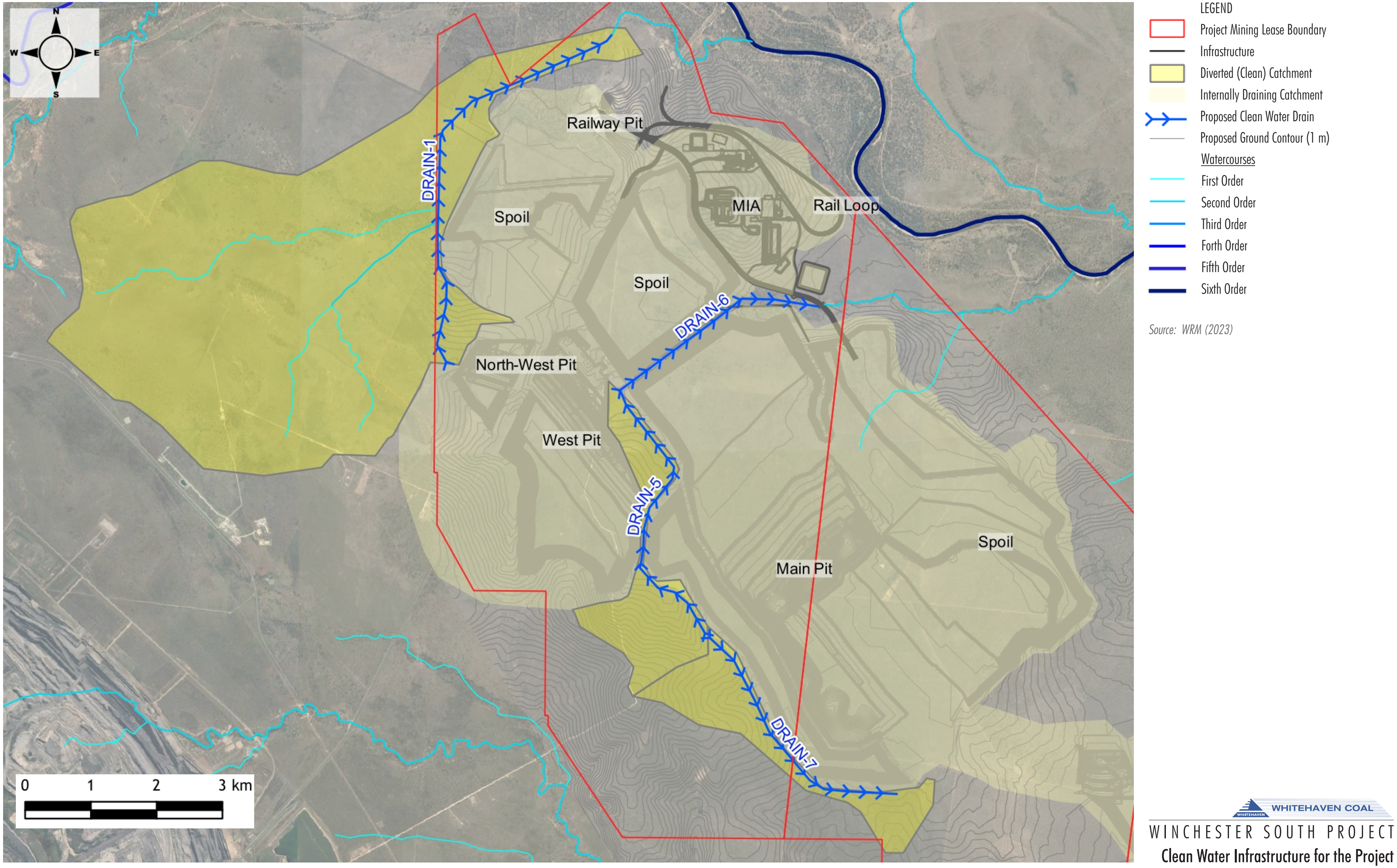
WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Clean Water Infrastructure for the Project (Phase 5)

WHC-18-62_IR_006A

Figure 3-1E



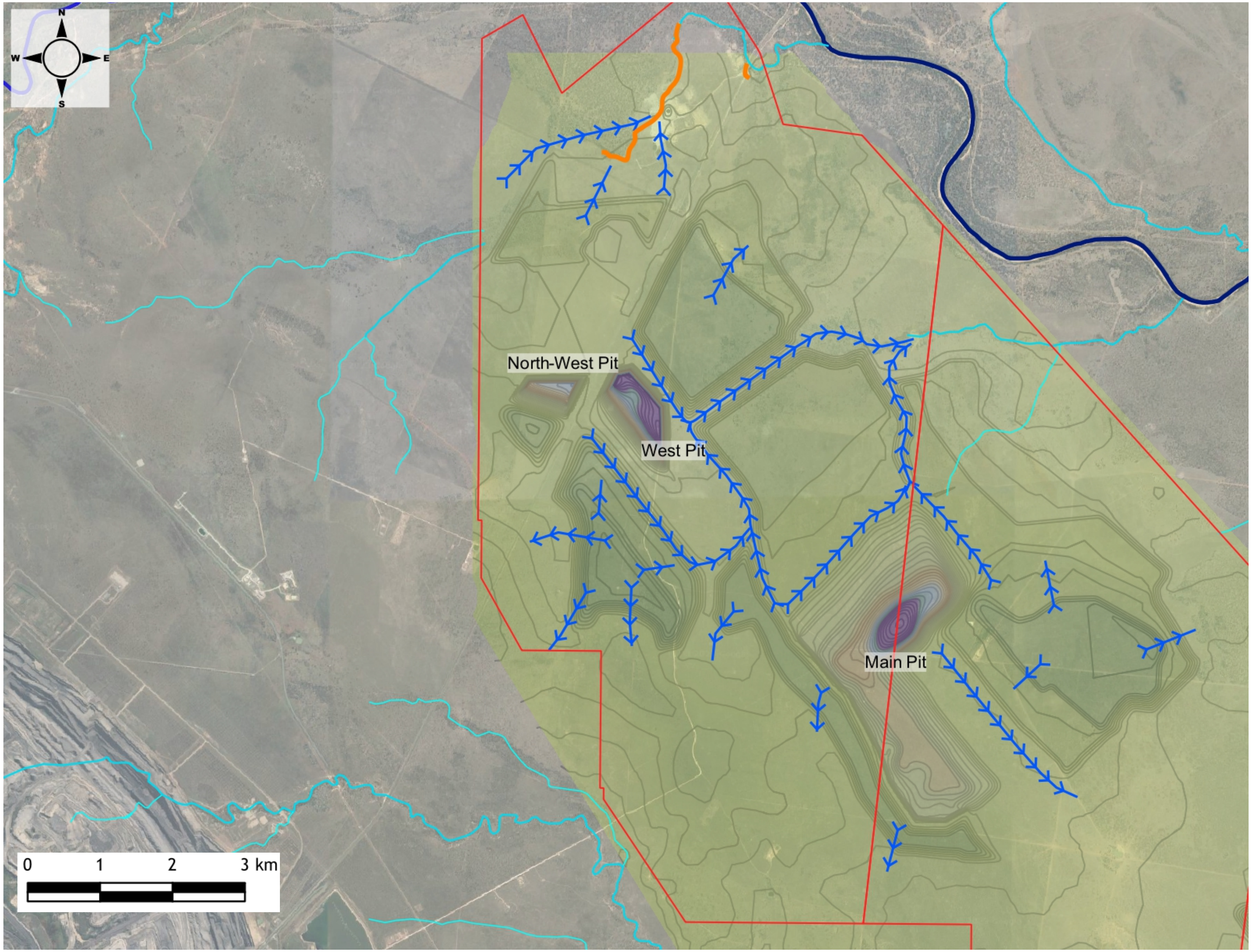
WHC-18-62_IR_007A

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Clean Water Infrastructure for the Project (Phase 6)

Figure 3-1F



LEGEND

Project Mining Lease Boundary

Reinstated Excised Portions of Watercourse

Drainage Flow Path

Proposed Ground Contour (1 m)

Watercourses

First Order

Second Order

Third Order

Forth Order

Fifth Order

Sixth Order

Source: WRM (2023)

WHC-18-62_IR_008B

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Clean Water Infrastructure for the Project (Final Landform)

Figure 3-1G

In addition to the clean water drains, clean water dams and associated pumping infrastructure may be required to successfully divert up-catchment runoff to the downstream receiving environment. The detailed design process will further investigate the need (or otherwise) for clean water dams to be included as part of the clean water management system. Whether the clean water dams would be necessary is a function of the topography along the proposed clean water drain alignment. If topography of the clean water catchment does not allow for only gravity-driven clean water drains, clean water dams may be required to temporarily capture and divert clean runoff around the mining activities. Clean water dams would generally comprise a downslope embankment which would act to retain clean water.

These clean water dams would be designed to capture runoff during rainfall events and then pump the clean water over any topographic feature until the topography allows for gravity to drain clean water towards the downstream receiving waters (i.e. Isaac River and associated tributaries). During operation, clean water dams would be dewatered as soon as practicable after filling, to a volume as low as practicable. Any temporary clean water drains/infrastructure would be required during Phase 2 and Phase 3 until the drainage path across the rehabilitated landform is suitably stable. Once the drainage path through the rehabilitated landform is established, clean up-catchment water would flow through the corridor (e.g. with no requirement for the clean water dams).

Upslope clean catchment runoff collected by the clean water dams would be pumped out at a rate of approximately 100 litres per second (L/s) allowing flow to the relevant tributaries and ultimately, the Isaac River. Pumping would prolong downstream flows and would be within natural variation. Therefore, it is unlikely that there would be any ecological impacts from the implementation of the clean water management system or from the retention of water or expected flow rates.

The design criteria for the clean water dams, if required, would be confirmed as part of the detailed design process for the Project. Preliminary design parameters of the clean water dams are provided in Table 3-1A.

Table 3-1A
Clean Water Dam Design Parameters

Dam Name	Dead Storage Volume Ranges (ML)	Total Storage Volume (ML)
Clean Water Dams 1/2	26 ML to 56 ML	523 ML to 1,121 ML

An overview of the proposed clean water management system is as follows:

- Project Year 1 to Project Year 6 (Phase 1) operations shown in Figure 3-1A:
  - A clean water drain (DRAIN-1) diverts clean runoff around the south and west of the Railway Pit.
  - A clean water drain (DRAIN-2) diverts clean runoff around the east of the Railway Pit mining area.
  - A clean water drain (DRAIN-3) diverts clean runoff around the south of the Mine Infrastructure Area.
- Project Year 7 to Project Year 11 (Phase 2) operations shown in Figure 3-1B:
  - DRAIN-1 remains, diverting clean runoff around the south and west of the Railway Pit.
  - DRAIN-2 is removed as part of mining activities.
  - A clean water drain (DRAIN-4) diverts clean runoff around the south and east of the Main Pit North.
  - DRAIN-3 is removed as part of mining activities.
  - A clean water dam (CWD1/CWD2) (if required) temporarily holds clean runoff diverted via DRAIN-4.

- Project Year 12 to Project Year 16 (Phase 3) operations shown in Figure 3-1C:
  - DRAIN-1 remains, diverting clean runoff around the south and west of the Railway Pit.
  - The upper section of DRAIN-4 remains, with the remainder removed as part of mining activities.
  - Two clean water drain (DRAIN-5 and DRAIN-6) divert clean runoff around the south of the Main Pit North and through the overburden dump corridor to the Isaac River tributary.
  - CWD1/CWD2 (if required) is removed as part of mining activities.
- Project Year 17 to Project Year 21 (Phase 4) operations shown in Figure 3-1D:
  - DRAIN-1 remains, diverting clean runoff around the south and west of the Railway Pit.
  - DRAIN-4, DRAIN-5 and DRAIN-6 remain, diverting runoff through the overburden dump corridor to the Isaac River tributary.
  - DRAIN-5 is extended to divert up-catchment runoff south of the out-of-pit emplacement.
  - A clean water (DRAIN-7) diverts clean runoff around the south of the out-of-pit emplacement, draining south towards a tributary of Ripstone Creek.
- Project Year 22 Project Year 26 (Phase 5) operations shown in Figure 3-1E:
  - DRAIN-1 remains, diverting clean runoff around the south and west of the Railway Pit.
  - DRAIN-4, DRAIN-5 and DRAIN-6 remain, diverting runoff through the overburden dump corridor to the Isaac River tributary.
  - DRAIN-7 remains, draining south towards a tributary of Ripstone Creek.
- Project Year 27 to Project Year 29 (Phase 6) operations shown in Figure 3-1F:
  - DRAIN-1 remains, diverting clean runoff around the south and west of the Railway Pit. It is extended south towards North-west Pit.
  - DRAIN-4 is removed as part of mining activities.
  - DRAIN-5 and DRAIN-6 remain, diverting runoff through the overburden dump corridor to the Isaac River tributary.
  - DRAIN-7 remains, draining south towards a tributary of Ripstone Creek.

Explicitly, Whitehaven WS would not take water from the Project clean water management system for use in the mining operations. Overland flow water collected from within the Project area (i.e. not clean water) may be used in accordance with the *Water Plan (Fitzroy Basin) 2011*. Overland flow water refers to rainfall and runoff water from within the Project area, and does not refer to diverted clean water. Section 110(2)(b) of the *Water Plan (Fitzroy Basin) 2011* refers to the allowable volumetric take of water rather than a volume of a storage dam. Importantly, an environmental authority will be issued under the *Environmental Protection Act 1994* for the Project (section 110(2)(d)(i) of the *Water Plan (Fitzroy Basin) 2011)*, and Whitehaven WS has assessed the impacts associated with the overland flow take as part of a grant of an environmental authority and <u>therefore a water licence would not be required for the Project and section 110(2)(b) does not apply</u>. The take of overland flow water is assessed in the Surface Water and Flooding Assessment prepared by WRM (2022). Section 110 of the *Water Plan (Fitzroy Basin) 2011* for reference below (relevant paragraphs **bolded**):

> ***(2) A person may only take overland flow water—***
> *(a) for stock or domestic purposes; or*
> *(b) for another purpose, if the works that allow the taking of overland flow water have a capacity of not more than the following—*
> *(i) for works located in the Downstream of Fitzroy Barrage subcatchment area—5ML;*
> *(ii) otherwise—50ML; or*
> *(c) under a water licence; or*
> ***(d) of not more than the volume necessary to satisfy the requirements of the following—***
> ***(i) an environmental authority issued under the Environmental Protection Act 1994.***

3.2 2. Lack of information on how waterway diversions will be managed to minimise potential impacts to environmental values

Information Request

> *2. Lack of information on how waterway diversions will be managed to minimise potential impacts to environmental values*
>
> *There is insufficient information in the DEIS, RDEIS and additional information on how waterway diversions will be managed to minimise potential impacts to environmental values.*
>
> *An inspection of waterways on site was conducted by representatives of OCG and DAF on 14 Feb 2023 to determine the capacity of waterways to provide fish passage. Following the site inspection, the following direction was given to the proponent (DAF, 2023): Where waterways cannot be avoided, any impacted waterways must be permanently diverted around the impact areas. Diversions must include 'natural like' meanders and waterway features such as pools, and natural vegetation with natural flow patterns and variation. Whitehaven has indicated in the additional information (Attachment 5 – Aquatic Ecology Reponses) that it will provide a financial offset for the waterways that provide fish passage, as well as reinstating a portion of the unnamed northern waterway. Clean water diversions are proposed to be constructed in a manner sympathetic to natural drainage features (i.e. waterways) in order to provide flows to offsite downstream waterways that provide fish passage.*
>
> *Without a detailed description of how waterway diversions will be managed for each stage of the project, and expected volumes of water that will pass through the proposed diversions (including potential losses as a result of harvesting of overland flow), it is difficult to understand the potential impacts on downstream environmental values including aquatic ecosystems, groundwater dependent ecosystems and the Wynette offset area.*
>
> *A thorough understanding of the water management strategy and water management system in relation to waterway diversions is required to determine whether proposed mitigation measures will adequately address environmental impacts. A reduction of surface water flows into the Wynette offset area could result in the offset failing to meet target objectives. Should this occur, DCCEEW has advised that the proponent would need to offset the original impacts as well as the lost gains from the Wynette offset area.*

Response

Determined Watercourses

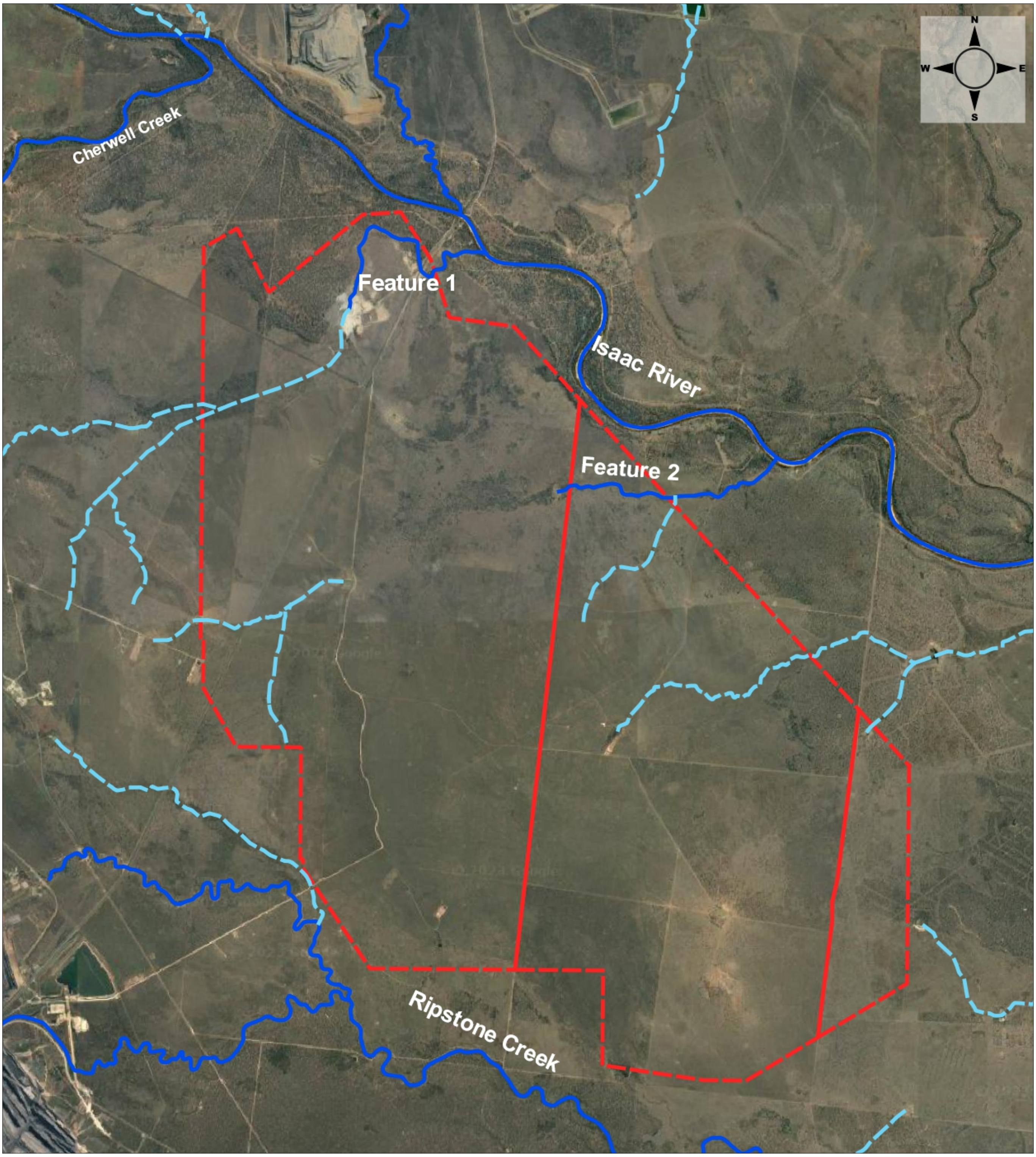
No watercourse diversions are proposed for the Project. Watercourse diversions are only required for ***determined watercourses***. There is only one watercourse within the Project area (i.e. the northern unnamed watercourse) that meets the definition of a watercourse in section 5 of the *Water Act, 2000*:

> *(1) A **watercourse** is a river, creek or other stream, including a stream in the form of an anabranch or a tributary, in which water flows permanently or intermittently, regardless of the frequency of flow events -*
> *(a) in a natural channel, whether artificially modified or not; or*
> *(b) in an artificial channel that has changed the course of the stream*
>
> *(2) A **watercourse** includes any of the following located in it –*
> *(a) in-stream islands;*
> *(b) benches;*
> *(c) bars.*
>
> *(3) However, a **watercourse** does not include a drainage feature*

The *Guideline: Works that interfere with water in a watercourse for a resource activity— watercourse diversions authorised under the Water Act 2000* (DNRME, 2019) states:

> *Permanent diversions - A permanent watercourse diversion should be designed and operated to ensure that it is stable, self-sustaining and does not impact on the adjoining **upstream and downstream reaches of the existing watercourse**.*
>
> *Temporary diversions - A temporary watercourse diversion should meet similar outcomes as required for permanent watercourse diversions, however, a temporary watercourse diversion is not expected to be self-sustaining or incorporate natural features typical of local watercourses.*

The northern unnamed watercourse does not extend upstream of the Project disturbance area and therefore there is no "watercourse" to divert and a watercourse diversion is not required. The central unnamed waterway within the Project area is not a determined watercourse and therefore does not require a watercourse diversion (Figure 3-2A). As described in the response to Item 1 of the Surface Water RFI (Section 3.1), a series of clean water drains will temporarily divert clean catchment runoff water around the active mining areas.



WHC-18-62_IR_009A

0 2 4 6 8 km

LEGEND
Mining Lease Application Boundary
Railway
Drainage Feature
Watercourse (Defined under the Water Act 2000)

Source: WRM (2023)

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT
Watercourses within the Project Area

Figure 3-2A

Catchment Excision and Streamflow

The Project water management system has been designed to temporarily divert up-catchment runoff around the active mining areas to the downstream receiving environment, with minimal impact on downstream environmental values. No watercourse diversions are required or proposed for the Project (Section 3.1), however clean water runoff will be directed around the Project area via a series of clean water drains (i.e. these are not watercourse diversions).

As discussed in the response to Item 1 of the Surface Water RFI (Section 3.1), the clean water management system may temporarily retain clean water runoff but downstream flows would be maintained within the natural variation, limiting the potential for environmental or ecological impacts. The clean water management water system would comprise clean water drains and may include clean water dams, if required. Whitehaven WS would not take water from the Project clean water management system for use in the mining operations. If water is retained in clean water dams, pumps would be used to move the water to gravity-driven drains and back into the natural downstream environment. Therefore, it is unlikely that there would be any ecological impacts from the implementation of the clean water management system from the temporary retention of water.

Catchment flows to the Isaac River and Ripstone Creek would be maintained over the life of the Project. Water captured on-site within the Project area (i.e. overland flow take), and the potential impacts associated with this take have been assessed in the Surface Water and Flooding Assessment (WRM, 2022) in consideration of the downstream environmental values. The maximum catchment areas of the Isaac River and Ripstone Creek excised by the Project represent between 0.2% and 1.0%, and up to 4.5% respectively. Given that areas managed under the Erosion and Sediment Control Plan (ESCP) would drain from the site, and the sediment dam catchments typically have higher runoff coefficients than under natural conditions, the loss of stream flows would likely be less than the total loss of catchment area (proportionally). On this basis, the loss of catchment flows in the Isaac River and Ripstone Creek would be indiscernible. Therefore, the potential impact on water quantity in the Isaac River and Ripstone Creek due to the excision of catchment was determined to be negligible.

The environmental and ecological values associated with the Wynette Offset Area are likely to be more reliant on the Isaac River due to proximity, compared to the central unnamed waterway, and therefore no impacts are expected at the Wynette Offset Area. Notwithstanding, Whitehaven WS would accept a condition requiring monitoring of the proposed Wynette Offset Area and, in the unlikely event that any Project-related impacts are identified (either direct or indirect), or if any predicted improvements in vegetation and habitat quality are not realised (e.g. from impacts from neighbouring projects), then additional offsets would be provided.

Waterways Providing for Fish Passage

The impact assessment for waterways providing for fish passage for the Project followed the *avoid*, *mitigate* and *offset* hierarchy. Whitehaven WS will offset the unavoidable impacts to waterways in accordance with the Financial Settlement Offset Calculation Methodology outlined in the *Queensland Environmental Offsets Policy (Version 1.11)*. These include impacts to the northern unnamed watercourse, the central unnamed waterway and the unmapped waterway identified as Waterway 3.

Offsets will be provided for impacts to the northern unnamed watercourse and central unnamed waterway. The design of the Project avoids the southern unnamed waterway and central unnamed waterway as assessed by ESP (2021). However, based on the Department of Agriculture and Fisheries (DAF) (2023) mapping of the waterways providing for fish passage, it is not possible to avoid the northern unnamed watercourse and central unnamed waterway due to the mine plan and infrastructure requirements.

Offsets will be provided for the unmapped waterway identified as 'Waterway 3' by DAF (2023). The design of the Project also avoids the downstream channel of 'Waterway 3', an unmapped waterway near the confluence with the Isaac River. ESP does not consider this unmapped feature to be a waterway providing for fish passage within the disturbance area as it does not have any identifiable channel. However, DAF (2023) mapped 'Waterway 3' as a waterway providing for fish passage, although the location mapped by DAF was not visited during the site inspection in February 2023.This waterway cannot be avoided by the Project due to overlap with key infrastructure components (e.g. Mine Access Road, Water Pipeline, electricity transmission line [ETL]).

As the Project design is unable to avoid impacts to the northern unnamed waterway, central unnamed waterway and Waterway 3 mapped by DAF (2023), Whitehaven WS committed to mitigating impacts by reinstating the northern waterway post-mining in the final landform and committed to re-establishing surface drainage that is sympathetic with the natural existing drainage features in a similar location to the central unnamed waterway in the final landform.

The clean water management system has been designed to redirect clean water flows from the upstream catchment around the proposed mining operations, as opposed to maintain fish passage. If water is retained in clean water dams, then pumping may result in a beneficial outcome of prolonging downstream flows within the natural variation of flow rate, with no impact to downstream users expected. The purpose of the clean water management system is to allow flow of upstream catchment to the downstream receiving environment, including the Isaac River and to the Wynette Offset Area via the existing undisturbed drainage paths along the central unnamed waterway. Therefore, the clean water management system is not permanent and is not designed for the provision of long-term fish passage.

Whitehaven WS has provided a proposed condition in Table H1 of Attachment 1 of the Response to Submissions (Whitehaven WS, 2023) providing performance objectives and indicators and completion criteria for the reinstated portions of the northern unnamed waterway for the post-mining final landform:

> *Rehabilitation Objective: Reinstatement of portions of the northern unnamed waterway.*
>
> *Performance Indicator: Reinstated portions of the northern unnamed waterway contain features similar to pre-existing conditions and would allow for fish passage.*
>
> *Completion Criteria: The reinstated portions of the northern unnamed waterway would provide for passage of fish and include the following features:*
>
> - *functionality and longevity of the riparian corridor, including revegetation and management of the riparian vegetation;*
> - *a waterway gradient of no more than 5%;*
> - *conditions within the waterway (depth and velocities) are suitable to provide adequate fish passage during 1, 2 and 5 year Average Recurrence Intervals (ARIs);*
> - *habitat and geomorphic features include material such as woody debris to create habitat diversity within the waterway; and*
> - *natural features such as pools and meanders, bed and bank profiles, and providing a mix of suitable substrate types.*

Prior to the reinstatement of the northern unnamed waterway in the post-mining final landform, Whitehaven WS would develop a fish passage monitoring program. The monitoring program would evaluate the effectiveness of fish passage within the reinstated northern waterway in the post-mining final landform. During the reinstatement works for the northern unnamed waterway, the monitoring program would include:

- site inspections to oversee the works and determine whether salvage is required; and
- fish salvage (if required, following visual inspection when it is evident that fish are trapped following recession of waters).

Following reinstatement of the northern unnamed waterway in the post-mining final landform, Whitehaven WS will also implement the following measures for the monitoring program to allow for data collection, during and immediately following rainfall events (i.e. when there is potential for fish passage):

- flow rate monitoring (as proposed by DAF) to assess the performance of the reinstated waterway in reducing flow velocities during flow events to allow for fish passage; and
- undertake fish habitat assessments to confirm there is adequate potential habitat (e.g. suitable flow types and shelter such as aquatic plants and woody debris) to allow for fish passage and fish habitat during periods of flow.

Whitehaven WS has also committed to fully offsetting all waterways providing for fish passage mapped by DAF (2023) that would be disturbed by the Project in accordance with the Financial Settlement Offset Calculation Methodology outlined in the *Queensland Environmental Offsets Policy (Version 1.11)* in consultation with DAF. A proposed condition to offset waterways providing for fish passage was included in Table H2 in Attachment 1 of the Response to Submissions.

3.3 3. Lack of information on how coal rejects and associated runoff will be managed to minimise potential impacts to environmental values (OWS 13, 15 and IESC 7, 23a, 24, 46)

Information Request

3. Lack of information on how coal rejects and associated runoff will be managed to minimise potential impacts to environmental values (OWS 13, 15, IESC 7, 23a, 24, 46)

Coal rejects will be disposed of in the out-of-pit waste rock emplacement for the Railway Pit in the first phase of the project. This has the potential to cause impacts to surface water and groundwater quality as a result of runoff and seepage.

In the additional information provided to OCG in March 2023, Whitehaven stated that the outcomes of the geochemical assessment indicate there is "no geochemical or scientific basis to require a different approach to the management of overburden runoff at the Project compared to other nearby recently approved projects". However, there are several key differences between the Winchester South project and other projects:

Other recently approved projects do not propose to dispose of coal rejects in out-of-pit waste rock emplacements.

*The **ratio of waste rock to coal rejects for Winchester is 11:1** compared to 56:1 for Olive Downs. This presents a different risk profile to other mines.*

33% of coal reject samples assessed in Appendix M of the DEIS (geochemistry assessment) are classed as PAF or uncertain, so there is a realistic risk of acid-forming runoff without implementation of management controls (which have not been provided in detail).

The salinity of waste rock at Winchester South (90th %ile = 1,102 µS/cm) is greater than at Olive Downs (90th %ile = 772 µS/cm) therefore the risk of saline runoff is increased. This is independent of the presence of coal rejects in the waste rock.

Neither OCG nor other agencies accept using release conditions from neighbouring mines unless robust evidence is provided that justifies why they should be applicable to the site-specific circumstances and conditions found at the proposed Winchester South mine with regard to geochemical characteristics, surface water and runoff parameters, potential impacts to environmental values and proposed mitigation measures.

In the additional information provided to OCG in March 2023, Whitehaven proposed a condition to prepare a waste management program that would describe the handling and disposal of coal reject material for the project, however this information is required at the assessment stage to fully understand the potential impacts of the project on environmental values.

Whitehaven stated in the responses to issues 584.56, 58, and 64 that it had committed to "co-disposed coal reject emplacement areas would be designed to be internally draining to the mine-affected water management system" however this commitment is not included in the proposed conditions and commitments.

In addition to the points above, the geochemistry assessment for the project only had one sample drill-hole from the Railway Pit (WS3155), and this only analysed waste rock (interburden), not coal. Coarse coal reject samples analysed for the geochemistry assessment were generated from a pilot plant process using samples from a range of drill-holes, however the location of these drill-holes is not provided and it is not clear if any were in the vicinity of the Railway Pit. Therefore, a full understanding of the geochemistry of coal rejects and potential impacts on environmental values is not possible from the available information.

OWS and IESC recommend that kinetic testing of coal rejects and waste rock be undertaken to understand the cumulative effects of mine material on groundwater resources over prolonged periods of time.

The proponent should provide further information on the geochemical nature of coal and/or coarse and fine coal rejects from the Railway Pit to fully understand potential impacts on surface water and groundwater resources as a result of disposal of coal rejects in out-of-pit waste rock emplacements.

Response

Terrenus (2023) has undertaken a re-evaluation of environmental geochemical data from potential coal reject from the Project and compared the data to environmental geochemical data for coal reject from neighbouring mines that mine and process coal from the Rangal Coal Measures. The re-assessment has found that:

- The geochemical characteristics of potential rejects samples obtained from the Project are consistent with the geochemical characteristics of actual rejects samples from neighbouring mines extracting and processing coal from the Rangal Coal Measures.
- Rejects from the Project, as a bulk material, have low sulfur and sulfide concentrations coupled with moderate to high acid neutralising capacity (ANC), which is mostly in a readily available form. As such, bulk rejects pose a low risk of developing acid drainage and a negligible risk of developing saline drainage from sulfide oxidation.
- Soluble multi-element results indicate that leachate from rejects from the Project is expected to contain low concentrations of soluble metals and metalloids, similar to rejects from neighbouring mines.

- Based on the results, rejects from the Project – as a bulk material – have a low potential to generate acid drainage (AD) and/or neutral and metalliferous drainage (NMD) and/or saline drainage (SD) (i.e. non-oxidative salinity from sulfide oxidation). A small proportion of rejects may have some potential to generate low-level AD and/or NMD (as discrete samples), however when mixed throughout bulk non-acid forming (NAF) material, the acid and metalliferous drainage (AMD) risk posed by what is expected to be a small proportion of rejects is low.

Reject material is expected to comprise approximately 5% of total mineral waste at the Project, with the overwhelming majority of mineral waste being mined waste rock (spoil). Item 3 of the Surface Water RFI references a waste rock to coal reject ratio of 11:1 (see **bolded** quote above for emphasis). This ratio is not within the Revised Draft EIS and the source is unclear (i.e. based on 5% of mineral waste comprising reject material, waste rock to coal ratio is 19:1).

Terrenus (2023) concluded that when placed amongst pH-neutral to alkaline NAF waste rock, rejects pose a low risk of environmental harm. Furthermore, Whitehaven WS has committed to direct any run-off and seepage from waste rock emplacement areas with co-disposal of coal reject material yet to be capped to the mine-affected water system as shown conceptually in Figure 3-3A, mitigating the potential for risks to the receiving environment.

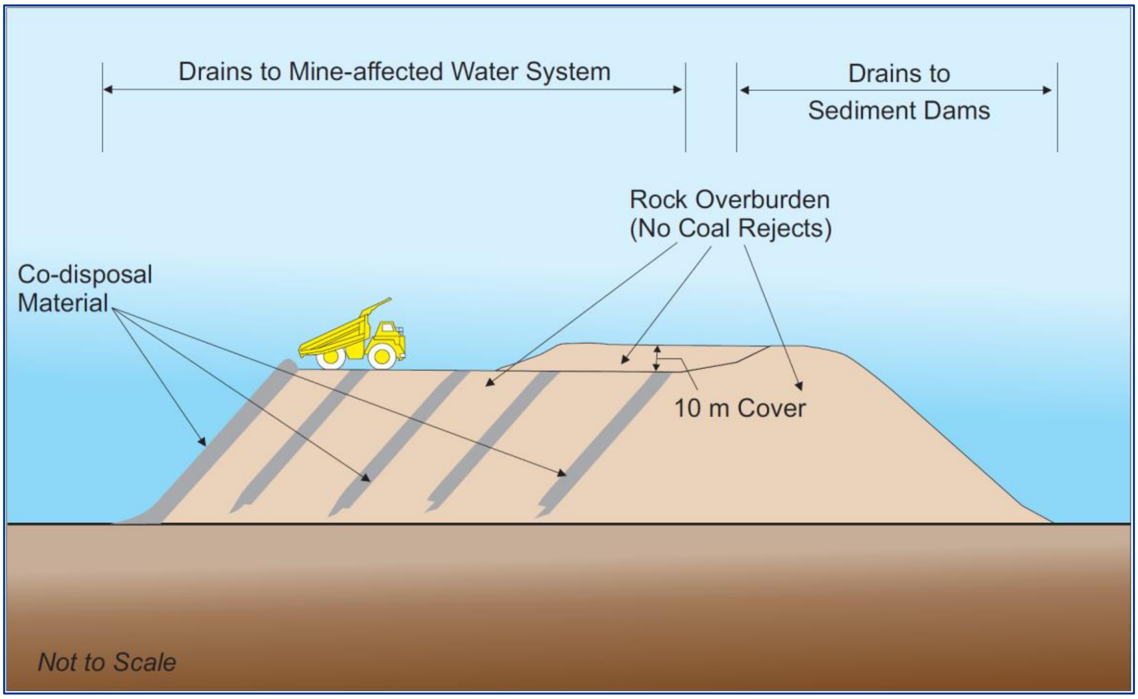


Figure 3-3A – Conceptual Diagram of Co-disposal Management Strategy for the Project

The mitigation and management measures adopted for the Project are consistent with a number of approved mining operations in the Bowen Basin that co-dispose coal rejects in out-of-pit waste rock emplacements when in-pit storage is not available, including the recently approved Olive Downs Project.

Item 3 of the Surface Water RFI included the following statement regarding the salinity of waste rock at the Project:

> *The salinity of waste rock at Winchester South (90th %ile = 1,102 µS/cm) is greater than at Olive Downs (90th %ile = 772 µS/cm) therefore the risk of saline runoff is increased. This is independent of the presence of coal rejects in the waste rock.*

Item 3 of the Surface Water RFI incorrectly references the salinity of 1,102 microSiemens per centimetre (µS/cm) used for modelling of **groundwater inflows** from the backfilled spoil to the residual voids (presented in Table 8.3 in Section 8.4 of the Surface Water and Flooding Assessment [Page 111]). Instead, Item 3 of the Surface Water RFI should refer to the **runoff salinities** for the backfilled spoil and rehabilitated landforms of 520 µS/cm and rehabilitated landform of 300 µS/cm (presented in Section 8.5 of the Surface Water and Flooding Assessment [Page 112]). Using the correct values, the salinity of waste rock runoff from the Project is lower than the modelled salinity of runoff from the waste rock at Olive Downs Project, therefore, the risk of saline runoff is lower.

Notwithstanding, Whitehaven WS has provided a range of commitments, including a commitment for the geochemical test work validation for coal reject from the coal handling and preparation plant (CHPP) to be undertaken during development of the Project. The test work would be undertaken during the first two years of CHPP operation and whenever new seams/plies are being processed. Test work will comprise a broad suite of environmental geochemical parameters, such as pH, electrical conductivity (EC), acid-base account parameters and total and soluble metals/metalloids. If the results of testing indicate that the coal rejects are high risk, then further measures will be implemented over the life of the Project.

In accordance with the DES' Model Mining Conditions, any water that comes into contact with coal or other carbonaceous material will be captured in the Project mine water management system. The water management system has been designed to align with leading practice objectives and principles for water management. The key principle is to achieve the **fullest separation possible of clean, sediment and mine-affected water** within the limits of operational requirements and local topography.

The mine-affected water system would store water pumped out of the open cut mining areas and collect runoff from the CHPP, coal stockpile area and waste rock emplacement areas with co-disposal of coal reject material. Mine-affected water systems comprises the Mine Water Dam, MIA Dam, CC Dam and ROM Dam, with incidental use of the open cut pits when required.

The results of the water balance modelling demonstrate that, under the current model assumptions and configuration, controlled releases of mine-affected water from the Project to the receiving environment would only be required under very wet climatic conditions (1%ile). A controlled release would only occur during an extreme rainfall event, that itself would generate significant volumes of runoff from the surrounding undisturbed catchment, as well as in the receiving waterways. Hence it is very unlikely that mine-affected dam-controlled releases will have a measurable impact on receiving water quality and therefore the environmental values. Sediment dams would also be sampled quarterly to monitor for potential contaminants reporting to these dams, until the area reporting to the sediment dam has been sufficiently rehabilitated.

With these mitigation and management measures, environmental risk from coal reject and associated runoff is expected to be low.

3.4 4. Proposed alternative approach to manage surface water runoff in sediment dams (IESC 7, 25, 26, 27, 39)

Information Request

4. Proposed alternative approach to manage surface water runoff in sediment dams (IESC 7, 25, 26, 27, 39)

Whitehaven's alternative surface water runoff strategy proposes that surface water and seepage run-off from mine disturbance areas (including waste rock and co-disposed coal-reject emplacements) would report to IECA type D sediment dams and releases would occur in an uncontrolled manner during a rain event greater than the design parameters. Mine water management systems typically direct this type of water to specified mine affected water storages.

OCG, OWS and DES note there is a potential significant risk of potential impacts to environmental values if the proposed EA conditions were implemented as drafted.

OCG can confirm that the definition of mine-affected water in the EA will be as per parts a) and b) of the Model mining conditions (DES 2017), not just part a) as proposed by Whitehaven.

Given an alternative water management approach is sought by the proponent, there are several updates required to demonstrate that risks to environmental values would be minimised in accordance with this definition:

On-site sediment dam monitoring should be conducted on a quarterly basis (as a minimum) and specified in the proposed EA conditions with:

- *Updated georeferenced location of the water storage monitoring points (currently proposed as 'dam wall' however coordinates provided are for the centre point of the water storage).*
- *The indicators to be monitored.*
- *Specified water quality trigger levels.*

Exceedances of any of these specified triggers should be conditioned in any draft EA to require pumping of this water to the internal mine affected water system where appropriate and effective management under controlled release conditions and associated monitoring are required.

The requested sediment dam water quality trigger levels specified in the draft EA are not acceptable to manage the potential risk, and in effect authorise releases of up to 10,000 µS/cm electrical conductivity and high sulphate levels in uncontrolled manner with no associated compliance requirements. Water quality trigger values for this water type must be designed to ensure that potential impacts from sediment dam overflows on downstream environmental values are appropriately managed.

OCG and DES advise that sediment dams which only receive run-off from verified and fully rehabilitated waste rock areas, or from verified minimally disturbed areas can be managed under appropriate sediment and erosion control plans. However, this does not include run-off and seepage from unrehabilitated waste rock emplacement areas.

OCG and DES can work with Whitehaven to refine proposed EA conditions to manage risks associated with surface water runoff in sediment dams.

Given the advice above, the site water balance for the project should be updated to include changes to surface water runoff management.

Response

The proposed water management strategy has been designed so that sediment-laden runoff water from the waste rock emplacement areas yet to be rehabilitated is captured and treated within the system of sediment dams. As described in the response to Item 3 of the Surface Water RFI (Section 3.3), and shown in Figure 3-3A, runoff and seepage from waste rock emplacement areas with co-disposal of coal reject material yet to be capped would be captured by the mine-affected water system and would not report to the sediment dams. The proposed water management system is consistent with the intent and definitions of the Model Mining Conditions.

The water management system has been designed in accordance with the intent and definitions of the Model Mining Conditions. Specifically, the design/operation of the sediment water system is consistent with Parts a) and b) of the Model Mining Conditions that provide the definition of mine-affected water, outlined below (emphasis added):

'mine affected water':

a) means the following types of water:

i) pit water, tailings dam water, processing plant water

ii) water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the Environmental Protection Regulation 2008 if it had not formed part of the mining activity

iii) rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, ***<u>excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage such runoff</u>****, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water*

iv) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated

v) groundwater from the mine's dewatering activities

vi) a mix of mine affected water (under any of paragraphs i)-v) and other water.

b) does not include surface water runoff which, to the extent that it has been in contact with areas disturbed by mining activities that have not yet been completely rehabilitated, has only been in contact with:

i) land that has been rehabilitated to a stable landform and either capped or revegetated in accordance with the acceptance criteria set out in the environmental authority but only still awaiting maintenance and monitoring of the rehabilitation over a specified period of time to demonstrate rehabilitation success, or

ii) land that has partially been rehabilitated and monitoring demonstrates the relevant part of the landform with which the water has been in contact does not cause environmental harm to waters or groundwater, for example:

a. areas that are been capped and have monitoring data demonstrating hazardous material adequately contained with the site

b. evidence provided through monitoring that the relevant surface water would have met the water quality parameters for mine affected water release limits in this environmental authority, if those parameters had been applicable to the surface water runoff, or

iii) both.

The inclusion of sediment-laden water into a broader definition of 'mine affected water' would have wide-reaching adverse environmental and industry outcomes and is inconsistent with the recommendations of the Queensland Floods Commission of Inquiry (2012).

The approach to the classification of water for the Project in the Surface Water and Flooding Assessment by WRM is consistent with the Model Mining Conditions and is also consistent with contemporary leading practice with the mining industry within the Bowen Basin (including all recent approved greenfield and brownfield operations). The approach (as detailed in Sections 5.2, 5.3 and 6.1 of the Surface Water and Flooding Assessment) classifies the different types of runoff according to their source and potential mixing with other types of water, as described in Table 3-4A. These classifications were included in the water balance modelling and were used to assess the potential impacts/risk to the environment, which were determined to be negligible.

The proposed sediment water management strategy for the Project is consistent with the definition of non-mine affected water as defined in Part a) iii) of the Model Mining Conditions. The sediment water management strategy is based on the capture of rainfall runoff from areas disturbed by mining activities that have not yet been rehabilitated, but the water will be managed through erosion and sediment control structures that will be installed in accordance with the standard and requirements of an ESCP. Water captured by the sediment water management system is not mixed with pit water, tailings dam water, processing plant water or workshop water. Therefore, water captured by the sediment water management system does not constitute mine-affected water.

Table 3-4A
Classification of Water Type and Management Strategy

Source	Water Type	Management Strategy
Rainfall runoff from undisturbed catchment	Clean water	Diverted around operations and temporarily captured in clean water dams and pumped to clean water drains. If runoff mixes with sediment-laden or mine-affected water, the runoff would report to sediment dams or the mine-affected water system, respectively.
Rainfall runoff from waste rock emplacement catchment	Sediment water	Runoff drains to erosion and sediment control structures (e.g. sediment dams). If rainfall event exceeds design criteria, then sediment dam may overflow to downstream receiving environment. Water within the sediment dams pumped back to mine-affected water system within 5 days of rainfall event to maintain design capacity for use. If runoff mixes with mine-affected water, the runoff would report to the mine-affected water system.
Rainfall runoff from cleared catchment	Sediment water	Runoff typically drains back to pit and managed within the mine-affected water system for use.
Rainfall runoff from rehabilitated catchment	Sediment water	Runoff drains to erosion and sediment control structures (e.g. sediment dams). If rainfall event exceeds design criteria, then sediment dam may overflow to receiving environment. Water within the sediment dams pumped back to mine-affected water system within 5 days of rainfall event to maintain design capacity for use. If water quality consistent with clean water (i.e. from undisturbed catchments), then sediment dams can be removed and runoff allowed reports to the downstream receiving environment.
Rainfall runoff from open cut pit	Mine-affected water	Runoff drains to mine-affected water system for use.
Rainfall runoff from hardstand	Mine-affected water	Runoff drains to mine-affected water system for use.
Rainfall runoff from coal contact	Mine-affected water	Runoff drains to mine-affected water system for use.
Groundwater inflows	Mine-affected water	Runoff drains to mine-affected water system for use.

Note: Runoff from co-disposed coal rejects material area within the waste rock emplacements would be classified as mine-affected water and would internally drain to the mine affected water management system.

The proposed sediment water management is consistent with the definition of what does not constitute mine-affected water as defined in Part b) of the Model Mining Conditions. Surface runoff from partially or fully rehabilitated land does not constitute mine-affected water. It does not in any way contradict or negate the classification of surface runoff from unrehabilitated waste rock emplacement areas as non-mine-affected water (as long as it is managed through an erosion and sediment control system).

The Surface Water and Flooding Assessment has been peer reviewed by Tony Marzalek, who was satisfied with the classification and management of the different runoff types. A direct quote from the peer review is provided below (within relevant comments bolded).

> *Through the peer review process I have made a number of requests for clarification and suggestions for modifications to the methodology and reporting.* ***The majority of these were resolved to my satisfaction. It is concluded that the assessment as it stands is sufficient and fit for purpose for the EIS, in terms of the assessment of surface water-related impacts, as it has:***
>
> - *adequately described the existing surface water environment in the vicinity of the Project, and the relevant environmental values;*
> - ***developed and described a proposed operational water management system and demonstrated through modelling that such a system is predicted to operate adequately under a range of climatic scenarios; and***
> - ***assessed the potential impacts on relevant environmental values due to the development of the Project.***

For sediment-laden water, a 'best practice' approach would be adopted for the design of erosion and sediment controls that is consistent with the International Erosion Control Association (IECA) recommendations.

The sediment dams have been sized and would be constructed in accordance with the guideline *Best Practice Erosion and Sediment Control* (IECA, 2018). These dams have been sized to capture inflows from the 85th percentile 5-day rainfall total and would be actively dewatered to recover the design capacity within 5 days of a design event occurring.

In rainfall events below the design standard of the sediment dams, runoff from disturbed areas would be captured and treated by sediment dams. In larger events that exceed the design standards, these dams would overflow. Temporary storage within the sediment dams prior to overflow would allow for settlement of sediment particles thereby reducing the sediment loads released downstream.

Available geochemical information indicates that the runoff draining to the sediment dams would have low to moderate salinity. Overflows would only occur during significant rainfall events which would also generate large volumes of runoff from surrounding undisturbed catchments. Therefore, it is unlikely that sediment dam overflows would have a measurable impact on receiving water quality or environmental values.

The Surface Water and Flooding Assessment for the Project included a comprehensive assessment of the potential impacts of sediment dam overflows, including modelling of the salinity of the sediment dam overflows and receiving Isaac River. WRM concluded the following which is represented in Figure 3-4A below:

The sediment dam overflow would have a negligible impact on the Isaac River quality with predicted increases of less than 7%.

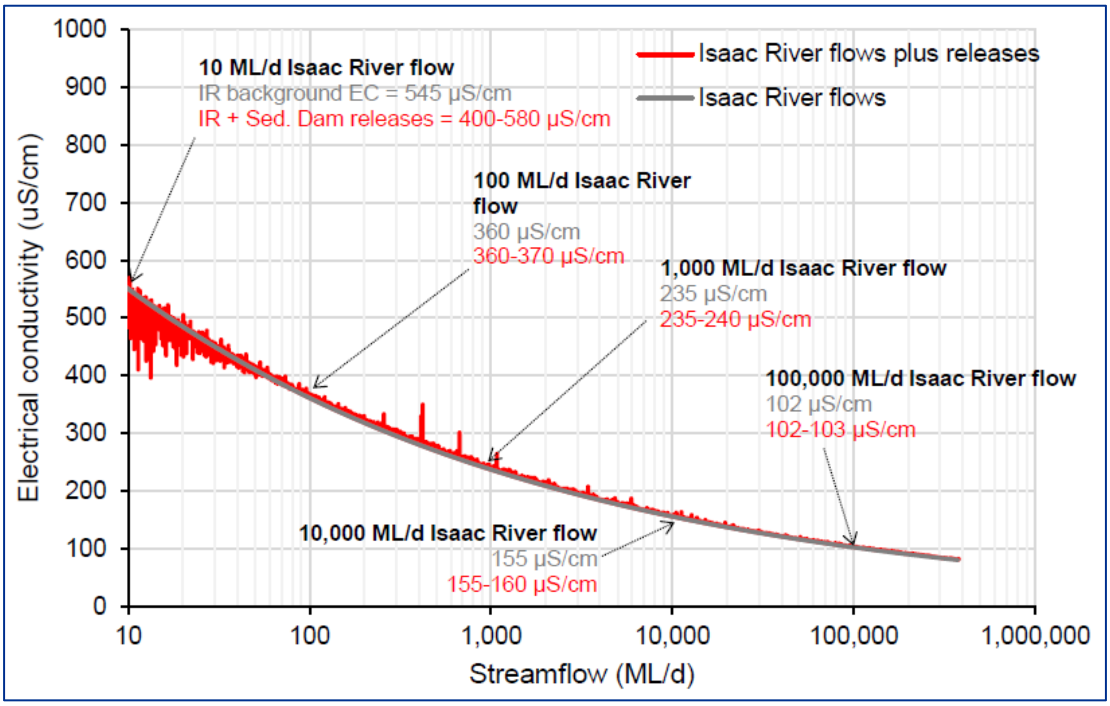


Figure 3-4A – Baseline Salinity of Isaac River (Black) and Predicted Salinity of Isaac River during Sediment Dam Overflows (Red)

Section 1.2 of *Reef discharge standards for industrial activities* (DES, 2022) states that:

> *The '2017 Scientific Consensus Statement: Land use impacts on Great Barrier Reef water quality and ecosystems' confirms that* ***poor water quality continues to be a significant issue for overall GBR health, with the main source of pollution being the cumulative nutrient and sediment run off from agricultural land use****, with local scale contributions from urban and industrial land uses.*

The pre-mining land use for the majority of the Project area is agricultural land use which, as noted in DES (2022), is a key source of pollution to the Great Barrier Reef through cumulative nutrient and sediment runoff. The proposed changes to the Project area land use would reduce the areas of agricultural activity.

During operations, significant areas of the Project area will be captured within the water management system, where it is either re-used within the mine water management system, or treated with the sediment water management system. The maximum catchment areas excised by the Project during operations represent:

- Up to 53 square kilometres (km^2) of the Isaac River catchment (to the Isaac River and Ripstone Creek confluence) compared to pre-mining conditions, that represents approximately 1% of the Isaac River catchment.
- Up to 13 km^2 of the Ripstone Creek catchment compared to pre-mining conditions, that represents approximately 4.5% of the Ripstone Creek catchment.

The post-mining final landform features significant areas of rehabilitated land (outside of the residual void waterbody areas), which are expected to generate similar water quality run-off as the pre-mining conditions. The change in the pre-mining topography by the proposed final landform would (e.g. catchment excision in perpetuity):

- Reduce the catchment draining to the Isaac River (to the Isaac River and Ripstone Creek confluence) by approximately 13.7 km^2 compared to pre-mining conditions, that represents less than 0.3% of the Isaac River catchment.
- Reduce the catchment draining to Ripstone Creek by approximately 4.3 km^2 compared to pre-mining conditions, that represents approximately 1.5% of the Ripstone Creek catchment.

As such, during operations and post-mining, the site is expected to generate similar or lesser amounts of nutrient and sediment runoff than under pre-mining conditions. Therefore, during both the operational and post-mining phases, the net impact on nutrient and sediment releases to the Isaac River (and subsequently the Great Barrier Reef) is expected to be less than under existing conditions.

Whitehaven has committed to undertaking a rigorous monitoring program to ensure that the quality of runoff from the overburden dump is consistent with expectations. Attachment 1 of the Response to Submissions described the frequency of monitoring and suite of parameters for the sediment dam monitoring would be reviewed and updated accordingly as part of the ESCP. Monitoring of sediment dams for the full suite of contaminants would continue until the area reporting to the sediment dam has been sufficiently rehabilitated. Proposed surface water EA conditions are commensurate or more stringent than conditions at other approved/existing operations in QLD, and include the following:

- comprehensive surface water quality and resource monitoring program, including monitoring of sediment dams to validate runoff water quality characteristics;
- sediment dams monitored quarterly, with water quality triggers and management actions;
- management actions if water quality triggers are exceeded, including, but not limited to, flocculation/coagulation and/or pump-back to the mine-affected water system;
- comprehensive site-specific triggers and investigation protocols for mine-affected water and receiving environment; and
- Whitehaven WS would investigate the source of any elevated contaminants and undertake remediation actions at the source to avoid impacts to the receiving environment (e.g. by dumping any material with geochemical complications in-pit or otherwise within the mine water management system).

Consistent with current design guidelines (IECA, 2018), the sediment dams would be dewatered within 5 days after a runoff event to provide free storage capacity of at least the settling zone volume. Trigger levels for contaminants (including EC, pH, sulphate, TSS, other major anions/cations and soluble metals/metalloids) have been specified in the proposed conditions in Attachment 1 of the Response to Submissions for releases from sediment dams to be adopted for the Environmental Authority for the Project. Where contaminant concentrations in sediment dams after a runoff event are less than the trigger levels specified in the Environmental Authority, sediment dams may be dewatered to the receiving environment. If water within the sediment dam exceeds any trigger level for contaminants, water in the sediments will be either:

- pumped into the mine-affected management system; or
- treated via flocculation prior to discharge from the sediment dam.

For rainfall events that exceed the design standard, the sediment dams would overflow to the receiving environment. Note, such overflows are likely to occur during large rainfall events when contaminant concentrations in the receiving environment are well below the trigger levels, due to significant dilution ratios, and therefore there would be low risk of impacts to the receiving environment.

Waste rock emplacement areas with co-disposal of coal reject material will be designed to be internally draining (surface and groundwater) to the mine affected water management system. There will be no flow paths that permit runoff or seepage from the waste rock emplacement areas with co-disposal of coal reject material to drain to the sediment dams.

3.5 5. Use of Isaac River flows to determine discharge rates of controlled releases of mine-affected water (OWS 15, 16 and IESC 7, 32, 33)

Information Request

5. Use of Isaac River flows to determine discharge rates of controlled releases of mine-affected water (OWS 15, 16, IESC 7, 32, 33)

Proposed controlled releases from RP1 and RP2 will discharge to an artificial channel that subsequently discharges to the unnamed central waterway at the edge of the mine disturbance area, and controlled releases from RP3 will discharge into the northern unnamed waterway. The combined discharge point into the unnamed central waterway is 2.2 km upstream of the Wynette offset area and 4.2 km upstream of the waterway's confluence with the Isaac River. Ecological habitat (aquatic and terrestrial) supported by the unnamed waterways and riparian connectivity of that habitat may be disproportionately significant for the species that rely on them due to the highly degraded nature of the surrounding landscape.

As detailed in table F4 of the proposed EA conditions, release rates for controlled releases of mine-affected water are contingent on flow rates in the Isaac River at Deverill Gauge, located downstream of the confluence of the northern and central unnamed waterways and the Isaac River.

The Isaac-Connors River catchment is a very large catchment, and if rains fall in sections of this catchment upstream of the proposed mine site, but not within the mine site specific tributary catchments - then Isaac River flow triggers may be reached with no natural flows occurring in the receiving waters of the unnamed northern and central waterways.

There is a need to take greater consideration of surface water impacts to the lower reaches of ephemeral creeks on site (prior to the confluence with the Isaac River). Not doing so may in turn lead to impacts on disproportionately significant riparian habitat, in-stream biota and the Wynette offset area downstream of the discharge points.

Controlled releases of mine affected water of up to 10,000 µS/cm Electrical Conductivity without sufficient near-field in-stream turbulence, mixing and flushing represents a significant risk of salinity stratification, and/or salinity contamination of these waterways and associated environmental values.

Additional surface water measurements (such as surface water flow data and standing water levels obtained for a minimum of two years) are needed to characterise baseline conditions for the three unnamed waterways present in the project area.

Site-specific discharge limits for controlled releases of mine-affected water should consider the water quality and flow regimes of the receiving waters of the northern and central unnamed waterways.

Response

Mine-affected water from the Project would be managed through a water management system which is designed to operate in accordance with typical EA conditions and the model water conditions. That is, it will have discharge conditions and in-stream trigger levels aligned with the water quality objectives in the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019*.

The water management system has been developed to minimise the risk of controlled releases being required to manage mine-affected water inventories on site. Controlled releases would only be required for the Project during very wet climatic conditions (1%ile). The proposed maximum release rate for the Project would maintain tributary flows within the range of predicted natural flow rates under pre-mining conditions and would therefore be unlikely to significantly impact stream geomorphology, as discussed below.

The potential impacts of the proposed controlled releases on the downstream tributaries were assessed in the Geomorphology Technical Study (Fluvial Systems, 2020) for the Draft EIS and the predicted overall geomorphic impact of the project would be relatively minor. The Geomorphology Technical Study was prepared by Dr Christopher Gippel and included a comprehensive review of the geomorphology of the tributaries downstream of the proposed controlled discharge points. The study described the proposed monitoring and management strategy for the tributaries, which would be undertaken using objective, scientifically sound methods, following a BACI (Before/After/Control/Intervention) design. Visual inspections would be undertaken following each controlled release event. A topographic survey (using LiDAR) would be undertaken if either of the following are observed:

- a channel exceeding 0.2 m deep for a length of 10 m or more; or
- initiation of a knickpoint higher than 0.3 m.

Appropriate mitigation measures would be applied in response to any observed geomorphic impacts. The appropriate mitigation would be assessed at the time and would range from doing nothing (self-sealing), to assisted recovery (e.g. plant vegetation and soft engineering such as coir matting and stakes), to hard engineering (e.g. rock rip-rap).

WRM undertook additional assessment of potential erosion/scour impacts of mine-affected water releases on the central unnamed tributary. Daily volumetric flow range was calculated for the downstream end of the central unnamed tributary for pre-mining conditions (catchment of 43.3 km^2) using the Australian Water Balance Model (AWBM) rainfall runoff model and over 133 years of climate data. The existing natural flow conditions (when flowing) in the central unnamed tributary are predicted between 1 ML/day to 5,940 ML/day, with a median flow volume of 165 megalitres per day (ML/day). The proposed maximum release rate for the Project is 432 ML/day (5 m^3/s) which **is well within the range of predicted natural flow rates under pre-mining conditions**, as shown in Figure 3-5A.

WRM developed a 1D hydraulic flood model of the unnamed tributary downstream of the Mine Water Dam release point using the HEC-RAS modelling platform to assess the predicted flow depths and velocities in the channel during release, shown in Figure 3-5B. The model predicts that, under maximum release conditions, the flow in the unnamed tributary would remain in-channel (depths of between 0.5 and 1.9 m) (Figure 3-5B), with typical velocities ranging between 0.4 and 0.8 metres per second (m/s) (Figure 3-5C). The predicted velocities are fairly low, and well within natural variation for the tributary. This assessment demonstrates that the hydraulic characteristics of the release flows are well within the typical range of flows within the unnamed tributary, and the discharges stay within the channel until the confluence with the Isaac River.

The proposed release conditions have been set to ensure that the impact of releases on the receiving environment are negligible due to the available dilution capacity within the Isaac River during releases. The water balance modelling predicts that controlled releases would only be required for the Project during very wet climatic conditions (1%ile) and therefore the 5% and 1% Annual Exceedance Probability (AEP) flood events for the Isaac River provide a general indication of the water levels that may be observed within the central unnamed waterway. Under these conditions the flows in the Isaac River would be high and have low salinity, i.e. high dilution capacity would be available, as predicted by the water balance modelling in the Surface Water and Flooding Assessment.

Two years of data has been collected along the central unnamed waterway from SW1 and SW2 (17 samples and 18 samples, respectively) and northern unnamed waterway from SW3 (19 samples) as provided in Attachment 4 of the Response to Submissions. Monitoring would continue for the duration of the Project and for at least the first two years of rehabilitation.

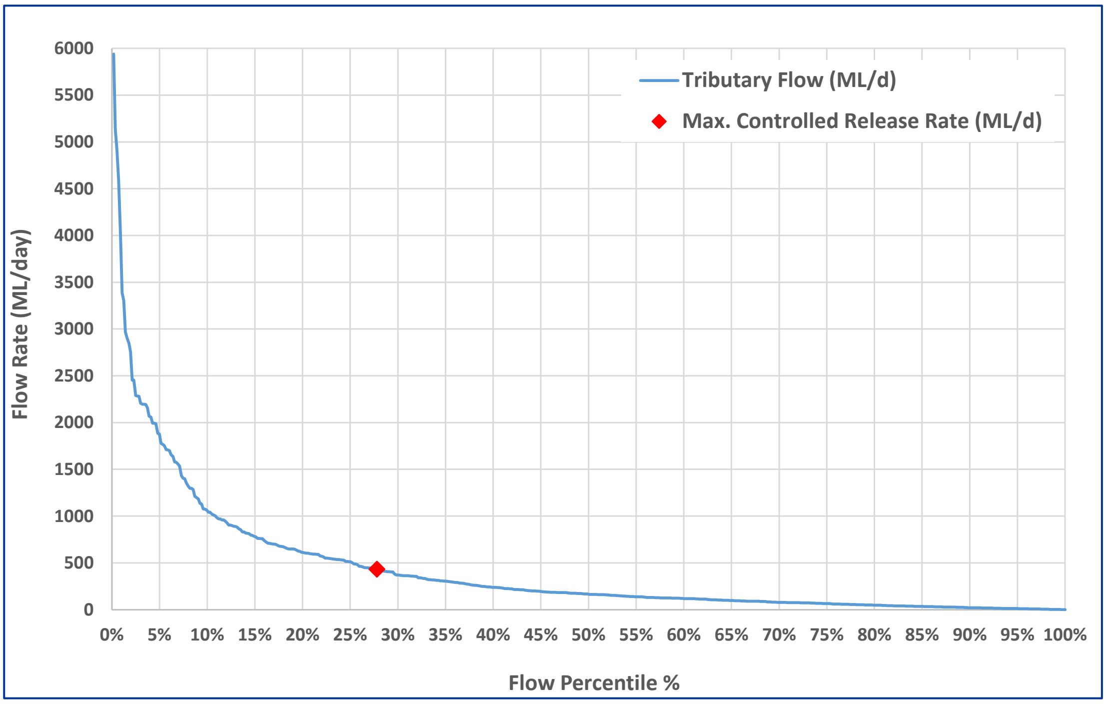


Figure 3-5A – Modelled Daily Flow Rates during Flow Events in the Central Unnamed Waterway

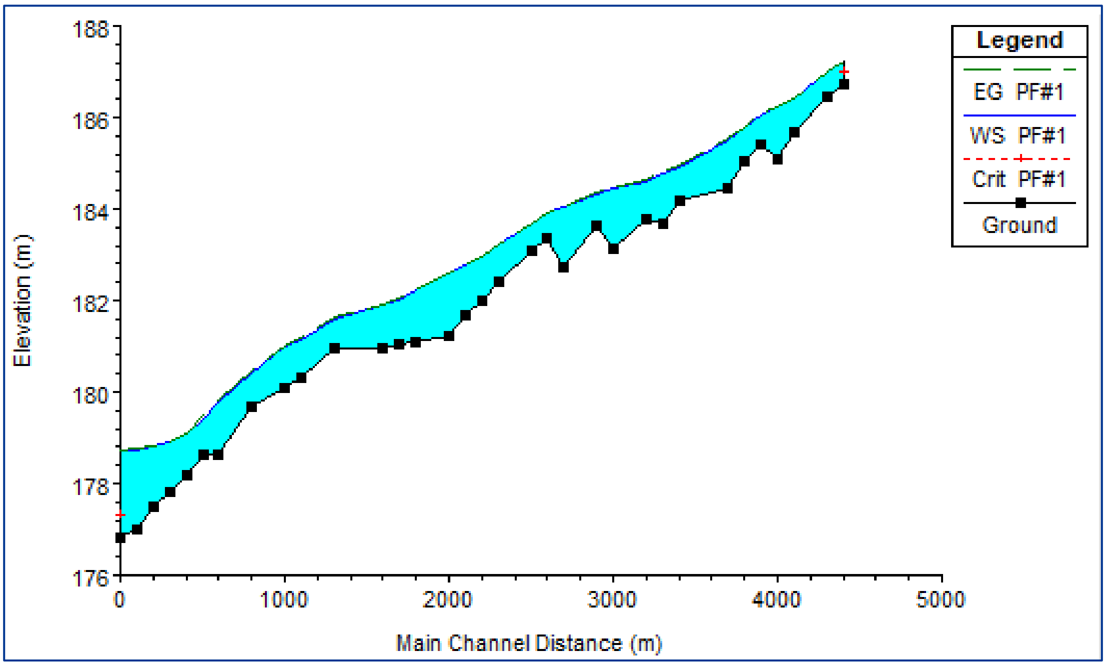


Figure 3-5B – Modelled Water Elevation in the Central Unnamed Waterway

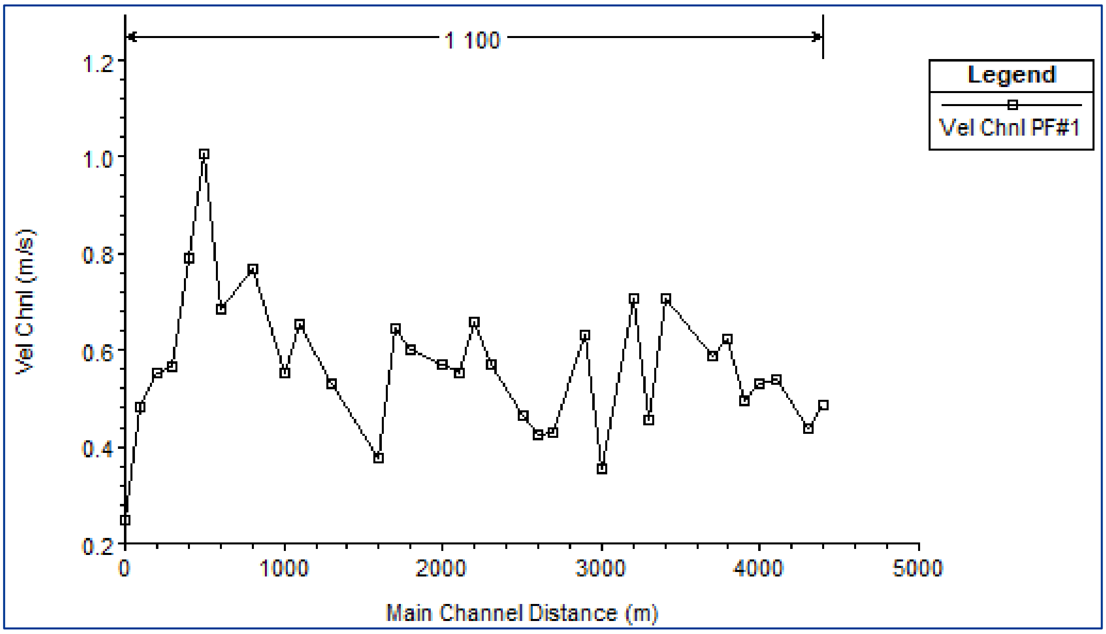


Figure 3-5C – Modelled Water Velocity in the Central Unnamed Waterway

3.6 6. Updated and consolidated impact assessment for controlled releases of mine-affected water

Information Request

> *6. Updated and consolidated impact assessment for controlled releases of mine-affected water*
>
> *Information provided to OCG in response to submissions on the RDEIS and in the meeting between OCG and Whitehaven on 3 May 2023 is key to understanding the potential impacts of controlled releases of mine-affected water on downstream environmental values.*
>
> *A consolidated impact assessment for controlled releases of mine-affected water is required to ensure mitigation measures and EA conditions aren't based on outdated or superseded information, and are adequate to mitigate the potential impacts.*
>
> *The impact assessment for controlled-releases of mine-affected water should be updated in consideration of:*
>
> - *Advice provided in points 4 and 5 above.*
> - *An updated site water balance.*
> - *Additional information presented to OCG on 3 May 2023, but not included in the RDEIS.*

Response

An assessment of the dilution ratio of controlled releases to Isaac River flow has been undertaken, where the dilution ratio is the daily volume of the Isaac River flow divided by the daily volume of controlled releases to the Isaac River. Figure 3-6A shows a ranked plot of the minimum modelled daily dilution ratio on release days, for all realisations. The results show that the minimum modelled dilution ratio that occurred from all release categories throughout all realisations is 407:1, with 50% of release days having a dilution ratio of at least 5,550:1. The model results demonstrate that controlled releases from the Project would have a negligible and unmeasurable impact on both flows and water quality within the Isaac River. Therefore, the dilution ratio is sufficient to have no significant impact on water quality in the Isaac River.

Figure 3-6B shows a ranked plot of modelled Isaac River salinity during controlled release events. It shows that, on controlled release days:

- the upstream Isaac River salinity ranges between 105 and 320 µS/cm;
- the controlled releases will have a negligible impact on the Isaac River salinity; and
- the mixed Isaac River salinity is well below the proposed receiving water salinity limits (1,000 µS/cm). The mixed salinity is also below the high flow WQO (250 µS/cm) on 95% of all controlled release days.

The modelling results show that the proposed controlled release strategy will have a negligible impact on downstream Isaac River water quality.

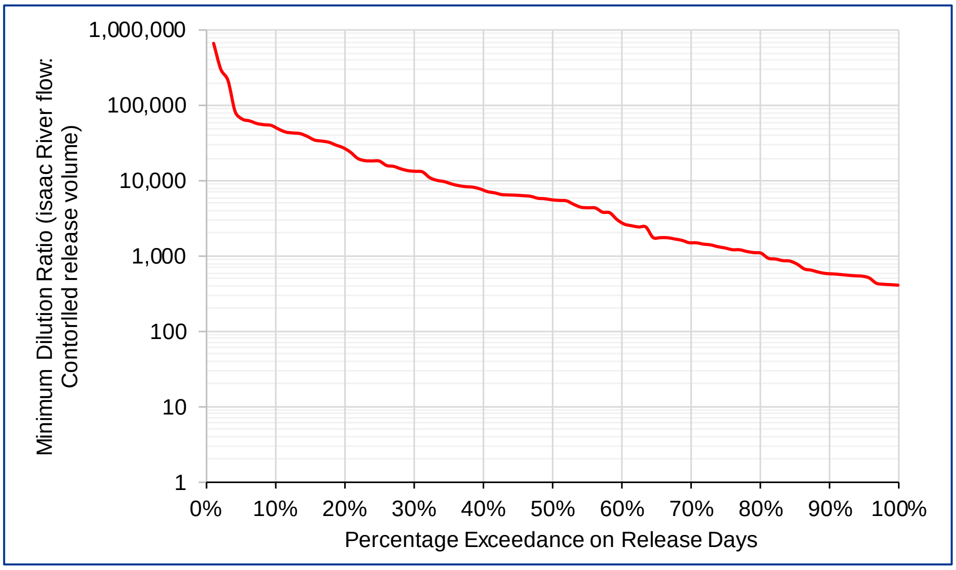


Figure 3-6A – Plot of Minimum Dilution Ratios on Days Requiring Mine-affected Release

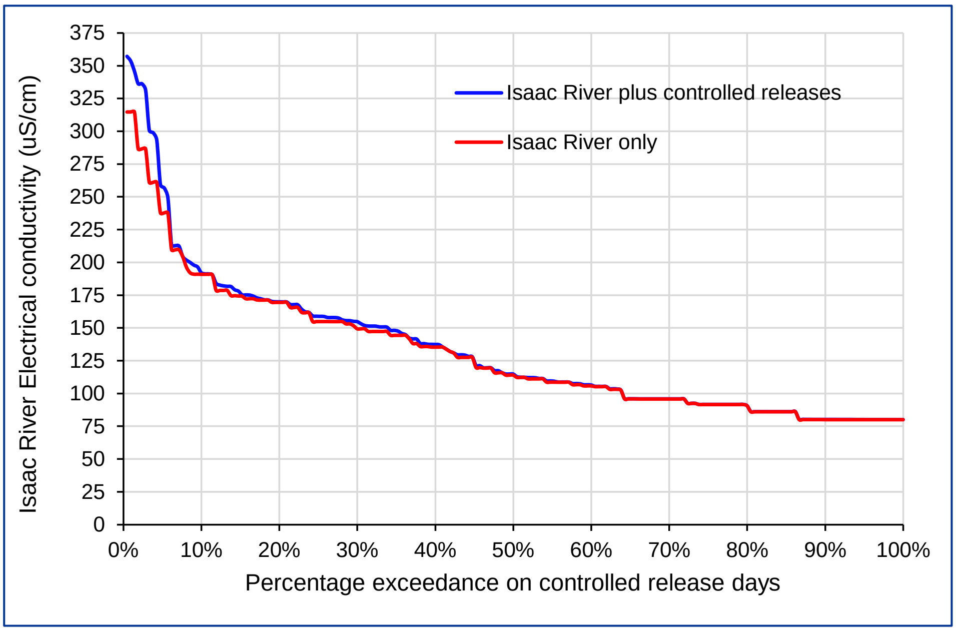


Figure 3-6B – Existing Salinity of Isaac River (Red) and Predicted Salinity of Isaac River during Controlled Releases (Blue)

To demonstrate the robustness of the proposed mine-affected water release conditions and receiving water triggers, an 'expected worst-case' cumulative scenario was prepared with coincident releases from neighbouring operations with similar release conditions (i.e. Olive Downs Mine and Isaac Downs Mine).

For this cumulative assessment, it is assumed that all three operations are releasing at their maximum flow rate and maximum contaminant concentration for the relevant release tier (Medium 1, High 1 etc).

The other nearby mining operations have not been included in this assessment as most nearby mine EAs do not include a volumetric limit on releases, making the volume of mine water (and hence contaminant load) that may be released in accordance with the respective approved EA conditions difficult to predict.

Cumulative Assessment of Electrical Conductivity

For the cumulative assessment of electrical conductivity, it was assumed that all three operations (the Project, Olive Downs Mine and Isaac Downs Mine) would be discharging at the same time, within the same release tiers. The outcomes from the assessment are provided in Table 3-6A. The results show that even with all three operations discharging simultaneously at their maximum release rates and EC concentrations (with each tier), the predicted downstream EC in the Isaac River is less than 800 µS/cm, which is well below the proposed downstream receiving trigger level of 1,000 µS/cm. The results demonstrate that there would still be significant capacity within the Isaac River to accommodate coincident releases from other mines that may discharge upstream of (or adjacent to) the Project.

The assessment is highly conservative, for the following reasons:

- It is unlikely that all three operations would be discharging at the same time, at the maximum of their flow rate and EC limits.
- The Project site water balance model predicts that there is only a 1% AEP probability that the water management system would require controlled releases, and these would only occur during high or very high flows in the Isaac River.
- The predicted EC within the mine-affected water storages at the Project is typically between 3,000 and 5,000 µS/cm, significantly less than the maximum allowable limit for the High 2 and Very High flow release tiers.

Table 3-6A
Mine-affected Water Releases - Cumulative Impact Assessment for Electrical Conductivity

Controlled Release Tier	Isaac River Upstream		Project Releases		Olive Downs Releases		Isaac Downs Releases		Predicted EC in Isaac River Downstream (µS/cm)
	Flow (m^3/s)	EC (µS/cm)	Rate (m^3/s)	EC (µS/cm)	Rate (m^3/s)	EC (µS/cm)	Rate (m^3/s)	EC (µS/cm)	
Medium 1	4	288	0.5	1,000	0.5	1,000	0.1	3,000	**784**
Medium 2	10	244	1.0	1,200	1.0	1,200	0.3	4,000	**729**
High 1	50	181	2.0	4,000	2.0	4,000	1.1	5,000	**762**
High 2	100	160	3.0	6,000	3.0	6,000	2.0	5,000	**761**
Very High	300	131	5.0	10,000	5.0	10,000	3.1	8,000	**681**

Cumulative Assessment of Sulphate

A similar assessment has been undertaken for sulphate (SO_4^{2-}). For the cumulative assessment of SO_4^{2-}, it was assumed that all three operations (the Project, Olive Downs Mine and Isaac Downs Mine) would be discharging at the same time, within the same release tiers. The outcomes from the assessment are provided in Table 3-6B. The results show that even with all three operations discharging simultaneously at their maximum release rates and SO_4^{2-} concentrations (with each tier), the predicted downstream SO_4^{2-} in the Isaac River is less than 150 milligrams per litre (mg/L), which is well below the proposed downstream receiving trigger level of 250 mg/L. The results demonstrate that there would still be significant capacity within the Isaac River to accommodate coincident releases from other mines that may discharge upstream of (or adjacent to) the Project. The water quality in the Isaac River is predicted to be less than proposed downstream receiving trigger level of 250 mg/L, and there would be significant capacity within the Isaac River to accommodate coincident releases from other mines that may discharge upstream of (or adjacent to) the Project.

The assessment is highly conservative, for the following reasons:

- It is unlikely that all three operations would be discharging at the same time, at the maximum of their flow rate and SO_4^{2-} limits.
- The Project site water balance model predicts that there is only a 1% AEP probability that the water management system will require controlled releases. These would only occur during high or very high flows in the Isaac River.

Table 3-6B
Mine-affected Water Releases - Cumulative Impact Assessment for Sulphate

Controlled Release Tier	Isaac River Upstream		Project Releases		Olive Downs Releases		Isaac Downs Releases		Predicted SO_4^{2-} in Isaac River Downstream (mg/L)
	Flow (m^3/s)	SO_4^{2-} (mg/L)	Rate (m^3/s)	SO_4^{2-} (mg/L)	Rate (m^3/s)	SO_4^{2-} (mg/L)	Rate (m^3/s)	SO_4^{2-} (mg/L)	
Medium 1	4	20	0.5	300	0.5	300	0.1	300	150
Medium 2	10	20	1.0	300	1.0	300	0.3	300	129
High 1	50	20	2.0	400	2.0	400	1.1	400	77
High 2	100	20	3.0	400	3.0	400	2.0	400	65
Very High	300	20	5.0	400	5.0	400	3.1	400	45

Proposed Monitoring and Conditions

The water management system has been designed to align with leading practice objectives and principles for water management. Proposed surface water EA conditions are commensurate or more stringent than conditions at other approved/existing operations in Queensland, and include the following:

- comprehensive surface water quality and resource monitoring program, including monitoring of mine-affected dams to validate water quality characteristics;
- mine-affected dams monitored quarterly, with water quality triggers and management actions;
- comprehensive site-specific triggers and investigation protocols for mine-affected water releases and receiving environment; and
- investigation and management actions if water quality triggers are exceeded.

3.7 7. Inadequacy of proposed management measures to minimise potential erosion risks (OWS 15, 22 and IESC 7, 25, 26, 27, 39, 40, 46)

Information Request

> *7. Inadequacy of proposed management measures to minimise potential erosion risks (OWS 15, 22, IESC 7, 25, 26, 27, 39, 40, 46)*
>
> *Draft EA condition F12 states: Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build-up of sediment in such waters.*
>
> *To comply with this condition, Whitehaven will need to prevent and avoid erosion taking place, rather than the BACI approach proposed which is to remediate erosion damage once it has happened.*
>
> *Given the disproportionately sensitive ecological values downstream of the discharge location (including the Wynette offset area) the proposed mitigation measures do not demonstrate that erosion and sedimentation risks and consequential downstream impacts will be adequately minimised.*

Response

As described in the response to Item 5 from the Surface Water RFI (Section 3.5) and presented at the meeting with OCG on 3 May 2023, additional assessment of potential erosion and scour impacts of mine-affected water releases on the central unnamed waterway was undertaken by WRM.

The proposed maximum release rate of 432 ML/day (5 m^3/s) is well within the range of natural flow rates of up to 5,940 ML/day (69 m^3/s) under pre-mining conditions. The one-dimensional hydraulic flood model demonstrated under maximum release conditions the flow in the central unnamed waterway would remain in-channel (depths of between 0.5 m and 1.9 m), with typical velocities ranging between 0.4 m/s and 0.8 m/s. Under these conditions, scour and erosion impacts to the bed and banks of this drainage path are not expected to be significant. However, additional measures to reduce scour and erosion risk have been developed to further minimise potential downstream impacts.

To manage scour and erosion risk from mine-affected water releases, Whitehaven WS would implement erosion and scour mitigation measures at the discharge points for the mine-affected water releases (i.e. end of pipe into natural drainage) and in the reach between the Mine Water Dam discharge location and the central unnamed waterway (Figure 3-7A). Mitigation measures at the discharge points would include (but are not limited to):

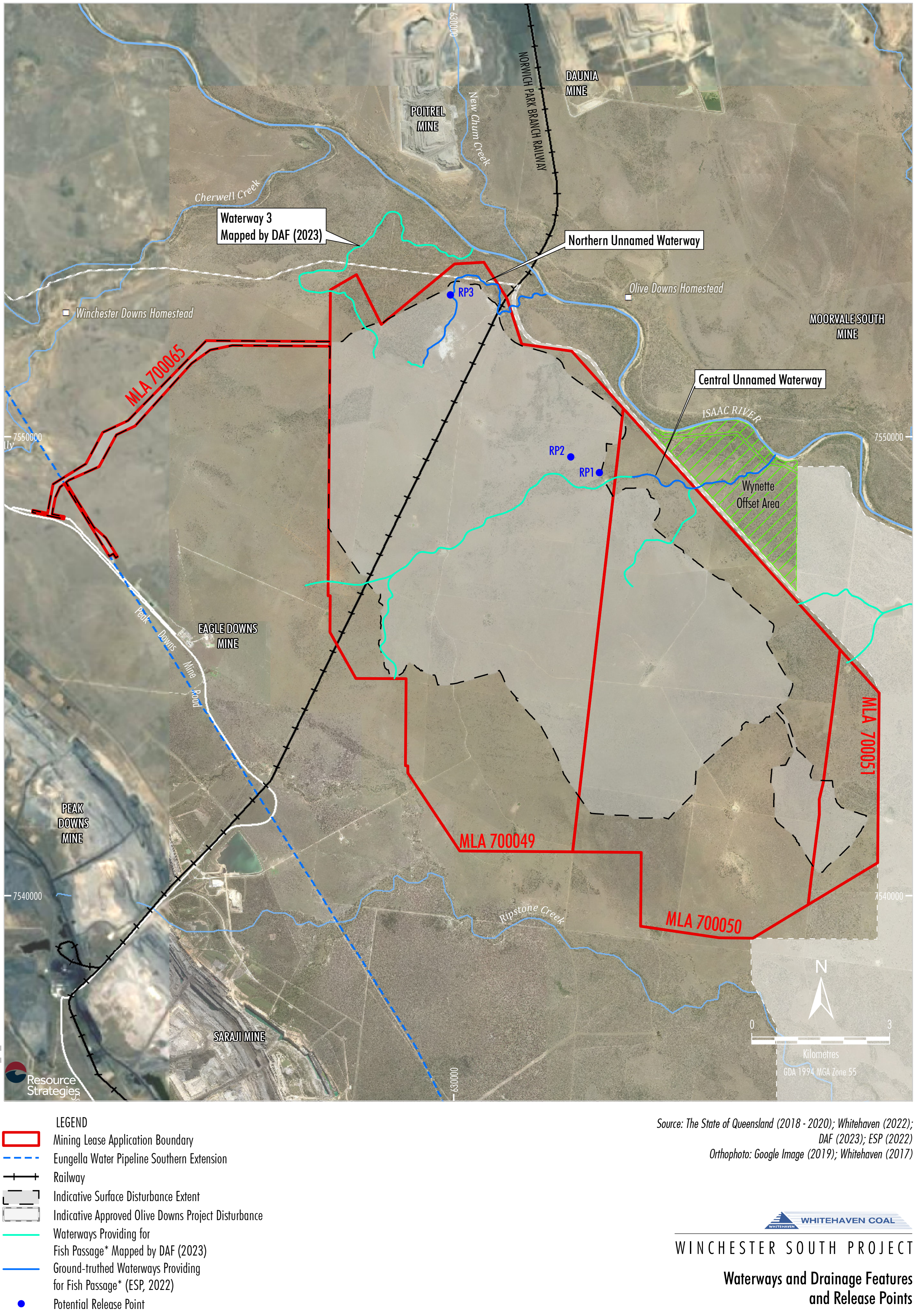
- planting vegetation;
- soft engineering (e.g. coir matting and stakes); and/or
- hard-engineering (e.g. rock riprap).

Potential options for scour protection in the reach between the Mine Water Dam discharge location and the central unnamed waterway include (not are not limited to):

- rock armouring (i.e. rock riprap);
- rock mattresses;
- cellular containment system; and
- grass lining.

Examples of erosion and scour mitigation measures commonly used by mining operations in the Bowen Basin for mine-affected water releases and sediment dam overflows are shown in Plates 3-7A and 3-7B. Indicative designs for the mine-affected water dam and sediment dam spillways for the Project are shown in Figure 3-7B.

Velocity control in a channel can also be achieved through techniques such as rock-check dams, sandbag check dams and fibre rolls. Appropriate scour protection measures would be determined during detailed design of the Mine Water Dam and the spillway. The proposed release rates and additional scour and erosion mitigation measures are expected to prevent erosion and adequately minimise risk of downstream impacts from the release of mine-affected waters.



** As defined under the Fisheries Act 1994*

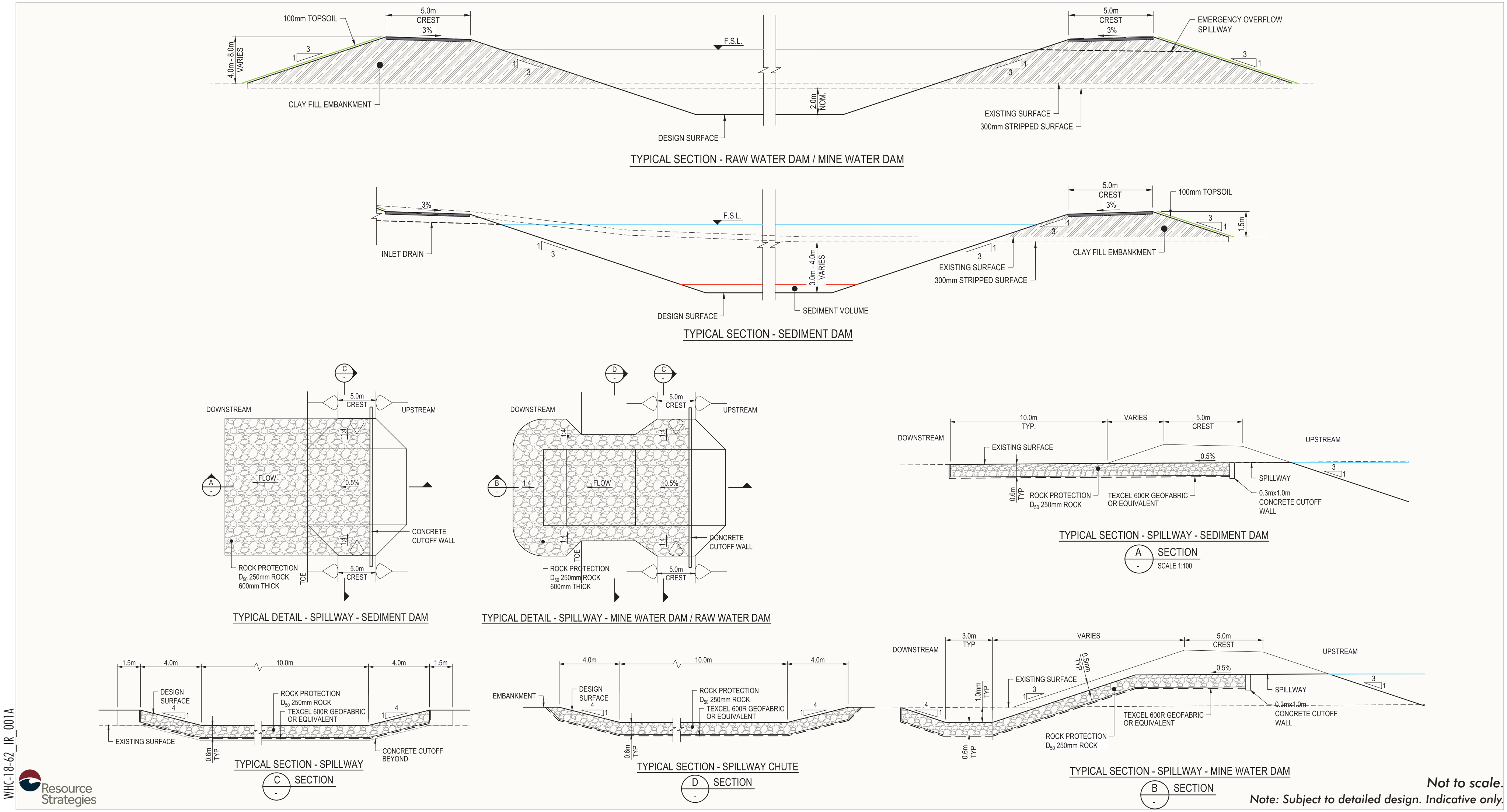
Source: The State of Queensland (2018 - 2020); Whitehaven (2022); DAF (2023); ESP (2022)
Orthophoto: Google Image (2019); Whitehaven (2017)

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Waterways and Drainage Features and Release Points

Figure 3-7A



Source: GHD (2020); Whitehaven (2020).

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Indicative Designs of Water Management Infrastructure and Erosion Protection

Figure 3-7B

Plate 3-7A – Example of Riprap-lined Spillway

Plate 3-7B – Example of Riprap-lined Dam Bank

4 GROUNDWATER REQUEST FOR INFORMATION

The following section have been prepared using information from the Revised Draft EIS (e.g. the Draft EIS, Additional Information and Response to Submissions) as well as other information prepared by the technical specialists and incorporated into the Water and Final Landform Addendum:

- Response to Submissions (March 2023):
  - Attachment 1 – Proposed Conditions and Commitments (Whitehaven WS, 2023).
  - Attachment 2 – Consolidated Project Description (Whitehaven WS, 2023).
  - Attachment 3 – Groundwater Responses (SLR, 2023).
  - Attachment 4 – Surface Water and Flooding Responses (WRM, 2023).
  - Attachment 5 – Aquatic Ecology Responses (ESP, 2023).
- Revised Draft EIS (November 2022):
  - Additional Information – Attachment 5 –Groundwater (SLR, 2022).
  - Additional Information – Attachment 6 –Surface Water and Flooding (WRM, 2022).
  - Additional Information – Attachment 7 –Offset Management Strategy (Whitehaven WS, 2022).
  - Additional Information – Attachment 9 –Aquatic Ecology and Stygofauna (ESP, 2022a).
  - Additional Information – Attachment 10 –Aquatic Ecology and Stygofauna Assessment Addendum (ESP, 2022b).
- Draft EIS (August 2021):
  - Appendix B – Appendix F – Geomorphology Technical Study (Fluvial Systems, 2020).
  - Appendix D – Terrestrial Ecology Assessment (E2M, 2021).
  - Appendix E – Aquatic Ecology and Stygofauna Assessment (ESP, 2021).
  - Appendix M – Geochemistry Assessment (Terrenus, 2021).

4.1 1. Site-specific data for alluvium and regolith to support the conclusions that GDEs will not be impacted by the project (OWS 4a, 5a, 5b, 5c, 6, 7, 8 and IESC 13, 14a, 19, 21b)

Information Request

1. Site-specific data for alluvium and regolith to support the conclusions that GDEs will not be impacted by the project (OWS 4a, 5a, 5b, 5c, 6, 7, 8. IESC 13, 14a, 19, 21b)

It is not clear from the DEIS, RDEIS and additional information what site-specific information supports the conclusions that GDEs will not be impacted by the project.

Whitehaven has indicated that there is data from site-specific drillholes and other surveys of the Isaac River alluvium at the Winchester South site, however this data is not included in the EIS.

Following a meeting between DCCEEW, OWS, OCG and Whitehaven on 30 March 2023, Whitehaven informed OCG there was comprehensive analysis and assessment of GDEs in the following parts of the EIS and included analysis of site-specific data (e.g. alluvial drillholes and logs and the transient electromagnetic [TEM] survey undertaken in the vicinity of GDEs) and ground-truthing. OCG reviewed the relevant documents and concluded the following:

- *DEIS Appendix F – Integrated assessment of Impacts on Groundwater Dependent Ecosystems*
  - *No alluvial drillhole/log data or TEM analysis is included. A figure of the drillhole locations (WSN204-7) and TEM surveys for palustrine wetland 2 (close to the rail loop and MIA) is included (Fig 12) but there is no discussion of results, only a statement that the conclusion that the aquatic ecosystems associated with the wetlands don't receive groundwater recharge is supported by drillhole logs and TEM surveys which confirm the presence of clay-rich sediments near the surface. It is not clear the extent of drillholes in the area, and it is not clear if clay-rich sediments were found in all drillholes.*
  - *Depth to groundwater is stated to be 10-20 mBGL (SLR 2021 is referenced) under the GDEs, and depth to groundwater contours are shown on Figure 5 and Figure 10, however it is not clear where this information comes from. Figure 5 references Whitehaven 2017 and 2020, and Figure 10 also references SLR 2021. Section 4.4.1 refers to bore records provided by Oasis Hydrology (pers. comm. 2019) but the logs are not provided and there is no discussion of the logs within the text.*
  - *Section 4.4.2 concludes that potential terrestrial GDEs in the form of riparian vegetation are likely to be GDEs, but that they are likely to be only facultative (i.e. opportunistic use during dry times, ecosystems can survive without groundwater) due to the 10-20 m depth to groundwater, and that potential terrestrial GDEs in the form of wetlands vegetation are unlikely to be GDEs due to underlying clay material being likely to hold surface water runoff for extended periods. It is not possible to verify this due to the lack of bore logs or information on how the depth to groundwater was determined.*
- *RDEIS Attachment 5 – Groundwater (SLR 2022)*
  - *Section 4.2.1.1 discusses the Isaac River alluvium, and refers to the TEM survey. It states that data from the TEM survey is included in Appendix A1, however A1 only includes a 2-D uninterpreted figure and a one-page executive summary – no data is provided. The TEM executive summary states that 2-D interpretation is complex and can make it difficult to distinguish alluvium from other layers, and states that interpretation should always be backed up by reference to 3-D projected vertical sections (not provided). The executive summary also states that further definition of the alluvium requires targeted drilling, and goes on to say "The permeable riverside alluvium is very limited in extent and has not been intersected by any holes documented in previous reports, all of which focused on the mining area away from the river".*
  - *Paragraph 4 of section 5.6.1.1.1 (p.94) states that the depth to groundwater beneath palustrine wetlands ranges from 10 – 20 m, however there is no reference provided, and it is not clear what this information is based on. This paragraph is identical to one included in Appendix F of the DEIS (para 3, p34), except the paragraph in Appendix F references SLR 2021 for the depth to groundwater.*
  - *Section 5.6.1 summarises the findings of DEIS Appendix F (see comments above). Section 5.6.2 summarises the findings of RDEIS Attachment 9 (Aquatic ecology and stygofauna). Sections 5.6.3-4 provide information on springs and internationally and nationally important wetlands based on mapping.*
- *DEIS Appendix D – Terrestrial Ecology Assessment – Part 1*
  - *This repeats word-for-word section 4.4.3 of DEIS Appendix F.*
- *RDEIS Attachment 7 – Offset management strategy*
  - *This summarises the findings of section 4.4.3 of DEIS Appendix F.*

A thorough understanding of the stratigraphy and depth to groundwater of the units underlying the GDEs and wetlands is required to understand potential impacts.

Provide site-specific data used to underpin the conclusion that GDEs will not be impacted by the project.

Response

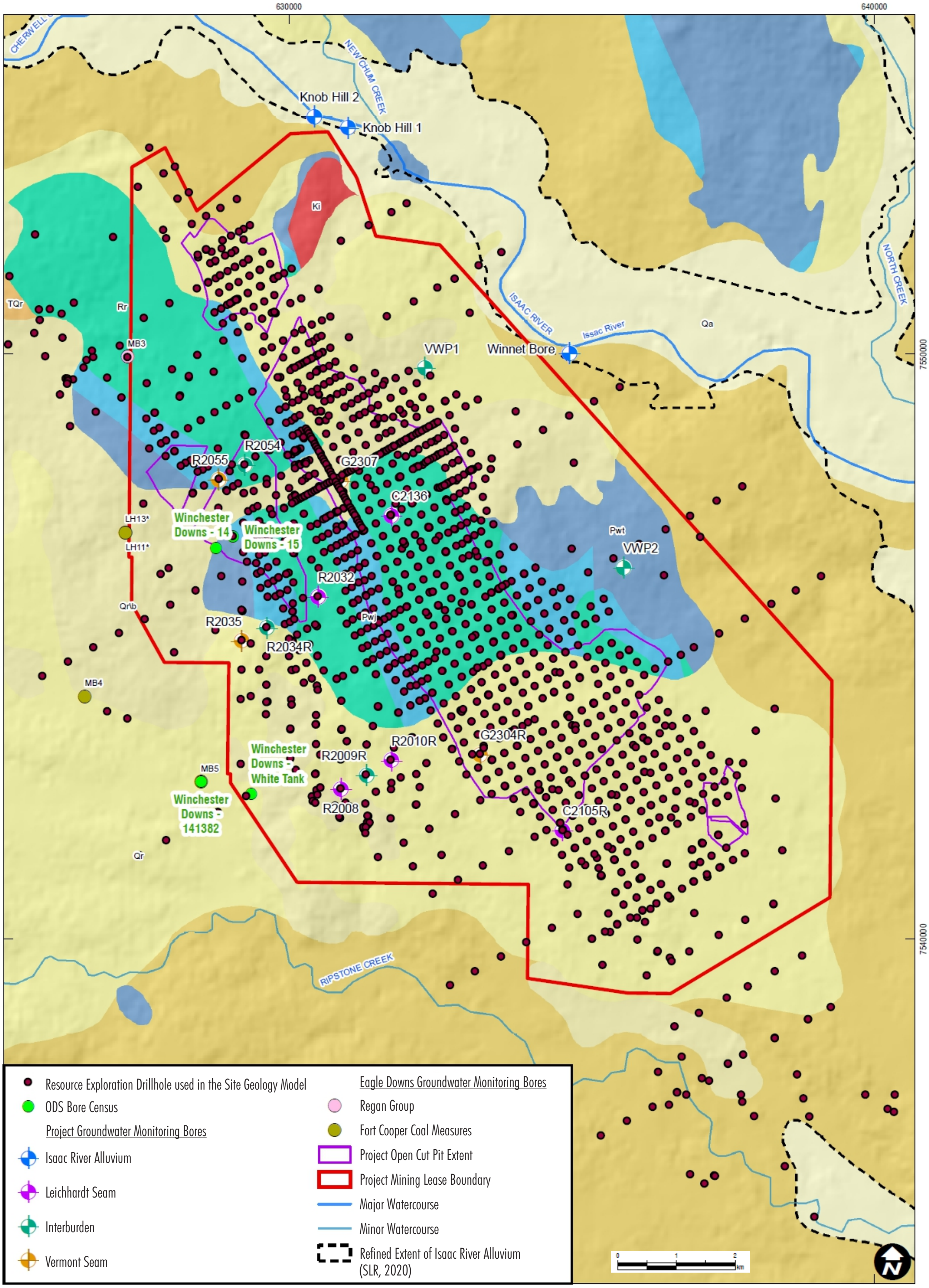
Table 4-1A provides a summary of key site-specific inputs used in the development of Project Site Geology Model and the numerical groundwater model for the Project. Whitehaven WS will separately provide the site-specific data that was used in the development of the numerical groundwater model (e.g. exploration hole logs, Transient Electromagnetic [TEM] Survey Report, etc.).

Table 4-1A
Key Site-specific Inputs for Development of Site Geology Model and Numerical Groundwater Model

Component	Site-specific Data	Other Data
Extent	▪ North-west expansion of groundwater model domain for the Project to avoid potential edge effects (Figure 4-1C). ▪ Fine 100 m cell refinement at Project.	▪ Approved and existing extents of other mines within the groundwater model domain. ▪ Regional Geologic Framework. ▪ Regional Hydrology.
Geology	▪ Project Site Geology Model with over 1,500 exploration drillholes and geophysical investigations. ▪ Information available on 19 groundwater bores across the site. ▪ TEM and Electrical Resistivity Tomography (DC-ERT) surveys across the site to inform extent of Isaac River alluvium. ▪ Light Detection and Ranging (LiDAR) surveys across the site. ▪ Slope break analysis to inform extent of Isaac River alluvium using LiDAR.	▪ Regional Geologic Framework. ▪ Queensland Government Mapping of Structural Geology. ▪ Queensland Government Mapping of Surface Geology. ▪ CSIRO's *Regolith Depth Map of the Australian Continent.* ▪ Site Geology Models from other mines within the groundwater model domain (i.e. Olive Downs Project and Moorvale South Project). ▪ Information available from 49 groundwater monitoring bores from other mines (i.e. Olive Downs Project, Moorvale South Project and Eagle Downs Mine). ▪ TEM and DC-ERT surveys across the other mine sites to inform extent of Isaac River alluvium (i.e. Olive Downs Project). ▪ Bore Logs available on Groundwater Database – Queensland.
Boundary Conditions	▪ Project Mine Plan.	▪ Approved and existing extents of other mines within the groundwater model domain and associated timing. ▪ Regional Hydrology. ▪ Queensland Government River Stage Data. ▪ Bureau of Meteorology (BoM) Rainfall Data. ▪ BoM Evapotranspiration Data.
Hydraulic Parameters	▪ 15 groundwater bore slug tests across the site. ▪ 9 core laboratory tests across the site. ▪ 8 downhole packer testing across the site.	▪ Groundwater bore slug tests across other sites within the groundwater model domain (i.e. Olive Downs Project and Moorvale South Project). ▪ Core laboratory tests across other sites within the groundwater model domain (i.e. Olive Downs Project and Moorvale South Project). ▪ Pumping tests across other sites within the groundwater model domain (i.e. Moorvale South Project). ▪ Downhole packer tests across other sites within the groundwater model domain (i.e. Olive Downs Project). ▪ Other publicly available reports and literature.
Calibration	▪ 24,261 water level measurements at 20 bores across the site.	▪ 2,305 additional water level measurements at 159 other bores across the groundwater model domain.

The Project Site Geology Model included data from over 1,500 exploration drillholes and geophysical investigations, locations shown in Figure 4-1A. The numerical groundwater model for the Project also used site geology models from the Moorvale South Project and Olive Downs Project that were also developed using the exploration drillholes shown in Figure 4-1B. The exploration drillholes and site geology models were incorporated into the model layers for the numerical groundwater model. This included extensive exploration drillhole data from the regolith (Figures 4-1A and 4-1B).

The following discussion summarises the conceptualisation and development of the numerical groundwater model used to assess the potential impacts of the Project on the surrounding groundwater systems and provides justification that the range of data incorporated into the numerical groundwater model allows robust and conservative assessment. Importantly, the numerical groundwater modelling predicted no drawdown impacts propagating into areas described as potential groundwater-dependent ecosystems (GDEs) (e.g. even if these potential GDEs are actual GDEs, there will be no impacts due to Project only groundwater drawdown as the drawdown does not reach these areas).



WHC-18-62_IR_010A

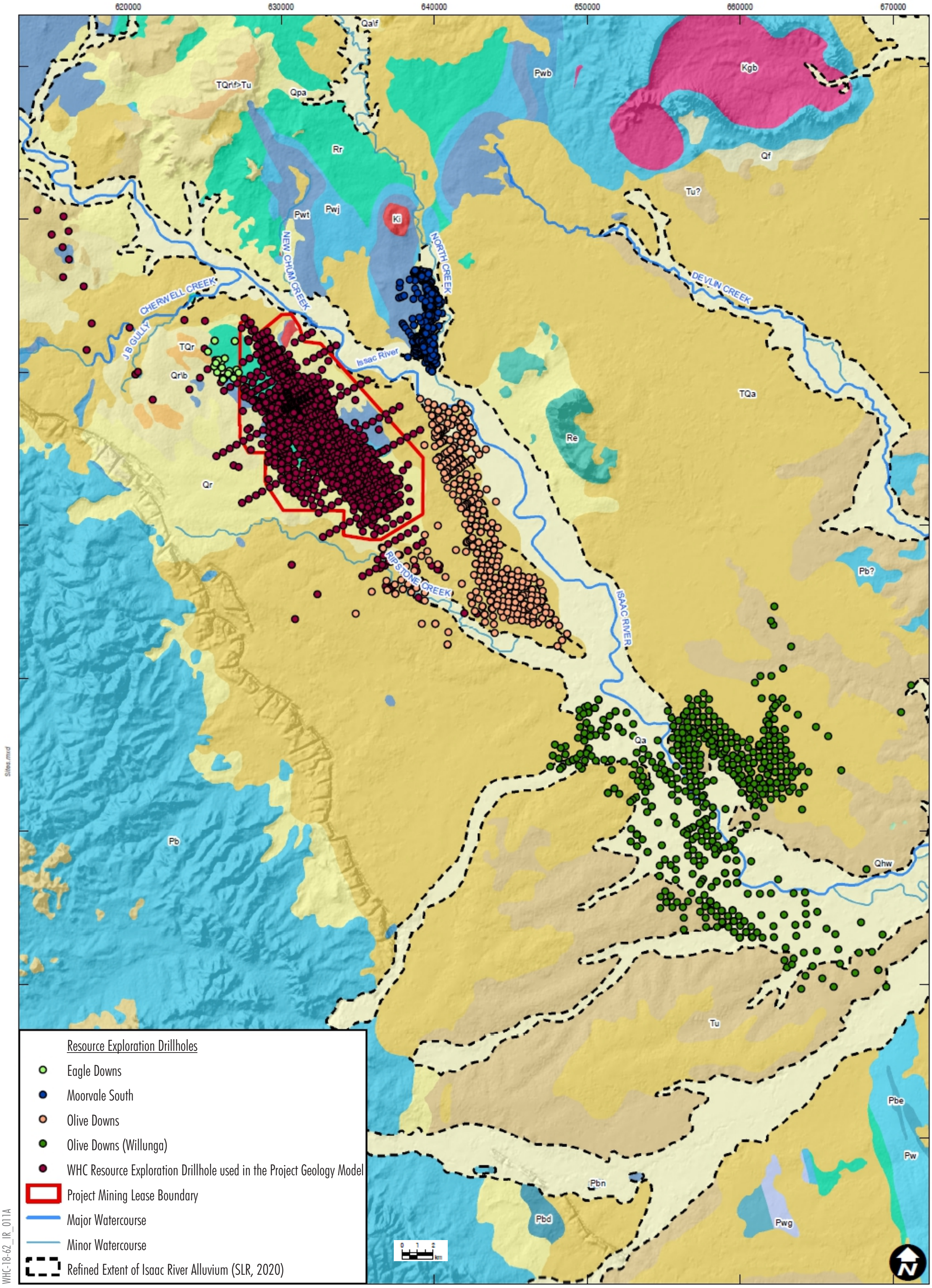
Source: SLR (2023)

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Site-specific Exploration Drillholes and Groundwater Bores within the Project Area used for Development of the Site Geological Model in the Numerical Groundwater Model

Figure 4-1A



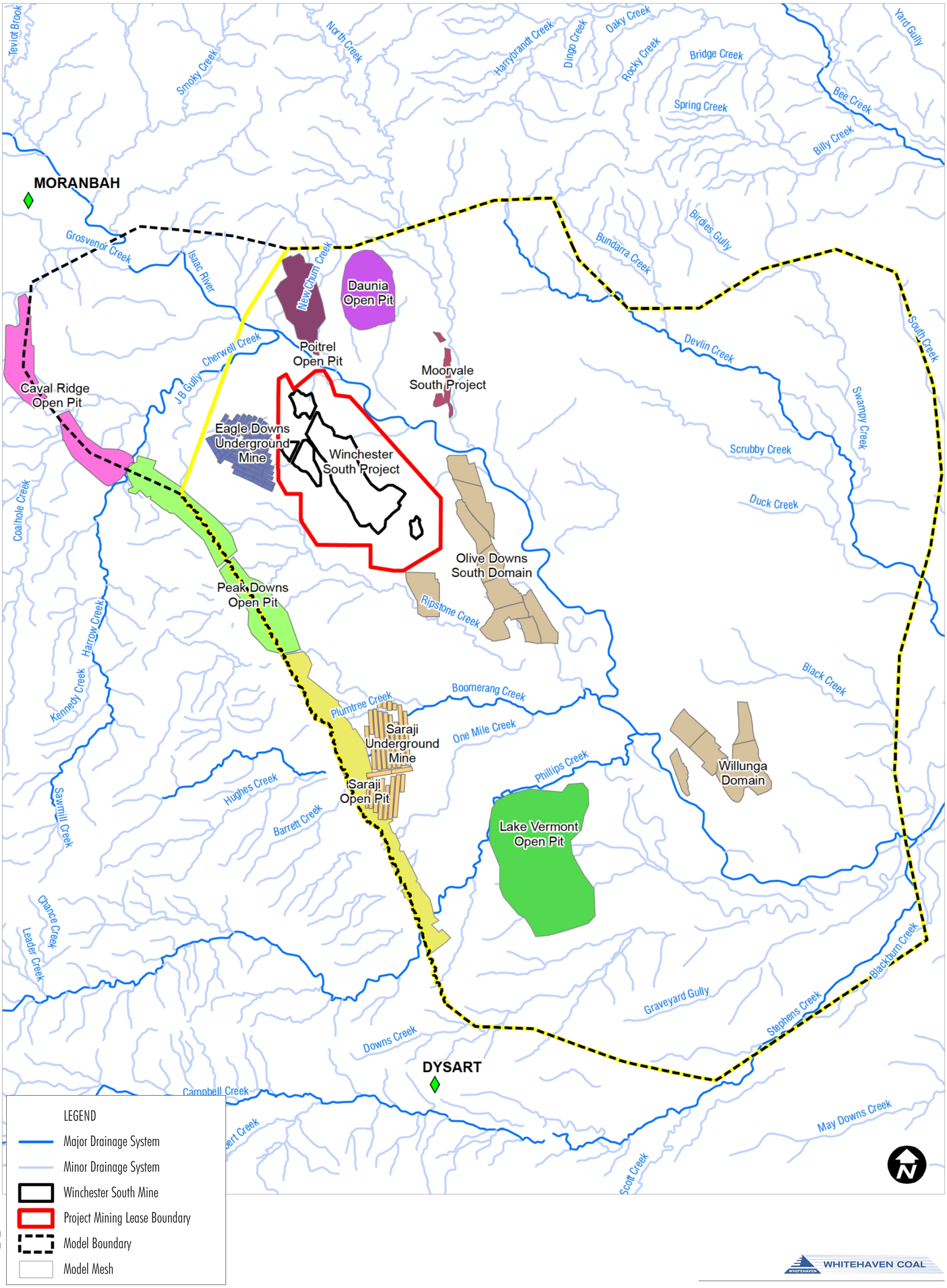
Source: SLR (2023)

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Site-specific and Regional Exploration Drillholes and Groundwater Bores Data used for Development of Geological Models in the Numerical Groundwater Model

Figure 4-1B



Source: SLR (2023)

WINCHESTER SOUTH PROJECT

Extent of Numerical Groundwater Model

Figure 4-1C

A conceptual hydrogeological model of the groundwater regime was developed by SLR based on the available groundwater data, and the results of the groundwater investigation program and TEM survey. The hydrogeological regime relevant to the Project comprises the following hydrogeological units:

- Cainozoic sediments:
  - Quaternary alluvium – unconfined aquifer localised along Isaac River; and
  - regolith – unconfined and largely unsaturated unit bordering alluvium;
- Triassic Rewan Group – aquitard.
- Permian coal measures with:
  - hydrogeologically 'tight' interburden units with aquitard properties; and
  - coal sequences that exhibit secondary porosity through cracks and fissures.

Figures 4-1D and 4-1E provide the conceptual cross-sections of the existing geological and hydrogeological systems through the Project area. Figure 4-1F provides the conceptual cross-sections of the hydrogeological system during mining for the Project, showing propagation of drawdown from the Project does not extend into the alluvium (based on numerical groundwater model predictions). The numerical groundwater model was developed based on the conceptualisation. The objectives of the numerical groundwater modelling were to quantify the groundwater inflows, simulate and predict the extent of the influence of dewatering and level and rate of drawdown/depressurisation at specific locations and identify areas of potential risk, where groundwater impact mitigation/control measures may be necessary.

The modelling undertaken for the Project involved an automated process that ran the numerical groundwater model through numerous simulations (1,400 in total, each with unique parameterisation across a wide range of hydraulic parameters as discussed in Section 4.2) to calibrate the model against the 26,820 measured water levels as best as possible (i.e. referred to as the calibration of the numerical groundwater model). Calibration performance of numerical groundwater models is typically measured as using the scaled root mean square (SRMS) error. The *Australian Groundwater Modelling Guidelines* (Barnett et al., 2012) recommends an SRMS of less than 10% is acceptable. The limit of SRMS adopted for the calibration of the numerical groundwater model for the Project was less than 6% and therefore well within guideline recommendations. On this basis, 229 models were deemed to be calibrated sufficiently (SRMS less than 6% and therefore satisfactorily matched historical measured water levels) and were thus deemed appropriate for use in impact predictions.

The accuracy of the groundwater level predictions for bores in the alluvium and colluvium units (i.e. Model Layer 1) are supported by the arithmetic mean calibration residual error of approximately 1 m, which is within the observed seasonal/natural variation in groundwater levels for bores in the alluvium. Therefore, model predictions are close to existing groundwater level data for alluvium providing confidence in the performance of the numerical groundwater model for predictions in the alluvium. Furthermore, the response to Item 2 of the Groundwater RFI (Section 4.2) outlines a large range of hydraulic conductivities were considered in the numerical groundwater modelling as part of the calibration, and additional field data in the alluvium and regolith would only constrain the limits of the modelled ranges but do not provide field values not already considered in the model. Therefore, the numerical groundwater model provides a more conservative assessment of groundwater impacts.

The numerical groundwater model predicted the Project would result in negligible drawdowns within the alluvium (Model Layer 1) (i.e. maximum predicted drawdowns do not exceed 0.3 m). The maximum predicted drawdowns associated with the Project within the regolith (Model Layer 2), where the unit is predicted to be saturated, are largely constrained to the Project area, with the 1 m drawdown only extending up to approximately 1.8 kilometres (km) to the north-west and 1.6 km to the south-east away from the Project area and does not overlap with any areas of high or moderate potential GDEs (i.e. even if these high or moderate potential GDEs are actual GDEs, there will be no impacts due to Project only groundwater drawdown as the drawdown does not reach these areas).

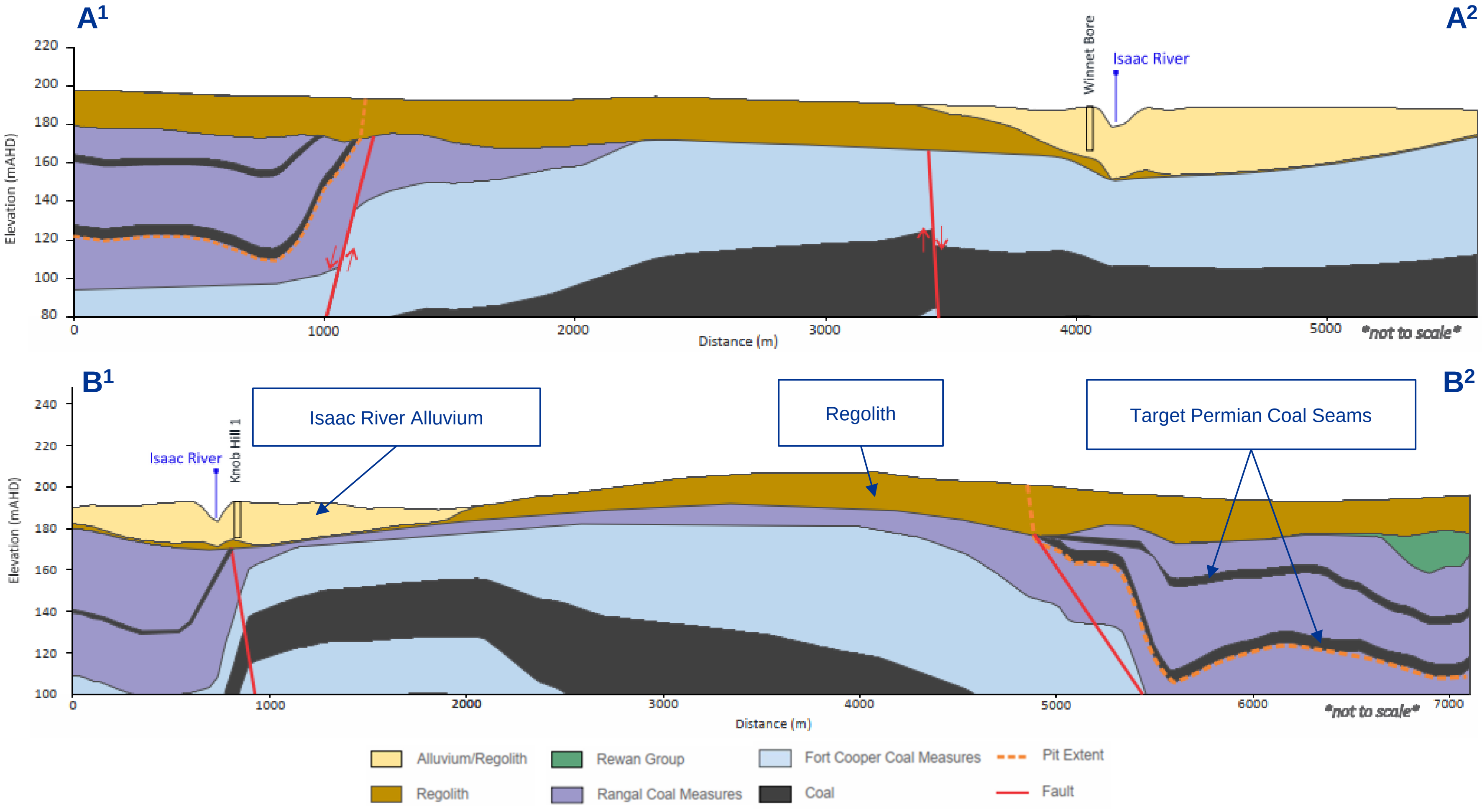


Figure 4-1D – Conceptual Visualisation of Geology Structures (Cross-sections A¹ – A² and B¹ – B²)

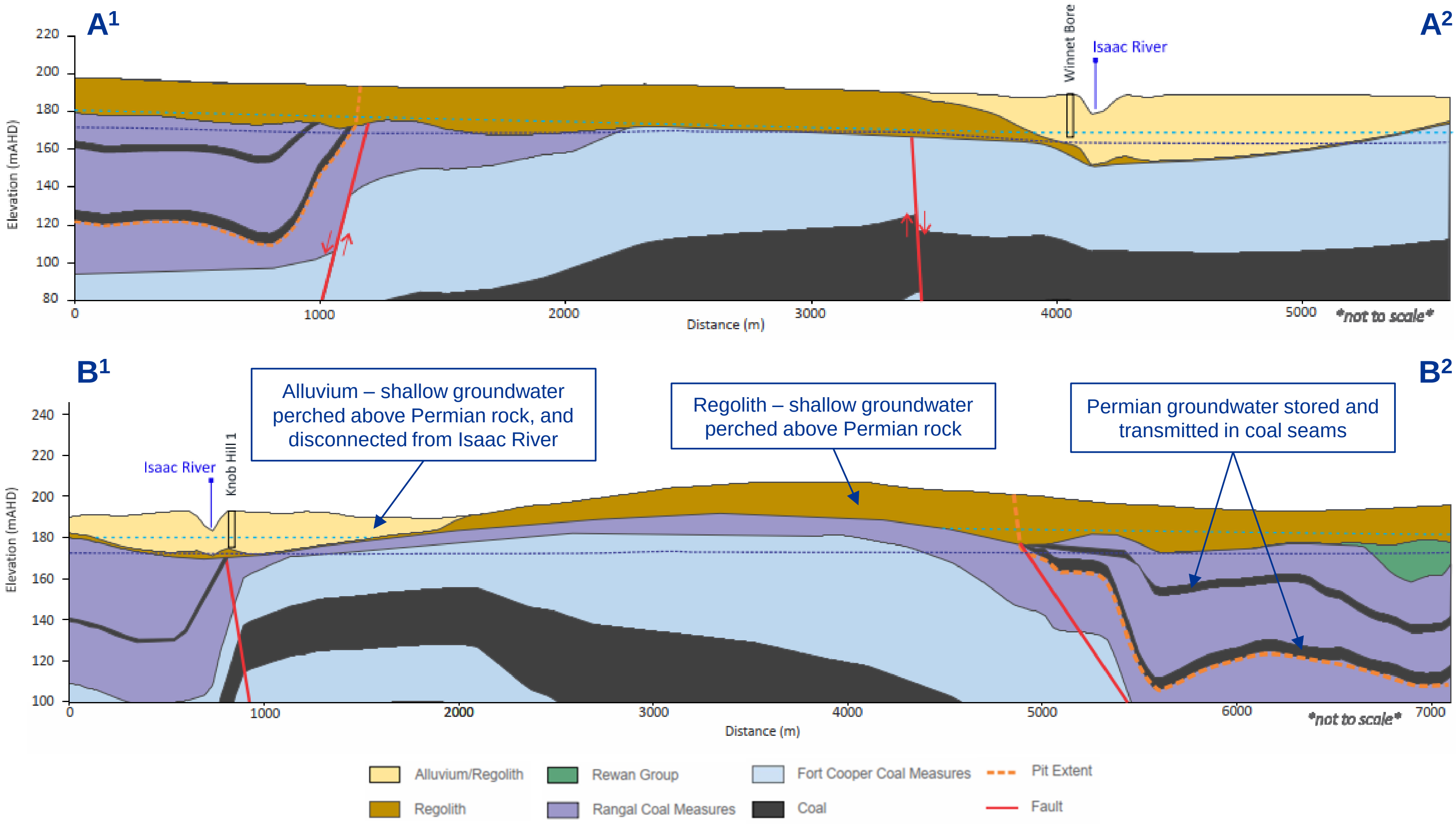


Figure 4-1E – Conceptual Visualisation of Hydrogeology prior to Mining (Cross-sections A¹ – A² and B¹ – B²)

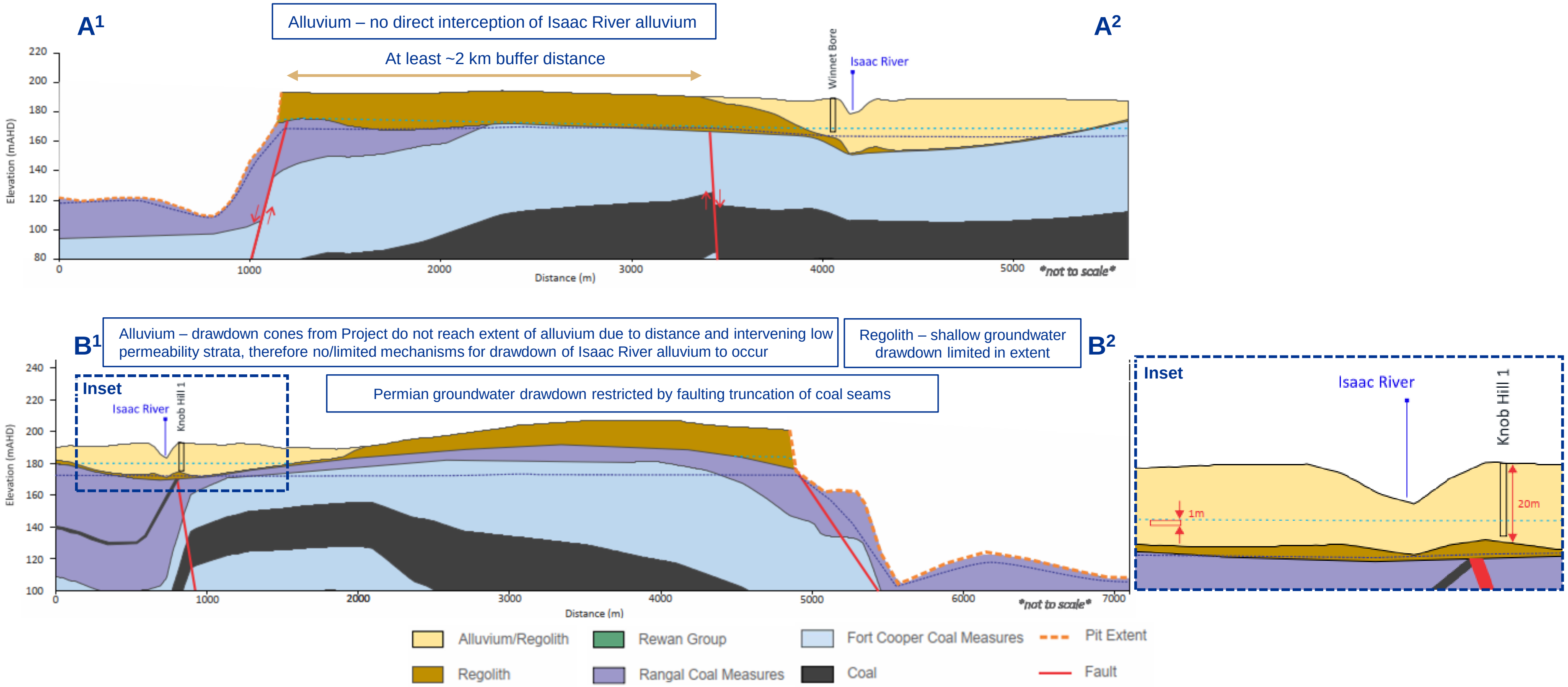


Figure 4-1F – Conceptual Visualisation of Hydrogeology during and after Mining (Cross-sections A¹ – A² and B¹ – B²)

4.2 2. Lack of site-specific data for the regolith to support hydraulic parameters used in the groundwater model (OWS 5a)

Information Request

2. Lack of site-specific data for the regolith to support hydraulic parameters used in the groundwater model (OWS 5a)

There are no groundwater bores for the Winchester South project or Moorvale South project that monitor the regolith, all data on the hydraulic parameters of the regolith is from four bores from the Olive Downs project:

- *GW6s (IF3835P) (located on WS mining lease boundary, 5 km from offset area, mapped in geological unit TQa (Tertiary-Quaternary alluvium not associated with the Isaac River)). Total depth 10 mBGL, screened depth 4-10 mBGL. Dry on all monitoring events.*
- *GW12s (VP3831P) (8km SE of WS mining lease boundary, 18 km from offset area, mapped in geological unit Tqa (Tertiary-Quaternary alluvium not associated with the Isaac River)). Total depth 42 mBGL, screened depth 30-42 mBGL. SWL 19 mBGL Feb 2017 (drilled Dec 2016).*
- *GW16s (VE3827P) (8km SE of WS mining lease boundary, 18 km from offset area, mapped in geological unit Tqa (Tertiary-Quaternary alluvium not associated with the Isaac River overlying Tertiary Duaringa Formation)). Total depth 27 mBGL, screened depth 12-27 mBGL (within the Duaringa Formation). Dry on all monitoring events.*
- *GW21s (VE3825P) (29km SE of WS mining lease boundary, 38 km from offset area, mapped in geological unit Tu (Tertiary Duaringa Formation)). Total depth 9 mBGL, screened depth 6-9 mBGL. SWL 7.6 mBGL Feb 2017 (drilled Nov 2016*

Of these bores, slug testing was performed on GW12s which recorded horizontal hydraulic conductivity of 0.17 to 0.61 m/day.

p.99 (para 4) of SLR 2022 states: Tertiary-Quaternary aged sediments (regolith) present across the Project Area form the base of the unconfined shallow groundwater system. The groundwater flow processes are similar to those of the Isaac River alluvium; however, the fluxes are expected to be significantly lower due to the dominance of clay within the Tertiary sediments.

This is almost identical to the wording in the Olive Downs groundwater assessment (p. 78 of HydroSimulations 2018), however the regolith underlying Olive Downs is predominantly made up of Tqa (Tertiary-Quaternary) alluvial deposits, while the regolith underlying Winchester South is predominantly Qr and Qr/b (Quaternary) colluvial deposits.

Provide site-specific data used to underpin the assumption that regolith underlying Winchester South will behave in a similar way to regolith underlying Olive Downs or Moorvale South when the geological units are different.

Response

The formal description of Tertiary-Quaternary (Tqa) alluvial deposits within the Queensland Government's State Detailed Surface Geology mapping is '*Locally red-brown mottled, poorly consolidated sand, silt, clay, minor gravel; high-level alluvial deposits (generally related to present stream valleys but commonly dissected)*'. The formal description of Quaternary (Qr) colluvial deposits is '*Clay, silt, sand, gravel and soil; colluvial and residual deposits*'. That is, the comprising sediments are very similar and would not be expected to function significantly differently in a hydrogeological sense.

At the Project area, Quaternary colluvial deposits are present within the open cut mining areas and comprise colluvium, residual deposits and weathered Permian units, specifically clay, silt, sand, gravel, and soil. To the east of the Project towards the Isaac River alluvium, the Tertiary-Quaternary alluvial deposits are the dominant surface geology. These are also the Tertiary-Quaternary alluvial deposits observed at the Olive Downs Project. The descriptions indicate the only difference is the age of the surface geology (rather than the lithology) which is supported by the exploration logs within in the Project area described in response to Item 1 of the Groundwater RFI (Section 4.1). As the older Tertiary-Quaternary alluvial deposits and Quaternary colluvial deposits exhibit similar geological characteristics and are not expected to function significantly differently in a hydrogeological sense, these deposits were grouped as 'regolith' within the numerical groundwater model, distinct from the Isaac River alluvium.

The field results for hydraulic conductivities for alluvium, regolith and other units is presented graphically on Charts 4-2A and 4-2B, as well as the ranges of hydraulic conductivity documented in literature. The numerical groundwater model used ranges for each model parameter rather than fixed values, including for hydraulic conductivities, with the allowable ranges based on over 120 test data points and published literature values shown on Charts 4-2A and 4-2B.

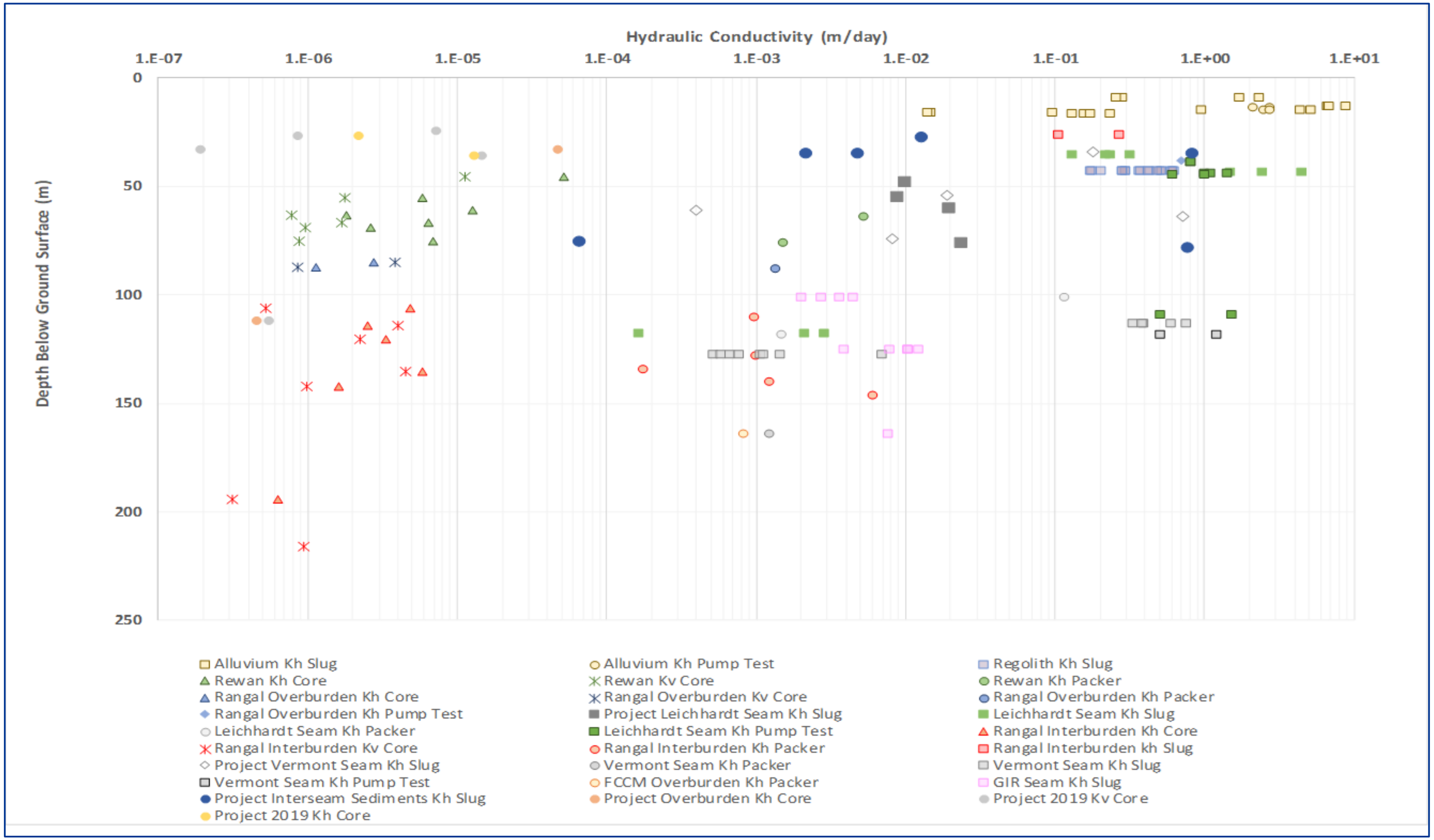


Chart 4-2A – Summary of Hydraulic Conductivity Results for All Field Testing

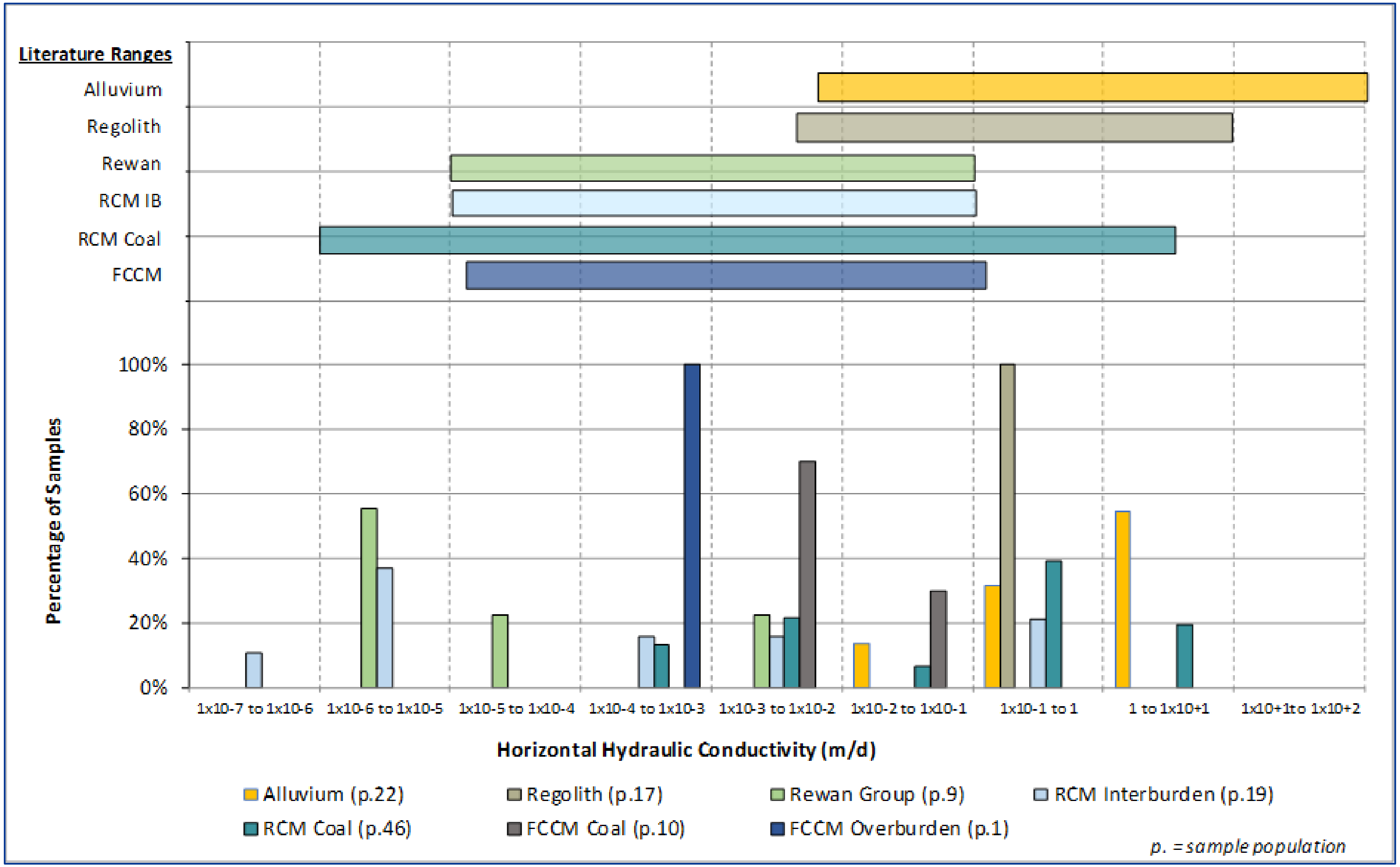


Chart 4-2B – Field Testing Results and Documented Literature Ranges for Horizontal Hydraulic Conductivity Distribution

Specifically, the ranges for horizontal hydraulic conductivity used in the numerical groundwater model typically covered multiple orders of magnitude, which ensured all possible field-testing results and hydraulic conductivities provided in published literature were considered in the numerical groundwater model. Chart 4-2A shows that the hydraulic conductivity of the alluvium and regolith is highly variable, ranging from approximately 0.01 to 10 metres per day (m/day), which reflects the heterogeneous nature of the alluvial and unconsolidated sediments. This is supported by the published literature ranges for hydraulic conductivity for alluvium for regolith, ranging from approximately 0.01 to 100 m/day shown in Chart 4-2B. All of these values were considered in the numerical model sensitivity and uncertainty analysis.

A range of parameters were assessed as part of the sensitivity and uncertainty analysis for the horizontal hydraulic conductivities in the alluvium and regolith. The parameter distribution for horizontal hydraulic conductivity of alluvium is provided in Charts 4-2C. Chart 4-2C shows the range of values considered in both calibration and prediction numerical groundwater modelling was 0.1 to 1,000 m/day (i.e. an even greater range of parameters than the available published literature). As a result, the range of horizontal hydraulic conductivities considered in the calibration and prediction numerical groundwater modelling is highly conservative including values that are even beyond foreseeable 'worst-case', as it is extremely unlikely the alluvium unit would have a horizontal hydraulic conductivity outside the range considered.

The parameter distribution for horizontal hydraulic conductivity of regolith is provided in Charts 4-2D and shows the range of values considered in both calibration and prediction numerical groundwater modelling was 0.001 to 100 m/day (i.e. again an even greater range considered than the available published literature). As a result, the range of horizontal hydraulic conductivities considered in the calibration and prediction numerical groundwater modelling is highly conservative including values that are even beyond foreseeable 'worst-case', as it is extremely unlikely the regolith unit would have a horizontal hydraulic conductivity outside the range considered.

In summary, as a large range of hydraulic conductivities were considered in the numerical groundwater modelling, additional field data in the alluvium and regolith would not result in potentially worse environmental outcomes but would only constrain the modelled ranges and thus potentially reduce predicted impacts. Therefore, the model currently provides a more conservative assessment of groundwater impacts.

In recognition of feedback, Whitehaven WS has committed to installing additional monitoring bores within the regolith groundwater unit to be incorporated into the groundwater monitoring program for the Project. This allows natural groundwater level fluctuations to be distinguished from potential groundwater level impacts due to drawdown resulting from proposed mining activities and whether any further investigations or test work (e.g. hydraulic testing, slug testing, etc.) should be undertaken to further refine the numerical groundwater model.

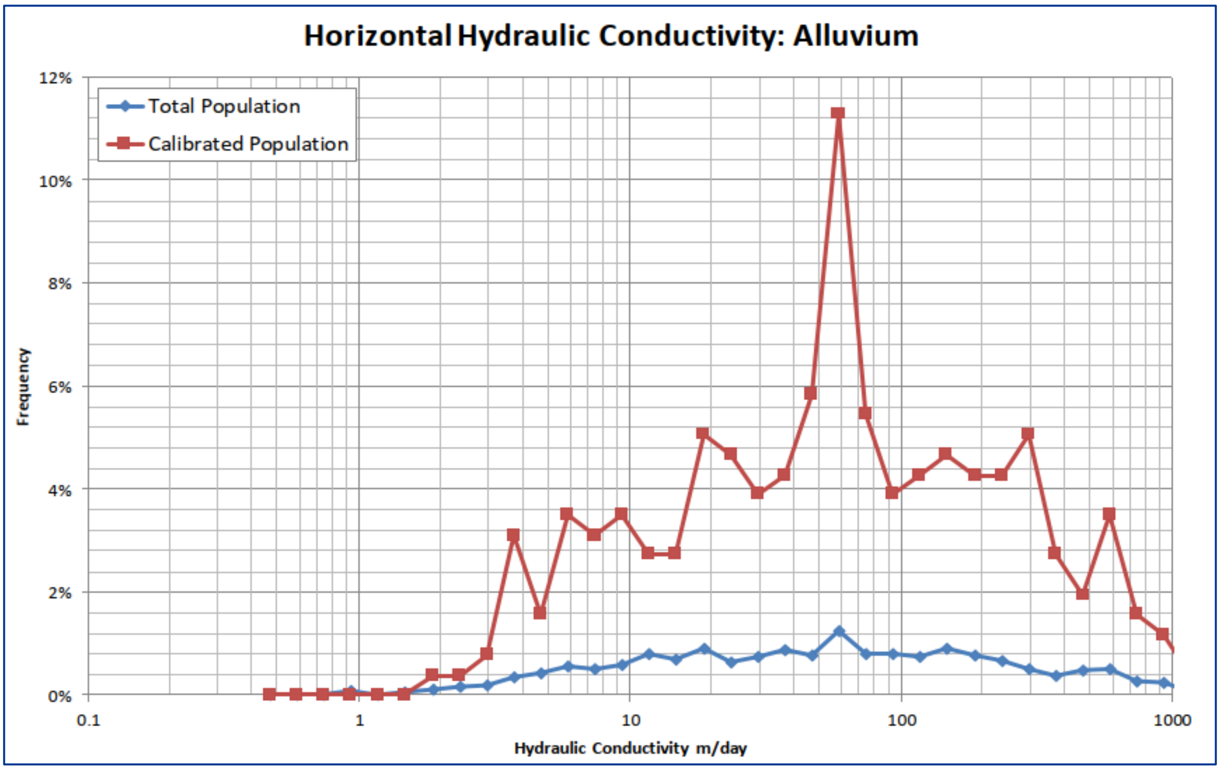


Chart 4-2C – Range of Horizontal Hydraulic Conductivities for Alluvium in Numerical Groundwater Modelling

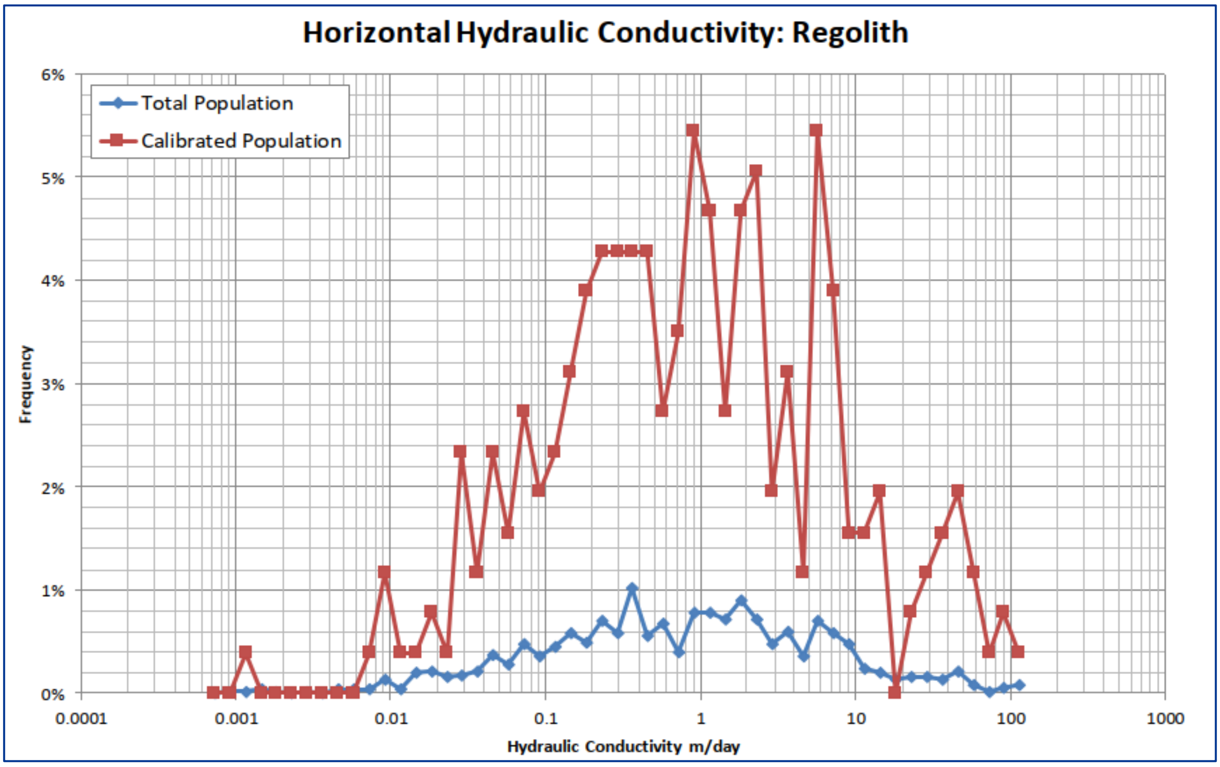


Chart 4-2D – Range of Horizontal Hydraulic Conductivities for Regolith in Numerical Groundwater Modelling

4.3 3. Inconsistencies between groundwater levels and saturation parameters used in the groundwater model and monitoring records (OWS 5b)

Information Request

3. Inconsistencies between groundwater levels and saturation parameters used in the groundwater model and monitoring records (OWS 5b)

Table 2-1 of the Winchester South groundwater modelling report (Appendix B of SLR 2022) sets out the model layers used in the groundwater model. Layer 1 ('surface cover') is stated to be made up of alluvium, colluvium and Tertiary basalt, while layer 2 (regolith) is stated to be made up of Tertiary and minor Triassic Clematis, weathered Permian, and Tertiary basalt.

The extent of the saturation of layer 2 used in predictions of water levels and groundwater drawdown (Figures 3-3 and 3-6 of Appendix B of SLR 2022) assumes it is unsaturated across much of the south-western part of the site. However, there are several bores included in the Olive Downs bore census located in this unsaturated area that demonstrate there is some saturation at this location. Two of these bores were identified in the regolith:

- *Winchester Downs 14: within mine lease, 6.75km W of offset area. Total depth 14 mBGL, SWL 3.3 mBGL, EC 3,003 µS/cm (2,012 mg/L)*
- *Winchester Downs 15: within mine lease, 7.25km W of offset area. Total depth 23.2 mBGL, SWL 9.5 mBGL, EC 2,063 µS/cm (1,382 mg/L)*

Two other bores were identified as being in the Back Creek Group (Permian strata), however the brackish salinity indicates the bores may target regolith or alluvium close to Ripstone Creek:

- *White Tank 14: within mine lease, 8.8km SW of offset area. Total depth 14 mBGL, SWL 16.7 mBGL, EC 1,721 µS/cm (1,153 mg/L)*
- *141382: 500m W of mine lease, 9km SW of offset area. Total depth 52.5 mBGL, SWL 14.4 mBGL, screened 48.5-51.5 mBGL, EC 2,281 µS/cm (1,528 mg/L)*

Likewise, in depth to groundwater figures included in the aquatic ecology reports (Figures 5 and 10 of Appendix F of the DEIS), the depth to groundwater is mapped to be 20-30 mBGL where these bores are located, however there is clear evidence of groundwater in the regolith at much shallower depths.

Provide site-specific data which supports groundwater levels used in the model. Provide accurate, verified spatial contours and flow direction mapping for groundwater that may be impacted by project-related drawdown. Provide figures that show groundwater contour mapping in the context of existing and proposed groundwater monitoring bores, surface water storages, controlled release points, major infrastructure, pits, out-of-pit waste rock emplacements and mining lease boundaries.

Response

As outlined in response to Item 1 of the Groundwater RFI (Section 4.1), the modelling undertaken for the Project involved an automated process that ran the numerical groundwater model through numerous simulations adopting unique model parameterisation (1,400 in total) to calibrate the model against the 26,820 measured water levels as best as possible (i.e. referred to as the calibration of the numerical groundwater model).

Calibration performance of numerical groundwater models is typically measured as using the SRMS error. The *Australian Groundwater Modelling Guidelines* (Barnett *et al*., 2012) recommends an SRMS of less than 10% is acceptable. The limit of SRMS adopted for the calibration of the numerical groundwater model for the Project was less than 6% and therefore well within guideline recommendations. On this basis, 229 models were deemed to be calibrated sufficiently (SRMS less than 6% and therefore satisfactorily matched historical measured water levels) and were thus, deemed appropriate for use in impact predictions.

The accuracy of the groundwater level predictions for bores in the alluvium and colluvium units (i.e. Model Layer 1) are supported by the arithmetic mean calibration residual error of approximately 1 m, which is within the observed seasonal/natural variation in groundwater levels for bores in the alluvium. Therefore, model predictions are close to existing groundwater data for alluvium providing confidence in the performance of the numerical groundwater model for alluvium.

Item 3 of the Groundwater RFI suggests there are four groundwater bores with evidence of some saturation of the regolith unit in the south-west of the Project area, which is predicted to be unsaturated in this area by the numerical groundwater model. The four groundwater bores listed below were identified in the Groundwater Assessment for the Olive Downs Project and are shown in Figure 4-1A:

- Winchester Downs 14 Bore.
- Winchester Downs 15 Bore.
- White Tank Bore.
- Bore 141382 (i.e. MB5).

A review of the groundwater bores listed is provided below, however, it should be noted that Figure 3-3 and 3-6 in Appendix B of the Groundwater Assessment show the predicted water level within the regolith (Model Layer 2) at the end of mining for Project-only and cumulative scenario, that is the <u>predicted water level after the drawdown from the Project-only and cumulative mining activities</u>, and therefore should not be compared to the <u>pre-mining groundwater levels</u> observed at Winchester Downs 14 Bore, Winchester Downs 15 Bore, White Tank 14 Bore and Bore 141382 as has occurred in Item 3 of the Groundwater RFI.

The measured depth of Winchester Downs 14 bore was 14.4 m which was identified in the bore census for the Olive Downs Project Groundwater Assessment. The Winchester Downs 14 bore was recorded as being in 'poor' condition and abandoned. The poor condition, disused status, and lack of bore logs reduce the reliability of measurements made from the Winchester Downs 14 bore. At this location, the base of the regolith is at a depth of 14.5 m based on the Project Site Geological Model, informed by the exploration holes shown on Figure 4-1A. The closest exploration hole (WSC1123) with detailed lithology information is approximately 480 m east of Winchester Downs 14 and reports a base of regolith depth of 17 m. As such, it is expected the Winchester Downs 14 bore may access the regolith as suggested in Item 3 of the Groundwater RFI.

The measured depth of Winchester Downs 15 bore was 23.4 m which was identified in the bore census for the Olive Downs Project Groundwater Assessment. At this location, the base of the regolith is at a depth of 17.6 m based on the Project Site Geological Model, informed by the exploration holes shown on Figure 4-1A. The closest exploration hole (WSN1010) with detailed lithology information is approximately 250 m east of Winchester Downs 15 and reports a base of regolith depth of 16 m. As such, it is expected the Winchester Downs 15 bore does not access the regolith, but the top of the underlying fresh Permian strata.

The measured depth of White Tank bore was 53 m (rather than 14 m outlined in Item 3 of the Groundwater RFI) which was identified in the bore census for the Olive Downs Project Groundwater Assessment. At this location, the base of the regolith is at a depth of 21 m based on the Project Site Geological Model, informed by the exploration holes shown on Figure 4-1A. White Tank bore aligns closely with an exploration hole (WSN41) (i.e. indicating White Tank bore may in fact be WSN41), which has detailed lithology information that reports a base of regolith depth of 21.6 m. As such, it is expected the White Tank bore does not access the regolith, but the top of the underlying fresh Permian strata.

The measured depth of Bore 141382 was 51.3 m which was identified in the bore census for the Olive Downs Project Groundwater Assessment and is a monitoring bore from the Eagle Downs Mine monitoring network named MB5. At this location, the base of the regolith is at a depth of 25.7 m based on the Project Site Geological Model, informed by the exploration holes shown on Figure 4-1A. Review of the available bore log for Bore 141382 (MB5) reports a base of regolith depth of 16 m. As such, it is expected the Bore 141382 (MB5) does not access the regolith, but the top of the underlying fresh Permian strata.

In summary, a review of available information suggests that only one of the four bores identified in Item 3 of the Groundwater RFI demonstrates potentially saturated regolith in the south-west of the Project area, with that one bore (Winchester Downs 14) being unreliable. The remaining three bores access groundwater in the underlying Permian coal measures, suggesting that groundwater was not encountered in the shallower regolith and therefore deeper drilling was required to access reliable groundwater.

4.4 4. Inconsistencies in conceptualisation of regolith (OWS 5b)

Information Request

4. Inconsistencies in conceptualisation of regolith (OWS 5b)

During a meeting between Whitehaven and OCG on 3 May 2023, when asked how the regolith was conceptualised where site-specific data was missing, SLR referred to the use of the CSIRO depth of regolith mapping tool. The CSIRO tool maps the depth of regolith as being 3-10 m across most of the site where underlain by Permian strata, and 10-20 m in areas mapped as Quaternary/Tertiary sediments.

This is in contrast to p.43 (para 5) of SLR 2020 which states that based on the CSIRO tool and geological logs: Within the Project Area, Permian units are, on average, weathered to a depth of 22 metres below ground level (mbgl) and Tertiary to Quaternary aged deposits are on average weathered to 25 mbgl.

The inconsistency between the mapped depths in the CSIRO tool and those recorded in drill logs (not included in the EIS) doesn't support the accuracy of the CSIRO tool to map regolith where there are no drill logs to correlate.

Provide site-specific data used to support conceptualisation of the regolith within the project area.

Response

As outlined in response to Items 1 and 2 of the Groundwater RFI, the Project Site Geology Model included over 1,500 exploration drillholes and geophysical investigations shown in Figure 4-1A. The numerical groundwater model for the Project also used site geology models from the Moorvale South Project and Olive Downs Project that were also developed using exploration drillholes shown in Figure 4-1B. The exploration drillholes and site geology models were incorporated into the model layers for the numerical groundwater model and included extensive exploration drillhole data in the regolith (Figures 4-1A and 4-1B). Explicitly, site-specific data (e.g. the Project Site Geology Model) was used to inform the depth and thickness of the regolith (as well as the other model layers) across the Project area as adopted in both the conceptualisation and numerical groundwater modelling.

Where the Project Site Geology Model and other site geology models were not available (e.g. in the north-west expansion area of the numerical groundwater model located at least 5 km away from the Project), model layers were constructed using data from the CSIRO's *Regolith Depth Map of the Australian Continent* (Wilford, *et al*., 2016), publicly available exploration drill and bore logs and average thicknesses. That is, the CSIRO's *Regolith Depth Map of the Australian Continent* was only used in areas distant from the Project (and other surrounding projects) where site-specific data (e.g. site geology models) were not available.

4.5 5. Lack of site-specific data to characterise water quality parameters in the regolith (OWS 5d, 11, 12, 13)

Information Request

5. Lack of site-specific data to characterise water quality parameters in the regolith (OWS 5d, 11, 12, 13)

p.82 of SLR 2022 states on salinity of the regolith: Where water is present within the regolith material, it is generally highly saline, but can be brackish to moderately saline with an average TDS of 10,510 mg/L [15,686 µS/cm] and ranging between 1,460 mg/L [2,179 µS/cm]and 18,600 mg/L [27,761 µS/cm].

There are no groundwater monitoring bores for the Winchester South project or Moorvale South project that monitor the regolith, and water quality parameters in the regolith is based on data from the following Olive Downs bores:

- *GW12s (VP3831P) (8km SE of WS mining lease boundary, 18 km from offset area, mapped in geological unit TQa (Tertiary-Quaternary alluvium not associated with the Isaac River)). Total depth 42 mBGL, screened depth 30-42 mBGL.*
- *GW21s (VE3825P) (29km SE of WS mining lease boundary, 38 km from offset area, mapped in geological unit Tu (Tertiary Duaringa Formation)). Total depth 9 mBGL, screened depth 6-9 mBGL.*

The Olive Downs bores were sampled 3 times in Oct and Dec 2017 and Feb 2018 for the Olive Downs project (Attachment A2 of Hydrosimulations 2018), however it's not clear if data from additional monitoring events at these bores was used for the Winchester South project. Olive Downs bores GW06s and GW16s were also sampled between June 2017 and February 2018, however were dry each time.

Discussions around water quality in SLR 2022 do not consider bore census data (included in the appendices, and identified in the groundwater report as privately owned bores) that provides surface water levels and EC data from bores within the lease area sampled during one event in November 2017 as part of the Olive Downs project. These include:

- *Winchester Downs 14: within mine lease, 6.75km NW of offset area. Total depth 14 mBGL, SWL 3.3 mBGL, EC 3,003 µS/cm (2,012 mg/L)*
- *Winchester Downs 15: within mine lease, 7.25km NW of offset area. Total depth 23.2 mBGL, SWL 9.5 mBGL, EC 2063 µS/cm (1,382 mg/L)*

RDEIS Attachment 9 – Aquatic ecology and stygofauna report summarises bores sampled for stygofauna in table 2.2. Borehole MB3 (Eagle Downs) is stated to be in the regolith with a salinity of 18,000 µS/cm, however it is actually located in the Rewan Group according to the geological mapping and Table 5-4 of SLR 2022 (although it is labelled as a regolith bore in Figure 5-2 of SLR 2022. It is not clear if data from this bore has been used to characterise water quality parameters in the regolith or Rewan Formation.

Discuss the data used for the water quality characterisation of the regolith, and whether it considered the site-specific data above.

Response

The Groundwater Assessment for the Project prepared by SLR described where water is present within the regolith material, it is generally highly saline, but can be brackish to moderately saline with an average Total Dissolved Solids (TDS) of 10,510 mg/L and ranging between 1,460 mg/L to 18,600 mg/L. The Groundwater Assessment for the Project also described water within the Permian strata was characterised as generally saline ranging between fresh and highly saline. Salinity in the coal seam units and interburden units of the Permian strata range between 923 mg/L to 16,400 mg/L and 421 mg/L and 18,400 mg/L, respectively.

As outlined in response to Item 3 of the Groundwater RFI (Section 4.3), it is inferred from available information that the Winchester Downs 14 bore may access the regolith. The salinity measurements collected for the bore census for the Olive Downs Project Groundwater Assessment reported a salinity of 3,003 µS/cm (2,012 mg/L) at the Winchester Downs 14 bore, which is in the salinity range for regolith (e.g. 1,460 mg/L to 18,600 mg/L) reported in the Groundwater Assessment for the Project and therefore does not change the characterisation of the water quality in this unit.

As outlined in response to Item 3 of the Groundwater RFI (Section 4.3), it is inferred from available information that the Winchester Downs 15 bore does not access the regolith, but the top of the underlying fresh Permian strata. The salinity measurements collected for the bore census for the Olive Downs Project Groundwater Assessment reported a salinity of 2,063 µS/cm (1,382 mg/L) at the Winchester Downs 15 bore, which is in the salinity range for Permian strata (e.g. 923 mg/L to 16,400 mg/L) reported in the Groundwater Assessment for the Project and therefore does not change the characterisation of the water quality in this unit.

Similar to the above, the salinity measurements within MB3 are also within the reported salinity ranges in the Groundwater Assessment for the Project and therefore does not change the characterisation of the water quality in this unit.

4.6 6. Lack of site-specific data to confirm the presence and extent of impermeable layers to interrupt movement of groundwater (IESC 28, 29)

Information Request

6. Lack of site-specific data to confirm the presence and extent of impermeable layers to interrupt movement of groundwater (IESC 28, 29)

p.69 (para 3) of RDEIS Attachment 5 - Groundwater (SLR 2022) states: Geological logs in the Study Area indicate the alluvium is underlain by low hydraulic conductivity stratigraphy (i.e. claystone, siltstone and sandstone), which restricts the rate of downward leakage to underlying formations. This is almost identical to the wording in the Olive Downs groundwater assessment (p. 53 of HydroSimulations 2018), however it is not clear what site-specific data supports the extent of clay barriers across the Winchester South site.

The geological logs referred to in SLR 2022 and their locations have not been included in the EIS and it is not clear whether these assumptions on the vertical hydraulic conductivity of the regolith made for Olive Downs should apply the Winchester South site.

p.43 (para 1) of SLR 2022 refers to drillhole WSN206 in the Isaac River alluvium where sand was underlain by (presumably less permeable) siltstone, however this drillhole is stated to be located 3 km north-east of the project boundary, therefore cannot be described as site-specific information.

For the Olive Downs groundwater drawdown predictions, the alluvium and regolith (both conceptualised as unconsolidated and unconfined units) were modelled together, however for Winchester South they were modelled separately, implying that there is limited interaction between the two units. *It is not clear what site-specific information is used to support this assertion, particularly considering the lack of site-specific data for the alluvium and regolith.*

Provide site-specific data that supports the presence and extent of impermeable layers that would interrupt the movement of groundwater. Provided data should clarify the thickness, lateral continuity and hydraulic conductivity of these layers.

Response

Item 6 of the Groundwater RFI requested site-specific data to support the presence and extent of impermeable layers that would interrupt movement of groundwater. The Groundwater Assessment prepared by SLR did not include statements that there were any **impermeable** layers in the geology, rather, the quotes below (**bolded** for emphasis) from the Groundwater Assessment describe the limited hydraulic conductivity associated with the presence of clay layers:

Geological logs in the Study Area indicate the alluvium is underlain by ***low hydraulic conductivity stratigraphy (i.e. claystone, siltstone and sandstone), which restricts the rate of downward leakage to underlying formations****. Localised perched water tables within the alluvium are evident where waterbodies continue to hold water throughout the dry period (e.g. pools in the Isaac River and floodplain wetlands) and occur where* ***clay layers slow the percolation of surface water****.*

…

Tertiary-Quaternary aged sediments (regolith) present across the Project Area form the base of the unconfined shallow groundwater system. The groundwater flow processes are similar to those of the Isaac River alluvium; however, the ***fluxes are expected to be significantly lower due to the dominance of clay within the Tertiary sediments****.*

Whitehaven WS has undertaken extensive exploration drilling across the Project area with over 1,500 drill holes used to inform the site-specific geology model. A total of 966 exploration drillholes across the Project area have logged clay (denoted as CL in drill logs) as the dominant lithology type within the uppermost 5 m of the drillholes as shown on Figure 4-6A. The exploration drill holes also provide the average thickness of clay logged in the uppermost 5 m of each of these drillholes is 3.3 m. Item 1 of the Groundwater RFI provides further detail site-specific inputs used in the development of Project Site Geology Model and the numerical groundwater model for the Project.

The bulk vertical hydraulic conductivity through a given hydrogeologic unit will be controlled by (biased towards) the lowest vertical hydraulic conductivity of the strata that comprise the unit. A fundamental principle of hydrogeology is that finer grained unconsolidated materials have a lower hydraulic conductivity than coarser grained unconsolidated materials. The presence of clay as a dominant lithology type in the upper 5 m of the vast majority of exploration drillholes across the Project area therefore supports the Groundwater Assessment conclusions of sufficient low permeability strata at very shallow depths that would limit vertical movement of groundwater downwards into the underlying groundwater system.

As described in response to Item 1 of the Groundwater RFI (Section 4.1), Whitehaven WS will separately provide the site-specific exploration hole logs and TEM Survey Report.

The response provided to Item 2 of the Groundwater RFI (Section 4.2), provides the detailed description of the calibrated aquifer parameters adopted for the Isaac River alluvium and regolith.

Specifically, the ranges for horizontal hydraulic conductivity used in the numerical groundwater model typically covered several orders of magnitude, which ensured all possible field-testing results and hydraulic conductivities provided in published literature where considered and used.

A range of parameters were assessed as part of the sensitivity and uncertainty analysis for the horizontal and vertical hydraulic conductivities in the alluvium and regolith. Vertical hydraulic conductivity was calibrated as a factor of horizontal conductivity, also referred to as anisotropy. The results of the sensitivity analysis for the regolith are provided in response to Item 2 of the Groundwater RFI (Section 4.2), it is considered extremely unlikely the regolith unit would have a hydraulic conductivity outside the range considered in the Groundwater Assessment.

Item 6 of the Groundwater RFI included the following statement regarding the model layers in the numerical groundwater model for the alluvium and regolith:

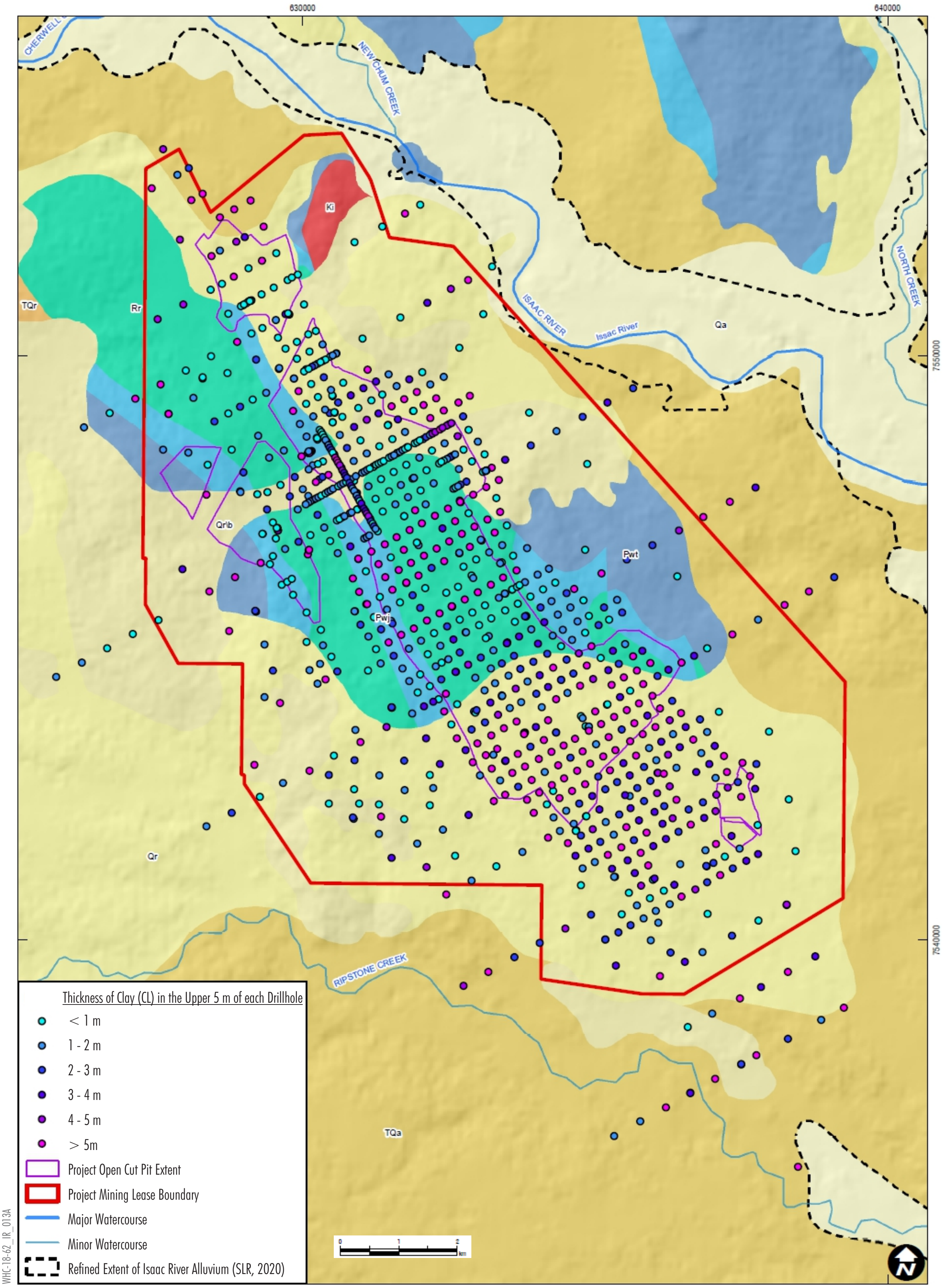
> *For the Olive Downs groundwater drawdown predictions, the* ***alluvium and regolith (both conceptualised as unconsolidated and unconfined units) were modelled together****, however for* ***Winchester South they were modelled separately, implying that there is limited interaction between the two units****.*

Item 6 of the Groundwater RFI incorrectly states the numerical groundwater modelling for the Olive Downs Project modelled alluvium and regolith together, as the Groundwater Assessment for the Olive Downs Project clearly states Model Layer 1 as 'Alluvium and Colluvium' and Model Layer 2 as 'Regolith' or 'Tertiary Sediments', consistent with the numerical groundwater model for the Winchester South Project.

Drawdown predictions for Model Layers 1 and 2 for the Olive Downs Project were only presented on a single figure and described as the 'Unconsolidated Sediments' as the Olive Downs Project was predicted to have drawdown in both surficial layers (where saturation is predicted). As there was negligible incremental drawdown predicted in the alluvium (i.e. Model Layer 1) for the Winchester South Project, the Groundwater Assessment for the Project only presented the predicted drawdown in the 'Regolith' (i.e. Model Layer 2).

Notwithstanding, Item 6 of the Groundwater RFI incorrectly states '*for Winchester South they were modelled separately, implying that there is limited interaction between the two units*'. The hydraulic interaction between Model Layer 1 and Model Layer 2 in the numerical groundwater model is a function of the associated hydraulic conductivities, particularly the vertical hydraulic conductivity rather than model layering. That is, modelling these units as separate layers in no way inhibits the potential interaction between the units in a modelling sense and is consistent with the previous modelling approach for the Olive Downs Project.

Furthermore, Whitehaven WS has committed to installing additional monitoring bores within the regolith groundwater unit to be incorporated into the groundwater monitoring program for the Project. This allows natural groundwater level fluctuations to be distinguished from potential groundwater level impacts due to drawdown resulting from proposed mining activities.



Source: SLR (2023)

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Site-specific Exploration Drillholes within Project Area and Thickness of Clay at Depths Less than 5 metres at each Exploration Drillhole

Figure 4-6A

4.7 7. Lack of site-specific data to confirm the presence and extent of impermeable layers to prevent seepage from waste rock emplacements (OWS 4)

Information Request

> *7. Lack of site-specific data to confirm the presence and extent of impermeable layers to prevent seepage from waste rock emplacements (OWS 4)*
>
> *P.132 (para 3) of SLR 2022 refers to 'in-situ Cainozoic sediments present between alluvium and regolith and out-of-pit waste rock emplacements' which would "prevent seepage from the waste rock emplacements to the regolith and alluvium."*
>
> *However, there is no data in the DEIS or RDEIS which demonstrates a consistent impermeable layer, especially given that some areas of out-of-pit waste rock emplacements will be directly overlying the regolith.*
>
> *While an impermeable layer beneath waste rock emplacements would prevent seepage to underlying formations, it may also prevent migration toward the pit as a groundwater sink. There is not enough detail to determine the fate of the seepage, i.e., whether all percolation of water through waste rock emplacements would express as surface water at the toe of the emplacements, or whether seepage would migrate along the top of any impermeable layer and express or collect elsewhere. This is particularly important for the out-of-pit waste rock emplacement associated with the Railway Pit which will receive coal rejects.*
>
> *Provide site-specific data that supports the presence and extent of impermeable layers that would prevent seepage from waste rock emplacements. Provided data should clarify the thickness, lateral continuity and hydraulic conductivity of these layers.*

Response

Item 7 of the Groundwater RFI requested site-specific data to support the presence and extent of 'impermeable layers' that would prevent seepage from waste rock emplacements. The Groundwater Assessment prepared by SLR did not include statements that there were any **impermeable** layers in the geology, rather, it states:

> *in-situ Cainozoic sediments present between the alluvium and regolith and the out-of-pit waste rock emplacements generally comprise surficial soil and clays, up to 10 m in thickness. Though not explicitly represented in the groundwater model, the surficial clays would inhibit potential seepage from the out-of-pit waste rock emplacements to the underlying regolith and alluvium. The flow path modelling is therefore conservative in this regard. Therefore, there would be no mechanism for groundwater seepage from the out-of-pit waste rock emplacements to impact on groundwater quality in the alluvium and regolith.*

In the context of the above, the use of the word **inhibit** refers to the significant reduction in vertical hydraulic conductivity that would occur with the presence of surficial soil and clays underlying the waste rock emplacements, as compared with higher hydraulic conductivity materials such as sand. It should not be taken to mean **impermeable**, which is by definition absolute and was not a term used in the Groundwater Assessment prepared by SLR.

Whitehaven WS has undertaken extensive exploration drilling across the Project area with over 1,500 drill holes used to inform the site-specific geology model. A total of 966 exploration drillholes across the Project area have logged clay (denoted as CL in drill logs) as the dominant lithology type within the uppermost 5 m of the drillholes as shown on Figure 4-6A. The exploration drill holes also provide the average thickness of clay logged in the uppermost 5 m of each of these drillholes is 3.3 m. Item 1 of the Groundwater RFI (Section 4.1) provides further detail site-specific inputs used in the development of Project Site Geology Model and the numerical groundwater model for the Project.

The bulk vertical hydraulic conductivity through a given hydrogeologic unit will be controlled by (biased towards) the lowest vertical hydraulic conductivity of the strata that comprise that unit. A fundamental principle of hydrogeology is that finer grained unconsolidated materials have a lower hydraulic conductivity than coarser grained unconsolidated materials. The presence of clay as a dominant lithology type in the upper 5 m of the vast majority of exploration drillholes across the Project area therefore supports the Groundwater Assessment conclusions of sufficient low permeability strata at very shallow depths that would limit vertical movement of seepage from waste rock emplacements downwards into the underlying groundwater system.

As described in response to Item 1 of the Groundwater RFI (Section 4.1), Whitehaven WS will separately provide the site-specific exploration hole logs and TEM Survey Report.

4.8 8. Geochemical data to further characterise the geochemical reactivity of waste rock and coal rejects (OWS 13, IESC 24)

Information Request

> *8. Geochemical data to further characterise the geochemical reactivity of waste rock and coal rejects (OWS 13, IESC 24)*
>
> *Coal rejects will be disposed of in the out-of-pit waste rock emplacement for the Railway Pit in the first phase of the project. 33% of coal reject samples assessed in Appendix M of the DEIS (geochemistry assessment) are classed as PAF or uncertain, so there is a potential risk of acid-forming runoff impacting surface water and groundwater without implementation of management controls. In addition, the geochemical analysis undertaken on samples from the single drill hole in the Railway Pit (WS3155) only analysed waste rock (interburden), not coal or rejects, therefore further geochemical analysis is required to fully understand the potential risks of disposal of coal rejects in out-of-pit waste rock emplacements.*
>
> *The proponent has only performed static geochemical tests, providing information on bulk geochemical characteristics of waste materials at a single point in time. While this provides a good indication of the physical, chemical and mineralogical composition of the potential overburden and coal reject waste material, static testing does not provide information on the reaction rates of chemical processes or the rates at which weathering products are released when exposed to the environment over long periods of time.*
>
> *The proponent should detail specific management controls to describe how on-site waste handling, storage and disposal will be managed to minimise co-disposal of coal reject and waste rock in the out-of-pit areas, and minimise the potential impacts of PAF material on groundwater.*
>
> *Management controls should be based on results from geochemical characterisation of the material across the site, including waste rock/overburden/interburden, fine coal reject (discussed as tailings) and mid/coarse coal reject with good sample design to cover site variability to determine with statistical certainty what material is NAF/PAF and other characteristics such as metal/metalloid concentrations.*
>
> *The proponent should undertake further geochemical testing on coal and/or coal rejects from the Railway Pit to fully understand potential impacts on surface water and groundwater resources as a result of out-of-pit waste rock emplacements.*
>
> *In addition, the proponent should perform kinetic tests on waste rock and coal reject samples assessing how water quality is affected when backfilled waste material interacts with water over prolonged periods of time. This will provide a better understanding of the cumulative effects of waste rock and coal reject backfill on groundwater resources.*

Response

Terrenus (2023) has undertaken a re-evaluation of environmental geochemical data from potential coal reject from the Project and compared the data to environmental geochemical data for coal reject from neighbouring mines close to the Project and mining and processing coal from the Rangal Coal Measures. The re-assessment has found that:

- The geochemical characteristics of potential rejects samples obtained from the Project are consistent with the geochemical characteristics of actual rejects samples from neighbouring mines extracting and processing coal from the Rangal Coal Measures.
- Rejects from the Project – as a bulk material – have low sulfur and sulfide concentrations coupled with moderate to high acid neutralising capacity (ANC), which is mostly in a readily available form. As such, bulk rejects pose a low risk of developing acid drainage and a negligible risk of developing saline drainage from sulfide oxidation.
- Soluble multi-element results indicate that leachate from rejects from the Project is expected to contain low concentrations of soluble metals and metalloids – similar to rejects from neighbouring mines.
- Based on the results, rejects from the Project – as a bulk material – have a low potential to generate AD and/or NMD and/or SD [i.e. non-oxidative salinity from sulfide oxidation]. A small proportion of rejects may have some potential to generate low-level AD and/or NMD (as discrete samples), however when mixed throughout bulk NAF material, the AMD risk posed by what is expected to be a small proportion of rejects is low.

Reject material is expected to comprise approximately 5% of total mineral waste at the Project and about 3% of mineral waste in the out-of-pit waste rock emplacement– with the overwhelming majority of mineral waste being mined waste rock (spoil). When placed amongst pH-neutral to alkaline NAF waste rock, rejects pose a low risk of environmental harm. Run-off and seepage from uncapped coal reject emplacement areas would be captured by the mine-affected water system as shown conceptually in Figure 4-8A.

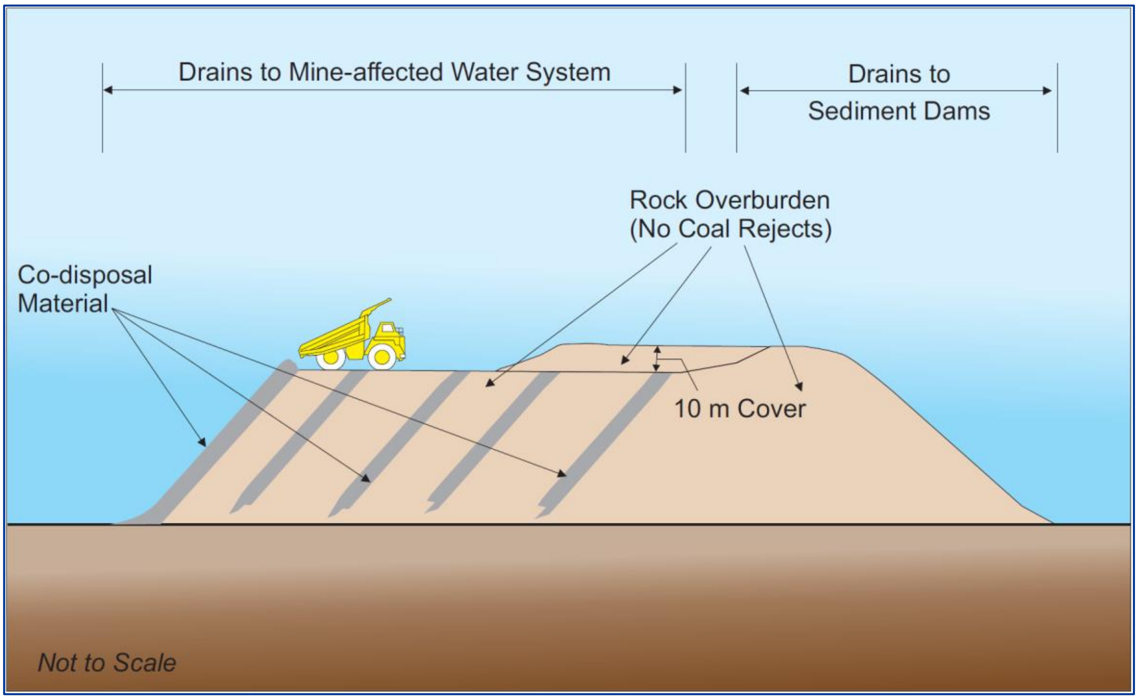


Figure 4-8A – Conceptual Diagram of Co-disposal Management Strategy for the Project

Notwithstanding, Whitehaven WS has provided a range of commitments, including a commitment for the geochemical test work validation for coal reject from the CHPP to be undertaken during development of the Project. The test work would be undertaken during the first two years of CHPP operation and whenever new seams/plies are being processed. Test work will comprise a broad suite of environmental geochemical parameters, such as pH, EC, acid-base account parameters and total and soluble metals/metalloids. If the results of testing indicate that the coal rejects are high risk then further measures will be implemented over the life of the Project.

With these mitigation and management measures, environmental risk from coal reject and associated seepage and runoff is expected to be low.

4.9 9. Inconsistent conceptualisation of the Isaac River (OWS 10 and IESC 13)

Information Request

> *9. Inconsistent conceptualisation of the Isaac River (OWS 10 and IESC 13)*
>
> *The mass balance for the groundwater model assumes the Isaac River will lose an average of 14.69ML/day to groundwater, and that groundwater will also provide an average of 12.8ML/day to the Isaac River as baseflow. However, the Isaac River is conceptualised as a losing stream in the groundwater assessment, and only acts as a gaining stream for short periods of time following extended periods of heavy rain.*
>
> *Describe the accuracy and adequacy of the groundwater model when the mass balance results don't align with the conceptualisation.*

Response

A conceptual model of the groundwater regime was developed based on the review of the hydrogeological data for the Project area and immediate surrounds. The numerical groundwater model, however, is significantly broader in scale, as is necessary to meet the requirements for cumulative impact assessment at the regional water resource scale in the *Information guidelines for proponents preparing coal seam gas and large coal mining development proposals* published by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (2018). The steady-state and transient mass balances for the numerical groundwater model is undertaken across the entire extent of the numerical groundwater model (i.e. at the regional water resource scale). As such, they are not directly comparable to the conceptual model of the groundwater regime at the scale of the Project area and immediate surrounds as they include regional processes occurring beyond the area of the conceptual model.

The conceptualisation model of the groundwater regime describes the Isaac River is conceptually 'losing' near the Project, specifically the section of the Isaac River between Moranbah and the Olive Downs Project, which is consistent with the numerical groundwater model near the Project.

However, approximately 40 km south-east of the Project (i.e. far downstream beyond the conceptual model), the numerical groundwater model predicts the Isaac River becomes a gaining system as part of the natural system. As a result, the mass balance for the Isaac River across the regional scale numerical groundwater model domain does show the Isaac River receives baseflow (e.g. a gaining system) in parts of the numerical groundwater model domain.

The mass balance error for the steady-state calibration is within the 1% error threshold recommended by the *Australian Groundwater Modelling Guidelines* (Barnett *et al.*, 2012). The maximum absolute mass balance error across all timesteps in the transient calibration was 0.04%, with cumulative absolute error remaining below 0.01%. This level of error is well within the recommended 1% error (Barnett *et al.*, 2012), indicating the numerical groundwater model is stable and the numerical solution achieved is accurate with respect to the simulated water balance.

4.10 10. Cumulative impacts – exclusion of other projects (OWS 8, 9 and IESC 14b, 14c and 48)

Information Request

10. Cumulative impacts – exclusion of other projects (OWS 8, 9, IESC 14b, 14c and 48)

The Isaac Downs and Millennium Mines were not included in the groundwater model due to being too distant (11 and 10 km away respectively) for cumulative drawdown impacts to occur, however this is not supported with specific evidence.

Poitrel mine has been excluded from the model calibration and predictive periods (p.53 of Appendix B of SLR 2022). This requires further discussion.

The Bowen Gas Project was not included in the cumulative model (confirmed during meeting between DCCEEW, OWS, OCG and Whitehaven on 30 March 2023) however the cumulative impacts were identified as being sensitive to the inclusion of this project, therefore it should be included in the cumulative modelling.

It is important to have this consideration prior to FEIS to fully understand cumulative impacts. It may be the case that there are no areas of overlying impacts with other operations, but this conclusion should be confirmed with the support of groundwater modelling.

Update the cumulative impact modelling to include excluded projects, or provide evidence that demonstrates excluded projects will not impact cumulative drawdown.

Response

Whitehaven WS has data sharing agreements with the owners of the Olive Downs Project and Moorvale South Project, which allows for the sharing of data, models and documentation. As such, the existing 3D numerical groundwater flow model that was developed for the Olive Downs Project and Moorvale South Project, was adopted for the Project and updated with site-specific data.

The groundwater model is centred over the Project and is elongated in the north-west to south-east direction to follow geological strike. The numerical groundwater model is approximately 65 km by 70 km (Figure 4-1C). The numerical groundwater model domain was specifically expanded in the north-west region for the Project to maintain a sufficient distance between the boundary conditions from the Project to not affect the modelling results (i.e. no edge effects). Furthermore, the numerical groundwater model domain was based on the following considerations:

- The western and eastern boundaries are represented by the outcrop of the Back Creek Group, which is considered the regional low permeability basement and is expected to be outside the range of predicted Project-related drawdown.
- The northern boundary contains the primary aquifers being mined by the Project and is at least 10 km away from the proposed open cut pits and is expected to be outside the range of predicted Project-related drawdown.
- The southern boundary is at least 35 km from the Project and is expected to be far outside the range of predicted Project-related drawdown.

The extent of the numerical groundwater model for the Project is sufficiently large to predict and assess the Project-only and cumulative drawdown associated with the Project. The Isaac Downs and Millennium Mines were not included in the cumulative modelling as these operations are located outside the extent of the numerical groundwater model and Poitrel Mine effectively acts as a hydraulic barrier between the Project and the Isaac Downs and Millennium Mines, limiting the ability of drawdown impacts from Isaac Downs and Millennium Mines to interact with the Project. A review of recent publicly available groundwater drawdown predictions for these operations were undertaken and supported that there would be no overlap between the predicted drawdown associated with the Project and the drawdowns predicted at the Isaac Downs and Millennium Mines. Similarly, the predicted drawdown for the Project does not overlap with the predicted extent of drawdown for the Bowen Gas Project, and as such the two do not have a cumulative drawdown impact. As such, whilst the cumulative modelling is sensitive to the inclusion of the Bowen Gas Project, the influence is to the east of the Project associated with the Olive Downs Project, but not in areas near the Project and therefore there is no overlap with the Project drawdown predictions (i.e. no cumulative drawdown impact).

The Groundwater Assessment included discussion regarding the Poitrel Mine influencing the Project-only predictions (e.g. incremental drawdowns, pit inflows, etc.). SLR identified isolated incremental drawdown areas at Poitrel Mine that were laterally separated from the drawdowns at the Project (e.g. not connected to Project-only drawdown) indicating that these results were erroneous. The numerical groundwater model was subject to thorough quality control processing. As such, Poitrel Mine was excluded from the calibration process only, however, the cumulative numerical groundwater modelling did include simulation of Poitrel Mine and was assessed.

4.11 11. Sensitivity and uncertainty analysis (OWS 5c and IESC 14a)

Information Request

11. Sensitivity and uncertainty analysis (OWS 5c and IESC 14a)

OWS and IESC commend the proponent for using a Type 3 Monte Carlo uncertainty analysis; however, the sensitivity and uncertainty analysis should be extended to encompass a plausible range of hydrogeologic parameters and to ensure that the likely range of drawdown is captured (Whitehaven Coal 2021, App. A, App. B, pp. 70- 73). If drawdown in the regolith is greater than predicted (5 m), then drawdown in the alluvium may be significantly greater than predicted.

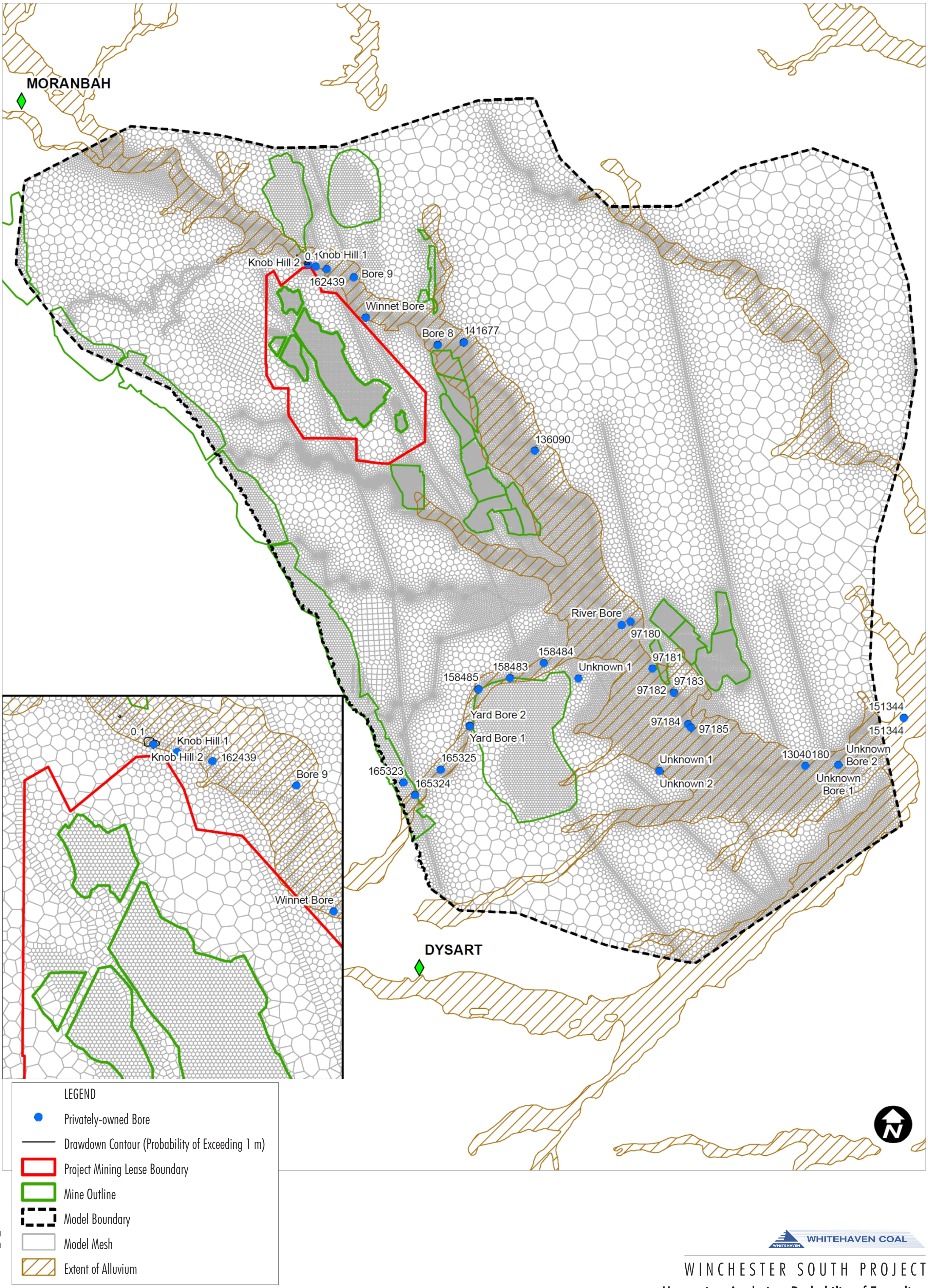
Expand the sensitivity and uncertainty analysis to a greater range of hydrogeologic parameters, or clearly justified as to why this is not necessary.

Response

The responses provided to Items 1 and 2 of the Groundwater RFI above (Sections 4.1 and 4.2) provides the site-specific data that was used to develop the Project Site Geology Model and numerical groundwater model, as well as the calibrated hydraulic parameters adopted in the model based on an extensive range of data. The ranges for hydraulic conductivity used in the numerical groundwater model typically covered orders of magnitude, which ensured all possible field testing results and hydraulic conductivities provided in published literature where considered and used. As a large range of hydraulic conductivities were considered in the numerical groundwater modelling, additional field data in the alluvium and regolith would only fall within the modelled ranges but not provide values not already considered in the model. Therefore, the numerical groundwater model provides a more conservative assessment of groundwater impacts by considering a wider range of hydraulic conductivities than would be obtained from further field testing.

The accuracy of the groundwater level predictions for bores in the alluvium and colluvium units (i.e. Model Layer 1) are supported by the arithmetic mean calibration residual error of approximately 1 m, which is within the observed seasonal/natural variation in groundwater levels for bores in the alluvium. Therefore, model predictions are close to existing groundwater data for alluvium, providing confidence in the performance of the numerical groundwater model for alluvium.

SLR undertook an uncertainty analysis of drawdown probabilities which provided a 'worst-case' assessment by using predictive simulation using the full possible range of parameter values across all 229 predictive numerical groundwater models. The uncertainty analysis calculated a 90% probability of drawdown less than 1 m in the alluvium and colluvium (e.g. Model Layer 1) within the numerical groundwater model domain with the exception of very small area near Knob Hill 2 bore (Figure 4-11A). Drawdown of less than 1 m in the Isaac River alluvium over the life of the Project would be unmeasurable as it would be indistinguishable from natural groundwater level variability.



Source: SLR (2023)

WINCHESTER SOUTH PROJECT

Uncertainty Analysis – Probability of Exceeding 1 m Drawdown in Quaternary Alluvium and Colluvium (Model Layer 1)

Figure 4-11A

4.12 12. Exclusion of excised or diverted waterways from the groundwater model (IESC 5, 9, 10, 11, 14e, 27, 48)

Information Request

12. Exclusion of excised or diverted waterways from the groundwater model (IESC 5, 9,10, 11, 14e, 27, 48)

The potential impacts to alluvial aquifers associated with ephemeral creeks prior to the confluence with the Isaac River have not been adequately discussed. Associated ecological features may be of particular significance due to the region being highly degraded and should therefore be given greater consideration when exploring impacts.

Update the groundwater model to include the impacts of excision or diversion of waterways on site.

Response

As described in the Groundwater Assessment, rainfall recharge was applied to the numerical groundwater model using the MODFLOW-USG Recharge Package. The numerical groundwater model distributed the recharge in zones across the model domain according to outcropping geology. The numerical groundwater model assigned a proportion of annual rainfall to each of these zones based on the recharge parameters that were calibrated during the model calibration process.

Where open cut mining for the Project is proposed in areas where within the existing streams are mapped (e.g. watercourses, waterways, drainage features, etc.), recharge from these streams is removed from the groundwater numerical model since no recharge is applied in active mining areas in the model. Therefore, the results from the numerical groundwater model presented in the Groundwater Assessment account for the reduction in recharge that might result from excising these streams.

Whitehaven WS maintains that the significant existing body of work that has been undertaken to characterise ecological features and potential GDEs in the region and specifically in the vicinity of the Project is sufficient, especially considering the lack of potential impact mechanisms to the potential GDEs. Notwithstanding, Whitehaven WS would accept a condition requiring preparation of GDE Management and Monitoring Program to monitor for potential impacts, and the provision of offsets if impacts observed are greater than predicted the impacts predicted, consistent with the approach taken for other contemporary projects in the vicinity of the Project.

4.13 13. Other groundwater characterisation and modelling issues raised by IESC and OWS

Information Request

13. Other groundwater characterisation and modelling issues raised by IESC and OWS

- *OWS 5a: Provide predicted drawdown for the interburden as there are private bores which access these units.*
- *OWS 5c: Include localised drawdown from privately owned bores in the model*
- *OWS 5i: Model climate change scenarios (including for residual voids – IESC 15).*
- *OWS 12: Provide details of privately-owned bores that could potentially reach the thresholds, defined in Chapter 3 of the Water Act 2000, of 2 m for unconsolidated aquifers and 5 m for consolidated aquifers due to the contribution of this project to the cumulative drawdown within and around the project area.*

Response

As described in response to Item 1 of the Groundwater RFI (Section 4.1), the interburden units of the Permian coal measures within the numerical groundwater model are conceptualised as hydrogeologically ‘tight’ with aquitard properties. As the interburden units show aquitard properties, the unit does not meet the definition of an aquifer. Further, predicted drawdown as a result of the Project is not expected to propagate to identified privately-owned bores that may be accessing the Permian coal measures and therefore, there is limited mechanism for impact to privately-owned bores.

Localised extraction and associated drawdown from privately-owned bores within the extent of the numerical groundwater model would be negligible in a regional water balance sense, particularly in comparison to regional mine related groundwater extraction, and therefore would be very unlikely to affect the outcomes for the drawdown predictions. Any incremental drawdown from localised extraction from privately-owned bores would occur in each of the model run scenarios (e.g. null run, approved and cumulative) and therefore, there would be no difference in the drawdown predictions presented in the Groundwater Assessment if that privately-owned bore extraction was included.

The sensitivity and uncertainty analysis undertaken by SLR for the Groundwater Assessment included analysis of recharge parameters to evaluate potential changes to the future climate. Different recharge zones were applied to the model for areas of different mapped surficial geologies. Figures 4-13A and 4-13B (from Appendix B of the Groundwater Assessment) show that the results of the predictive sensitivity analysis for these recharge zones provide sensitivity derivatives of less than 0.2 for all recharge zones, in terms of the effect of recharge on groundwater drawdown predictions. This indicates little sensitivity of the model drawdown predictions to applied recharge rates. Therefore, recharge (from rainfall) is considered to be less impactful to model predictions and therefore, climate change would have limited effect on the outcomes of the numerical groundwater modelling.

The majority of water inflows to the residual voids would be via direct rainfall to the water body and surface water runoff from rehabilitated land within the residual void catchment area (approximately 97% of inflows from direct rainfall and runoff). The characteristics of runoff from within the rehabilitated land is expected to be similar to natural runoff from undisturbed land. Groundwater inflows to the residual voids only accounts for approximately 3% of the inflows, having relatively little, if any, effect on the residual void water levels and significantly reducing the effect of the water quality from the groundwater inflows on the water quality in the residual voids. Therefore, variability of groundwater inflows as a result of climate change is unlikely to materially change the outcomes of the residual void balance, particularly in comparison to variability of runoff as a result of climate change. WRM undertook a sensitivity analysis on residual void behaviour using climate change projections and methodologies given in the CSIRO and the BoM report titled *Climate Change in Australia Technical Report* (CSIRO, 2015). The response provided to Item 20 of the Groundwater RFI (Section 4.2) provides the outcomes of the sensitivity analysis on residual void behaviour using the climate change projections.

As described in the Groundwater Assessment prepared by SLR, no privately-owned bores are predicted to exceed relevant bore trigger thresholds in the Chapter 3 of the Water Act and therefore there are no existing privately-owned bores that would be impacted by the Project. Notwithstanding, in accordance with Chapter 3 of the Water Act, if any impacts on bore users exceed the magnitude of impacts predicted in the Groundwater Assessment, Whitehaven WS would 'make good provisions' to allow the bore user to have access to a similar quantity and quality of water for the authorised purpose. Examples of 'make good provisions' include deepening a bore to increase its pumping capacity, constructing a new water supply bore, providing water from an alternative source or financial compensation.

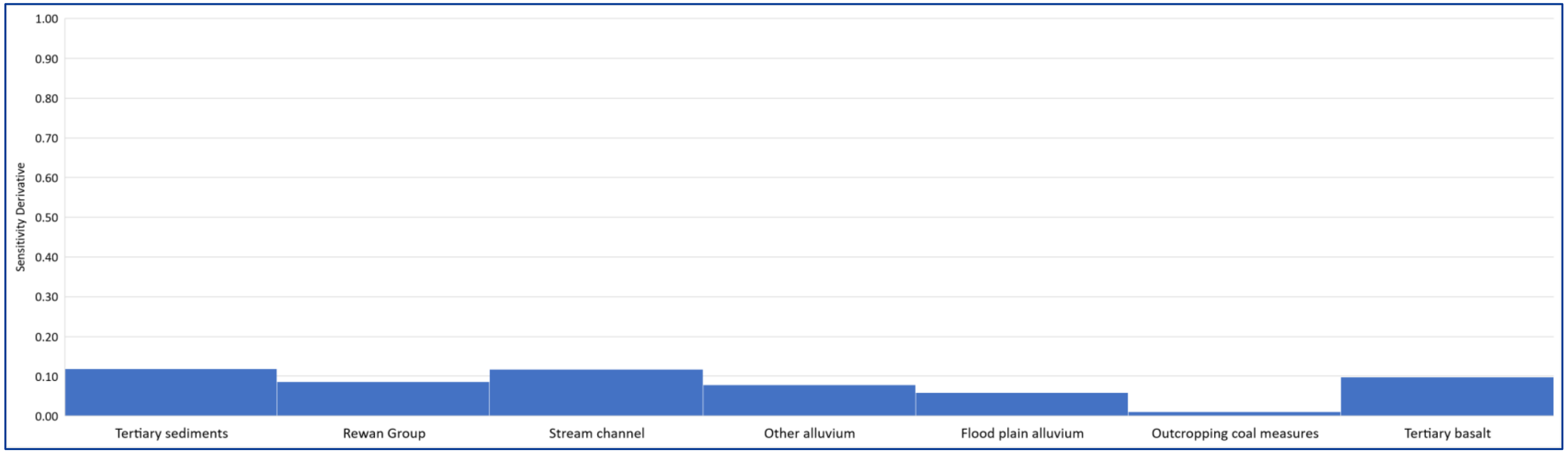


Figure 4-13A – Alluvium/Colluvium Drawdown Area (Layer 1) Sensitivity Derivatives – Recharge

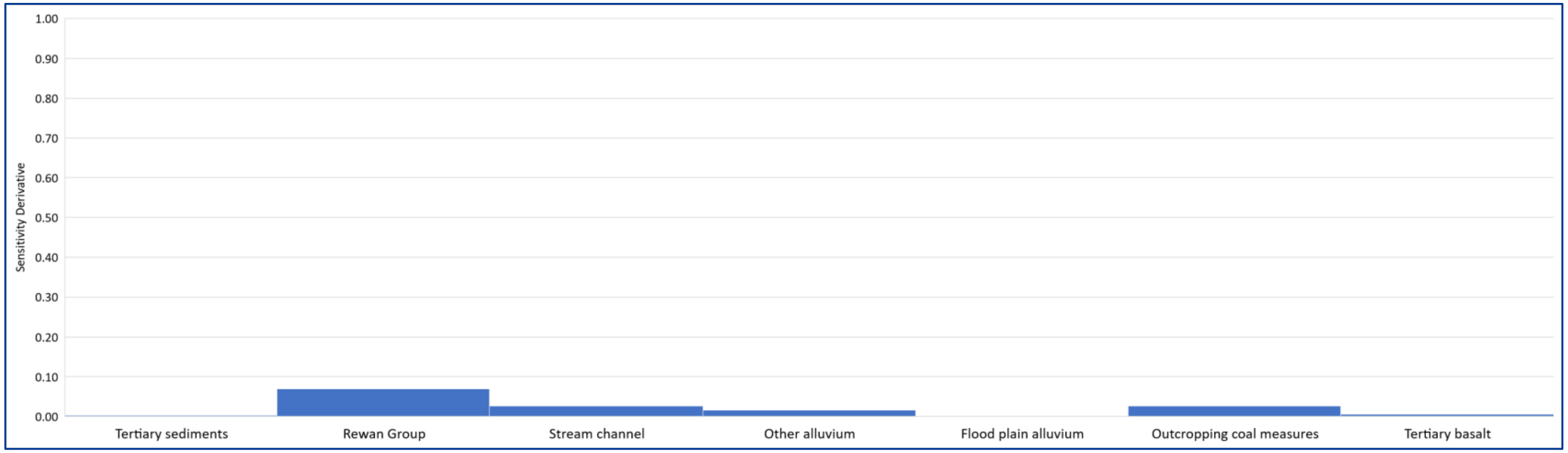


Figure 4-13B – Permian Coal Seam Drawdown Area (Layer 7) Sensitivity Derivatives – Recharge

4.14 14. Disproportionate significance of GDEs providing habitat for MNES (OWS 18, 20 and IESC 3, 11, 32, 33, 42, 43, 44, 50)

Information Request

> *14. Disproportionate significance of GDEs providing habitat for MNES (OWS 18, 20, IESC 3, 11, 32, 33, 42, 43, 44, 50)*
>
> *Groundwater drawdown as a result of the project may impact on groundwater dependent ecosystems (GDEs). GDEs in and adjacent to the project area and the proposed Wynette offset area (such as Brigalow) may provide habitat for MNES and as previously raised by OWS and the IESC, these pockets of habitat may be disproportionately significant for the species that rely on them given the highly degraded surrounding landscape.*
>
> *Update the groundwater impact assessment to include the disproportionate significance of GDEs to provide habitat for MNES*

Response

Integrated Assessment of Impacts on Groundwater Dependent Ecosystems (Appendix F of the Revised Draft EIS) adopted vegetation mapping that was based on terrestrial ecology ground-truthing surveys (including for the Brigalow TEC and Poplar Box TEC) throughout the Project area and surrounds, as well as within the Wynette Offset Area undertaken by E2M Consulting. Extensive ground-truthing surveys across the Project area included:

- 318 quaternary assessments;
- 6 tertiary assessments;
- 54 BioCondition assessments; and
- 98 threatened ecological community assessments.

SLR undertook an uncertainty analysis of drawdown probabilities which provided a 'worst-case' assessment by using predictive simulation using the full possible range of parameter values across all 229 predictive numerical groundwater models. The uncertainty analysis calculated a 90% probability of drawdown less than 1 m in the alluvium across the numerical groundwater model domain with the exception of very small area near Knob Hill 2. Drawdown of less than 1 m in the Isaac River alluvium would be unmeasurable over the duration of the Project as it would be indistinguishable from natural groundwater level variability. As such, regardless of any groundwater-dependency, there is negligible predicted groundwater drawdown of the Isaac River alluvium due to the Project and therefore, there is no mechanism for drawdown-related impacts to GDEs as a result of the Project.

Drawdown in the regolith due to the Project does not overlap with any areas of riparian vegetation or any areas of ground-truthed Brigalow TEC or Poplar Box TEC, and therefore, there is no mechanism for drawdown-related impacts as a result of the Project.

As the Project would not result in groundwater drawdown at areas of potential GDE there is little consequence of debating actual groundwater-dependency. Augmenting the ecological and environmental significance of the areas of potential GDEs has no effect on the potential impacts of Project-driven groundwater drawdown as the impact mechanism, pathway and likelihood is not affected by the real or perceived ecological and environmental significance of the potential GDEs.

Supplementary stygofauna sampling was completed by ESP in February 2022, targeting bores in the regolith and Isaac River alluvium. During the supplementary survey, stygofauna taxa were recorded from one bore targeting the Isaac River alluvium, including *Ostracods* from family *Candonidae* (2 specimens) and *Syncarida* from family *Bathynellidae* (10 specimens). Both of these families are obligate inhabitants of groundwater ecosystems (i.e. stygobites). *Bathynellidae* are widespread and occur in most alluvial aquifers across Australia. The taxonomy of the family *Bathynellidae* is relatively unresolved, with only a few genera described (Peter Hancock, 2022, pers. comm.). All are obligate groundwater dwellers that rely on groundwater habitats for their entire lifecycle. *Candonidae* includes both surface water and groundwater dwelling *ostracod* species. Although it was not possible to identify the specimens recorded during the current survey to species level, examination of key features determined that they were likely obligate stygofauna species (Peter Hancock 2022, pers. comm.). As described above, there is negligible predicted groundwater drawdown of the Isaac River alluvium due to the Project and therefore, aquatic ecosystems downstream of the Project area are not expected. As such, the Project is not expected to impact on subterranean or aquatic GDEs.

Whitehaven WS has also provided commitments to installation additional monitoring bores for the regolith and Leichhardt Seam groundwater units and incorporated into the groundwater monitoring program for the Project. This allows natural groundwater level fluctuations to be distinguished from potential groundwater level impacts due to depressurisation resulting from proposed mining activities. Whitehaven WS has also committed to installing additional monitoring alluvial bores in the vicinity of the existing Winnet and Knob Hill bores with opportunity for bore locations to be selected in consultation with the relevant Government agencies prior to installation.

4.15 15. Ground-truthing of GDEs (OWS 17, 18a, 18b and IESC 2, 9, 28, 29, 30, 45)

Information Request

> *15. Ground-truthing of GDEs (OWS 17, 18a, 18b, IESC 2, 9, 28, 29, 30, 45)*
>
> *Given the potentially disproportionate significance of these ecosystems in the area, the proponent should remove all possible uncertainty on the groundwater dependency of riparian vegetation.*
>
> *Notwithstanding the provision of site-specific data to support groundwater modelling, the proponent should undertake robust ground-truthing surveys of GDEs including the Brigalow TEC and Poplar Box TEC, as well as further stygofauna sampling in the alluvium and regolith.*
>
> *Furthermore, the presence of underlying clay material should not be relied on to justify terrestrial ecosystems being unlikely to be dependent on groundwater. The proponent should use ground-truthing methods as specified by Doody et al. (2019) and reflected in previous OWS and IESC advice.*

Response

Integrated Assessment of Impacts on Groundwater Dependent Ecosystems (Appendix F of the Revised Draft EIS) adopted vegetation mapping that was based on terrestrial ecology ground-truthing surveys (including for the Brigalow TEC and Poplar Box TEC) throughout the Project area and surrounds, as well as within the Wynette Offset Area, undertaken by E2M Consulting. Extensive ground-truthing surveys across the Project area included:

- 318 quaternary assessments;
- 6 tertiary assessments;
- 54 BioCondition assessments; and
- 98 threatened ecological community assessments.

SLR undertook an uncertainty analysis of drawdown probabilities which provided a 'worst-case' assessment by using predictive simulation using the full possible range of parameter values across all 229 predictive numerical groundwater models. The uncertainty analysis calculated a 90% probability of drawdown less than 1 m in the alluvium within the numerical groundwater model domain with the exception of very small area near Knob Hill 2. Drawdown of less than 1 m in the Isaac River alluvium would be unmeasurable over the duration of the Project as it would be indistinguishable from natural groundwater level variability. As such, regardless of any groundwater-dependency, there is negligible predicted groundwater drawdown of the Isaac River alluvium due to the Project and therefore, there is no mechanism for drawdown-related impacts to GDEs as a result of the Project.

Drawdown in the regolith due to the Project does not overlap with any areas of riparian vegetation or any areas of ground-truthed Brigalow TEC or Poplar Box TEC, and therefore, there is no mechanism for drawdown-related impacts as a result of the Project.

As the Project would likely not result in groundwater drawdown at areas of potential GDEs, there is little consequence of debating actual groundwater-dependency. Augmenting the ecological and environmental significance of the areas of potential GDEs has no effect on the potential impacts of Project-driven groundwater drawdown as the impact mechanism, pathway and likelihood is not affected by the real or perceived ecological and environmental significance of the potential GDEs.

Supplementary stygofauna sampling was completed by ESP in February 2022, targeting bores in the regolith and Isaac River alluvium. During the supplementary survey, stygofauna taxa were recorded from one bore targeting the Isaac River alluvium, including *Ostracods* from family *Candonidae* (2 specimens) and *Syncarida* from family *Bathynellidae* (10 specimens). Both of these families are obligate inhabitants of groundwater ecosystems (i.e. stygobites). *Bathynellidae* are widespread and occur in most alluvial aquifers across Australia. The taxonomy of the family *Bathynellidae* is relatively unresolved, with only a few genera described (Peter Hancock, 2022, pers. comm.). All are obligate groundwater dwellers that rely on groundwater habitats for their entire lifecycle. *Candonidae* includes both surface water and groundwater dwelling ostracod species. Although it was not possible to identify the specimens recorded during the current survey to species level, examination of key features determined that they were likely obligate stygofauna species (Peter Hancock 2022, pers. comm.). As described above, there is negligible predicted groundwater drawdown of the Isaac River alluvium due to the Project and therefore, aquatic ecosystems downstream of the Project area are not expected. As such, the Project is not expected to impact on subterranean or aquatic GDEs.

Whitehaven WS has provided commitments for the installation of additional monitoring bores within the regolith and Leichhardt Seam groundwater units to be incorporated into the groundwater monitoring program for the Project. This allows natural groundwater level fluctuations to be distinguished from potential groundwater level impacts due to depressurisation resulting from proposed mining activities. Whitehaven WS has also committed to installing additional alluvial monitoring bores in the vicinity of the existing Winnet Bore and Knob Hill 1 and 2 Bores (as potential replacements) with opportunity for bore locations to be selected in consultation with the relevant Government agencies prior to installation.

4.16 16. Monitoring of GDEs and Wynette offset area

Information Request

> *16. Monitoring of GDEs and Wynette offset area*
>
> *There is significant uncertainty around potential impacts to GDEs and the proposed Wynette offset area from cumulative groundwater drawdown from the Winchester South project and neighbouring coal mines. Given this uncertainty, and the fact that the impacts of excised or diverted waterways have not yet been incorporated into the groundwater model, a conservative approach to conditioning is required to monitor potential impacts to GDEs and the Wynette offset area.*
>
> *Provide clear environmental commitments to monitor drawdown and ecosystem health in the Wynette offset area. If additional bores are required to monitor potential impacts on GDEs and the Wynette offset area, provide detailed spatial information (including mapping), and timing for the addition of these bores. In addition, provide evidence-based justification for the selected locations of these bores. Bore locations should be considered in terms of predictive drawdown modelling, protection of environmental values, and ease of ongoing bore accessibility. These bores should be established as soon as possible to ensure that adequate baseline data is collated to enable water level and quality information to be included in the proposed EA conditions.*
>
> *OCG, OWS and DES can work with Whitehaven to refine proposed bore locations to ensure the groundwater monitoring network is sufficient to monitor potential impacts to GDEs and the Wynette offset area.*

Response

Integrated Assessment of Impacts on Groundwater Dependent Ecosystems (Appendix F of the Revised Draft EIS) adopted vegetation mapping that was based on the terrestrial ecology ground-truthing surveys of the vegetation throughout the Project area and surrounds, as well as vegetation mapped within the Wynette Offset Area undertaken by E2M Consulting.

SLR undertook an uncertainty analysis of drawdown probabilities which provided a 'worst-case' assessment by using predictive simulation for the full possible range of parameter values across all 229 predictive numerical groundwater models. The uncertainty analysis calculated a 90% probability of drawdown less than 1 m in the alluvium within the numerical groundwater model domain with the exception of very small area near Knob Hill 2. Drawdown of less than 1 m in the Isaac River alluvium would be unmeasurable over the duration of the Project as it would be indistinguishable from natural groundwater level variability. As such, regardless of any groundwater-dependency, there is negligible predicted groundwater drawdown of the Isaac River alluvium due to the Project and therefore, there is no mechanism for drawdown-related impacts as a result of the Project.

Drawdown in the regolith due to the Project does not overlap with any areas of riparian vegetation or any areas of ground-truthed Brigalow TEC or Poplar Box TEC, and therefore, there is no mechanism for drawdown-related impacts as a result of the Project.

As the Project would not result in groundwater drawdown at areas of potential GDE there is little consequence of debating actual groundwater-dependency. Augmenting the ecological and environmental significance of the areas of potential GDEs has no effect on the potential impacts of Project-driven groundwater drawdown as the impact mechanism, pathway and likelihood is not affected by the real or perceived ecological and environmental significance of the potential GDEs.

Whitehaven WS maintains that the significant existing body of work that has been undertaken to characterise GDEs in the region and specifically in the vicinity of the Project is sufficient, especially considering the lack of potential impact mechanisms to the potential GDEs. Notwithstanding, Whitehaven WS would accept a condition requiring preparation of GDE Management and Monitoring Program to monitor for potential impacts, and the provision of offsets if impacts observed are greater than the impacts predicted, consistent with the approach taken for other contemporary projects in the vicinity of the Project.

Whitehaven WS has provided commitments for the installation additional monitoring bores within the regolith and Leichhardt Seam groundwater units to be incorporated into the groundwater monitoring program for the Project. This allows natural groundwater level fluctuations to be distinguished from potential groundwater level impacts due to depressurisation resulting from proposed mining activities. Whitehaven WS has also committed to installing additional alluvial monitoring bores in the vicinity of the existing Winnet Bore and Knob Hill 1 and 2 Bores (as potential replacements) with opportunity for bore locations to be selected in consultation with the relevant Government agencies prior to installation.

In addition to the proposed conditions and commitments outlined above, Whitehaven WS has also provided a comprehensive set of groundwater-related conditions for the EA, including conditions for site-specific triggers and investigation protocols, annual review of the groundwater monitoring program, review, and validation of the groundwater numerical model results against monitoring data and measured mine dewatering within two years of commencement and at least every five years thereafter.

4.17 17. Bores in the alluvium and regolith

Information Request

> *17. Bores in the alluvium and regolith*
>
> *There are concerns that the proposed groundwater monitoring program will not provide a representative or sufficiently early warning of potential drawdown impacts to the Isaac River alluvium and regolith. Worst-case drawdown impacts have been modelled in the RDEIS to result in a up to 0.3 m drawdown in the Isaac River alluvium, but a targeted alluvial-only monitoring regime is not clearly proposed.*
>
> *The three currently nominated alluvial bores (Winnet Bore and Knob Hill 1 and 2) lack detailed strata logs, drilling logs, well completion, and/or construction reports, and these bores may not specifically target the alluvial geologies alone (but may also target deeper regolith geologies). Without this information it is not possible to confirm the representativeness, specificity and sensitivity of the compliance monitoring data collected from these bores against any triggers or limits. In addition, two of these bores do not have assured accessibility within the draft EIS documents. They are privately owned, and no long-term agreements appears to be in place for bore access.*
>
> *Provide drilling logs for the proposed alluvial monitoring bores to enable evaluation of proposed draft EA conditions.*
>
> *For alluvial and regolith bores in the groundwater monitoring network that have not yet been constructed, provide a clear commitment, detailed spatial information (including mapping), and timing for the addition of these bores. In addition, provide evidence-based justification for the selected locations of these bores. Bore locations should be considered in terms of accurate alluvial contour mapping, predictive drawdown modelling, protection of environmental values, and ease of ongoing bore accessibility. These bores should be established as soon as possible to ensure that adequate baseline data is collated to enable water level and quality information to be included in the proposed EA conditions.*
>
> *OCG, OWS and DES can work with Whitehaven to refine proposed bore locations to ensure the groundwater monitoring network is sufficient to monitor potential impacts.*

Response

Whitehaven WS has provided commitments for the installation of additional monitoring bores within the regolith and Leichhardt Seam groundwater units to be incorporated into the groundwater monitoring program for the Project. This allows natural groundwater level fluctuations to be distinguished from potential groundwater level impacts due to depressurisation resulting from proposed mining activities. Whitehaven WS has also committed to installing additional alluvial monitoring bores in the vicinity of the existing Winnet Bore and Knob Hill 1 and 2 Bores (as potential replacements) with opportunity for bore locations to be selected in consultation with the relevant Government agencies prior to installation.

As the proposed additional monitoring bores in the alluvium, regolith and Leichhardt Seam groundwater units described above have not yet been installed, the drill logs cannot be provided. Once drilled, these will be provided as part of the Groundwater Management Plan to be implemented for the Project as well as via the required Queensland Government bore registration process.

Notwithstanding the groundwater monitoring program outlined above, the predicted Project-related drawdown of less than 1 m in the Isaac River alluvium would be unmeasurable over the duration of the Project as it would be indistinguishable from natural groundwater level variability.

4.18 18. Other bores

Information Request

> *18. Other bores*
>
> *Bore logs, strata logs and construction reports for monitoring bores in the groundwater monitoring program have not been provided. This information is required to enable appropriate draft EA conditioning.*
>
> *Provide drilling logs for seven (7) of the proposed monitoring bores presented in the draft EIS – (C2136, G2307, R2008, R20032, R2035, R2054, R2055) to enable evaluation of proposed draft EA conditions.*

Response

Whitehaven WS will separately provide the available drill logs for the groundwater monitoring bores outlined in the proposed EA conditions (i.e. C2136, G2307, R2008, R20032, R2035, R2054 and R2055).

Note, sufficient information to evaluate the proposed EA conditions for the groundwater monitoring bores was provided in the Attachment 1 of the Response to Submissions, including location, elevation, screen depth and the target aquifer. Indicative information for the proposed groundwater monitoring bores that are yet to be constructed has been provided, with specific information (e.g. final coordinates, drill logs, etc.) to be provided following installation.

4.19 19. Baseline water level data

Information Request

> *19. Baseline water level data*
>
> *Table E3 of the proposed EA conditions provides trigger thresholds for groundwater levels in each of the proposed monitoring bores. These thresholds are described as '> X metres beyond baseline data ranges' however baseline water level ranges for each bore have not been clearly identified in the EIS documents provided to date.*
>
> *Provide clearly identified baseline water level ranges for each bore in the groundwater monitoring network, including VWPs, to enable evaluation of proposed draft EA conditions.*

Response

The baseline water level data for the standpipe groundwater monitoring bores was provided in Appendix A of Appendix B of the Groundwater Assessment (SLR, 2022). Table 4-19A below provides the minimum and maximum groundwater levels for each of the proposed monitoring bores from the baseline water level data and the relevant groundwater level trigger thresholds.

Table 4-19A
Baseline Water Level Ranges for Groundwater Monitoring Bores

Monitoring Bore		Minimum Groundwater Level in Baseline Data (mAHD)	Maximum Groundwater Level in Baseline Data (mAHD)	Groundwater Level Trigger Threshold
C2105R		166.8	167.0	>17.0 m beyond baseline data range
C2136		165.4	166.5	>42.6 m beyond baseline data range
G2304R		166.7	166.9	>24.0 m beyond baseline data range
G2307		166.7	167.2	>62.0 m beyond baseline data range
R2008		182.1	183.4	>2 m beyond baseline data range
R2009R		138.9	141.8	>2 m beyond baseline data range
R2010R		176.2	176.7	>2 m beyond baseline data range
R2032		185.0	188.8	>27.6 m beyond baseline data range
R2034R		182.2	183.7	>2 m beyond baseline data range
R2035		188.5	189.5	>2 m beyond baseline data range
R2054		181.2	187.5	>79.2 m beyond baseline data range
R2055		187.5	189.2	>7.5 m beyond baseline data range
Knob Hill 1‡*		173.2	177.0	>2 m beyond baseline data range
Knob Hill 2‡*		178.3	181.6	>2 m beyond baseline data range
Winnet Bore*		169.9	171.6	>2 m beyond baseline data range
VWP1	Sensor 1	159.7	160.2	>2 m beyond baseline data range
	Sensor 2	167.0	168.7	>2 m beyond baseline data range
	Sensor 3	163.8	165.4	>2 m beyond baseline data range
VWP2	Sensor 1	163.5	163.8	>2 m beyond baseline data range
	Sensor 2	167.3	167.5	>2 m beyond baseline data range
	Sensor 3	158.2	158.4	>2 m beyond baseline data range

‡ Privately-owned bore, inclusion in monitoring network dependent on continued approval to access the bore from bore owner.
* Any additional monitoring bores in alluvium may replace these bores.

4.20 20. Assumptions for residual void modelling (IESC 4, 16)

Information Request

20. Assumptions for residual void modelling (IESC 4, 16)

Minimal additional information was provided regarding modelling on the behaviour of residual void lakes post mining (WRM 2022, pp. 111 – 117). The parameters used, and uncertainty was not provided for the residual void modelling. The salinity of groundwater inflows were provided, but no justification was provided for these, and appear to be based on inconsistent interpretations of the collected data.

Update the impact assessment of residual voids to consider how hypersaline voids may affect groundwater flow within the system, particularly variable density flow.

Response

WRM undertook a sensitivity analysis on residual void behaviour using climate change projections and methodologies given in the CSIRO and BoM report titled *Climate Change in Australia Technical Report* (CSIRO, 2015). *Climate Change in Australia Technical Report* (CSIRO, 2015) provides guidance on the possible projections of future climate for the Australian East Coast based on a current understanding of the climate system, historical trends, and model simulations of the climate response to changing greenhouse gas and decreasing aerosol emissions.

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

For this assessment, the conservative Representative Concentration Pathway 8.5 (RCP 8.5) emissions scenario has been adopted. WRM selected Year 2090 as the representative year as it is the current limit of climate change projections and is approximately 40 years post-mine closure. Potential changes in climate were obtained using the projection builder tool provided in the Climate Change Australia website. Climate variable inputs for the 'best-case', 'maximum consensus' case and 'worst-case' as defined by CSIRO (2015) for the RCP 8.5 climate change scenarios are provided in Table 4-20A.

As outlined in WRM (2022), the sensitivity analysis used a range of annual changes in rainfalls and evaporation as shown in Table 4-20A. The climate variable inputs (rainfall and evaporation) to the water balance model were adjusted to undertake the climate change impact assessment. All three scenarios have been assessed for the proposed residual voids.

Table 4-20A
Projections of Change to Climate – Year 2090 (RCP 8.5) Adopted for Sensitivity Analysis

Case	Climate Model	Annual Change in Rainfall	Annual Change in Evapotranspiration
Best-case	GFDL-ESM2M	-34.0%	14.5%
Maximum consensus	ACCESS1-0	-15.4%	15.2%
Worst-case	NorESM1-M	19.1%	8.3%

A summary of the climate change sensitivity analysis for residual voids is provided in Table 4-20B. The results indicated the water levels would be lower than under baseline climatic conditions for the 'best-case' and 'maximum consensus' climate scenarios due to the significant decrease in rainfall and increase in evapotranspiration for these climate scenarios. For the 'worst-case' climate scenario, the residual void water levels will be higher than under baseline climatic conditions. The sensitivity analysis for residual voids indicated the water salinity would be similar to or higher than under baseline climatic conditions. This is expected given the significant decrease in rainfall and increase in evapotranspiration for these climate scenarios, resulting in lower stored volumes and higher concentrations.

Table 4-20B
Summary of Sensitivity Analysis for Residual Void Behaviour

Void	Best-case	Maximum Consensus	Worst-case
Water Level			
North-west Void	The equilibrium and peak water level are around 8 m lower than under baseline climate conditions.	The equilibrium and peak water level are around 6 m lower than under baseline climate conditions.	The equilibrium and peak water level are around 6 m higher than under baseline climate conditions.
West Void	The equilibrium and peak water level are around 18 m lower than under baseline climate conditions.	The equilibrium and peak water level are around 11 m lower than under baseline climate conditions.	The equilibrium and peak water level are around 12 m higher than under baseline climate conditions.
Main Void	The equilibrium and peak water level are around 40 m lower than under baseline climate conditions.	The equilibrium and peak water level are around 19 m lower than under baseline climate conditions.	The equilibrium and peak water level are around 8 m higher than those under baseline climate conditions.
Salinity			
North-west Void	The salinity range is similar to baseline climate conditions, except for a higher peak concentration within the first 15 years of the simulation.	The salinity range is similar to baseline climate conditions.	The salinity range is slightly higher than baseline climate conditions.
West Void	The salinity range is similar to baseline climate conditions, except it does not exhibit as high concentrations peak during extended drought conditions.	The salinity range is similar to baseline climate conditions.	The salinity range is higher than baseline climate conditions, with a peak concentration of around 24,000 µS/cm at the end of the 500 year simulation (compared with 8,500 µS/cm).
Main Void	The salinity range is higher than baseline climate conditions, with a peak concentration of around 8,400 µS/cm at the end of the 500 year simulation (compared with 6,200 µS/cm).	The salinity range is higher than baseline climate conditions, with a peak concentration of around 9,000 µS/cm at the end of the 500 year simulation (compared with 6,200 µS/cm).	The salinity range is slightly higher than baseline climate conditions.

Salt occurring naturally in the Project groundwater systems and surface water runoff would also enter the residual voids. Evaporation from the residual void water bodies would lead to the accumulation of salt over time, except when water is pumped out of the voids for use.

To assess whether the saline water in the residual voids has potential to migrate away from the residual void water body due to density differential; the water in the residual void is converted to an equivalent freshwater head. The calculated equivalent freshwater head can be compared to elevations in the receiving environment to determine if there is a gradient away from the residual void water body and the potential for migration. The equation to calculate the equivalent freshwater head is presented below (Kuniansky, 2018):

$$H_f = \frac{\rho}{\rho_f} H$$

Where 'Hf' is the equivalent head of freshwater, 'ρf' is the density of freshwater, 'ρ' is the density of the water within the residual void and 'H' is the head of the water within the residual void. The density of the residual void water is dependent on the amount of salt dissolved in the water stated above in terms of EC represented in units 'µS/cm'. Calculating the density of the water in the residual void (ρ) requires conversion of the predicted EC to a density through TDS using the standard conversion factor of 0.67 (Australian and New Zealand Environment and Conservation Council [ANZECC], 2000).

The modelled equivalent freshwater heads have been estimated in Table 4-20C using the 'worst-case' climate change projection from the sensitivity analysis. The adopted methodology is highly conservative as it applies both the maximum salinity and maximum modelled water level for each void. In practice, the higher observed salinities occur when the water levels in the voids are lower.

Table 4-20C
Residual Void Density-driven Flow Calculations for 'Worst-case' Climate Change Scenario

Void	Modelled Maximum Void Water Level*	Maximum Modelled Void Salinity*	Maximum Void Waterbody Head^	Maximum Equivalent Freshwater Head
North-west Void	137 mAHD	28,000 µS/cm	23 m	23.43 m
West Void	121 mAHD	24,500 µS/cm	39 m	39.63 m
Main Void	157 mAHD	6,800 µS/cm	83 m	83.38 m

* Maximum residual void water levels and salinity for 'worst-case' climate projection (note these maximums are not predicted to occur at the same time).
^ Calculated by subtracting the maximum void water level from the base of the void.

Under the 'worst-case' climate change scenario, the equivalent freshwater head is less than 0.63 m above the modelled head in the residual void waterbodies. The resultant residual void water levels remain well below the post-mining water level in the Isaac River alluvium predicted to be 170 metres in Australian Height Datum (mAHD) in (SLR, 2022) and therefore variable density flow is not expected to impact on the receiving groundwater systems, even under the highly conservative adopted methodology which applies both the maximum salinity and maximum modelled water level for each residual void (in practice, the higher observed salinities occur when the water levels in the voids are lower).

Under all scenarios modelled by WRM (2022) the water levels in the residual voids would be significantly less than the overflow level (i.e. 51 m is the smallest differential between water level and spill level) and therefore, there would be no overflows to receiving surface water environment.

4.21 21. Behaviour of voids as sinks or sources (IESC 4, 15, 16 and DES issue 584.23)

Information Request

> *21. Behaviour of voids as sinks or sources (IESC 4, 15, 16 and DES issue 584.23)*
>
> *The modelled recovery period considers a 2,000 year period post mining, however the main void might not necessarily behave as a sink as shown in the Predicted Residual Void inflows plot (SLR 2022, Figure 4-3, App. B, p. 57) as it appears to behave as a source for the first 150 years. See also DES issue 584.23 (original issue 480.25) that identifies the north-west void as a source rather than a sink.*
>
> *Describe how residual voids will act as groundwater sinks or sources, supported by modelled outputs.*

Response

Groundwater inflows into the West Void were modelled by SLR as a time series over 250 years and provided to WRM for the residual void water balance. The residual void water balance shows the water level in the West Void reaches equilibrium between 90 mAHD and 109 mAHD and is predicted to vary between these levels. The maximum modelled water level is around 87 m below the level at which West Void would spill to the surrounding environment. Therefore, the West Void is not predicted to spill to the receiving environment under any climate scenario. The predicted residual void water levels are also well below the surrounding pre-mining groundwater levels, which means the residual voids would act as sinks to groundwater flow and there is no mechanism for movement of residual void water to the receiving groundwater environment.

The modelled groundwater inflows take into account the movement of water between the residual voids and both the backfilled in-pit waste rock and coal seams (i.e. modelled groundwater inflows represent both native groundwater in host geological rock and groundwater within backfilled in-pit waste rock/spoil). Groundwater inflows to the residual voids are initially negative whilst the groundwater level in the surrounding backfilled spoil are low from the drawdown effects from mining (i.e. whilst the spoil remains largely unsaturated). As the water level in the residual void increases (e.g. due to capturing rainfall runoff), the groundwater levels in the backfilled spoil rise as groundwater inflows from the residual void water body enter the spoil in addition to rainfall infiltration and some groundwater flow from surrounding native rock (i.e. whilst the backfilled material becomes saturated). This occurs until the spoil fills with groundwater to a point that the hydraulic gradient reverses and the residual voids receive groundwater inflows from the backfill spoil, with those long-term inflows dominantly originating as rainfall infiltration on the spoil.

No water that flows from the residual void water bodies into the backfilled spoil migrates off-site or to the downstream receiving groundwater regime (e.g. Isaac River alluvium, regolith, etc.), thus the final landform is acting as a groundwater sink. This conclusion was validated via groundwater fate modelling (e.g. particle movement simulations) to simulate the flow of water throughout the final landform (Figure 4-21A). The groundwater particle movement simulation predicted that water within the backfill spoil and West Void would not flow off-site, therefore demonstrating that as a whole the residual voids would remain groundwater sinks in perpetuity (generally driven by hydraulic gradient towards the residual voids, particularly the West Void).

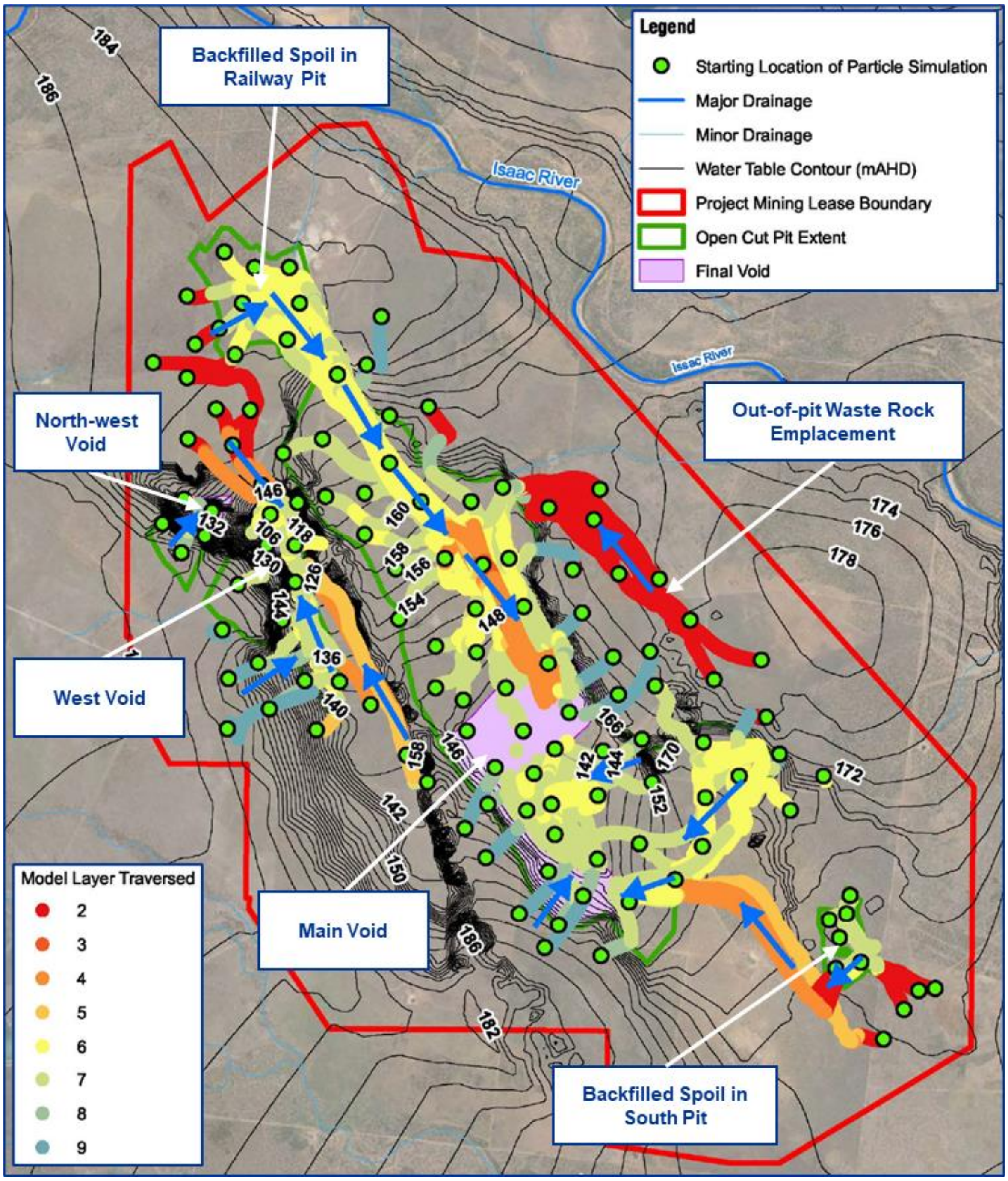


Figure 4-21A – Predicted Groundwater Particle Movement over 2,000-year Simulation for the Final Landform

4.22 22. Hydraulic properties of backfilled pits (OWS 5h and IESC 17, 23a)

Information Request

22. Hydraulic properties of backfilled pits (OWS 5h, IESC 17, 23a)
It is unclear whether the hydraulic properties of the backfilled pits have been updated for residual void modelling.
Update the hydraulic properties to reflect the different consolidation and compaction properties of the backfilled pits.

Response

The responses provided to Items 1 and 2 of the Groundwater RFI above (Sections 4.1 and 4.2) provides the site-specific data that was used to develop the numerical groundwater model and the calibrated aquifer parameters.

As described in the Groundwater Assessment, Hawkins (1998) and Mackie (2009) indicate that spoil and waste rock that is extracted and backfilled within open cut pits is more permeable than the undisturbed strata of the spoil and waste rock, however wide ranges of hydraulic parameters prevail. Therefore, as open cut mining pits are progressively backfilled with spoil and waste rock as extraction proceeds, different parameters are applied behind the active mine faces in the numerical groundwater model for the Project.

The hydraulic conductivity, storage and recharge parameters applied for backfilled spoil were 0.2 metres per day (m/day) for horizontal hydraulic conductivity, 5% for specific yield (Sy), 1×10^{-5} for specific storage (SS) and 1% of annual rainfall for rainfall recharge.

In the transient calibration and prediction numerical groundwater modelling, backfill properties were applied two years behind the active mine faces and hydraulic properties were varied with time using the Time-variant materials (TVM) package of MODFLOW-USG Transport.

4.23 23. Modelling of scenarios for climate change and potential differences in cumulative drawdown (OWS 5i, IESC 15)

Information Request

23. Modelling of scenarios for climate change and potential differences in cumulative drawdown (OWS 5i, IESC 15)
While climate change scenarios have been used to inform evapotranspiration modelling, they haven't been considered for groundwater inflows.
Likewise, future groundwater inflow scenarios, particularly for residual voids, have not been modelled.
Model a range of groundwater inflow scenarios based on potential impacts of climate change, and potential impacts of projects included in the cumulative model not going ahead. Describe how these scenarios could impact the behaviour of residual voids post-closure.

Response

WRM undertook a sensitivity analysis on residual void behaviour using climate change projections and methodologies given in the CSIRO and BoM report titled *Climate Change in Australia Technical Report* (CSIRO, 2015). The response provided to Item 20 of the Groundwater RFI (Section 4.20) provides the outcomes of the sensitivity analysis on residual void behaviour using the climate change projections.

The majority of water inflows to the residual voids would be via direct rainfall to the water body and surface water runoff from rehabilitated land within the residual void catchment area (approximately 97% of inflows from direct rainfall and runoff). The characteristics of runoff from within the rehabilitated land is expected to be similar to natural runoff from undisturbed land. Groundwater inflows to the residual voids only accounts for 3% of the inflows, significantly reducing the effect of groundwater inflows on resulting residual void water levels and water quality. Therefore, any variability of groundwater inflows as a result of climate change is unlikely to materially change the outcomes of the residual void balance.

It is not possible, nor would it be appropriate, for Whitehaven WS to determine whether the approved projects and/or existing operations in the vicinity of the Project will or will not occur. As a result, the cumulative assessments undertaken for the Project, including cumulative numerical groundwater modelling for the Groundwater Assessment, conservatively assumed approved projects will occur in accordance with approval documentation that was publicly available.

4.24 24. Impacts of void water on biota in the surrounding area (IESC 9)

Information Request

> *24. Impacts of void water on biota in the surrounding area (IESC 9)*
>
> *Potential impacts of void water on biota in the surrounding area, especially mobile fauna such as birds and aerial insects that may access the residual voids has not been discussed.*
>
> ***Arsenic levels of up to 0.4 mg/l were detected in baseline groundwater monitoring**. Stock water guidelines for arsenic are 0.5 mg/l, so concentration of arsenic levels to the point of exceeding stock water guidelines may occur.*
>
> *Discuss potential accumulation or enrichment of metals and metalloids, major ions, nutrients, acidity and hydrocarbons in residual voids, and how these may impact environmental values.*

Response

Item 24 of the Groundwater RFI above references a result of 0.4 mg/L for Arsenic in the baseline groundwater monitoring (see **bolded** quote above for emphasis). This result is not within the Revised Draft EIS and the source is unclear. Whitehaven WS has provided all the water quality measurements over all the groundwater monitoring network to the OCG for consideration by DES.

The majority of water inflows to the residual voids would be via direct rainfall to the water body and surface water runoff from rehabilitated land within the residual void catchment area (approximately 97% of inflows from direct rainfall and runoff). The characteristics of runoff from within the rehabilitated land is expected to be similar to natural runoff from undisturbed land. The comprehensive surface water monitoring undertaken for the Project throughout the local area and data collected for the surrounding region did not indicate any elevated concentrations of Arsenic above the water quality objectives.

Groundwater inflows to the residual voids only accounts for 3% of the inflows, significantly reducing the effect of the water quality from the groundwater inflows on the water quality in the residual voids. The highest concentration of Arsenic in the baseline groundwater monitoring undertaken for the Project was one instance of 0.2 mg/L at R2034R, with all other groundwater quality measurements for Arsenic across the groundwater monitoring network at or well below 0.06 mg/L. This baseline groundwater measurement is part of the natural fluctuation in water quality and all other measurements are well below the water quality objectives, supporting that it is unlikely the residual voids would accumulate elevated concentrations of Arsenic.

The PMLU of the residual voids involves an outflow of water through cattle consumption and would not be a closed void system, limiting the potential for accumulation or enrichment of metals and metalloids, major ions, nutrients, acidity and hydrocarbons in residual voids. In consideration of the above, the water quality of the water in the residual voids pose a low to nil risk to the surrounding biota.

Notwithstanding, Whitehaven WS has provided proposed completion criteria for the residual voids (e.g. RA3) that require surface water and groundwater quality monitoring to be undertaken. The results of the 'standard' water quality parameter monitoring (including, but not limited to, pH, EC, major anions [sulfate, chloride and alkalinity], major cations [sodium, calcium, magnesium and potassium], TDS and a broad suite of soluble metals/metalloids) would need to demonstrate that water within the residual voids is suitable for the post-mining land use (PMLU) (e.g. cattle consumption). Whitehaven WS would accept a condition that would require further analysis of the potential contaminants during Project operations to validate the water quality as well as monitoring of water within the residual voids for a period of at least five years post-rehabilitation (monitoring for at least two years previously proposed) to demonstrate that the water quality meets the relevant criteria.

Further discussion regarding the predicted water quality in each of the residual voids and monitoring to be undertaken, during operations and prior to relinquishment of the final landform, to demonstrate water quality is suitable with no impacts on the receiving environment, is provided in Section 5.1.

5 FINAL LANDFORM AND RESIDUAL VOIDS REQUEST FOR INFORMATION

5.1 Final Landform and Residual Voids

Information Request

OCG Information Request

Rehabilitation language

OCG notes the Winchester South project is subject to the transitional provisions of the Environmental Protection Act 1994 (EP Act) and preparation of a progressive rehabilitation and closure plan (PRCP) will be required post-EIS.

Self-sustaining landforms

Following public notification of the RDEIS, OCG requested residual void modelling data to demonstrate that the proposed post-mine land use could be maintained over the long term without active management.

Modelling of residual void salinity without abstraction of water for agriculture was provided on 3 April 2023 (see Attachment 4 (surface water responses) of additional information). This modelling showed that the Main Void would broadly comply with stock water guidelines for salinity for approximately 450 years with no active management. However, the modelling demonstrated that without active management, the North-West Void would exceed stock water guidelines after approximately 30 years, and the West Void after approximately 150 yrs. DES' submission on the RDEIS identified that reliance on water abstraction or proposals to dilute water in smaller voids with water from the Main Void to maintain salinity levels do not align with DES' requirements for residual voids to be self-sustaining.

OCG met with Whitehaven on 3 May 2023 to discuss outstanding matters for rehabilitation and final land use to be addressed prior to final EIS (FEIS). Whitehaven disagreed with DES' submission that the proposed post-mine land use must be self-sustaining, using the justification that any use proposed would require some degree of active management e.g., weeding to control pests in native ecosystems or removal of solar panels at end of life if the site had a post-mine land use of a solar farm.

Cost-benefit analysis

In a meeting between DES and OCG on 28 April 2023, DES preliminary review of the cost-benefit analysis included in the Winchester South RDEIS determined it was not sufficiently adequate to demonstrate the feasibility of the proposed optimised landform against full and partial backfilling options.

DES Information Request

Residual voids and self-sustaining final land use – Department of Environment and Science – 1 June 2023

Due to the rehabilitation requirements for the project in the context of the SDPWO Act and EP Act a document must be prepared by the proponent that addresses the follow matters.

- *Describes the proposed rehabilitation approach for voids in the Winchester South project in accordance with direction from OCG and the department.*
- *Justifies the proposed residual void and final land use, including presenting and suitably assessing project alternatives that fully consider other void outcome scenarios, including:*
    1. *Full backfill of all residual voids to create a landform with no ponding of water and having a final land use depending on slope.*
    2. *Full backfill of West and North-West residual voids, and partial backfill of the Main Void to limit its size (as presented in the optimised (2022) final landform for the Main Void included in the RDEIS), which can have alternative partial backfill levels and size of voids and how this improves water quality.*
    3. *Full backfill of the North-West void and partial backfill of the West and Main voids and limiting the size of the voids and catchments (as presented in the optimised (2022) final landform for the West and Main voids included in the RDEIS), which can have alternative partial backfill levels and size of voids to improve water quality and state if each has a final land use or the EC levels remain too high for it to be used as stock drinking water.*
- *Incorporates a detailed cost-benefit analysis using the information provided in* ***Attachment 1*** *for residual void outcome scenarios, including the residual voids not having a final land use. The cost-benefit analysis must be itemised for each individual void and residual void outcome scenario, and must detail the potential financial benefit to the State of Queensland balanced against the financial costs associated with achieving the alternative residual void outcome scenarios, as well as financial costs to the State of Queensland associated with managing the residual risks of a hypersaline void in perpetuity or remediating by backfilling the void (residual risk requirements detailed in s.272 of the EP Act).*

- *Justifies and details each voids proposed to be used as stock drinking water with more quantitative data and assessments including with resultant total salt loads, and worst case EC concentrations, pH, sulphate (<1000 mg/L), calcium (<1000 mg/L), magnesium, nitrate (<400mg/L), nitrite (<30mg/L), total aluminium (<5mg/L), total arsenic (<0.5mg/L), total boron (<5 mg/L), total cadmium (<0.01 mg/L), total chromium (< 1mg/L), total cobalt (<1mg/L), total copper (0.5mg/L), fluoride (<1-2 mg/L), total lead (<0.1mg/L), total mercury (<0.002mg/L), total molybdenum (<0.15mg/L), total nickel (1 mg/L), total selenium (0.02 mg/L), total uranium (<0.2mg/L), total zinc (20 mg/L), radiological quality (see table 9.2.33 of ANZECC 2000) and water levels over 500 years contributed by each void and void partial backfill option as discussed in 1-3 above. Present all details of the comparison of worst-case concentrations for each indicator against the relevant guideline numerical value. Refer to ANZECC 2000 for detailed advice for stock watering risk assessment and guidelines (available at Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) - Volume 3 - Chapter 9 - Primary Industries).*
- *Fully detail the modelling assumptions and limitations and presents the results of modelling in a void specific manner. Section 2.5 Groundwater Inflows Enclosure-1-assessment of alternative landforms (WH WRM 29 June 2022) outlines that void salinity modelling has used groundwater inflow volume assumptions provided by SLR Consulting Pty. Ltd. (SLR). This document, however, omits to present any detail or reference a section in the draft EIS where this information is presented in detail. This information is required to allow for full, robust and detailed technical assessment of the void modelling components, and prior to a completed EIS assessment of the rehabilitation elements of this proposal. Provide detailed quantitative assumptions used for:*
  - *Flow volume assumptions from the spoil adjacent to the residual voids.*
  - *Flow volume assumptions from the backfilled spoil in residual voids.*
  - *Flow volume assumptions from geologies other than the coal seams “rest of pit” even if this water passes through backfilled spoil.*
  - *Flow volume assumptions from the in-situ coal seams to the residual voids (e.g., via the highwalls and end walls).*
  - *It is not clear from the presented residual void information modelling, to date, which void inflow water types (for each proposed residual void) represent the greatest source of contaminants on a load and/or concentration basis.*
- *Assesses the modelling data in more detail to support scenario 2 above. Based on rough estimates, the Main void may only represent approximately 50% of the salt load from all currently proposed residual voids (as the project currently is planned and modelled) and yet is predicted to supply 87% of water volume for beneficial reuse via stock watering. Describe the comparative beneficial reuse weightings which appear to favour in-filling the Northwest void and West void to ensure a reduction in total site salt load (from residual voids), without a significant removal of volume of water for beneficial reuse with stock watering.*
- *Presents robust risk assessments and proposed mitigation measures be provided for voids used as stock drinking water, including the potential for algal blooms or pathogenic or parasitic contamination within any residual void used for stock watering, as this may render the water unusable for stock watering (for e.g., cyanobacteria (blue-green algae) generic stock watering limit of microcystins-LR toxicity equivalents <2.3 µg/L). See ANZECC 2000 for more details for type of stock and for guidelines and advice for coliforms limits and parasite assessments. Stock faecal wastes may drain to the proposed residual voids and may contaminate the proposed water source for their drinking with parasites and faecal coliforms. Additionally, the runoff of stock urine wastes may trigger conditions suitable for algal blooms.*
- *Details the environmental risks of each residual void outcome scenario considered, including how the behaviour of the residual voids affects the movement of potentially contaminated water within and outside the mining lease—including risks to groundwater and risks to surrounding environment from overtopping or flooding—and how these risks impact evaluations of the recommended void/landform design.*
- *Incorporates responses to the comments in December 2022 DES submissions on rehabilitation matters should be included in the assessment of the residual void outcome scenarios, water quality forecasts and presence or absence of final land uses including implications for costs and benefits of the scenarios.*
- *Presents an integrated document (or a ‘minimum viable product’) on rehabilitation matters such as residual voids, final land uses and disturbances domains, where all relevant information related to rehabilitation are presented in a full updated version, rather than picking bits out of previous versions of the EIS documents, or addendums.*

Response

In consideration to feedback received throughout the assessment process, Whitehaven WS reviewed the Project mine plan and sequence with the aim of reducing the number of residual voids in the final landform, reducing the impacts of the Project on threatened species habitat and investigating uses for the residual void water bodies. The final landform for the Project (Figure 5-1A), would achieve these improvements by:

- Backfilling an additional void, the South Pit mine void.
- Providing a PMLU for all remaining proposed residual voids (i.e. no Non-use Management Areas [NUMAs]).
- Reducing the overall surface disturbance extent by approximately 179 hectares (ha), with further minimised out-of-pit waste rock emplacements to reduce impacts to threatened species habitat.
- Smoothing low-walls to minimise slopes to approximately 10 degrees (°) or lower.
- Providing water supply to stock via the residual voids.
- Re-establishing a post-mining surface water drainage that is sympathetic with the natural drainage lines.
- Reinstating excised portions of the northern waterway in the final landform.

Whitehaven WS proposed a PMLU for all areas of the final landform for the Project, including a low-intensity grazing PMLU and water storage for agricultural production PMLU (for the highwall, low wall and residual void water bodies). NUMAs are not proposed for the Project as the low walls, highwalls and water bodies of the residual void would provide a PMLU as water storage infrastructure for agriculture (or other purposes).

Note, Whitehaven WS will be required to have an approved and also comply with a Progressive Rehabilitation and Closure Plan (PRCP) for the Project, but as a result of the transitional provisions of the Queensland *Environmental Protection Act 1994* (EP Act), it does not form part of the Environmental Authority (EA) application requirements. As such, further modelling and analysis of the final landform, residual voids and associated PMLUs could be undertaken and included in the PRCP to the satisfaction of relevant Government agencies.

Table 1, Part 3, Schedule 8A of the Queensland *Environmental Protection Regulation 2019* (EP Regulation) outlines that the Performance Outcomes for a PMLU (see below with bold for emphasis):

PRCP Performance Outcomes

1 Each post-mining land use—

(a) is viable, having regard to the use of land in the surrounding region; and

(b) satisfies at least 1 of the following—

i. the use is consistent with how the land was used before a mining activity was carried out on the land;

ii. the use is consistent with a development approval relating to the land;

iii. the use is consistent with a use of the land, other than a use that is mining, permitted under a State or Commonwealth Act, including, for example, a planning instrument under the Planning Act;

iv. the use will deliver, or is aimed at delivering, a beneficial environmental outcome.

2 The total area of land proposed as a non-use management area is minimised to the extent possible by, for example, demonstrating that the land, or any part of the land, can not be used for any post-mining land use.

3 Each non-use management area is located to prevent or minimise environmental harm having regard to—

(a) all reasonably practical alternatives for the location; and

(b) the nature of the environmental harm that may be caused because of the proposed location; and

(c) the sensitivity of the environment surrounding the proposed location.

The PMLUs across the final landform for the Project (e.g. low-intensity grazing and water storage for agricultural production PMLUs) are consistent with Table 1, Part 3, Schedule 8A of the EP Regulation as:

- Low-intensity grazing and water storage for agricultural production PMLUs are the existing (pre-mining) land uses within the Project area and surrounding landscape, and are consistent with the social, economic, and environmental objectives of relevant regional plans and local planning strategies, and community views (Items 1(a) and 1(b)(i) in Table 1, Part 3, Schedule 8A of EP Regulation).
- Water storage for agricultural production PMLU provides an opportunity for reliable water supply to be used for agricultural production (Items 1(b)(i) and 1(b)(iv) in Table 1, Part 3, Schedule 8A of EP Regulation).
- Low-intensity grazing and water storage for agricultural production PMLUs will deliver, or is aimed at delivering, a beneficial environmental outcome (Items 1(b)(iv) in Table 1, Part 3, Schedule 8A of EP Regulation) as:
  - the residual void water bodies would not become hypersaline voids and water storage for agricultural production PMLU and allows for a safe and non-polluting method for removing salt through the beneficial use;
  - the residual void water bodies would not spill to the downstream receiving surface water environment (e.g. Isaac River and associated tributaries); and
  - the final landform acts as a groundwater sink in perpetuity and there would not be migration/seepage of water off-site to the downstream groundwater regime (e.g. Isaac River alluvium and regolith).
- Low-intensity grazing and water storage for agricultural production PMLUs are proposed across the final landform with no NUMAs proposed (e.g. extent of the NUMA has been minimised to the greatest extent possible) (Item 2 in Table 1, Part 3, Schedule 8A of the EP Regulation).

Section 3.2 of the *Guideline Progressive rehabilitation and closure plans (PRC plans) (Version 3.00)* (DES, 2023) states that land with constraints may still have a viable PMLU and may be appropriate to consider the development of a site management plan (bold added for emphasis):

> *4) Identification of any statutory constraints that may need to be imposed to prevent or limit the likelihood of an inappropriate land use in the future.* ***It is recognised that land with constraints may still have a viable PMLU*** *and will not necessarily be considered a NUMA. For instance, if* ***contaminated materials are retained but encapsulated on site, it may be appropriate to consider developing a site management plan*** *as defined in section 370 of the EP Act to* ***ensure that contaminated material continues to be managed appropriately (e.g. capping is maintained)****, and that any future land use is appropriate given the type and levels of contamination.*

Section 6.2 of the *Leading Practice Approaches to Select Post-Mining Land Uses For Residual Mine Voids: Technical Paper* published by the Office of the Queensland Mine Rehabilitation Commissioner (Côte *et al*., 2023) also states long-term closure strategies for residual voids can include limited management such as remediation involving pumping or can be undertaken as part of the beneficial reuse of void water (bold added for emphasis):

> *Long-term closure strategies for residual voids require remediation methods that are self-sustaining and* ***require no or limited management inputs and maintenance (e.g., pump and treat remediation, nutrient addition, in-lake liming)****. Treatment technologies can be classified as either active or passive treatment. Active treatment requires continuous operation and maintenance and is often used in operating mines when there are personnel on site and revenue is dedicated to water treatment. Passive treatment is intended to be self-sustaining after an initial set-up phase and is ideal for treating mine water after closure although some level of management is inevitable.* ***Active treatment technologies are generally only implemented post-closure*** *where there is a risk of contamination to social or environmental receptors or* ***as a requirement in the beneficial reuse of void water.***

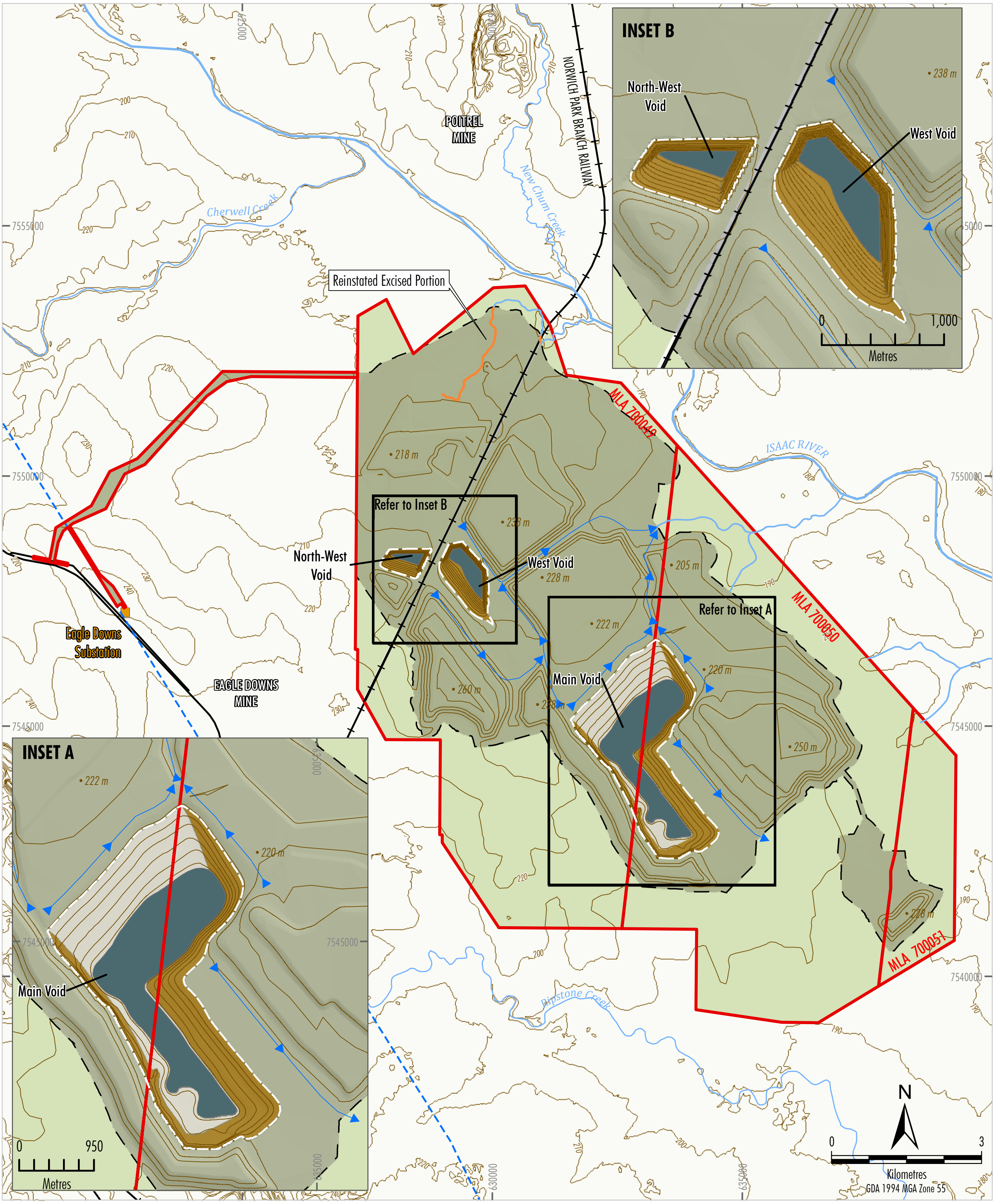
It should be noted that all land uses (e.g. National Parks, Nature Reserves, agriculture, housing developments, waste facilities, solar farms, industrial, commercial, biodiversity offsets, fauna habitat, etc.) require a level of active or passive management to maintain the viability of that land use. For example, grazing land uses for any standard agricultural enterprise would generally require:

- pest, weed and land management practices;
- installation and maintenance of fencing and access tracks;
- transfer of water via pumping from the water sources (e.g. rivers, dams and/or supply pipelines) to the points of use (e.g. farm dams, tanks and troughs) for use across properties; and
- during drought periods, may require purchase of external water supply and/or feedstock to support cattle production.

These are standard practices for the management of an agricultural enterprise. Therefore, it would be expected that the low-intensity grazing PMLU and water storage for agriculture PMLU for the final landform (e.g. rehabilitated land and residual voids) would be able to use these standard agricultural practices and management, subject to the land meeting the completion criteria for the PMLU following mining activities. Management may include cattle having restricted, or no direct access to the water storages, with water reticulated to tanks, dams and troughs for consumption.

In regard to additional economic analysis, Whitehaven WS previously reviewed the Project mine plan, reduced the number of residual voids by backfilling South Void and the updated assessment including a cost-benefit analysis. This additional economic analysis was provided in Attachment 16 of the Additional Information.

Notwithstanding, a separate cost-benefit analysis has been undertaken by Deloitte Access Economics (Deloitte) for individually backfilling each of the residual voids and is presented in the following subsections. Deloitte adopted a conservative estimate of costs and assumed the costs associated with backfilling each of the three residual voids would be entirely incurred after cessation of coal extraction (Year 30 and onwards).



LEGEND

- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent
- Contours (10 m)
- Waterway Providing for Fish Passage Mapped by DAF (2023) Not Disturbed by the Project
- Indicative Surface Water Flow

Matters of State Environmental Significance

- Reinstated Excised Portions of Waterways Providing for Fish Passage ^

Post Mining Land Use

- Indicative Extent of Water Storage for Agriculture use Post-mining Land Use
- Indicative Extent of Water Storage for Agriculture Post-Mining Land Use (Waterbody)
- Indicative Extent of Water Storage for Agriculture Post-Mining Land Use (Slopes less than 10 degress)
- Indicative Extent of Water Storage for Agriculture Post-Mining Land Use (Slopes greater than 10 dregrees)
- Indicative Extent of Rehabilitation to Low-Intensity Grazing Post-Mining Land Use (Rehabilitated Landform)
- Land Outside Indicative Surface Disturbance Extent with a Low-Intensity Grazing Post-Mining Land Use

^

Source: The State of Queensland (2018 - 2020); Whitehaven (2020); DAF (2023)

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Conceptual Final Landform and Post-mining Land Use

Figure 5-1A

5.1.1 Main Void

The residual void modelling adopted a large number of climate sequences reflecting the full range of historical climatic conditions, including risk associated with extreme weather conditions. The modelling, therefore, provides an assessment of the system performance under very wet, very dry and average climatic conditions.

Water levels in the residual voids would vary over time, depending on the prevailing climatic conditions, and the balance between evaporation losses and inflows from rainfall, surface runoff, and groundwater. A GOLDSIM model was developed and used to assess the likely long-term water level behaviour of the residual voids, with the historical rainfall and evaporation sequences (133 years) repeated five times to create an indicative long-term climate record. This approach is significantly more conservative than other approaches (e.g. using averaged climate data) and results in repeating periods of severe climate conditions (i.e. drought) and it is unlikely the region would be able to sustain cattle production due to lack of feedstock.

Groundwater inflows into the Main Void were provided by SLR as a time series over 2,000 years. The groundwater inflows take into account the movement of water between the residual void and both the backfilled in-pit waste rock and coal seams. Generally, the net groundwater inflows to the residual voids are initially negative whilst the groundwater level in the surrounding backfilled spoil rises post-mining (i.e. while the backfilled material becomes saturated). As a result, groundwater flow to the residual voids themselves have been reduced to 0 ML/day in the model during these periods. As the groundwater level in the backfilled spoil rises during the simulation and reaches equilibrium (i.e. the material becomes saturated), the groundwater inflows to the Main Void are predicted to range between 0 ML/day to 1.8 ML/day with most of that water originating from rainfall infiltrating into the spoil.

Groundwater inflow salinities from the backfilled waste rock at 1,012 µS/cm based on geochemical water quality sampling results for overburden and interburden and from the coal seams at 13,230 µS/cm based on groundwater bore sampling data from the coal seams and interburden near the Main Void.

Water level in the Main Void reaches equilibrium between 128 mAHD and 148 mAHD, and is predicted to vary between these levels. The maximum modelled water level is around 59 m below the level at which the Main Void would spill to the surrounding environment. Therefore, the Main Void is not predicted to spill to the receiving environment under any climate scenario. The predicted residual void water levels are also well below the surrounding pre-mining groundwater levels, which means the residual voids would act as sinks to groundwater flow. This conclusion was validated via groundwater fate modelling (e.g. particle movement simulations) to simulate the flow of water throughout the final landform. The particle movement simulation predicted that water within the backfill spoil and Main Void would not flow off-site, therefore indicating residual voids would remain groundwater sinks in perpetuity (generally driven by hydraulic gradient towards the residual voids, particularly the Main Void) with no potential for discharge to the broader receiving groundwater environment under any climate scenario.

Salinity of water within the Main Void reaches equilibrium within 500 years of residual void water balance modelling, with the salinity predicted to range mostly between 1,000 µS/cm to 4,000 µS/cm (Chart 5-1A). Some periods of higher salinity (up to 6,500 µS/cm) are predicted when the stored volume within the Main Void is very low. The Main Void salinity concentration is trending upwards after the 500-year simulation. The results of the water balance model indicate that the Main Void can provide a sustainable and reliable supply water suitable for cattle consumption as the predicted salinity is less than 7,500 µS/cm based on the upper limit in ANZECC (2000)[1] (up to 5,000 mg/L) and less than 6,000 µS/cm (up to 4,000 mg/L) based on the preferred limit for cattle consumption in ANZECC (2000) advised by DES (pers. Comms). It should be noted that ANZECC (2000) provides a range of salinity limits for different livestock, some of which are more tolerant of higher salinities (e.g. up to 20,000 µS/cm for sheep).

Given the above, a water consumption rate for cattle of 70 ML/year was adopted for the residual void water balance using an average annual water consumption rate for cattle of 15,000 litres per year per head of cattle and a carrying capacity of 2.4 ha per head of cattle applied over only the Mining Lease Application area for the Project (approximately 11,200 ha).

1 Salinity limits were adopted from Table 4.3.1 of ANZECC (2000) and were converted from milligrams per litre (mg/L) to microSiemens per centimetre (µS/cm) using a conversion factor of 0.67.

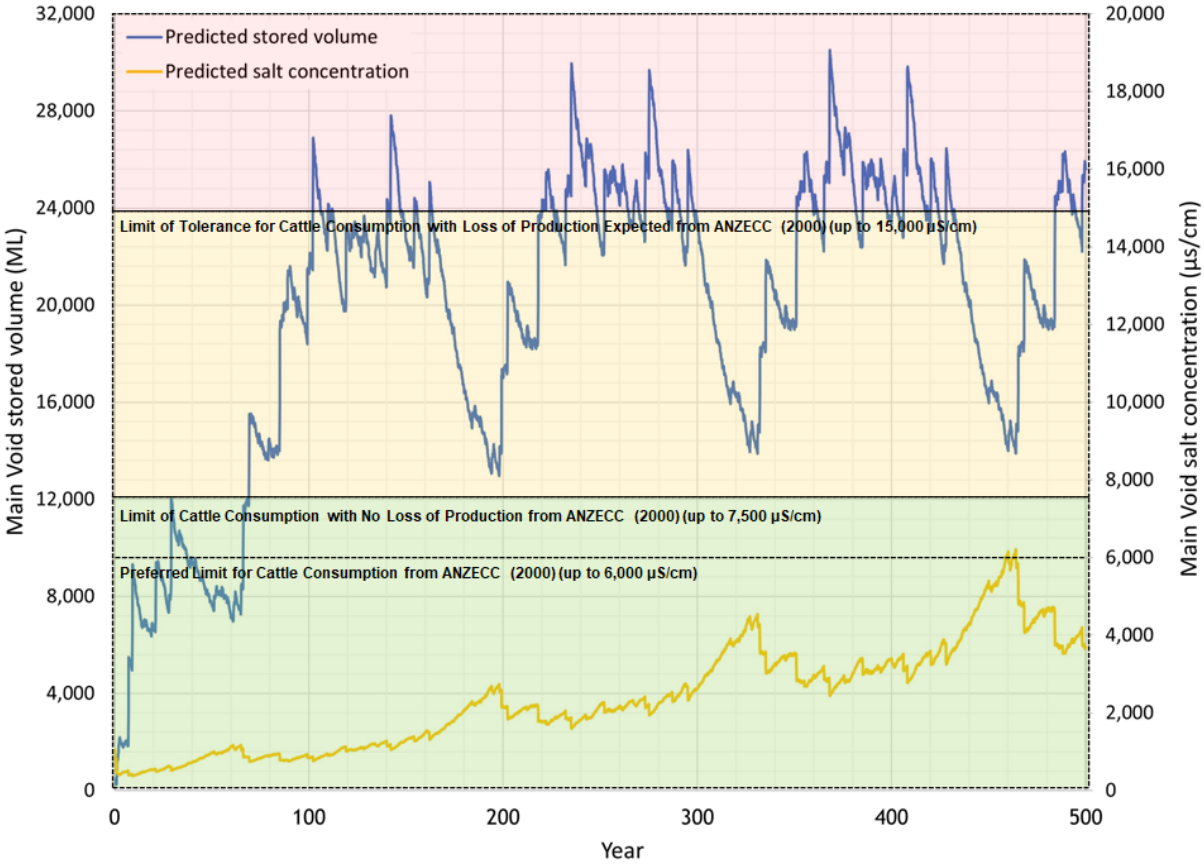


Chart 5-1A – Predicted Water Volume and Salinity for Main Void and Cattle Tolerance Limits

In practice, these assumptions are very conservative as the proposed water storages would support cattle in an area much greater than the Mining Lease Application area. For example, the Winchester Downs property contains up to 30,000 ha of cattle grazing land and using the same carrying capacity would support approximately 12,500 head of cattle. Applying the consistent consumption rate of water to the Winchester Downs property would increase the water extraction from 70 ML/year to 190 ML/year. The proposed completion criterion for portions of the final landform dedicated to cattle production (e.g. low-intensity grazing PMLU) would need to demonstrate a carrying capacity of approximately 2.4 ha per head of cattle, which is consistent with the modelled carrying capacity rate and existing carrying capacity of the land. Given the above, the water consumption rate for cattle of 70 ML/year is considered to be robust for the residual void balance and the water consumption rate for cattle was split across the residual voids to provide a reliable supply of water, with Main Void providing approximately 31.5 ML/year (i.e. 45% of 70 ML/year).

Similar to standard agriculture practices and management of pumping water around a property, if there are periods of low volume and elevated salinity in the North-west Void or the West Void, the water within these voids could be pumped into the Main Void or mixed with water from the Main Void at the point of use (e.g. troughs, tanks, dams) to meet the water quality limits. This can be achieved with standard pumping equipment that would be used at cattle properties in the region. Under these circumstances, Main Void would still be able to supply suitable water quality, as the relatively small salt loads transferred from North-west Void and West Void would only have a minor impact on Main Void salinity. Pumping all the higher salinity water from North-west Void and West Void into Main Void would only increase Main Void salinity by around 100 µS/cm (on average) and would be within the preferred limit for cattle consumption (Chart 5-1B).

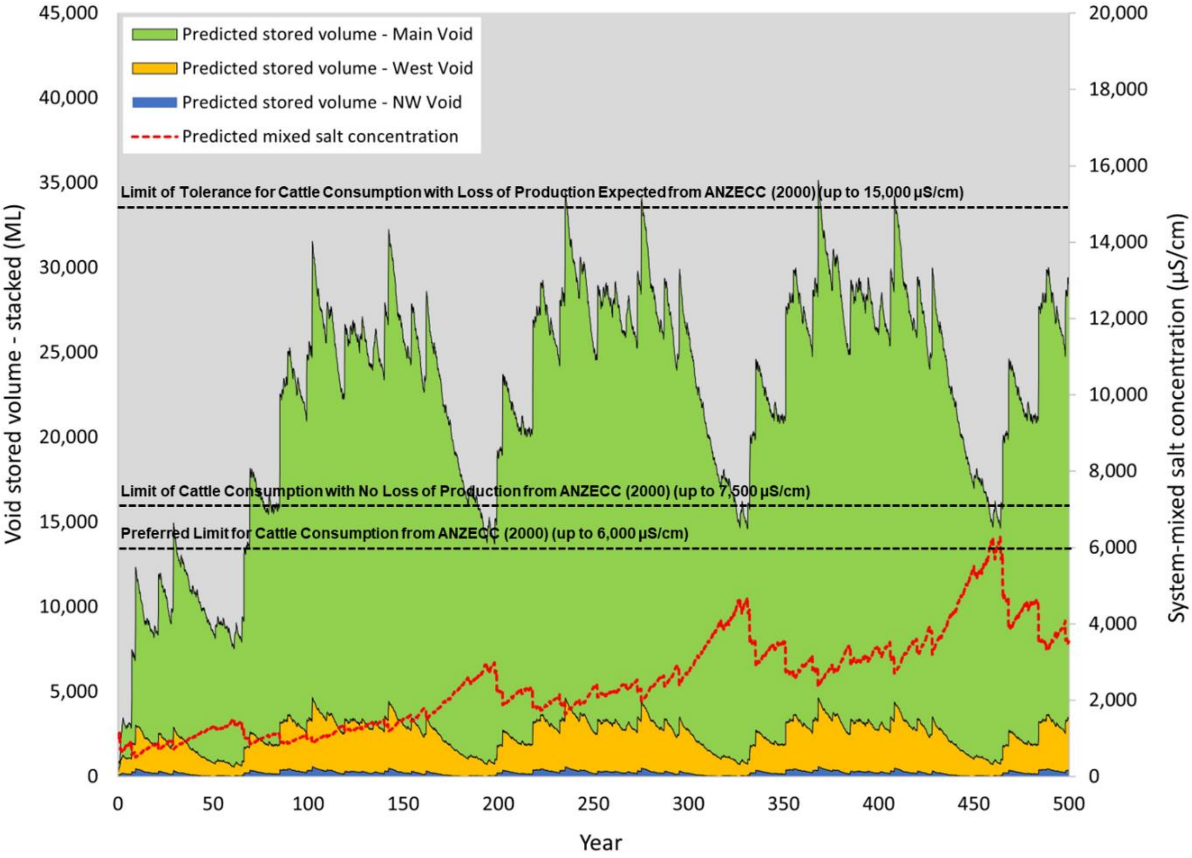


Chart 5-1B – Predicted Water Volume and Salinity for Residual Void System and Cattle Tolerance Limits

The proposed completion criteria for the Residual Voids (RA3), including Main Void, require surface water and groundwater quality monitoring to be undertaken. The results of the 'standard' water quality parameter monitoring (including, but not limited to, pH, EC, major anions [sulfate, chloride and alkalinity], major cations [sodium, calcium, magnesium and potassium], TDS and a broad suite of soluble metals/metalloids) would need to demonstrate that water within the residual voids is suitable for the PMLU (e.g. cattle consumption). Whitehaven WS would accept a condition that would require further analysis of the potential contaminants during Project operations to validate the water quality as well as monitoring of water within the residual voids for a period of at least five years post-rehabilitation (monitoring for at least two years previously proposed) to demonstrate that the water quality meets the relevant criteria.

Monitoring would be undertaken throughout the life of the Project for each of the water storages (including water dewatered from the open cut pits) and at the groundwater monitoring network across the Project area as part of the EA. The trigger levels in the proposed EA conditions are more stringent than the concentrations recommended by DES. As such, if there was any elevated concentrations of these contaminants in the water storages, it would be identified during operations and subsequent trigger investigations would be undertaken in accordance with the conditions of the EA.

Potential risks of algal blooms, pathogenic and/or parasitic contamination from cattle urine or faecal waste would be managed using standard agriculture practices and management (similar to those adopted for standard dams and troughs) and therefore would not be expected to render the water within the Main Void as unsuitable for the PMLU. Management of this risk may include cattle having restricted, or no direct access to the water storages, with water reticulated to tanks, dams and troughs for consumption.

As outlined above, the Main Void has been designed to avoid spills and present negligible risk of water interacting with the surrounding environment (including the surrounding groundwater systems) and therefore, would be safe, stable and non-polluting (e.g. not causing environmental harm).

In regard to additional economic analysis, Whitehaven WS previously reviewed the Project mine plan, reduced the number of residual voids by backfilling South Void and the updated assessment including a cost-benefit analysis. This additional economic analysis was provided in Attachment 16 of the Additional Information.

Notwithstanding, a separate cost-benefit analysis has been undertaken for individually backfilling the Main Void. Deloitte adopted a conservative estimate of costs and assumed the costs associated with backfilling each of the three residual voids, including the Main Void would be entirely incurred after cessation of coal extraction (Year 30 and onwards). As a result, costs are heavily discounted (i.e. 7% discount rate).

The outcomes of the cost-benefit analysis associated with backfilling Main Void only (i.e. in isolation of the other two residual voids) are summarised below:

- Additional costs attributed to Whitehaven WS estimated to be approximately $137 million AUD in NPV terms or approximately $1,381 million AUD in undiscounted terms.
- Reduction in the net economic benefits to the Queensland community by $19 million AUD in NPV terms.
- Increase greenhouse gas emissions associated with the Project from consumption of additional diesel fuel and prolonging operations.
- Increase potential for environmental impacts or prolong predicted environmental impacts (e.g. water quality, noise and air quality impacts).

On balance, the backfilling of Main Void would result in reduced benefits to the Queensland community in comparison to the final landform proposed for the Project and is therefore considered to not be in the public interest.

5.1.2 West Void

The residual void modelling adopted a large number of climate sequences reflecting the full range of historical climatic conditions, including risk associated with extreme weather conditions. The modelling, therefore, provides an assessment of the system performance under very wet, very dry and average climatic conditions.

Water levels in the residual voids would vary over time, depending on the prevailing climatic conditions, and the balance between evaporation losses and inflows from rainfall, surface runoff, and groundwater. A GOLDSIM model was developed and used to assess the likely long-term water level behaviour of the residual voids, with the historical rainfall and evaporation sequences (133 years) repeated five times to create an indicative long-term climate record. This approach is significantly more conservative than other approaches (e.g. using averaged climate data) and results in repeating periods of severe climate conditions (i.e. drought) and it is unlikely the region would be able to sustain cattle production due to lack of feedstock.

Groundwater inflows into the West Void were provided by SLR as a time series over 2,000 years. The groundwater inflows take into account the movement of water between the residual void and the both the backfilled in-pit waste rock and coal seams. Generally, the net groundwater inflows to the residual voids are initially negative whilst the groundwater level in the surrounding backfilled spoil rises post-mining (i.e. while the backfilled material becomes saturated). As a result, groundwater flow to the residual voids themselves have been reduced to 0 ML/day in the model during these periods. As the groundwater level in the backfilled spoil rises during the simulation and reaches equilibrium (i.e. the material becomes saturated), the groundwater inflows to the West Void are predicted to range between 0.1 ML/day to 0.9 ML/day, with most of that water originating from infiltrating into the spoil.

Groundwater inflow salinities from the backfilled waste rock at 1,012 µS/cm based on geochemical water quality sampling results for overburden and interburden and from the coal seams at 8,400 µS/cm based on groundwater bore sampling data from the coal seams and interburden near the North-west Void and West Void.

Water level in the West Void reaches equilibrium between 90 mAHD and 109 mAHD, and is predicted to vary between these levels. The maximum modelled water level is around 87 m below the level at which West Void would spill to the surrounding environment. Therefore, the West Void is not predicted to spill to the receiving environment under any climate scenario. The predicted residual void water levels are also well below the surrounding pre-mining groundwater levels, which means the residual voids would act as sinks to groundwater flow. This conclusion was validated via groundwater fate modelling (e.g. particle movement simulations) to simulate the flow of water throughout the final landform. The particle movement simulation predicted that water within the backfill spoil and West Void would not flow off-site, therefore demonstrating residual voids would remain groundwater sinks in perpetuity (generally driven by hydraulic gradient towards the residual voids, particularly the West Void) with no potential for discharge to the broader receiving groundwater environment under any climate scenario.

Salinity of water within the West Void reaches equilibrium within 150 years of residual void water balance modelling, with the salinity predicted to range mostly between 2,000 µS/cm to 4,000 µS/cm (Chart 5-1C). Some periods of higher salinity (greater than 7,500 µS/cm) are predicted when the stored volume within the West Void is very low. The results of the water balance model indicate that the West Void can provide a sustainable and reliable supply water suitable for cattle consumption as the predicted salinity is less than 7,500 µS/cm based the upper limit in ANZECC (2000)[2] (up to 5,000 mg/L) and less than 6,000 µS/cm (up to 4,000 mg/L) based on the preferred limit for cattle consumption in ANZECC (2000) advised by DES (pers. comms). It should be noted that ANZECC (2000) provides a range of salinity limits for different livestock, some of which are more tolerant of higher salinities (e.g. up to 20,000 µS/cm for sheep).

Given the above, a water consumption rate for cattle of 70 ML/year was adopted for the residual void water balance using an average annual water consumption rate for cattle of 15,000 litres per year per head of cattle and a carrying capacity of 2.4 hectares (ha) per head of cattle applied over only the Mining Lease Application area for the Project (approximately 11,200 ha).

[2] Salinity limits were adopted from Table 4.3.1 of ANZECC (2000) and were converted from milligrams per litre (mg/L) to microSiemens per centimetre (µS/cm) using a conversion factor of 0.67.

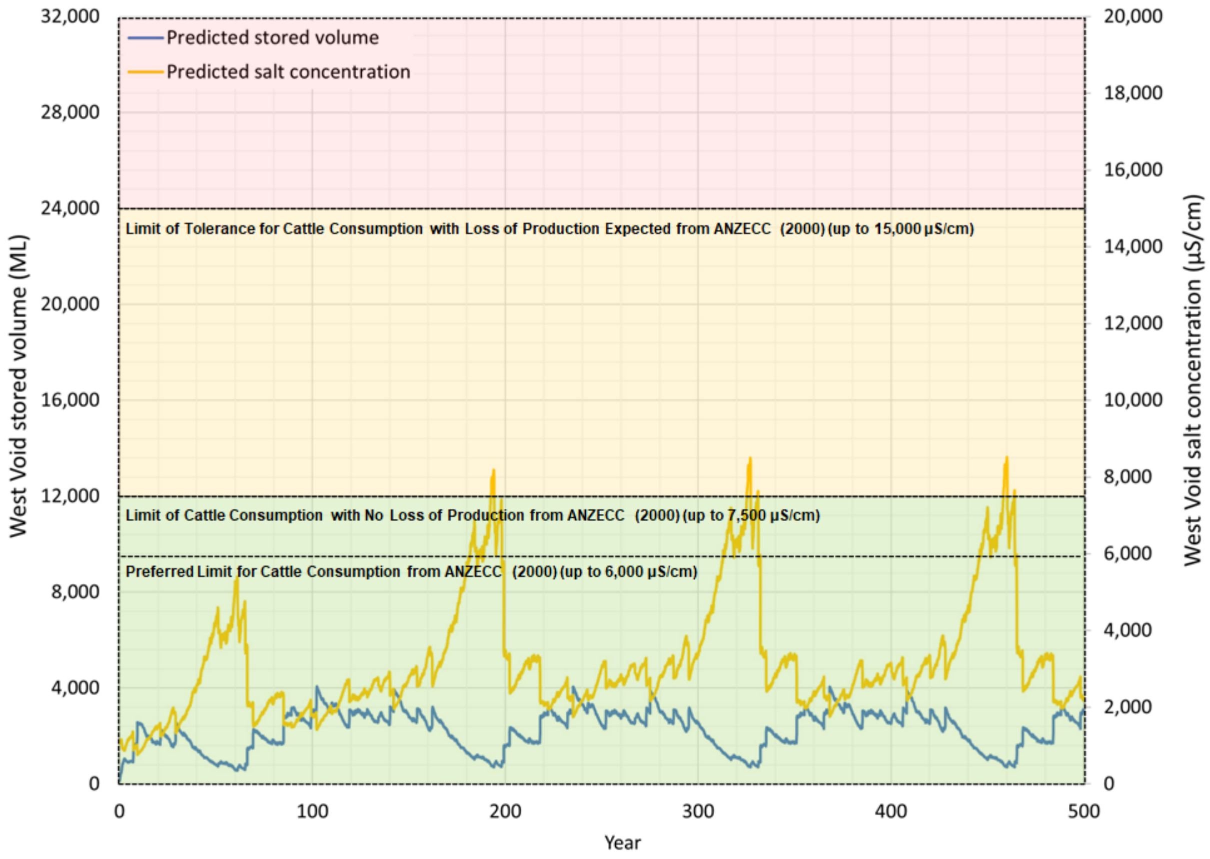


Chart 5-1C – Predicted Water Volume and Salinity for West Void and Cattle Tolerance Limits

In practice, these assumptions are very conservative as the proposed water storages would support cattle on an area much greater than the Mining Lease Application area. For example, the Winchester Downs property contains up to 30,000 ha of cattle grazing land and using the same carrying capacity would support approximately 12,500 head of cattle. Applying the consistent consumption rate of water to the Winchester Downs property would increase the water extraction from 70 ML/year to 190 ML/year. The proposed completion criterion for portions of the final landform dedicated to cattle production (e.g. low-intensity grazing PMLU) would need to demonstrate a carrying capacity of approximately 2.4 ha per head of cattle, which is consistent with the modelled carrying capacity rate and existing carrying capacity of the land. Given the above, the water consumption rate for cattle of 70 ML/year is considered to be robust for the residual void balance and the water consumption rate for cattle was split across the residual voids to provide a reliable supply of water, with West Void providing approximately 28 ML/year (i.e. 40% of 70 ML/year).

Similar to standard agriculture practices and management of pumping water around a property, if there are periods of low volume and elevated salinity in the West Void, the water within the West Void could be pumped into the Main Void or mixed with water from the Main Void at the point of use (e.g. troughs, tanks, dams) to meet the water quality limits (Chart 5-1B). This can be achieved with standard pumping equipment that would be used at cattle properties in the region.

The proposed completion criteria for the Residual Voids (RA3), including West Void, require surface water and groundwater quality monitoring to be undertaken. The results of the 'standard' water quality parameter monitoring (including, but not limited to, pH, EC, major anions [sulfate, chloride and alkalinity], major cations [sodium, calcium, magnesium and potassium], TDS and a broad suite of soluble metals/metalloids) would need to demonstrate that water within the residual voids is suitable for the PMLU (e.g. cattle consumption). Whitehaven WS would accept a condition that would require further analysis of the potential contaminants during Project operations to validate the water quality as well as monitoring of water within the residual voids for a period of at least five years post-rehabilitation (monitoring for at least two years previously proposed) to demonstrate that the water quality meets the relevant criteria.

Monitoring would be undertaken throughout the life of the Project for each of the water storages (including water dewatered from the open cut pits) and at the groundwater monitoring network across the Project area as part of the EA. The trigger levels in the proposed EA conditions are more stringent than the concentrations recommended by DES. As such, if there was any elevated concentrations of these contaminants in the water storages, it would be identified during operations and subsequent trigger investigations would be undertaken in accordance with the conditions of the EA.

Potential risks of algal blooms, pathogenic and/or parasitic contamination from cattle urine or faecal waste would be managed using standard agriculture practices and management (similar to those adopted for standard dams and troughs) and therefore would not be expected to render the water within the West Void as unsuitable for the PMLU. Management of this risk may include cattle having restricted, or no direct access to the water storages, with water reticulated to tanks, dams and troughs for consumption.

As outlined above, the West Void has been designed to avoid spills and present negligible risk of water interacting with the surrounding environment (including the surrounding groundwater systems) and therefore, would be safe, stable and non-polluting (e.g. not causing environmental harm).

In regard to additional economic analysis, Whitehaven WS previously reviewed the Project mine plan, reduced the number of residual voids by backfilling South Void and the updated assessment including a cost-benefit analysis. This additional economic analysis was provided in Attachment 16 of the Additional Information.

Notwithstanding, a separate cost-benefit analysis has been undertaken for individually backfilling the West Void. Deloitte adopted a conservative estimate of costs and assumed the costs associated with backfilling each of the three residual voids, including West Void would be entirely incurred after cessation of coal extraction (Year 30 and onwards). As a result, costs are heavily discounted (i.e. 7% discount rate).

The outcomes of the cost-benefit analysis associated with backfilling West Void only (i.e. in isolation of the other two residual voids) are summarised below:

- Additional costs attributed to Whitehaven WS estimated to be approximately $38 million AUD in NPV terms or approximately $322 million AUD in undiscounted terms.
- Reduction in the net economic benefits to the Queensland community by $6 million AUD in NPV terms.
- Backfilling and rehabilitation of the West Void results in additional land available for grazing (approximately 92 ha) at the disbenefit of removing the reliable water storage and supply from the West Void (approximately 28 ML/year), with the following estimated values:
  - additional land for grazing has an estimated annual benefit of $140,000 in undiscounted terms;
  - opportunity for a reliable water storage and supply from the West Void for use by existing agricultural land uses has an estimated annual benefit of $390,000 in undiscounted terms; and
  - net annual disbenefit of approximately $250,000 in undiscounted terms if West Void was backfilled rather than retained.
- Increase greenhouse gas emissions associated with the Project from consumption of additional diesel fuel and prolonging operations.
- Increase potential for environmental impacts or prolong predicted environmental impacts (e.g. water quality, noise and air quality impacts).

On balance, the backfilling of West Void would result in reduced benefits to the Queensland community in comparison to the final landform proposed for the Project and is therefore considered to not be in the public interest.

5.1.3 North-west Void

The residual void modelling adopted a large number of climate sequences reflecting the full range of historical climatic conditions, including risk associated with extreme weather conditions. The modelling therefore, provides an assessment of the system performance under very wet, very dry and average climatic conditions.

Water levels in the residual voids would vary over time, depending on the prevailing climatic conditions, and the balance between evaporation losses and inflows from rainfall, surface runoff, and groundwater. A GOLDSIM model was developed and used to assess the likely long-term water level behaviour of the residual voids, with the historical rainfall and evaporation sequences (133 years) repeated five times to create an indicative long-term climate record. This approach is significantly more conservative than other approaches (e.g. using averaged climate data) and results in repeating periods of severe climate conditions (i.e. drought) and it is unlikely the region would be able to sustain cattle production due to lack of feedstock.

Groundwater inflows into the North-west Void were provided by SLR as a time series over 2,000 years. The groundwater inflows take into account the movement of water between the residual void and both the backfilled in-pit waste rock and coal seams. Generally, the net groundwater inflows to the residual voids are initially negative whilst the groundwater level in the surrounding backfilled spoil rises post-mining (i.e. while the backfilled material becomes saturated). As a result, groundwater flow to the residual voids themselves have been reduced to 0 ML/day in the model during these periods. As the groundwater level in the backfilled spoil rises during the simulation and reaches equilibrium (i.e. the material becomes saturated), the groundwater inflows to the North-west Void are predicted to range between 0 ML/day to 0.55 ML/day, with most of that water originating from rainfall infiltrating into the spoil.

Groundwater inflow salinities from the backfilled waste rock at 1,012 µS/cm based on geochemical water quality sampling results for overburden and interburden and from the coal seams at 8,400 µS/cm based on groundwater bore sampling data from the coal seams and interburden near the North-west Void and West Void.

Water level in the North-west Void reaches equilibrium between 118 mAHD and 131 mAHD, and is predicted to vary between these levels. The maximum modelled water level is around 78 m below the level at which North-west Void would spill to the surrounding environment. Therefore, the North-west Void is not predicted to spill to the receiving environment under any climate scenario. The predicted residual void water levels are also well below the surrounding pre-mining groundwater levels, which means the residual voids would act as sinks to groundwater flow. This conclusion was validated via groundwater fate modelling (e.g. particle movement simulations) to simulate the flow of water throughout the final landform. The particle movement simulation predicted that water within the backfill spoil and North-west Void would not flow off-site, therefore indicating residual voids would remain groundwater sinks in perpetuity (generally driven by hydraulic gradient towards the residual voids, particularly the North-west Void) with no potential for discharge to the broader receiving groundwater environment under any climate scenario.

Salinity of water within the North-west Void reaches equilibrium within 100 years of residual void water balance modelling, with the salinity predicted to range mostly between 2,000 µS/cm to 6,000 µS/cm (Chart 5-1D). Some periods of higher salinity (up to 18,000 µS/cm) are predicted when the stored volume within the North-west Void is lower. The results of the water balance model indicate that the North-west Void can provide a sustainable and reliable supply water suitable for cattle consumption as the predicted salinity is less than 7,500 µS/cm based the upper limit in ANZECC (2000)[3] (up to 5,000 mg/L) and less than 6,000 µS/cm (up to 4,000 mg/L) based on the preferred limit for cattle consumption in ANZECC (2000) advised by DES (pers. comms). It should be noted that ANZECC (2000) provides a range of salinity limits for different livestock, some of which are more tolerant of higher salinities (e.g. up to 20,000 µS/cm for sheep).

Given the above, a water consumption rate for cattle of 70 ML/year was adopted for the residual void water balance using an average annual water consumption rate for cattle of 15,000 litres per year per head of cattle and a carrying capacity of 2.4 ha per head of cattle applied over only the Mining Lease Application area for the Project (approximately 11,200 ha).

[3] Salinity limits were adopted from Table 4.3.1 of ANZECC (2000) and were converted from milligrams per litre (mg/L) to microSiemens per centimetre (µS/cm) using a conversion factor of 0.67.

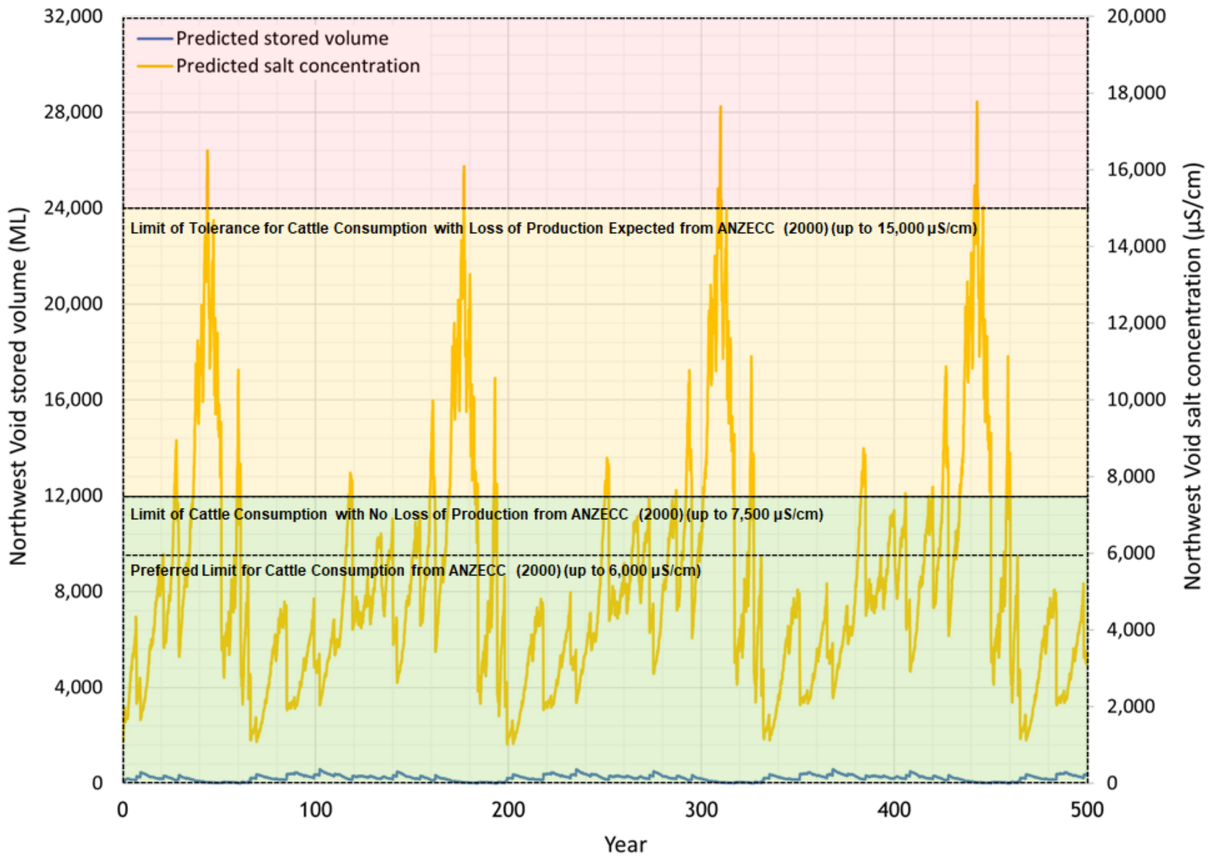


Chart 5-1D – Predicted Water Volume and Salinity for North-west Void and Cattle Tolerance Limits

In practice, these assumptions are very conservative as the proposed water storages would support cattle on an area much greater than the Mining Lease Application area. For example, the Winchester Downs property contains up to 30,000 ha of cattle grazing land and using the same carrying capacity would support approximately 12,500 head of cattle. Applying the consistent consumption rate of water to the Winchester Downs property would increase the water extraction from 70 ML/year to 190 ML/year. The proposed completion criterion for portions of the final landform dedicated to cattle production (e.g. low-intensity grazing PMLU) would need to demonstrate a carrying capacity of approximately 2.4 ha per head of cattle, which is consistent with the modelled carrying capacity rate and existing carrying capacity of the land. Given the above, the water consumption rate for cattle of 70 ML/year is considered to be robust for the residual void balance and the water consumption rate for cattle was split across the residual voids to provide a reliable supply of water, with North-west Void providing approximately 10.5 ML/year (i.e. 15% of 70 ML/year).

Similar to standard agriculture practices and management of pumping water around a property, if there are periods of low volume and elevated salinity in the North-west Void, the water within the North-west Void could be pumped into the Main Void or mixed with water from the Main Void at the point of use (e.g. troughs, tanks, dams) to meet the water quality limits (Chart 5-1B). This can be achieved with standard pumping equipment that would be used at cattle properties in the region.

The proposed completion criteria for the Residual Voids (RA3), including North-west Void, require surface water and groundwater quality monitoring to be undertaken. The results of the 'standard' water quality parameter monitoring (including, but not limited to, pH, EC, major anions [sulfate, chloride and alkalinity], major cations [sodium, calcium, magnesium and potassium], TDS and a broad suite of soluble metals/metalloids) would need to demonstrate that water within the residual voids is suitable for the PMLU (e.g. cattle consumption). Whitehaven WS would accept a condition that would require further analysis of the potential contaminants during Project operations to validate the water quality as well as monitoring of water within the residual voids for a period of at least five years post-rehabilitation (monitoring for at least two years previously proposed) to demonstrate that the water quality meets the relevant criteria.

Monitoring would be undertaken throughout the life of the Project for each of the water storages (including water dewatered from the open cut pits) and at the groundwater monitoring network across the Project area as part of the EA. The trigger levels in the proposed EA conditions are more stringent than the concentrations recommended by DES. As such, if there was any elevated concentrations of these contaminants in the water storages, it would be identified during operations and subsequent trigger investigations would be undertaken in accordance with the conditions of the EA.

Potential risks of algal blooms, pathogenic and/or parasitic contamination from cattle urine or faecal waste would be managed using standard agriculture practices and management (similar to those adopted for standard dams and troughs) and therefore would not be expected to render the water within the Northwest Void as unsuitable for the PMLU. Management of this risk may include cattle having restricted, or no direct access to the water storages, with water reticulated to tanks, dams and troughs for consumption.

As outlined above, the North-west Void has been designed to avoid spills and present negligible risk of water interacting with the surrounding environment (including the surrounding groundwater systems) and therefore, would be safe, stable and non-polluting (e.g. not causing environmental harm).

In regard to additional economic analysis, Whitehaven WS previously reviewed the Project mine plan, reduced the number of residual voids by backfilling South Void and the updated assessment including a cost-benefit analysis. This additional economic analysis was provided in Attachment 16 of the Additional Information.

Notwithstanding, a separate cost-benefit analysis has been undertaken for individually backfilling the North-west Void. Deloitte adopted a conservative estimate of costs and assumed the costs associated with backfilling each of the three residual voids, including North-west Void would be entirely incurred after cessation of coal extraction (Year 30 and onwards). As a result, costs are heavily discounted (i.e. 7% discount rate).

The outcomes of the cost-benefit analysis associated with backfilling North-west Void only (i.e. in isolation of the other two residual voids) are summarised below:

- Additional costs attributed to Whitehaven WS estimated to be approximately $11 million AUD in NPV terms or approximately $92 million AUD in undiscounted terms.
- Reduction in the net economic benefits to the Queensland community by $1 million AUD in NPV terms.
- Backfilling and rehabilitation of the North-west Void results in additional land available for grazing (approximately 38 ha) at the disbenefit of removing the reliable water storage and supply from the North-west Void (approximately 10.5 ML/year), with the following estimated values:
  - additional land for grazing has an estimated annual benefit of $60,000 in undiscounted terms;
  - opportunity for a reliable water storage and supply from the West Void for use by existing agricultural land uses has an estimated annual benefit of $150,000 in undiscounted terms; and
  - net annual disbenefit of approximately $90,000 in undiscounted terms if North-west Void was backfilled rather than retained.
- Increase greenhouse gas emissions associated with the Project from consumption of additional diesel fuel and prolonging operations.
- Increase potential for environmental impacts or prolong predicted environmental impacts (e.g. water quality, noise and air quality impacts).

On balance, the backfilling of North-west Void would result in reduced benefits to the Queensland community in comparison to the final landform proposed for the Project and is therefore considered to not be in the public interest.

5.2 Existing Winchester Quarry

Information Request

OCG Information Request

Existing Winchester Quarry

There is an existing quarry on site operated by a third party under standard EA EA0001796.

In all versions of the project description, Whitehaven states that quarry operations will continue, and Whitehaven is in discussions with the quarry operator to minimise any interference as a result of the operations proceeding in parallel. Whitehaven also propose to use material from the quarry (or a similar source) for construction of the mine.

It is not clear from information provided to date how operation and rehabilitation of the quarry will be clearly delineated from mine operation and rehabilitation. The proposed disturbance footprint for the Winchester South project appears to overlie parts of the existing quarry footprint and areas such as topsoil stockpiles. See Figure 1 at the end of this document.

It is not clear from information provided to date how operation and rehabilitation of the quarry will be clearly delineated from mine operation and rehabilitation.

Provide details on how Winchester Quarry and Winchester South project will operate in the context of:

- *How the two EAs will operate in parallel for each stage of the Winchester South project, including rehabilitation.*
- *How use of materials from the Winchester Quarry will be managed for the Winchester South project and whether these will be procured under a commercial arrangement.*
- *Clear delineation of activities and areas covered by each EA*
- *If the EAs are proposed to be merged at some point in the future, prior to the completion of the Winchester South project, and how this would be managed.*

DES Information Request

It is not clear from information provided to date how operation and rehabilitation of the quarry will be clearly delineated from mine operations, disturbance and rehabilitation. Note that if the quarry will continue to supply quarry material external to the mine it cannot be permitted under the mine's EA—it must continue to operate under a separate EA. If the quarry will be operated solely to provide quarry material for the mine it can be considered as an ancillary mining activity under the mine's EA, provided the applicable legislative requirements (especially regarding EA holders and land holders) are met.

The proponent must provide clear details on how Winchester Quarry and the proposed Winchester South project will operate in the context of:

- *How the two EAs will operate in parallel for each stage of the Winchester South project, including rehabilitation*
- *How use of materials from the Winchester Quarry will be managed for the Winchester South project and whether these will be procured under a commercial arrangement*
- *Clear delineation of activities and areas covered by each EA*
- *If the EAs are proposed to be merged at some point in the future, prior to the completion of the Winchester South project, provide details on how this would be managed, including consideration of any residual voids in accordance with rehabilitation advice above.*

Response

The interactions for each stage of the Winchester South Project (the Project) and the Winchester Quarry (the Quarry) are set out below. These arrangements will be documented in an agreement between Whitehaven WS, Quarrico (the operator of the Quarry) and the landowner (the holder of Environmental Authority [EA] 0001796 for the Quarry, which is also a development approval under the Queensland *Planning Act 2016*), as necessary. Figure 5-2A reproduces the figure included in the Final Landform and Residual Voids RFI and DES information request.

Initial operations of the Project (Project Year 1): The EAs will remain separate for the Project and the Quarry. Each party will carry out their respective environmentally relevant activities (ERAs) in accordance with each EA. The area of the Quarry will not form part of the operational area of the Project and will be excluded from Whitehaven WS' SSE responsibility. Any access interactions will be carried out in accordance with an interaction agreement between Whitehaven WS and Quarrico.

Commencement of mining operations for the Project in vicinity of the Quarry (Project Years 2 to 29): Prior to commencement of mining activities in Railway Pit for the Project, Whitehaven WS will notify Quarrico and require it to cease quarrying operations and vacate the area of the Quarry. The area of the Quarry will become part of Whitehaven WS' operational areas and activities in that area will be carried out in accordance with the mining EA, Progressive Rehabilitation and Closure Plan (PRCP) and Whitehaven WS' SSE responsibility.

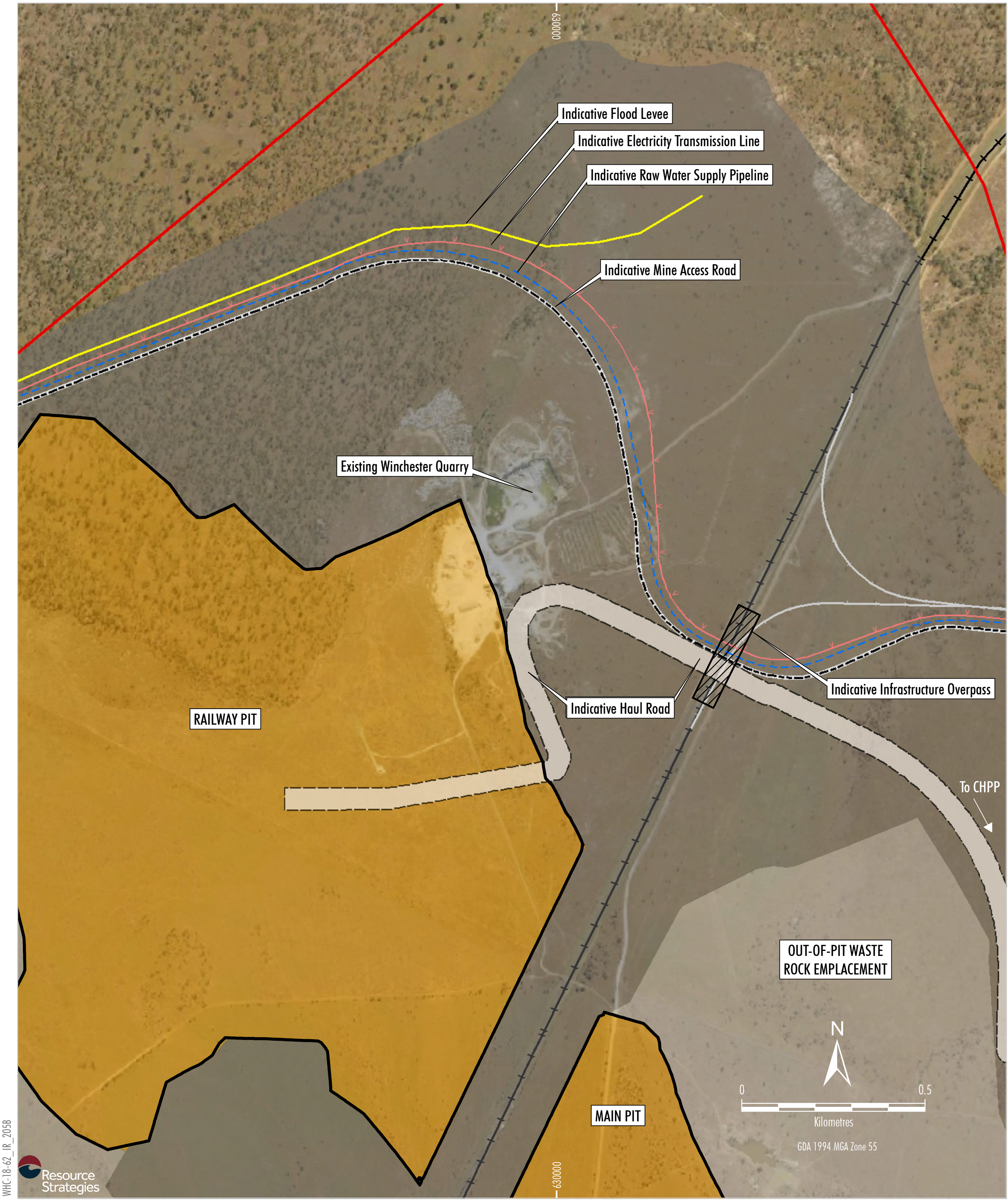
If the landowner does not require retention of the Quarry at the end of the Project life, the EA for the Quarry will be surrendered on the basis that the rehabilitation conditions of the PRCP for the Project will address all rehabilitation requirements of the EA for the Quarry. Alternatively, if the landowner intends to continue operation of the Quarry at the end of the Project life, the EA for the Quarry will remain on foot, but no activities will be carried out under the EA.

Rehabilitation (Project Year 30 onwards): Whitehaven will progressively rehabilitate any disturbance it has carried out in vicinity of the Quarry area in accordance with its EA and approved PRCP for the Project. If the landowner does not require retention of the Quarry at the end of the Project life, it will be backfilled and the Quarry area rehabilitated to a low intensity grazing post-mining land use (PMLU) consistent with the surrounding land. Alternatively, if the landowner intends to continue operation of the Quarry at the end of the Project life, Whitehaven WS will reflect the area as a quarrying PMLU, having regard to the EA for the Quarry status as a development approval. In that case, rehabilitation of any part of the Quarry area not disturbed by Whitehaven WS would be carried out by the landowner/Quarry operator in accordance with the EA for the Quarry.

Any procurement of materials from the Quarry for the Project will be under standard commercial arrangements with Quarrico. There are no such arrangements currently proposed.

Mining and quarrying activities will be carried out under the respective EAs. While they are ongoing, quarrying activities are expected to be confined to the existing disturbance footprint of the Quarry. Once mining commences in Railway Pit for the Project, quarrying activities will cease and the area of the quarry will form part of the mine's operational areas. The parties' operational areas and any interaction (e.g. the use of Mine Access Road by Quarrico) will be defined in an agreement.

The EAs are not proposed to be merged. To the extent quarry operations are to continue following the end of the Project life, they will be carried out under the existing quarrying EA/development approval. The approved PRCP for the Project would reflect a quarry PMLU for the relevant area, as authorised under the existing EA/development approval. If quarry operations are to permanently cease, then the quarrying EA will be surrendered on the basis that Whitehaven WS will rehabilitate disturbance carried out under the quarrying EA to a low intensity grazing PMLU, including by backfilling any residual voids.



LEGEND

- Mining Lease Application Boundary
- Railway
- Indicative Infrastructure Area
- Indicative Out-of-pit Waste Rock Emplacement
- Indicative Open Cut Pit Including In-pit Waste Rock Emplacement
- Indicative Mine Access Road
- Indicative Rail Spur and Loop
- Indicative Electricity Transmission Line
- Indicative Raw Water Supply Pipeline
- Indicative Flood Levee
- Indicative Haul Road for the Project
- Indicative Infrastructure Overpass

Source: The State of Queensland (2018 - 2020); Whitehaven (2022)
Orthophoto: Google Image (2019); Whitehaven (2017)

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Existing Winchester Quarry and the Project

Figure 5-2A

6 CONSOLIDATED IMPACT ASSESSMENT

The following section has been prepared using information from the Revised Draft EIS (e.g. the Draft EIS, Additional Information and Response to Submissions) as well as other information prepared by the technical specialists and incorporated into the Water and Final Landform Addendum:

- Response to Submissions (March 2023):
  - Attachment 1 – Proposed Conditions and Commitments (Whitehaven WS, 2023).
  - Attachment 2 – Consolidated Project Description (Whitehaven WS, 2023).
  - Attachment 3 – Groundwater Responses (SLR, 2023).
  - Attachment 4 – Surface Water and Flooding Responses (WRM, 2023).
  - Attachment 5 – Aquatic Ecology Responses (ESP, 2023).
- Revised Draft EIS (November 2022):
  - Additional Information – Attachment 5 –Groundwater (SLR, 2022).
  - Additional Information – Attachment 6 –Surface Water and Flooding (WRM, 2022).
  - Additional Information – Attachment 7 –Offset Management Strategy (Whitehaven WS, 2022).
  - Additional Information – Attachment 9 –Aquatic Ecology and Stygofauna (ESP, 2022a).
  - Additional Information – Attachment 10 –Aquatic Ecology and Stygofauna Assessment Addendum (ESP, 2022b).
  - Additional Information – Attachment 16 –Economics (Deloitte, 2022).
- Draft EIS (August 2021):
  - Appendix B – Appendix F – Geomorphology Technical Study (Fluvial Systems, 2020).
  - Appendix D – Terrestrial Ecology Assessment (E2M, 2021).
  - Appendix E – Aquatic Ecology and Stygofauna Assessment (ESP, 2021).
  - Appendix M – Geochemistry Assessment (Terrenus, 2021).

Based on the Surface Water, Groundwater and Final Landform and Residual Voids RFIs, Table 6-1A has been prepared to provide a consolidated impact assessment for water-related matters relevant to the Project.

The consolidated impact assessment providing in Table 6-1A considered the relative local importance of the features identified and a range of potential direct and indirect impact mechanisms relevant to the Project.

The key assessment outcomes and avoidance, mitigation and offset measures that would be adopted for the Project are summarised to inform the residual impact magnitude ranking. The relative local importance and residual impact magnitude were considered against each feature to determine the significance of the residual impacts.

Table 6-1A
Consolidated Impact Assessment for Water Matters for the Project

<table>
<tr><th>Feature</th><th>Relative Local Importance[1]</th><th>Potential Impact Mechanisms</th><th>Assessment Outcomes and Avoidance, Mitigation and Offset Measures Adopted for the Project</th><th>Residual Impact Magnitude</th><th>Significance of Residual Impacts</th></tr>
<tr><td colspan="6">Surface Water</td></tr>
<tr><td rowspan="2">Isaac River</td><td rowspan="2">High</td><td>Water quality changes from sediment-laden water
Increased leakage from Isaac River to underlying alluvium from depressurisation of coal seam aquifers</td><td rowspan="2">Avoidance of direct disturbance of Isaac River.
Clean water drains limit catchment excision and flow volume impacts.
Reduced surface disturbance reduces catchment excision.
Sediment water management system.
Mine-affected water releases only required during very-wet conditions (1%ile) using tiered criteria based on Isaac River flows.
Mine-affected water releases into tributaries of the Isaac River (no direct release into the Isaac River) limiting potential for scour and erosion.
Residual voids not predicted to overflow.
Limited mining activities and infrastructure located within Isaac River floodplain and development of temporary flood levees.
Negligible leakage and baseflow losses in Isaac River and alluvium predicted from depressurisation in the coal seam aquifers.
Extensive water monitoring program to be implemented.</td><td>Very Low</td><td>Low</td></tr>
<tr><td>Catchment excision impacting downstream flows
Water quality changes from mine-affected water
Scour/erosion from controlled releases
Changes to flooding regime</td><td>Negligible</td><td>Negligible</td></tr>
<tr><td rowspan="2">Ripstone Creek</td><td rowspan="2">Moderate</td><td>Water quality changes from sediment-laden water
Catchment excision impacting downstream flows</td><td rowspan="2">Avoidance of direct disturbance of Ripstone Creek.
Clean water drains limit catchment excision and flow volume impacts.
Reduced surface disturbance reduces catchment excision.
Sediment water management system.
No mine-affected water releases into Ripstone Creek.
No mining activities and infrastructure located within Ripstone Creek floodplain and development of temporary flood levees.
Extensive water monitoring program to be implemented.</td><td>Very Low</td><td>Low</td></tr>
<tr><td>Changes to flooding regime
Water quality changes from mine-affected water</td><td>Negligible</td><td>Negligible</td></tr>
</table>

Feature	Relative Local Importance[1]	Potential Impact Mechanisms	Assessment Outcomes and Avoidance, Mitigation and Offset Measures Adopted for the Project	Residual Impact Magnitude	Significance of Residual Impacts
Cherwell Creek	Moderate	Water quality changes from sediment-laden water Catchment excision impacting downstream flows Changes to flooding regime Water quality changes from mine-affected water	Avoidance of direct disturbance, catchment excision, releases to or changes in the flooding regime of Cherwell Creek.	Nil	Nil
Northern Unnamed Waterway	Low	Direct surface disturbance Catchment excision impacting downstream flows Scour/erosion from controlled releases	Reinstatement of excised portions of the Northern Unnamed Waterway. Northern Unnamed Waterway will be offset in accordance with the Financial Settlement Offset Calculation Methodology outlined in the *Queensland Environmental Offsets Policy*. Clean water drains limit catchment excision and flow volume impacts. Sediment water management system. Extensive water monitoring program to be implemented.	Low	Low
		Water quality changes from sediment-laden water Water quality changes from mine-affected water		Negligible	Negligible
Central Unnamed Waterway	Low	Direct surface disturbance Catchment excision impacting downstream flows Scour/erosion from controlled releases	Avoidance of the disturbance to determined watercourse alignment. Re-establishment of surface drainage sympathetic with the natural existing drainage features. Central Unnamed Waterway will be offset in accordance with the Financial Settlement Offset Calculation Methodology outlined in the *Queensland Environmental Offsets Policy*. Clean water drains limit catchment excision and flow volume impacts. Sediment water management system. Extensive water monitoring program to be implemented.	Low	Low
		Water quality changes from sediment-laden water Water quality changes from mine-affected water		Negligible	Negligible

Feature	Relative Local Importance[1]	Potential Impact Mechanisms	Assessment Outcomes and Avoidance, Mitigation and Offset Measures Adopted for the Project	Residual Impact Magnitude	Significance of Residual Impacts
Southern Unnamed Waterway	Negligible	Direct surface disturbance Catchment excision impacting downstream flows Water quality changes from sediment-laden water	Avoidance of disturbance to determined watercourse alignment and waterway alignment. No mine-affected water releases into Southern Unnamed Waterway. No local importance as the Southern Unnamed Waterway is approved to be disturbed as part of the Olive Downs Project.	Negligible	Negligible
Waterway 3	Negligible	Direct surface disturbance Catchment excision impacting downstream flows	There is no evidence that Waterway 3 provides for fish passage. Notwithstanding, Waterway 3 will be offset in accordance with the Financial Settlement Offset Calculation Methodology outlined in the *Queensland Environmental Offsets Policy*.	Negligible	Negligible
Groundwater					
Isaac River alluvium (Quaternary alluvium unconfined aquifer with water-bearing strata of permeable rock, sand, or gravel along the Isaac River)	High	Direct interception of Isaac River alluvium Indirect influence on Isaac River alluvium through depressurisation of coal seam aquifers (baseflow losses) Drawdown in the Isaac River alluvium Cumulative drawdown impacts in the Isaac River alluvium Water quality changes in the Isaac River alluvium	Avoidance of direct interception of Isaac River alluvium, resulting in no direct take of groundwater. No drawdown greater than 0.3 m in Isaac River alluvium due to the Project and would be indistinguishable from natural variation. No seepage from the Project, during operations or post-mining, is predicted to flow off-site and therefore there is no mechanism for impacts to water quality to Isaac River alluvium. No known/registered privately-owned bores in the Isaac River alluvium predicted to experience Project-only drawdown greater than 1 m. Final landform behaves as groundwater sink. Clean water drains limit catchment excision and flow volume impacts. Reduced surface disturbance reduces catchment excision. Negligible leakage and baseflow losses in Isaac River and alluvium predicted from depressurisation in the coal seam aquifers. Extensive water monitoring program to be implemented, including validation of groundwater modelling predictions against actual groundwater measurements during operations.	Negligible	Negligible

Feature	Relative Local Importance[1]	Potential Impact Mechanisms	Assessment Outcomes and Avoidance, Mitigation and Offset Measures Adopted for the Project	Residual Impact Magnitude	Significance of Residual Impacts
Regolith (Quaternary to Tertiary colluvium and weathered units unconfined and largely unsaturated unit bordering alluvium)	Moderate	Direct interception of regolith Indirect influence on regolith through depressurisation of coal seam aquifers Drawdown in the regolith Cumulative drawdown impacts in the regolith Water quality changes in the regolith	Predicted effects of drawdown in the saturated regolith are largely constrained to the Project Area, with drawdown due to the Project limited to 1 m to 2 m off-site. No seepage from the Project, during operations or post-mining, is predicted to flow off-site and therefore there is no mechanism for impacts to water quality to the regolith. No known/registered privately-owned bores in the regolith predicted to experience Project-only drawdown greater than 1 m. Final landform behaves as groundwater sink. Reduced surface disturbance reduces catchment excision. Extensive water monitoring program to be implemented, including validation of groundwater modelling predictions against actual groundwater measurements during operations.	Low	Low
Coal seam aquifers (Permian Coal Measures exhibiting water bearing properties associated with secondary porosity through cracks and fissures)	Low	Direct interception of the coal seam aquifers Depressurisation of coal seam aquifers Cumulative depressurisation impacts in the coal seam aquifers Water quality changes in the coal seam aquifers	Propagation of depressurisation in the coal seam aquifers limited by faulting truncation of coal seams and is largely constrained to the Project area. No known privately-owned bores within the coal seam aquifers predicted to experience Project-only drawdown greater than 1 m. No seepage from the Project, during operations or post-mining, is predicted to flow off-site and therefore there is no mechanism for impacts to water quality to the coal seam aquifers. Final landform behaves as groundwater sink. Extensive water monitoring program to be implemented, including validation of groundwater modelling predictions against actual groundwater measurements during operations.	Negligible	Negligible

Feature	Relative Local Importance[1]	Potential Impact Mechanisms	Assessment Outcomes and Avoidance, Mitigation and Offset Measures Adopted for the Project	Residual Impact Magnitude	Significance of Residual Impacts
Water Dependent Assets					
Potential aquatic GDEs along Isaac River mapped as high potential for groundwater interaction	Moderate/ High	Direct disturbance of feature Potential impact mechanisms described above for Isaac River and Isaac River alluvium	Avoidance of direct disturbance of aquatic GDEs along Isaac River. Avoidance, mitigation and offset measures adopted for the Project as described above for Isaac River and Isaac River alluvium. No drawdown greater than 0.3 m in alluvium due to the Project and would be indistinguishable from natural variation. Extensive water monitoring program to be implemented.	Negligible	Negligible
Riparian vegetation along the Isaac River and Cherwell Creek mapped as high potential for groundwater interaction	Moderate/ High	Direct disturbance of feature. Potential impact mechanisms described above for Isaac River, Cherwell Creek and Isaac River alluvium.	Avoidance of direct disturbance of riparian vegetation along the Isaac River and Cherwell Creek. Avoidance, mitigation and offset measures adopted for the Project as described above for Isaac River, Cherwell Creek and Isaac River alluvium. No drawdown greater than 0.3 m in alluvium due to the Project and would be indistinguishable from natural variation. Extensive water monitoring program to be implemented.	Nil	Nil
Wetlands on the Isaac River floodplain mapped as potential aquatic GDEs with high/moderate potential for groundwater interaction	Moderate/ High	Direct disturbance of feature. Potential impact mechanisms described above for Isaac River, Isaac River alluvium and regolith.	Avoidance of direct disturbance of wetlands on the Isaac River floodplain mapped as potential aquatic GDEs with high/moderate potential for groundwater interaction (e.g. Palustrine Wetlands). No drawdown predicted in areas of wetlands on the Isaac River floodplain mapped as potential aquatic GDEs with high/moderate potential for groundwater interaction. Palustrine Wetlands PW1, PW2 and PW3 would be disturbed as part of the Olive Downs Project. Palustrine Wetland PW4 located within the Wynette Offset Area would be provided protection. Extensive water monitoring program to be implemented.	Nil	Nil

Feature	Relative Local Importance[1]	Potential Impact Mechanisms	Assessment Outcomes and Avoidance, Mitigation and Offset Measures Adopted for the Project	Residual Impact Magnitude	Significance of Residual Impacts
Terrestrial vegetation associated with wetlands on the Isaac River floodplain mapped as high and moderate potential for groundwater interaction	Moderate/ High	Direct disturbance of feature. Potential impact mechanisms described above for Isaac River, Isaac River alluvium and regolith.	Avoidance of direct disturbance of terrestrial vegetation associated with wetlands on the Isaac River floodplain. No drawdown predicted in areas of terrestrial vegetation associated with wetlands on the Isaac River floodplain. Terrestrial vegetation associated with Palustrine Wetlands PW1, PW2 and PW3 would be disturbed as part of the Olive Downs Project. Terrestrial vegetation associated with Palustrine Wetland PW4 located within the Wynette Offset Area would be provided protection from direct disturbance. Extensive water monitoring program to be implemented.	Nil	Nil
Wetlands east of Project mapped as potential aquatic GDEs with moderate potential for groundwater interaction	Moderate	Direct disturbance of feature. Potential impact mechanisms described above for Isaac River, Isaac River alluvium and regolith.	Avoidance of direct disturbance of wetlands east of Project mapped as potential aquatic GDEs with moderate potential for groundwater interaction. No drawdown predicted in areas of wetlands east of Project mapped as potential aquatic GDEs with moderate potential for groundwater interaction. Wetlands east of Project mapped as potential aquatic GDEs with moderate potential for groundwater interaction would be disturbed as part of the Olive Downs Project. Wetlands east of Project mapped as potential aquatic GDEs with moderate potential for groundwater interaction located within the Wynette Offset Area would be provided protection from direct disturbance. Extensive water monitoring program to be implemented.	Nil	Nil

Feature	Relative Local Importance[1]	Potential Impact Mechanisms	Assessment Outcomes and Avoidance, Mitigation and Offset Measures Adopted for the Project	Residual Impact Magnitude	Significance of Residual Impacts
Terrestrial vegetation on the Isaac River and Ripstone Creek floodplains (outside of wetlands) mapped as moderate potential for groundwater interaction	Moderate	Direct disturbance of feature. Potential impact mechanisms described above for Isaac River, Ripstone Creek Isaac River alluvium and regolith.	Avoidance of direct disturbance of terrestrial vegetation on the Isaac River and Ripstone Creek floodplains (outside of wetlands). No drawdown predicted in areas of terrestrial vegetation on the Isaac River and Ripstone Creek floodplains (outside of wetlands). Terrestrial vegetation on the Isaac River and Ripstone Creek floodplains (outside of wetlands) proximal to the Project would be disturbed as part of the Olive Downs Project. Extensive water monitoring program to be implemented.	Nil	Nil
Terrestrial vegetation in the vicinity of the Project mapped as low potential for groundwater interaction	Low	Direct disturbance of feature. Potential impact mechanisms described above for regolith.	Direct disturbance avoided as far as practicable. Direct disturbance of Matters of State Environmental Significance (MSES) and Matters of National Environmental Significance (MNES) within the Project area would be offset. Extensive water monitoring program to be implemented.	Low	Low
Farm dams mapped as potential aquatic GDEs with high/moderate potential for groundwater interaction	Nil	Direct disturbance of feature.	Waterbodies in the farm dams are not considered to be dependent on groundwater.	Nil	Nil

1 'Relative Local Importance' has been determined based on the relativity of similar features in the immediate vicinity of the Project. The determined importance would be reduced if this assessed at a regional scale.

7 REFERENCES

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

Barnett, B., Townley, L.R., Post, V., Evans, R.E., Hunt, R.J., Peeters, L., Richardson, S., Werner, A.D., Knapton, A. and Boronkay, A. (2012) *Australian Groundwater Modelling Guidelines*.

Commonwealth Scientific and Industrial Research Organisation and Bureau of Meteorology (2015) *Climate Change in Australia Technical Report – Predictions for Australia's NRM Regions.*

Côte, C.M., Holloway, E., Dunlop, J. and Chrystal, R. (2023) *Leading Practice Approaches to Select Post-Mining Land Uses For Residual Mine Voids: Technical Paper*. Brisbane: Office of the Queensland Mine Rehabilitation Commissioner, Queensland Government.

Deloitte Access Economics (2022) *Winchester South Project – Economic Assessment.* Prepared for Whitehaven WS Pty Ltd.

Deloitte Access Economics (2023) *Personal Communication*.

Department of Agriculture and Fisheries (2023) *Winchester South Project: Waterway Site Inspections.* Prepared for Department of Agriculture and Fisheries.

Department of Environment and Science (2022) *Reef discharge standards for industrial activities*.

Department of Natural Resources, Mines and Energy (2019) *Water Monitoring Information Portal (WMIP)*. Available at: https://water-monitoring.information.qld.gov.au/

Doody, T.M., Hancock, P.J., Pritchard, J.L. (2019) *Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems*. Report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2019.

E2M Pty Ltd (2021) *Winchester South Project – Terrestrial Ecology Assessment*. Prepared for Whitehaven WS Pty Ltd.

Ecological Service Professionals Pty Ltd (2021) *Winchester South Project - Aquatic Ecology and Stygofauna Assessment*. Prepared for Whitehaven WS Pty Ltd.

Ecological Service Professionals Pty Ltd (2022a) *Winchester South Project - Aquatic Ecology and Stygofauna Additional Information*. Prepared for Whitehaven WS Pty Ltd.

Ecological Service Professionals Pty Ltd (2022b) *Winchester South Project - Aquatic Ecology and Stygofauna Assessment Addendum*. Prepared for Whitehaven WS Pty Ltd.

Ecological Service Professionals Pty Ltd (2023) *Winchester South Project - Aquatic Ecology Responses*. Prepared for Whitehaven WS Pty Ltd.

Fluvial Systems Pty Ltd (2020) *Winchester South Project Environmental Impact Statement – Technical Study Report – Geomorphology Assessment.* Prepared for Whitehaven WS Pty Ltd.

Hancock, P.J. (2022) *Personal Communication*.

Hawkins, J.W. (1998) *Hydrogeologic characteristics of surface-mine spoil. In Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania*.

Hydro Engineering & Consulting Pty Ltd (2021) Winchester South Project EIS – *Surface Water and Flooding Assessment Peer Review.*

HydroSimulations (2018) *Olive Downs Project – Groundwater Assessment*. Prepared for Pembroke Olive Downs Pty Ltd. May 2018.

Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (2018) *Information guidelines for proponents preparing coal seam gas and large coal mining development proposals*.

International Erosion Control Association (2018) *Best Practice Erosion and Sediment Control Guideline*.

Eve L. Kuniansky (2018) *Equivalent Fresh Groundwater Head for Potentiometric Maps*.

Mackie, C.D. (2009) *Hydrogeological characterisation of Coal Measures and overview of impacts of coal mining on groundwater systems in the upper Hunter Valley of NS*W.

SLR Consulting Australia Pty Ltd (2022) *Winchester South Project Additional Information – Groundwater Impact Assessment.* Prepared for Whitehaven WS Pty Ltd.

SLR Consulting Australia Pty Ltd (2023) *Environmental Authority Groundwater Limits and Triggers Derivation Report.* Prepared for Whitehaven WS Pty Ltd.

The State of Queensland (Queensland Floods Commission of Inquiry) (2012) *Final Report.*

Terrenus Earth Sciences (2021) *Winchester South Project - Geochemical Assessment of Potential Waste Rock and Coal Reject Materials*. Report prepared for Whitehaven WS Pty Ltd.

Terrenus Earth Sciences (2023) *Environmental geochemical characteristics of potential rejects from the Winchester South Project [Rangal Coal Measures] compared to rejects from neighbouring mines [Rangal Coal Measures]*. Prepared for Whitehaven WS Pty Ltd.

Whitehaven WS Pty Ltd (2022) *Winchester South Project – Additional Information – Offset Management Strategy*.

Whitehaven WS Pty Ltd (2023) *Winchester South Project – Environmental Impact Statement – Response to Submissions*.

Wilford, J., Searle, R., Thomas, M., Pagendam, D., & Grundy, M. (2016) *A Regolith Depth Map of the Australian Continent.* Geoderma. Vol. 266, p.1-13. https://doi.org/10.1016/j.geoderma.2015.11.033.

WRM Water & Environment Pty Ltd (2022) *Winchester South Project Additional Information Surface Water and Flooding Assessment*.

WRM Water & Environment Pty Ltd (2023) *Winchester South Project – Surface Water and Flooding Responses*. Prepared for Whitehaven WS Pty Ltd.