Appendix C

Surface Water-Groundwater Interaction Assessment

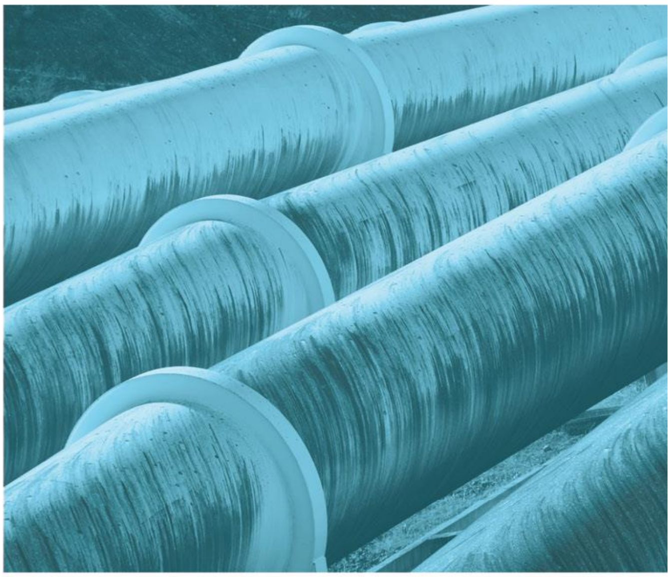
REGIS
RESOURCES LTD


McPhillamys Gold Project

Surface water-groundwater interaction assessment

Prepared for LFB Resources NL

September 2020

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McPhillamys Gold Project

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EMM Sydney
Ground floor, 20 Chandos Street
St Leonards NSW 2065

T 02 9493 9500
E info@emmconsulting.com.au

www.emmconsulting.com.au

McPhillamys Gold Project

Surface water-groundwater interaction assessment

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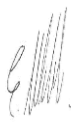
Prepared by

Kate Holder
Associate Hydrogeologist
1 September 2020

Approved by



Liz Webb
Director - Water and Land
1 September 2020

Executive Summary

ES1 Introduction

Understanding the interaction between surface water (creeks, the Belubula River, dams and springs) and groundwater has been a focus for LFB Resources NL (Regis) in the application for State Significant Development consent for the construction and operation of the McPhillamys Gold Project. This report provides an update and additional detail to the information presented in the Environmental Impact Statement (EIS) on the local hydrogeological and hydrological environment, including additional water monitoring data, which further adds to the conceptual understanding of the water environment in the McPhillamys and broader area.

The McPhillamys Gold Project is a greenfield open cut gold mine and associated water supply pipeline in the Central West of New South Wales (NSW). The mine development is around 8 kilometres (km) north-east of Blayney within the Blayney and Cabonne local government areas, and in the upper reaches of the Belubula River catchment, within the greater Lachlan River catchment. The EIS was prepared to assess the potential environmental, economic and social impacts of the project. During EIS exhibition period, Regis received submissions from regulators, businesses and other organisations and the community regarding varying aspects of the project, including questions and concerns about the potential effect of the project on the flows in the Belubula River and springs in the area.

Developing an understanding of the surface water and groundwater environment and the way they interact within a project area is important when considering how the development of a project may or may not cause changes. A spring is an area where groundwater emerges naturally from the rock or soil and flows onto land or into a body of surface water. Springs can be classified based on the rate of flow, type of aquifer, chemical characteristics, water temperature, direction of water migration, and relation to topography and geologic structure. The way in which a spring may or may not be affected by the development of a project is dependent on the type of spring it is – different spring types will react differently, or not at all, to changes in the groundwater system.

ES2 Environment setting

The hydrogeology surrounding the project area is dominated by the Palaeozoic metamorphic rocks of the eastern Lachlan Fold Belt. The groundwater system is recharged locally by the percolation of rainfall and leakage from surface watercourses. Groundwater discharge occurs via evapotranspiration, spring flow, and contributions to surface watercourses (baseflow). More than five years of groundwater monitoring has provided information on the local watertable elevation and groundwater flow direction, as well as groundwater quality.

The project disturbance area (ie where the tailings storage facility (TSF) and open cut mine will be located) is within the headwaters of the Belubula River, and is located close to the surface water catchment divide between the Lachlan River and the Macquarie River. The Belubula River flows south into Carcoar Dam (26 km from the project area) and then west before joining the Lachlan River. More than six years of surface water quality monitoring from the Belubula River and tributaries, and several dams, springs and seeps within the project area has provided information on the water quality and groundwater contribution to the surface watercourses.

ES3 Surface water–groundwater interaction

Surface water – groundwater interactions within the project area have been further investigated using isotope water chemistry sampling and analysis, to gain an understanding of the source of the water at the sampling point (including dams, springs, watercourse, and groundwater bores). This data, combined with field observations, water chemistry, and the geological understanding has allowed for classification of the springs/seeps identified within the project area into one of six spring types.

Most springs (more than two thirds) in the project area are associated with areas where the topographic gradient changes abruptly and intercepts shallow groundwater flow. Many of these springs and seeps have been excavated into dams to increase water access for stock. Whilst some springs do contribute flow to the Belubula River, a large amount of the discharging groundwater will evaporate, be used by vegetation, or for stock and domestic purposes.

Rainfall and runoff are the main contributing sources of water to the Belubula River flows; the upper reaches (above Trib E) are ephemeral and flow only during and after heavy rainfall. Groundwater discharges to the river downstream of Trib A (and to Trib A), contributing around 5% of overall flow immediately downstream of Trib A and around 20% of flow downstream of the Mid Western Highway.

ES4 Impact assessment

ES4.1 Streamflow

The project will not have a significant impact on streamflow in the Belubula River. The changes that are predicted to occur are within the current natural variability of the Belubula River flows. Users downstream of the project who rely on and access water from the Belubula River will not experience reduced access to water and are not expected to be affected by the project.

The predicted change to streamflow is minor and is mostly due to the change in the catchment size (ie reduced rainfall runoff into the river). This results in a maximum 4% reduction of streamflow at Carcoar Dam and 9% at Mid Western Highway during operation of the project and reduces to 0.5% following completion of the project.

The project will also not have a significant impact on streamflow because of changes in groundwater discharge and/or surface water – groundwater interaction. Immediately upstream of Trib A, groundwater currently contributes approximately 5% of overall streamflow to both Trib A and the Belubula River; the maximum amount this will reduce because of the project is by 15%. That is, at the time when the project has the most impact on groundwater, groundwater contribution to streamflow above Trib A will be 4.25% (compared to the 5% of contribution in the current situation). Downstream of the project area, groundwater discharge to the Belubula River will not change and will continue to contribute around 20% to the watercourse flows.

ES4.2 Groundwater levels

Changes to the watertable and groundwater levels as result of mining will be localised within the project area and within approximately 1.4 km around the open cut pit. Groundwater level changes are not predicted to affect landholder bores on neighbouring properties.

ES4.3 Springs and seeps

The project will not impact springs and seeps outside of the project area, as groundwater levels are not predicted to change outside the project area. Within the project area, the water that currently discharges from existing springs and seeps mostly either evaporates or is used by vegetation or for stock and domestic purposes rather than contributing significantly to streamflow. Groundwater that currently discharges at springs/seeps in areas where the TSF and other project infrastructure is planned, will no longer be able to discharge at that location and instead will continue moving underground, until a new discharge point is reached. In this area, the TSF seepage interception drain will capture most of this shallow groundwater. Otherwise, the shallow groundwater will continue moving underground, as it currently does, eventually discharging at the Belubula River, the open cut or at new or existing spring locations downstream.

ES4.4 Water quality

Tailings will undergo cyanide destruction as part of the ore processing to greatly reduce concentrations of cyanide and other metals in tailings water, minimising potential impacts to the environment through project design. Work by ATC Williams Pty Ltd (2020) demonstrates that the proposed TSF multi-barrier seepage management system provides a robust system and is effective at reducing seepage.

The groundwater assessment predicts that groundwater and surface water quality will not be adversely affected by the TSF.

Using the highly conservative results of the groundwater model, a simple mixing calculation was conducted to estimate the concentration of aluminium, electrical conductivity (as salinity), sulphate, selenium, cyanide, cobalt. The results show that, following mixing, water will have concentrations that are:

- below or within the range of water quality concentrations currently measured in groundwater, and the Belubula River and its tributaries;
- below ANZECC (2000) livestock drinking water guideline values (with the exception of cobalt); and
- below ANZECC (2000) 95% protection level for freshwater aquatic ecosystem guideline values.

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Figures

1 Introduction

1.1 Background

LFB Resources NL is seeking State Significant Development consent for the construction and operation of the McPhillamys Gold Project, a greenfield open cut gold mine and associated water supply pipeline in the Central West of New South Wales (NSW). LFB Resources NL is a 100% owned subsidiary of Regis Resources Limited (herein referred to as Regis).

As shown in Figure 1.1, the McPhillamys Gold Project comprises two key components; the mine site where the ore will be extracted, processed and gold produced for distribution to the market (the mine development), and an associated water pipeline that will enable the supply of water from approximately 90 kilometres (km) away near Lithgow to the mine site (the pipeline development). The mine development is around 8 km north-east of Blayney within the Blayney and Cabonne local government areas (LGAs). It is also in the upper reaches of the Belubula River catchment, within the greater Lachlan River catchment.

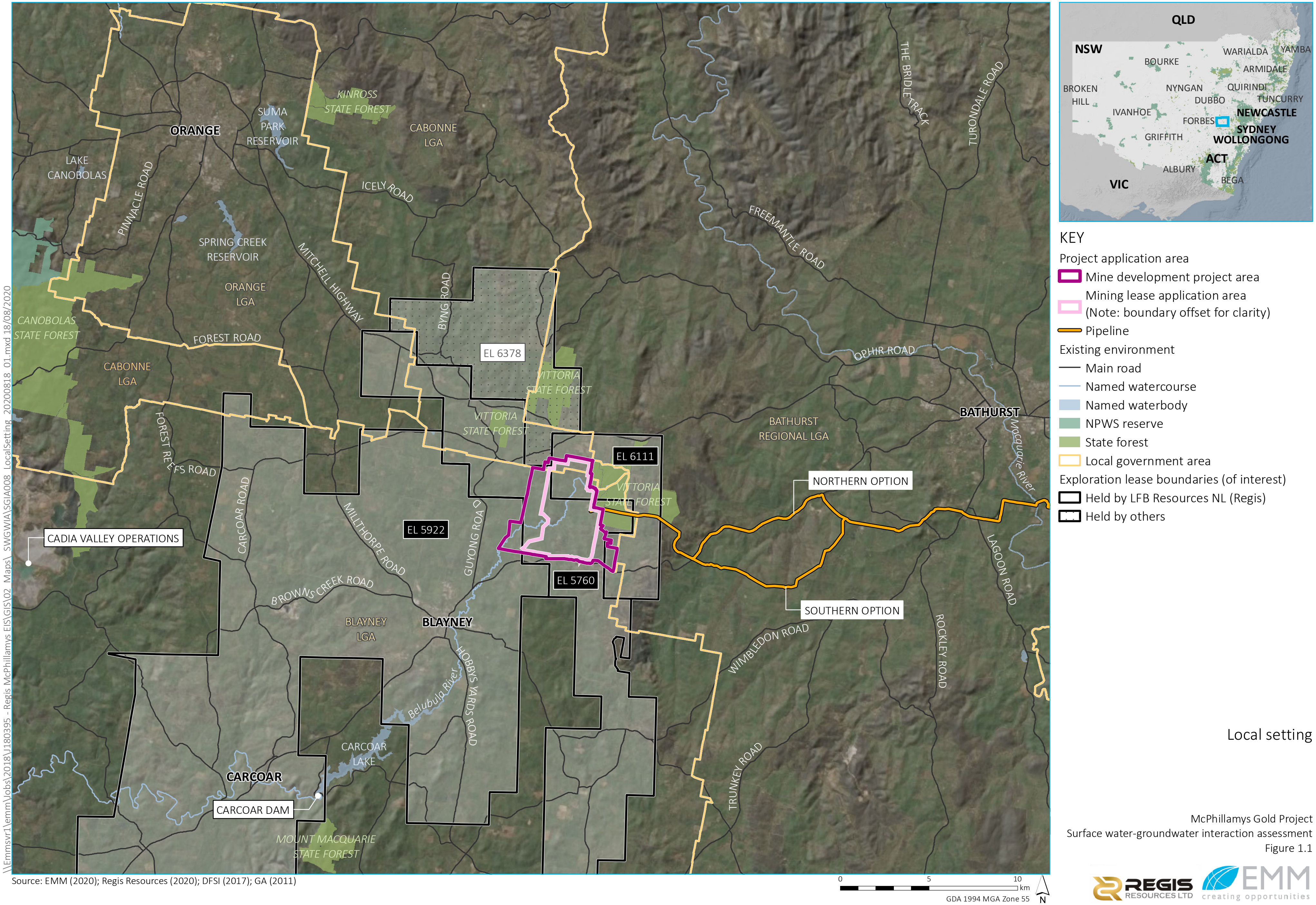
Up to 8.5 million tonnes per annum (Mtpa) of ore will be extracted from the McPhillamys gold deposit over a total project life of 15 years. The mine development will include a conventional carbon-in-leach processing facility, waste rock emplacement, an engineered tailings storage facility (TSF) and associated mine infrastructure including workshops, administration buildings, roads, water management infrastructure, laydown and hardstand areas, and topsoil stockpiles.

In accordance with the requirements of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), the NSW *Environmental Planning & Assessment Regulation 2000* (EP&A Regulation) and the Secretary's Environmental Assessment Requirements (SEARs) for the project, an Environmental Impact Statement (EIS) was prepared to assess the potential environmental, economic and social impacts of the project. The development application and accompanying EIS were submitted to the NSW Department of Planning, Industry and Environment (DPIE) in August 2019 and publicly exhibited for six weeks, from 12 September 2019 to 24 October 2019.

During this exhibition period Regis received submissions from regulators, businesses and other organisations and the community regarding varying aspects of the project.

1.2 Purpose of this report

The interaction between surface water (creeks, the Belubula River, dams and springs) and groundwater was considered in detail within the groundwater assessment prepared for the EIS (EMM 2019a) because of known community interest in this topic. Members of the community continue to raise questions and concerns about the potential effect of the project on the flows in the Belubula River and springs in the area. This report therefore provides an update and additional detail to the information presented in the EIS on the local hydrogeological and hydrological environment, including additional water monitoring data, which further adds to the conceptual understanding of the water environment in the McPhillamys and broader Blayney area.



Source: EMM (2020); Regis Resources (2020); DFSI (2017); GA (2011)

Local setting

McPhillamys Gold Project
Surface water-groundwater interaction assessment
Figure 1.1

The objectives of this assessment are to:

- describe the interaction between surface water and groundwater within the mine development and Blayney area;
- describe the categories of springs typically observed in the area and more broadly within Australia;
- categorise the springs identified in the mine development area; and
- discuss the potential changes to the interaction between surface water and groundwater, including springs, within the mine development area and Blayney area as a result of the project.

This report applies to the mine development component of the project, as it is this component where springs were raised in the submissions received. Therefore, references to 'the project' herein are referring to the mine development component, and the 'mine development project area' is referred to as the 'project area' or 'McPhillamys' throughout.

1.3 Submissions on the EIS

Concerns relevant to springs in the area (and how groundwater interacts with surface water) were raised by various interest groups in submissions received on the EIS. These concerns have been considered in this assessment. Submissions related to other groundwater related matters have been addressed in the Submissions Report prepared for the project (EMM 2020a), which has been prepared in conjunction with the Amendment Report (EMM 2020b). A summary of the key concerns relevant to this assessment are provided in Table 1.1, together with how each matter has been addressed within this report.

Table 1.1 Key comments received in submissions relating to springs and how they have been addressed

Issue	Where addressed
Concern about project infrastructure (TSF and open cut mine) being built over or near the springs and how it will affect springs	Section 4.3.4
Concern about contamination of springs	Section 4.3.5

1.4 What is surface water-groundwater interaction?

1.4.1 Groundwater

Groundwater is water that occurs below the ground surface, but does not include water held in underground tanks, pipes or other works. Groundwater can flow through the following:

1. Primary permeability, which refers to the gaps (pore spaces) between the grains or minerals of the rock itself. Groundwater flow via primary permeability is generally very slow, and the movement is dependent both on the size, amount, and connectivity of these pore spaces within the rock.

2. Secondary permeability, which refers to gaps such as cracks, fissures and bedding plains between sediments or cracks in rocks. Groundwater flow via secondary permeability is dependent again on the size, amount, and connectivity of these cracks/gaps/fissures.

Some rocks are referred to as 'dual permeability' systems, with groundwater flow occurring both via primary permeability and secondary permeability.

The rate of groundwater movement is affected by the sediment/rock permeability. Rocks and sediments that have large and/or connected pore spaces and cracks are considered to have 'high permeability' and groundwater can move rapidly through it (over 82 metres (m) per day, such as the sandstone aquifers in the Arckaringa subregion of the Great Artesian Basin (GAB) in northern South Australia (Department of Agriculture, Water and the Environment 2017)). However, rocks and sediments that have smaller and/or not-well connected pore spaces and cracks are considered 'low permeability', with groundwater moving very, very slowly (for example, only several metres in 1,000 years for the Anson Formation, which is within the project area (EMM 2019a)).

Rocks that store and can transmit groundwater at a 'high' rate are often called 'aquifers', but all saturated rock can store and transmit groundwater in some capacity. The term 'aquifer' is relative to local conditions and can be subjective; it generally relates to the highest permeability rocks within an area. For example, a saturated rock that can yield around 2 litres per second (L/s) at a bore may be termed an 'aquifer' in an area where other rocks yield less than 0.1 L/s. Whereas in other areas, a rock yielding 2 L/s may not be considered an 'aquifer' if there is, for example, sand / gravel that yields 5−10 L/s at bores nearby.

Groundwater moves from areas of higher pressure (high groundwater elevation, as measured in groundwater bores) to areas of lower pressure (lower groundwater elevation, as measured in groundwater bores). Often (ie in local flow systems represented by the watertable), this direction of movement (groundwater flow direction) is a subdued reflection of the land surface/topography (ie groundwater generally flows in a similar direction to how water flows on the land surface above, but with flatter peaks and valleys).

1.4.2 Surface water

Surface water is water located on top of the ground surface and includes rivers, creeks, lakes, wetlands and dams. The largest contribution to surface water is precipitation (rainfall) and runoff. Surface water flow in a watercourse (a river, creek, stream or drainage line) can come from:

- rainfall directly to the watercourse;
- overland runoff from the ground to the watercourse;
- quickflow/bankflow, which is seepage from riverbanks following rainfall events – this seepage may last for several months following rain events and does not come from the regional or perched groundwater systems (sometimes referred to as spring flow); and
- groundwater discharge into the watercourse (referred to as baseflow or sometimes referred to as spring flow).

Watercourses can be:

- perennial – continuous flow all year round, during periods of normal rainfall;
- intermittent – not continuous flow, with flow ceasing in very dry periods and/or at some locations along the watercourse during periods of normal rainfall; or
- ephemeral – temporary flow (eg only hours or days) during and following periods of rainfall.

Groundwater and surface water interact in the following ways:

- water within the watercourse can seep through the streambed to groundwater, "recharging" the groundwater – this is called river leakage/losing stream; and

- groundwater can flow (discharge) into the watercourse – this is called baseflow/gaining stream.

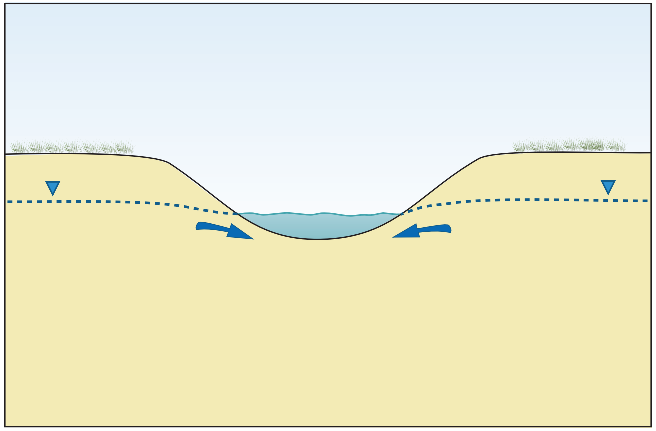
Baseflow and river leakage can occur along different sections of the same watercourse and can also reverse between wetter and drier periods. Whether surface water recharges groundwater or whether groundwater discharges to surface water depends on the relationship between the height of water in the watercourse and the depth (pressure) of the adjacent groundwater table.

When a section of a watercourse is receiving groundwater, it is referred to as “gaining”. When a section of a watercourse is leaking water to groundwater, it is referred to as “losing”. The interaction between the watercourse and groundwater can, and often does, change along the length of a watercourse, changing from gaining to losing or vice versa.

If there is water within the watercourse during an extended dry period, it is a good indication of groundwater discharge (ie river receiving baseflow). This is noted to occur in places along the Belubula River where permanent pools of water in the river occur, ie sections of the river that never or very rarely dry out even during droughts. The groundwater contributing to these pools is mostly local and discharging to the river laterally; that is, water comes in from groundwater from the side slopes, and not from ‘upstream’ springs or creek flows.

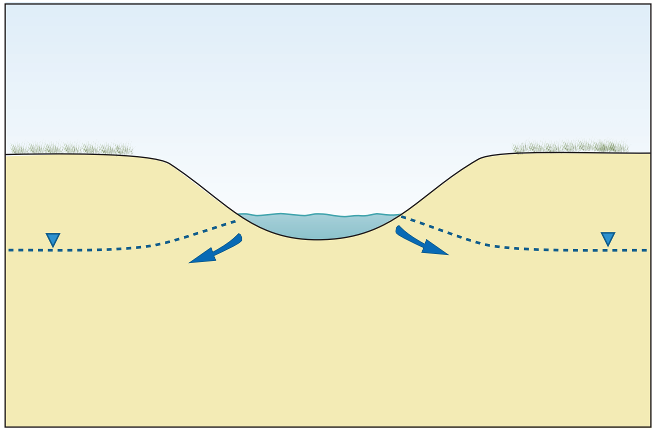
Figure 1.2 provides a graphical representation of how watercourses can interact with groundwater. The surface water-groundwater interactions in Figure 1.2 can change seasonally and also vary along the length of a watercourse. For example, the connection between surface water and groundwater of an intermittent watercourse is dependent on the groundwater level and the water level in the watercourse. That is, there may be times when parts of the watercourse is gaining and other times where it may be losing.

Gaining - connected



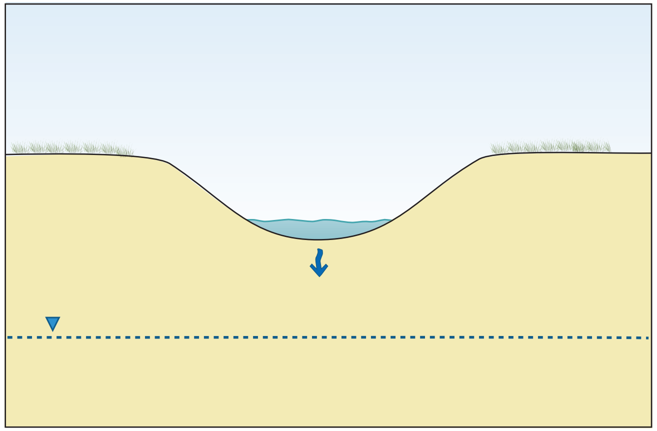
Baseflow occurs when/where groundwater level is higher than the surface water . Groundwater discharges to the watercourse.

Losing - connected



River leakage occurs when/where the groundwater level is high enough to be connected to surface water, but lower than the surface water level of the watercourse.

Disconnected



The surface water and groundwater are not connected when/where the groundwater level is lower than the base of the watercourse. River leakage may still occur if the watercourse flows after rainfall. However, any change in groundwater level will not affect the surface water level or flow.

KEY

Groundwater level

Groundwater flow

EMM creating opportunities

Watercourse interaction with groundwter

Regis Resources

Surface water–groundwater interaction assessment

Figure 1.2

1.5 Spring classification

1.5.1 Overview

A spring is an area where groundwater emerges naturally from the rock or soil and flows onto land or into a body of surface water (World Meteorological Organisation 2012). A seep is generally regarded as a type of spring where water emerges from the ground, not from any definite opening, but instead through the pores of the ground over an area (Bryan 1919; Davis and DeWiest 1966; Bouwer 1978). In contrast to springs, seeps generally do not have any visible or measurable flow emanating from their source.

Springs can be classified based on the rate of flow, type of aquifer, chemical characteristics, water temperature, direction of water migration, and relation to topography and geologic structure (Davis and DeWiest 1966).

For the purposes of this report, six spring categories are introduced to assist with the categorisation of springs identified within the project area and others found in Australia. The terms in the list have been refined and adjusted since the EIS (EMM 2019c) to be consistent with terminology used by others (for example Springer and Stevens 2009 and Green et al 2013), and to provide additional clarity on the differences between local springs:

1. break of slope seeps/springs[1];
2. outcrop springs[2];
3. fault springs;
4. bankflow/lowland pools;
5. basalt springs; and
6. springs in the Great Artesian Basin (GAB).

1.5.2 Break of slope seep/spring

Break of slope seeps/springs are present in more elevated areas, where shallow groundwater moving through the weathered rock intersects (or comes close to) a change/break of slope in the ground surface (Figure 1.3). The occurrence of the seep or spring is due to:

- a relatively rapid change of surface elevation (break of slope); and
- a reduced thickness of the weathered zone (ie more permeable shallow rock) on top of the more competent (less weathered and lower permeability) rock that results in shallow groundwater intercepting the ground surface.

It is easier for some of the groundwater to flow horizontally within the weathered zone rather than to continue flowing downward into the lower permeability unweathered (or fresh) rock. This groundwater then discharges to the ground surface at the break of slope (Figure 1.3).

1 Described as "highland seeps" in the EIS.

2 Described as "highlands springs" occurring in areas of outcrop in the EIS.

The emerging groundwater forms a damp or wet area at the ground surface (seep area), often identified by increased vegetation and grass. At some sites, such as those near or within drainage lines, where water flow can be observed it is called a spring. The seep or spring area can change seasonally, as high temperatures and evaporation will limit the wet area.

The break of slope seeps/springs are "fresh", with water quality expected to be similar to rainfall and water in drainage lines in the area. This is due to short groundwater residence times reducing the potential for hydrogeochemical reactions with geological formations.

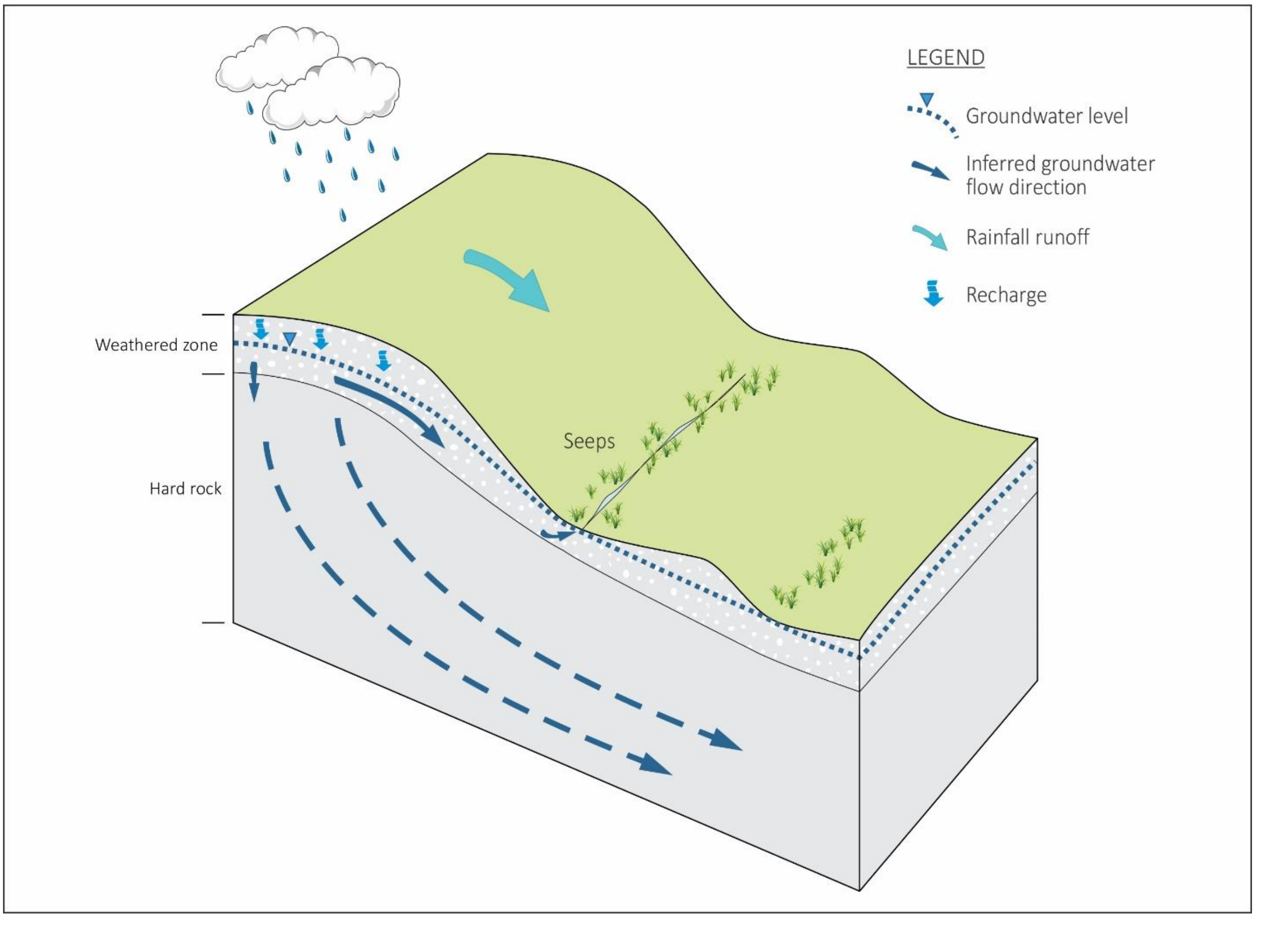


Figure 1.3 Break of slope seep /spring schematic

1.5.3 Outcrop springs

Outcrop seeps/springs are similar to break of slope seeps/springs in that they are sourced from shallow groundwater within the weathered rock that discharges to the surface. Outcrop springs are observed where the boundary between higher permeability weathered rock and the lower permeability rock beneath (hard, unweathered rock) meet at the side of a hill or cliff (Figure 1.4). Due to the lower permeability layer below the weathered zone, it is easier for some of the groundwater to flow horizontally within the weathered zone rather than to continue flowing downward into the lower permeability unweathered (or hard) rock. The emerging groundwater forms a damp or wet area at the ground surface, often identified by increased vegetation and grass. In the project area and broader Blayney area, these seep /spring areas are often excavated by farmers to construct dams to increase access to the water. The spring discharge rate and area changes seasonally, depending on temperatures and rainfall.

Similar to break of slope seeps/springs, the water quality of outcrop springs is expected to be fresh due to short groundwater residence times.

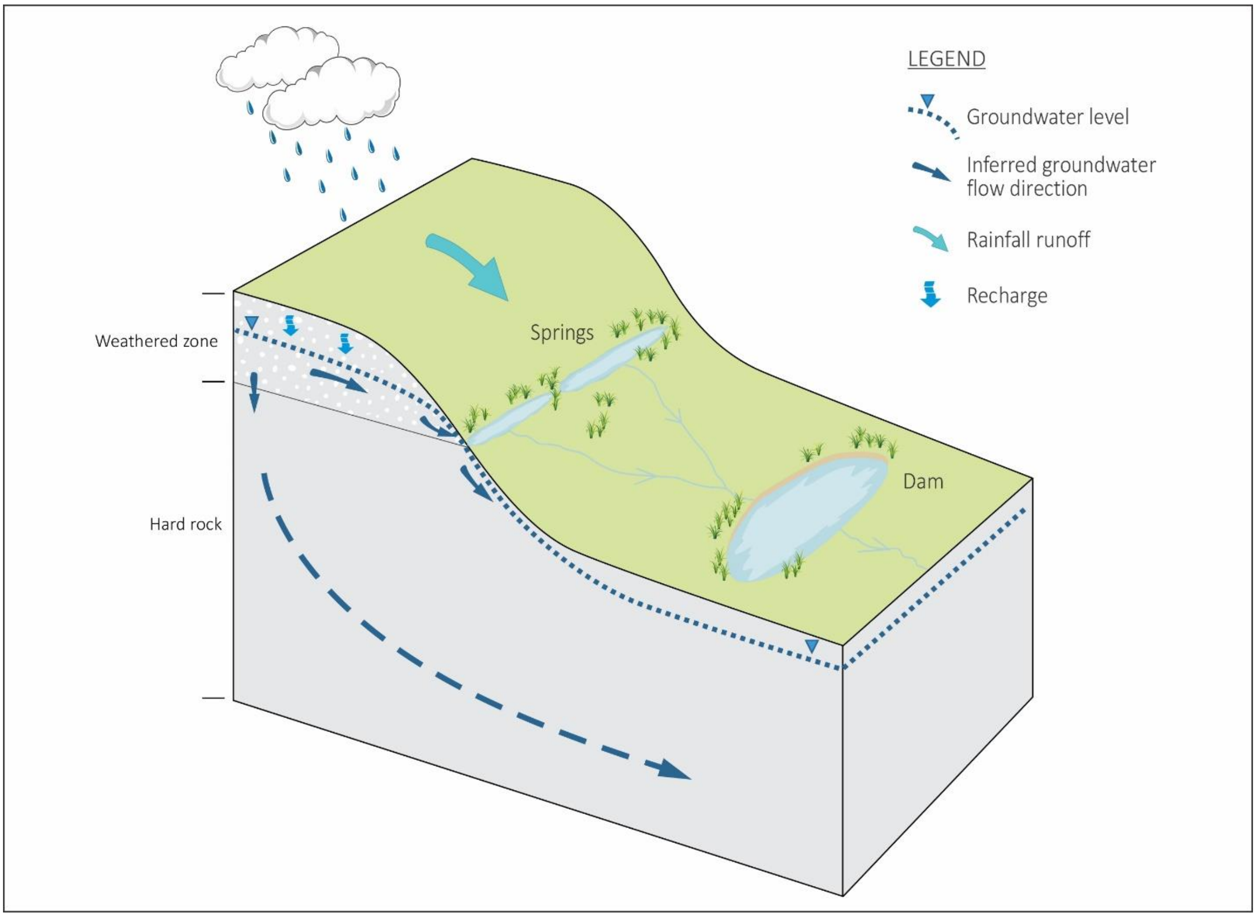


Figure 1.4 Outcrop spring schematic

1.5.4 Fault springs

Fault seeps/springs or geological structure springs occur where geological faulting and/or fracturing create weaknesses within the lithology and preferential pathways for groundwater under pressure to flow to the surface (Figure 1.5) (Green et al 2013).

In the project area, the majority of faults/structures are filled with low permeability clay and act as a barrier to groundwater flow, diverting groundwater to flow along the contact between the fault and the surrounding rock and discharge to the surface rather than flow across or within the fault zone. In other areas, faults/geological structures may act as conduits to groundwater flow, providing a mechanism for deeper groundwater to travel to the surface.

The time for groundwater to move through the rock and fracture(s) will be longer than shallow groundwater and, therefore, the groundwater will generally have higher salinity compared to that of the “fresh” break of slope and outcrop seep/springs. The water quality is expected to be similar to groundwater within the hard, unweathered volcaniclastics and metasediments.

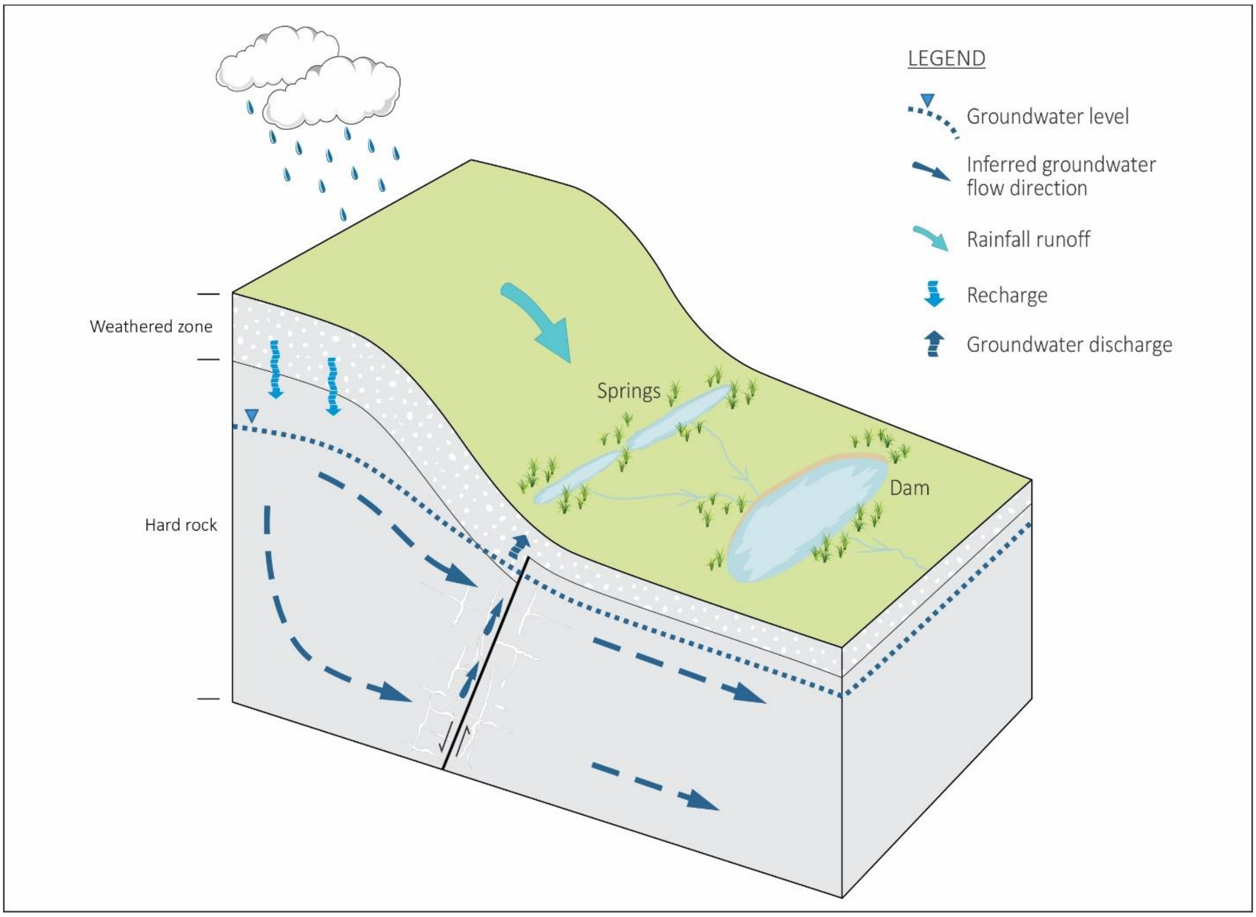


Figure 1.5 Fault spring schematic

1.5.5 Bankflow/lowland pools

Bankflow/lowland pools can be present within shallow alluvial deposits adjacent to or within a watercourse in the low-lying areas of the catchment. During times of high streamflow, water will move from the watercourse into the riverbank. As the water level in the watercourse declines ('falling stream'), water stored in the riverbank will flow back to the watercourse, maintaining water in the stream after the streamflow event (Figure 1.6).

During streamflow events or just after rainfall, water in these lowland pools is expected to have low salinity. As the water level in the watercourse drops, and assuming no further rainfall, evaporation of some of the water will occur and may result in areas of higher salinity water remaining within the pools. However, generally, the water quality is expected to be more like local rainfall and streamflow quality than the regional and deeper groundwater system.

In addition to pools being maintained by bankflow, groundwater discharge can also maintain pools or waterholes along sections of a watercourse (as described in Section 1.4.2 above; a 'gaining stream').

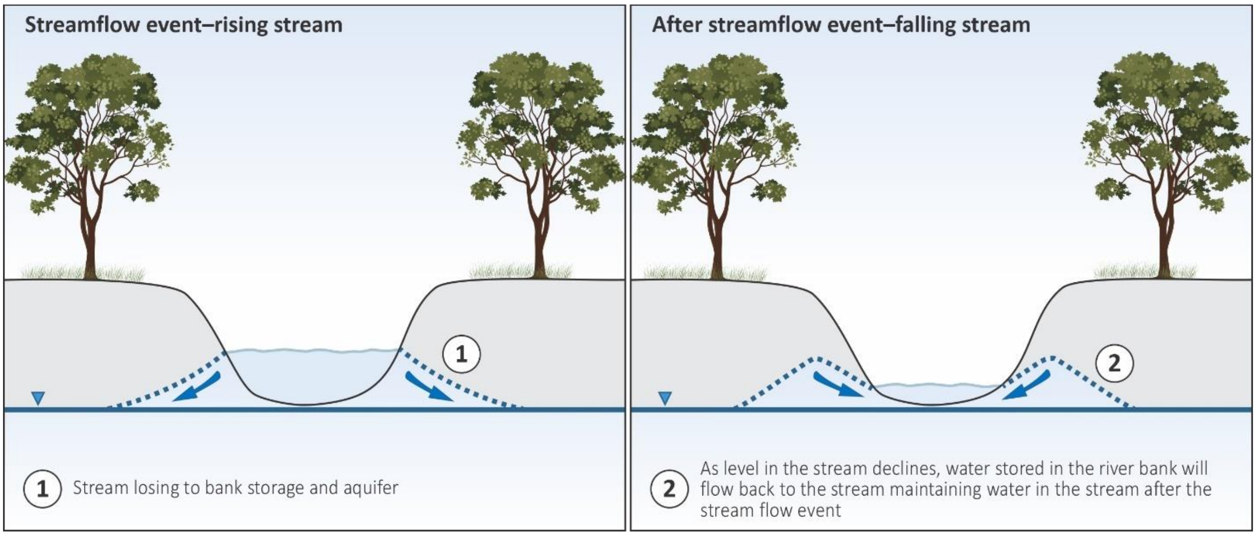


Figure 1.6 Bankflow\lowland pool schematic

1.5.6 Basalt springs

Basalt springs have been mapped within the basalt cap that is present to the north-west and outside of the project area – the Orange Basalt. These types of springs are also observed in other areas of NSW where basalt is present at the surface. The Orange Basalt has high permeability compared to the surrounding other rock formations (except alluvium). Areas of higher permeability are associated with fractures that developed during cooling of the basalt flows as the rock formed or later weathering and/or structural movement (eg faulting and folding) (DPI Water 2012a). In a similar way that the outcrop springs occur, basalt springs occur where the boundary between higher permeability basalt and the underlying lower permeability formations meet at the side of a hill or cliff (Figure 1.7). Springs can also occur where the boundary of the higher permeability weathered basalt and the lower permeability unweathered basalt meets at the ground surface (Figure 1.7).

The groundwater that discharges at basalt springs is expected to have varied water quality, depending on how far and for how long the groundwater has travelled before discharging, and the extent of the fracture/joint network within the basalt. The water quality will be typically less mineralised compared to groundwater sourced from different geology, such as the metasediments within the project area.

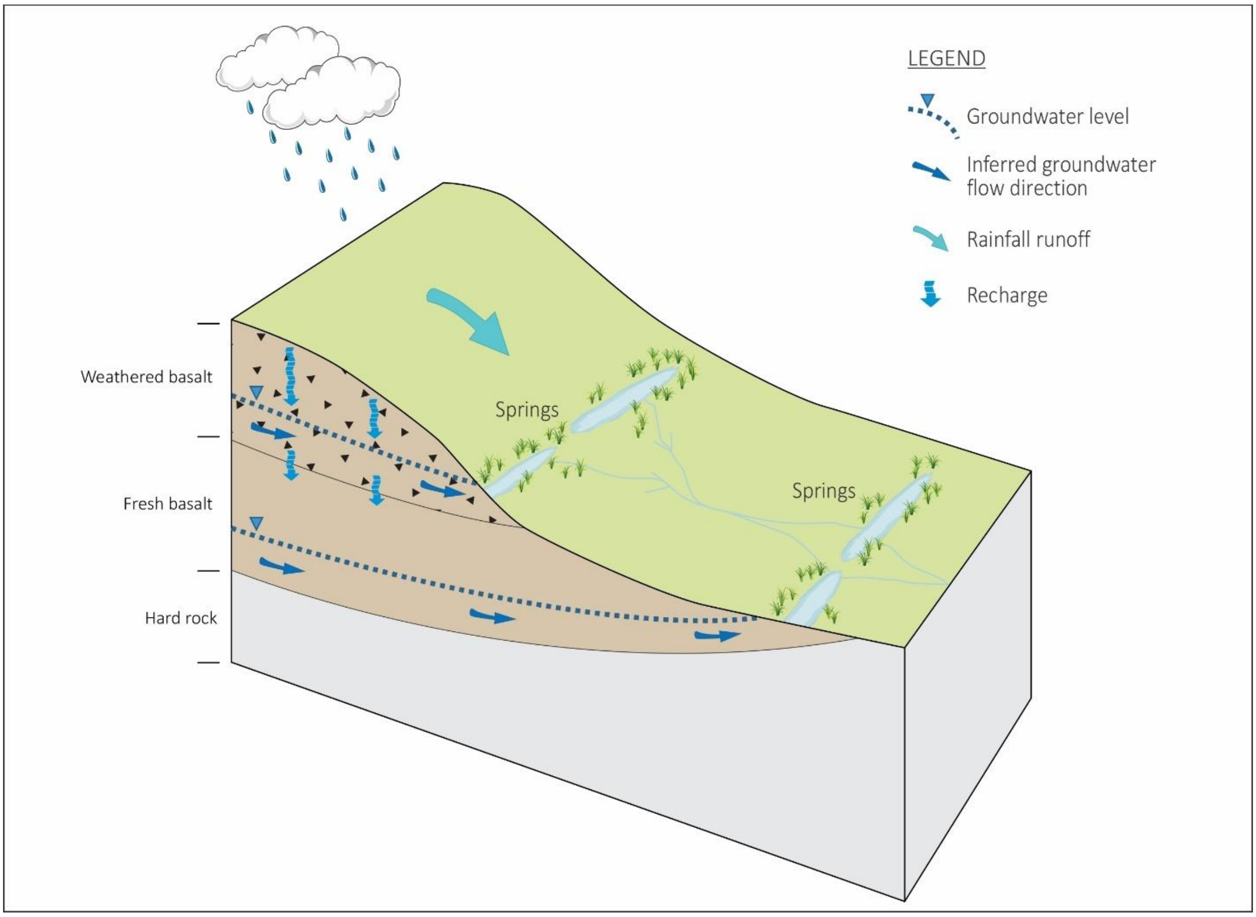


Figure 1.7 Basalt spring schematic

1.5.7 Springs in the Great Artesian Basin

Another example of a spring type is artesian springs. These do not occur within the project area, but are observed more broadly in the GAB in central and north-eastern Australia.

These springs occur where an aquifer is confined by an overlying unit of lower permeability, pressurising the aquifer, and where there is an upward hydraulic gradient towards the surface or an overlying unconfined aquifer. These springs can result from pressurised groundwater flowing upward through a relatively thin confining layer (Figure 1.8) or from geological structures/faulting creating a pathway for deeper groundwater to flow to the ground surface. Mound springs are a well-known spring type in the GAB (Figure 1.8). As groundwater discharges at the surface, minerals (such as calcium carbonate) and clay are deposited and accumulate at the surface, creating a mound over time. Wind-blown particles also contribute to the mounding (Green et al 2013).

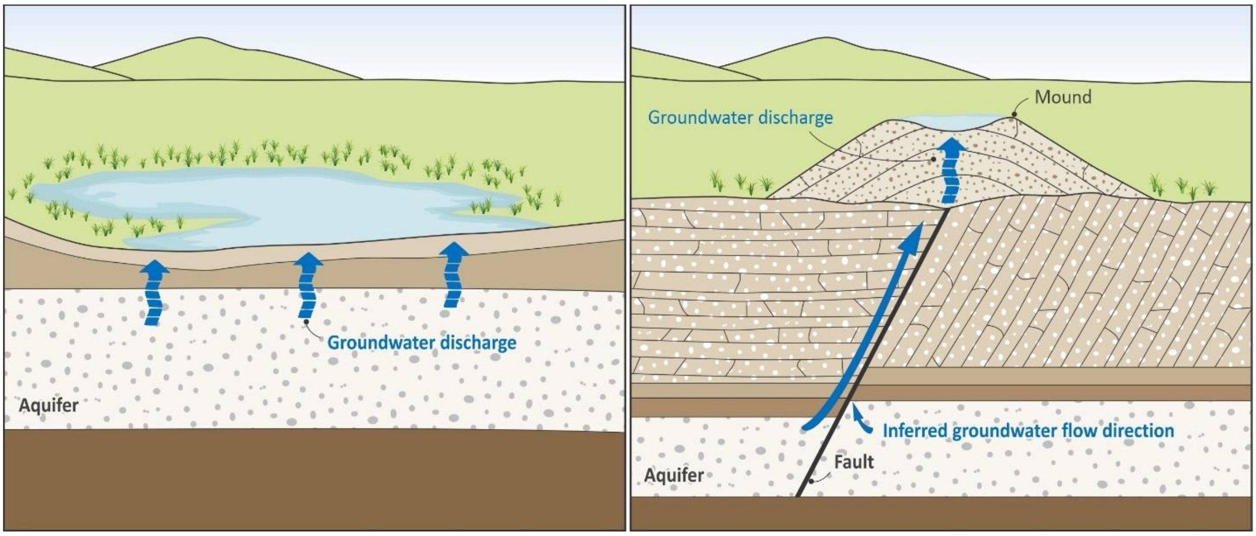


Figure 1.8 GAB spring examples schematic

2 Description of existing environment

2.1 Baseline monitoring

Routine water monitoring commenced for the project in May 2014 across a network of landholder bores and surface water features. Up to six years of baseline water (surface water and groundwater) data has been collected across the project area. In December 2016, a project specific groundwater monitoring network was installed and over three years of continuous groundwater level data and water quality data has been collected.

The network and monitoring program were developed in consultation with the then Department of Industry (DoI) - Water via the project Groundwater Monitoring and Modelling Plan (GMMP) (EMM 2017).

2.2 Climate

The Blayney-Orange district is characterised by a mild temperate climate with warm to hot summers and cool to cold winters. Rainfall is typically highest during the winter months. Rainfall data have been acquired from the site weather station since 2013 and the surrounding Bureau of Meteorology (BoM) weather stations (Blayney (station 63294); Bathurst (station 63306); Orange airport (station 63303) and Orange Agricultural Institute (station 63254)).

Records from the Scientific Information for Land Owners (SILO) Data Drill (accessed May 2020) have been obtained to supplement the available rainfall data. SILO datasets are constructed from observational records provided by the BoM. SILO processes the raw data, which may contain missing values, to derive datasets which are both spatially and temporally complete.

The long-term average annual rainfall for the area ranges from 702 millimetres (mm) (SILO) to 916 mm (Orange Agricultural Institute, BoM station 63254). The average annual rainfall total recorded at the site weather station between 2013 and 2018 is 670 mm (due to technical problems with the data, a complete dataset for 2019 is not available). The SILO rainfall total for 2019 was 461 mm. The annual pan evaporation for the area exceeds the rainfall total and averages 1,339 mm (SILO).

2.3 Groundwater

2.3.1 Hydrogeology overview

The hydrogeology surrounding the project area is dominated by the Palaeozoic metamorphic rocks of the eastern Lachlan Fold Belt.

The groundwater system is recharged locally by the percolation of rainfall and leakage from surface watercourses. Groundwater discharge occurs via evapotranspiration, spring flow, and contributions to surface watercourses (baseflow). Some minimal alluvial deposits along the creek banks and drainage lines provide temporary groundwater storage following rainfall and a delayed source of baseflow.

The five key hydrostratigraphic units in the project area include:

- Shallow, disconnected alluvial sequences. These unconfined, typically perched systems are likely recharged by the infiltration of rainfall and surface flows. They provide a source of delayed flow to the Belubula River and major tributaries, however, rapidly deplete between recharge events.

- Chemically weathered metasediments and volcaniclastics sediments, collectively referred to as ‘saprock’. These weathered systems are recharged via the infiltration of rainfall and surface flow. The saprock is comprised of fine-grained clay, with limited permeability and low specific yield.

- The Byng and Blayney Volcanics. These volcanics are comprised of basalt, fine volcanic siltstones and sandstones, and are dominated by andesitic composition. These volcanic units have low primary porosity and permeability. Groundwater flow is predominantly via secondary permeability (faulting and joints) and geological contacts. Bore yields are relatively low and the unit generally acts as a confining unit rather than an aquifer. Recharge to the fractured rock is via rainfall in areas of outcrop and vertical leakage from overlying saprock or alluvial sediments (where present).

- The Silurian Anson Formation and Cunningham Formation. The Anson Formation underlies the project area and the Cunningham Formation is located to the east of the project area. Both these formations have low primary porosity and permeability. Groundwater flow is primarily along fault zones or associated fracturing. Recorded bore yields are typically low (<5 L/s). Recharge is via rainfall in areas of outcrop and vertical leakage.

- The Orange Basalt. The Orange Basalt is a well-developed aquifer system to the north-west of the project area. The Orange Basalt is a productive aquifer accessed for town water supply, industry and domestic purposes. Groundwater is accessed from relatively shallow (<100 m) basalt flows. The Orange Basalt is not present in the project area.

2.3.2 Groundwater monitoring network

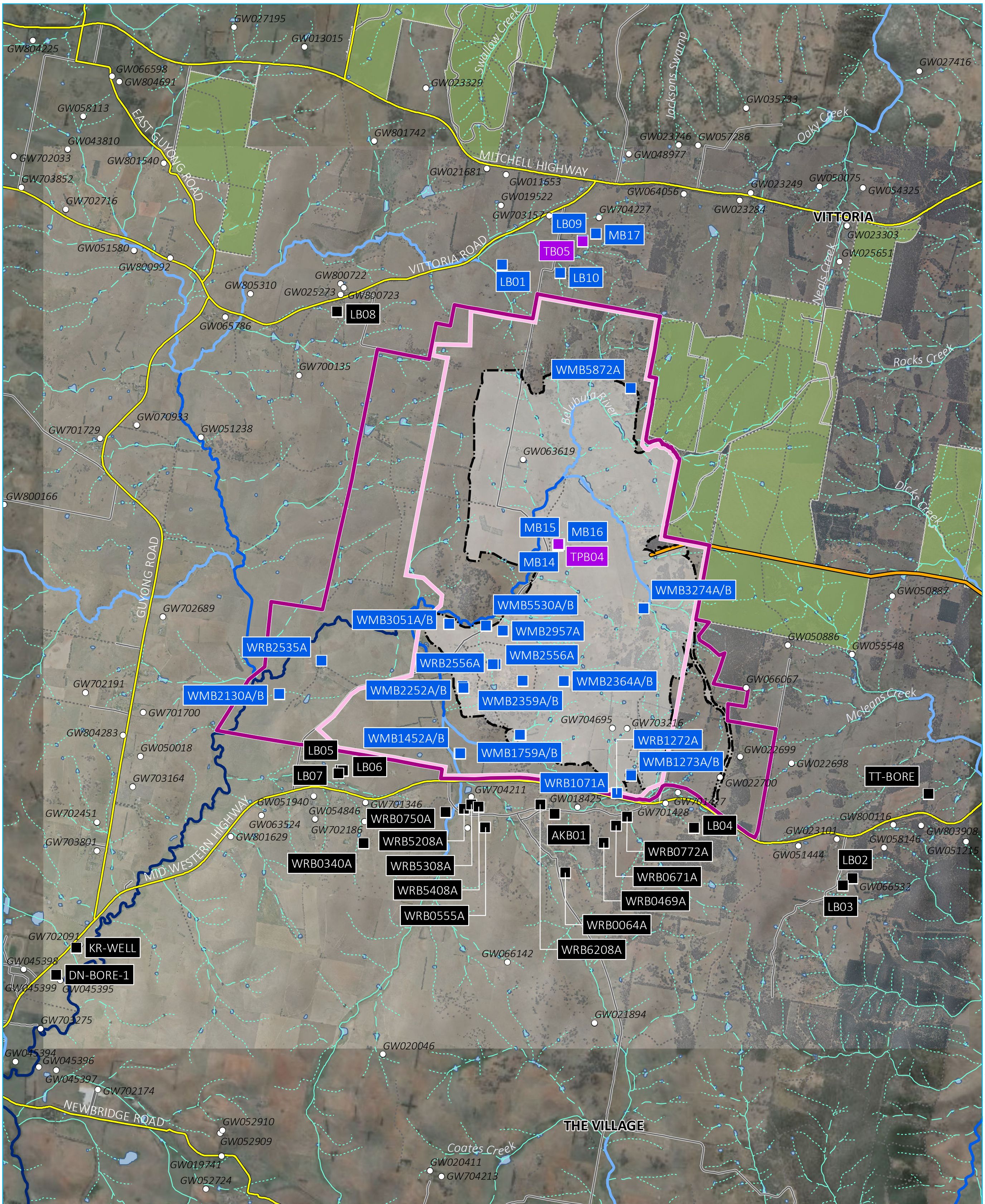
The groundwater monitoring network consists of 27 monitoring points, distributed across 18 locations on Regis-owned land (Figure 2.1). Figure 2.1 presents all groundwater monitoring locations, including bores located on neighbouring properties and bores historically monitored but no longer subject to routine monitoring.

The network comprises standpipe piezometers with nested monitoring sites (which consist of both a shallower and a deeper bore). Monitoring coverage spans the key hydrogeological units in the project area, including the saprock, metasediments, volcaniclastics and alluvium. A monitoring bore was also drilled and installed into the carbonaceous alteration unit in the open cut area to provide information on whether the hydraulic properties of that unit are materially different to the rest of the Anson Formation.

The locations of the monitoring bores were selected to ensure adequate coverage across the different hydrostratigraphic units and aligned to the NSW DPI (2014) guideline *'Groundwater Monitoring and Modelling Plans – Information for prospective mining and petroleum exploration activities'* which ensures sufficient data is available to meet the requirements of the Aquifer Interference Policy. Therefore, in accordance with this guideline, the monitoring sites considered proximity to potentially sensitive features such as Groundwater Dependent Ecosystems (GDEs) and areas of potential interaction between surface water and groundwater.

All monitoring bores were drilled and constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee 2012) and the conditions of the relevant monitoring bore licences.

In addition to the project specific monitoring bores installed by Regis, monitoring is also conducted at bores that were previously drilled and are located on Regis-owned property. The Regis-owned monitoring bores are shown as blue points on Figure 2.1. Groundwater monitoring (as groundwater level measurements and/or groundwater quality sampling and analysis) is also routinely conducted at some neighbouring landholder bores (shown as black points on Figure 2.1).



Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017); DPI (2016); DPE (2015); ELVIS (2014)

0 1 2 km

GDA 1994 MGA Zone 55

N

KEY

- Groundwater monitoring site - Regis
- Groundwater monitoring site - other landholder
- Test bore
- Registered bore - not monitored

Project application area

- Mine development project boundary
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- Pipeline

Existing environment

- Main road
- Local road
- Vehicular track
- Vittoria State Forest

- Waterbody

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order
- 6th order

Groundwater monitoring and project bore locations

McPhillamys Gold Project
Surface water-groundwater interaction assessment
Figure 2.1

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The number of baseline monitoring events at third-party bores and Regis-owned bores (between May 2014 and April 2020) is presented in Figure 2.2.

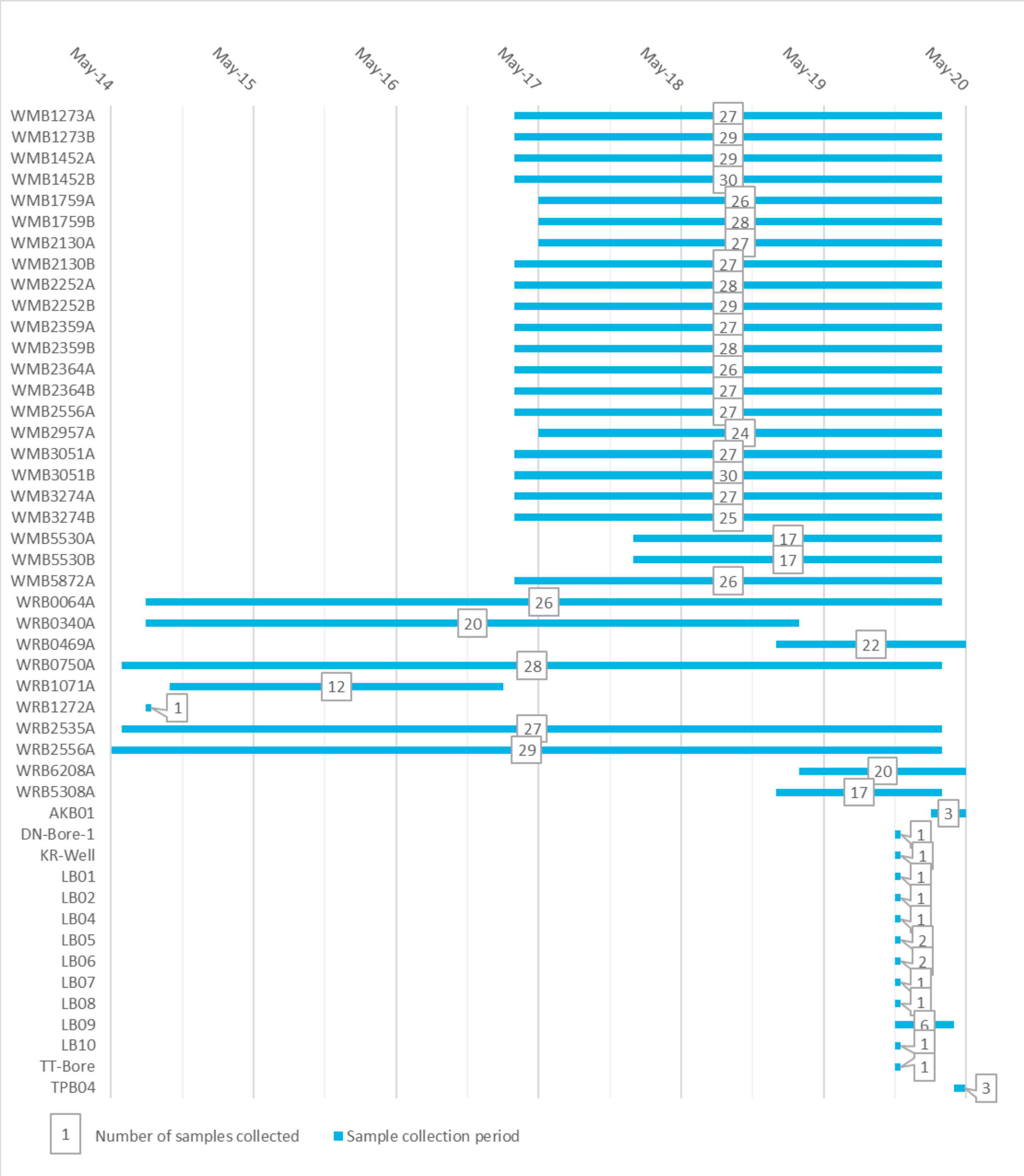


Figure 2.2 Groundwater quality baseline sampling summary

2.3.3 Groundwater flow directions

The inferred watertable elevation contours and groundwater flow direction in and surrounding the project area is presented on Figure 2.3. This figure shows the local groundwater flow direction (watertable) which is a subdued reflection of topography, and the regional groundwater flow direction which is in a south-west direction. High groundwater elevations (both regional and local) occur in the Vittoria State Forest area. Recharge occurs throughout the catchment, particularly on the upper and side slopes of the catchment but also occurs in lower areas of the catchment and along creek lines. As shown on Figure 2.3, groundwater is inferred to discharge locally to the Belubula River downstream of Trib E; ie sections of the Belubula River can be classified as a gaining stream downstream of Trib E, but it is not a gaining stream upstream of Trib E, with groundwater contribution to flows inferred to reduce with distance upstream from Trib A.

2.3.4 Groundwater quality

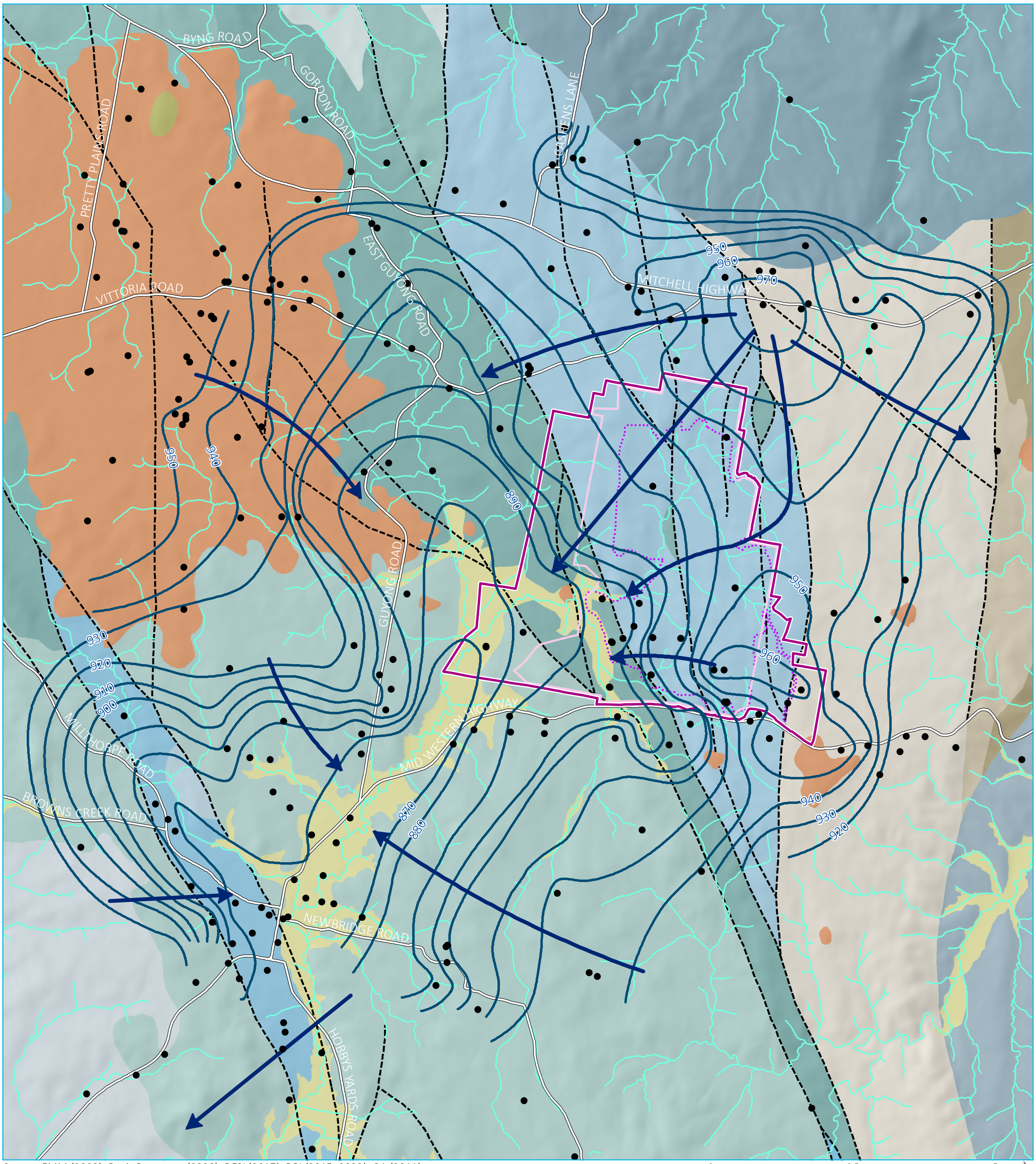
In this assessment, water salinity is reported as a measure of total dissolved solids (TDS). TDS represents the total concentration of dissolved substances in water and can be reported as milligrams per litre (mg/L) which is equivalent to parts per million (ppm).

As part of the groundwater assessment completed for the EIS in 2019 (EMM 2019b) and this additional assessment, groundwater quality data has been reviewed to assess salinity, identify trends and contribute to the existing understanding of the water environment. The data shows:

- groundwater sampled from all geology units is suitable for livestock drinking (less than 10,000 mg/L TDS) and is generally less than 2,000 mg/L TDS, except for groundwater at some Anson Formation bores that have salinities up to 5,200 mg/L TDS;
- groundwater within the alluvium ranges from 440 to 926 mg/L TDS (one monitoring bore);
- groundwater within the Anson Formation has a relatively high salinity:
  - groundwater within the Anson Formation saprock ranges from 570 to 4,250 mg/L TDS; and
  - groundwater within the fresh Anson Formation ranges from 236 to 5,200 mg/L TDS, not including an erroneous measurement from WMB2364A in March 2017;
- groundwater within the Byng Volcanics saprock ranges from 460 to 928 mg/L TDS;
- groundwater within the fresh Byng Volcanics ranges from 83 to 1,010 mg/L TDS; and
- groundwater within the Blayney Volcanics ranges from 290 to 840 mg/L TDS.

Time series plots of groundwater salinity is provided in Attachment A.1. Figure 2.4 presents the spatial distribution of average TDS for the water sampled from bores in the project area. It shows that groundwater sampled from the Anson Formation is typically more saline that groundwater sampled from the other geologies.

To assist with assessing groundwater quality and potential for interaction with surface water, it can be useful to plot the major ions on a trilinear diagram. This shows the dominant ions in the water sampled and can indicate the potential source and age of the water. A trilinear plot of laboratory reported groundwater chemistry data is presented on Figure 2.5. It shows some variation for groundwater bores in the Anson Formation and Byng Volcanics; however, groundwater in the area is generally bicarbonate dominant and shows signs of mixing between different water types.



\\Emmsvr1\emm\Jobs\2018\J180395 - Regis McPhillamys EIS\GIS\02_Maps_GWA\GWA010_WaterTableContours_20200805_11.mxd 18/08/2020

Source: EMM (2020); Regis Resources (2020); DFSI (2017); DPI (2015, 2003); GA (2011)

0 2.5 5 km
GDA 1994 MGA Zone 55
N

KEY

Regional bore
Watertable elevation (mAHD) (inferred)
Groundwater flow direction
Major road
Watercourse/drainage line

Project application area
Mine development project area
Mining lease application area (Note: boundary offset for clarity)
Disturbance footprint

Geology (Bathurst 250k, 2nd Edition)
Fault

Quaternary / Tertiary
Alluvium
Tertiary basalt
Trachyte

Carboniferous
Bathurst Batholith - Gresham Granite
Bathurst Batholith - Icely Granite

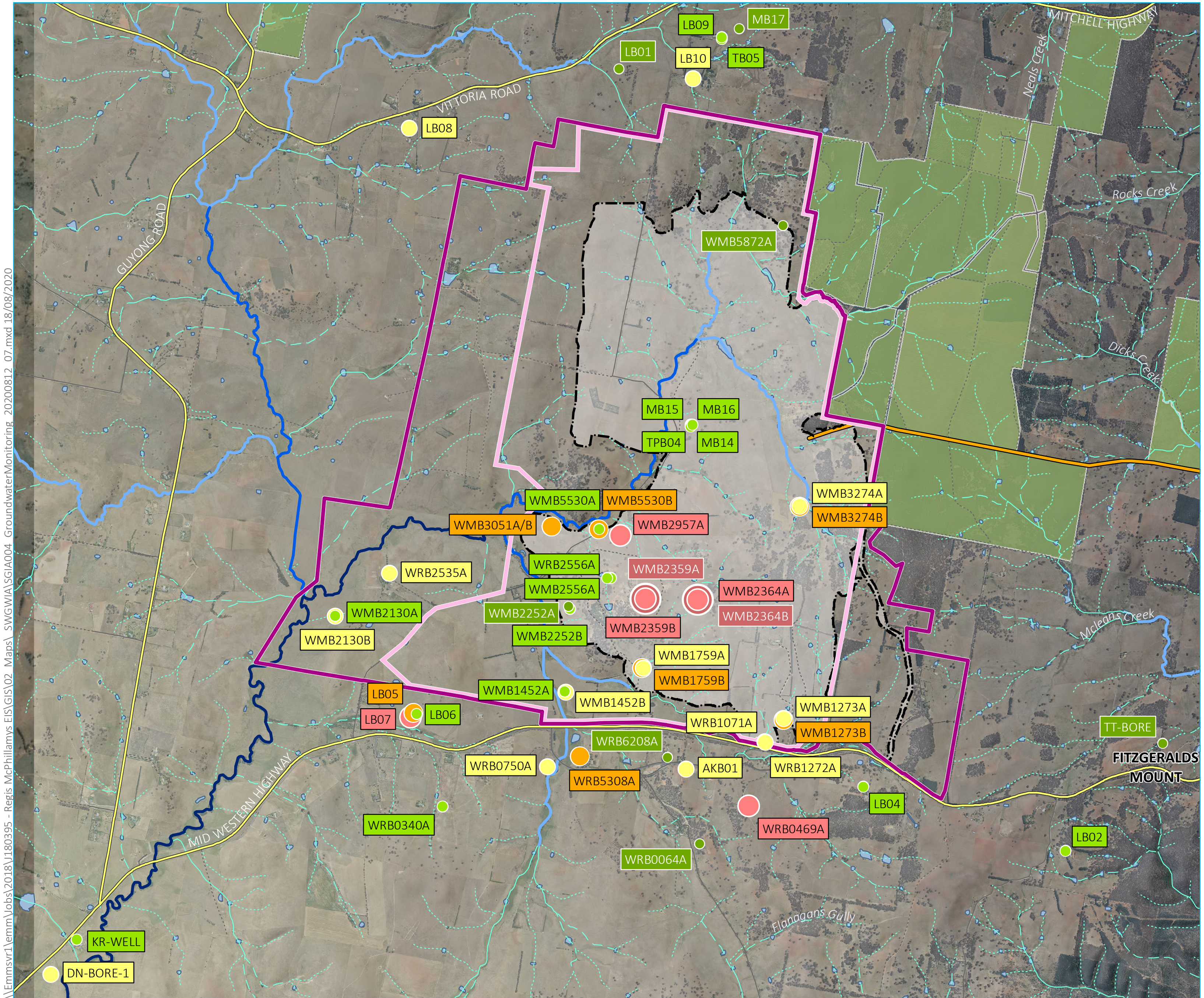
Devonian
Ungrouped Devonian Formations - Cunningham Formation
Crudine Group - Bushranger Volcanics
Crudine Group - Waterbeach Formation

Silurian
Other Silurian Intrusions - Carcoar Granodiorite
Other Silurian Intrusions
Mumbil Group (Northwest) - Anson Formation
Mumbil Group (Northwest) - Wombiana Formation
Mumbil Group (East) - Campbells Formation

Ordovician
Ordovician Intrusions
Cabonne Group - Blayney Volcanics
Cabonne Group - Oakdale Formation
Cabonne Group - Byng Volcanics

Inferred watertable elevation and groundwater flow direction

McPhillamys Gold Project
Surface water-groundwater interaction assessment
Figure 2.3



KEY

Project application area

Mine development project area

Mining lease application area (Note: boundary offset for clarity)

Disturbance footprint

Pipeline

Existing environment

Major road

Minor road

Vehicular track

Waterbody

Vittoria State Forest

Strahler stream order

1st order

2nd order

3rd order

4th order

5th order

6th order

Groundwater salinity

Average TDS (mg/L)

155 - 319

320 - 468

469 - 637

638 - 815

816 - 2140

2141 - 4261

Source: EMM (2020); Regis Resources (2020); ESRI (2020); Survey Graphics (2019); DFSI (2017); DPE (2015); ELVIS (2014)

0 1 2 km

GDA 1994 MGA Zone 55

N

Groundwater monitoring salinity map (as TDS)

McPhillamys Gold Project

Surface water-groundwater interaction assessment

Figure 2.4

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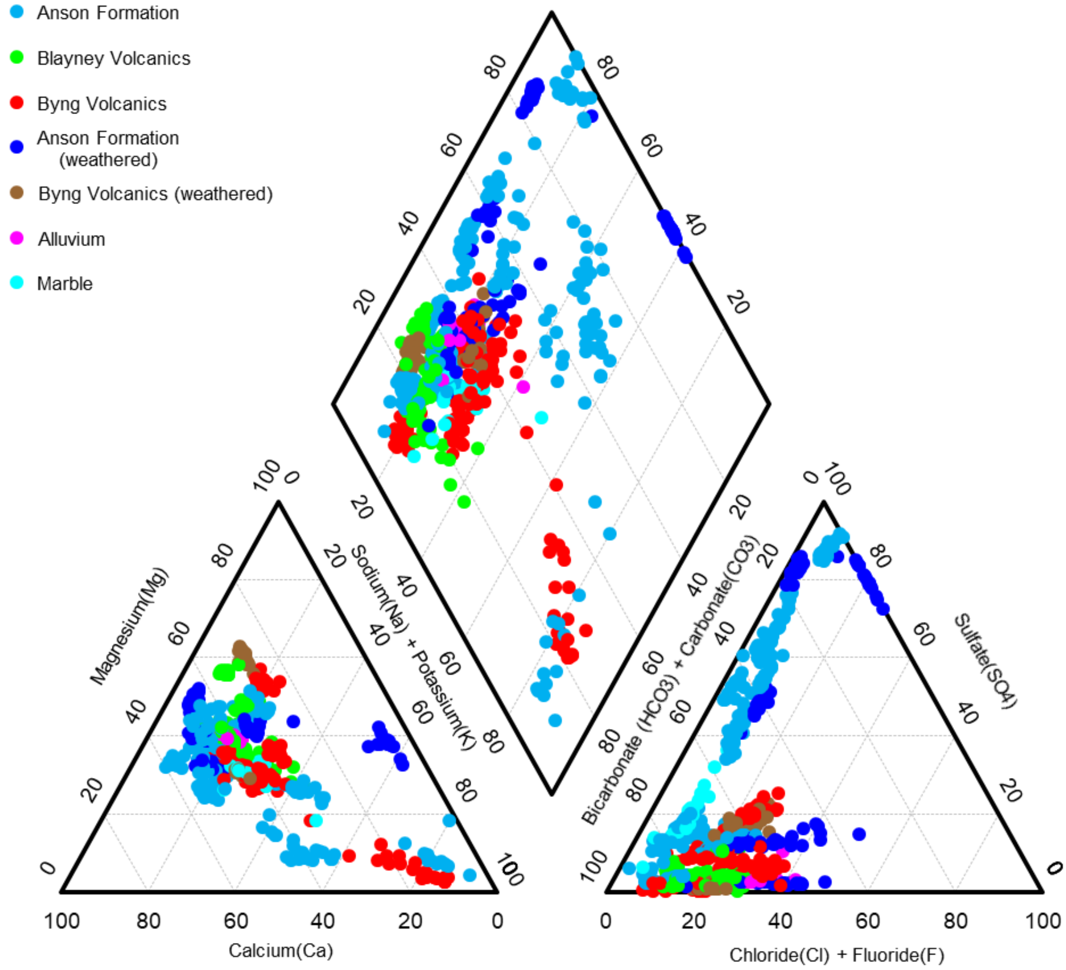


Figure 2.5 Groundwater trilinear diagram

2.4 Belubula River

The project area is west of the Great Dividing Range within the Lachlan Fold Belt. The project disturbance area (ie where the TSF and open cut mine will be located) is within the headwaters of the Belubula River, which is part of the greater Lachlan River catchment, and is located close to the surface water catchment divide between the Lachlan River and the Macquarie River. The Belubula River flows south into Carcoar Dam (26 km from the project area) and then west before joining the Lachlan River. To the north of the project area, and into the Macquarie catchment, the Macquarie River flows north through Bathurst, Wellington and Dubbo before entering the Macquarie Marshes and flowing to Lower Barwon and Darling Rivers.

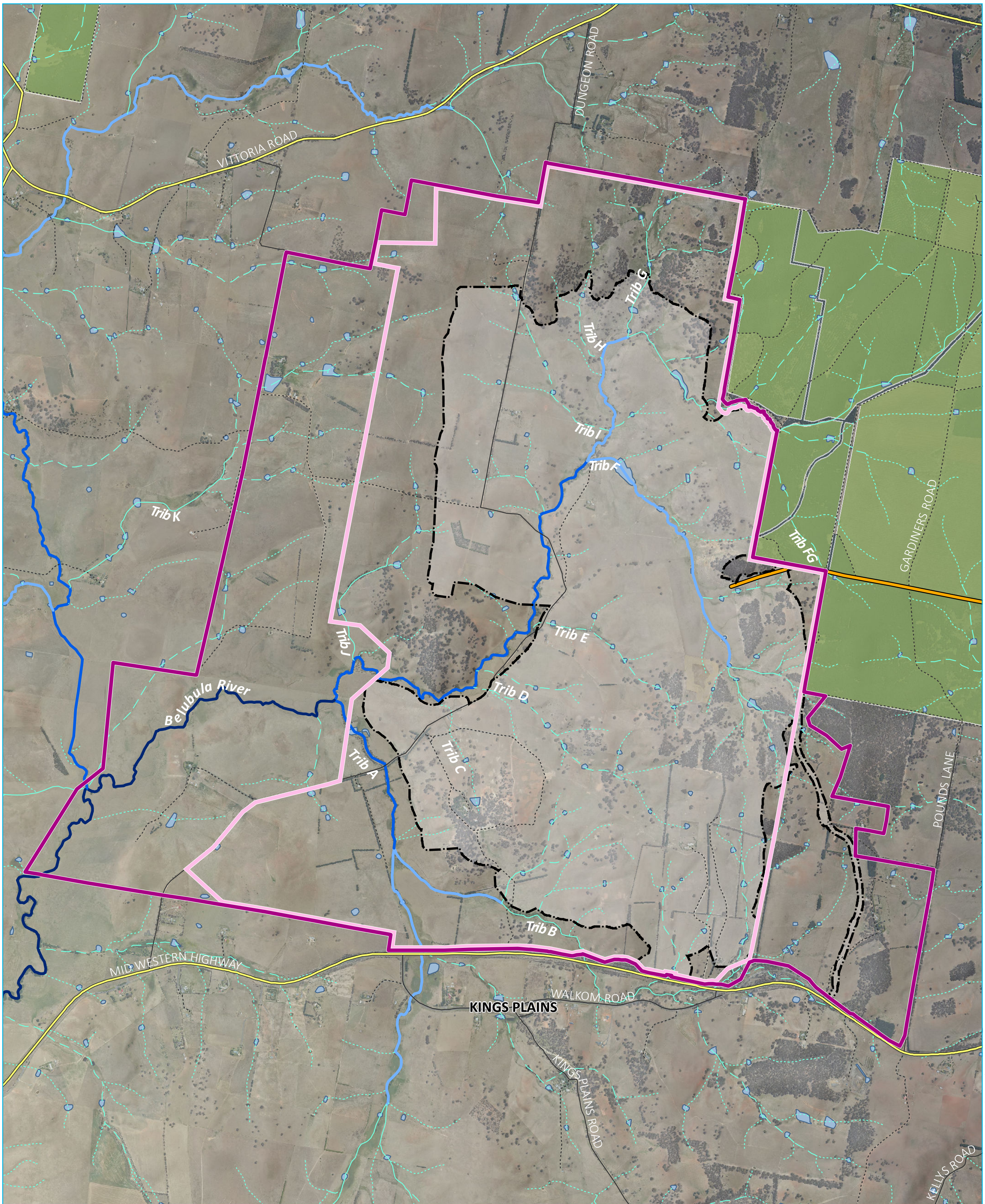
The Lachlan River catchment has an area of 86,554 km and is bounded to the east by the Great Dividing Range, to the north by the Macquarie catchment, to the south by the Murrumbidgee catchment and the north-west by the Darling catchment.

A series of unnamed tributaries flow into the Belubula River in the project area. The upper reaches of the Belubula River are ephemeral with isolated pools. For the purpose of assessment, the tributaries are referred to as Trib A to Trib K (refer Figure 2.6). The catchment area of Trib A and Trib B (combined) is the largest of these tributaries, with a catchment area of approximately 24.4 square kilometres (km^2). By comparison, the Belubula River at the confluence with Trib A (previously referred to as Dungeon Creek) has a catchment area of approximately 17.5 km^2. The Trib A and Trib B catchments contribute the majority of surface water flow to the Belubula River when compared to the named Belubula River catchment itself. However, many farm dams constructed along Trib A constrain flows, requiring larger or sustained periods of rainfall for streamflow to be seen at the confluence with the Belubula River. Downstream of the confluence with Trib A, the Belubula River appears to be perennial and, as mentioned in Section 2.3.3, receives contributions from groundwater baseflow.

The closest gauging station to the project area is the disused station GS 412104 Belubula River at Upstream Blayney, located at the Mid Western Highway. The period of record for this station was 1993 to 1997. Available flow data suggest that this gauging station was effectively perennial for the four years of recorded data (Hydro Engineering & Consulting Pty Ltd (HEC) 2019).

A catchment water balance model was developed for the Carcoar Dam catchment as part of the EIS (HEC 2019) and updated for the amended project (HEC 2020) to estimate existing flow conditions and assess the potential effects of the project on water flows to Carcoar Dam. The work estimated:

- median annual flows to Carcoar Dam are at least 4,485 mega litres per year (ML/year), and flows are 1,574 ML/year or higher 95% of the time;
- median flows at the old gauging station at the Mid Western Highway are at least 2,193 ML/year, and flows are at least 764 ML/year 95% of the time; and
- median flows downstream of the confluence between Trib A and Belubula River (where a gauging station has recently been commissioned for the project) are at least 869 ML/year, and are at least 300 ML/year 95% of the time.



Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017); DPI (2015); ELVIS (2014)

0 1 2 km

GDA 1994 MGA Zone 55

N

KEY

Project application area

- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- Pipeline

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order
- 6th order

Existing environment

- Major road
- Minor road
- Vehicular track
- Waterbody
- Vittoria State Forest

Project area surface drainage

McPhillamys Gold Project
Surface water-groundwater interaction assessment
Figure 2.6

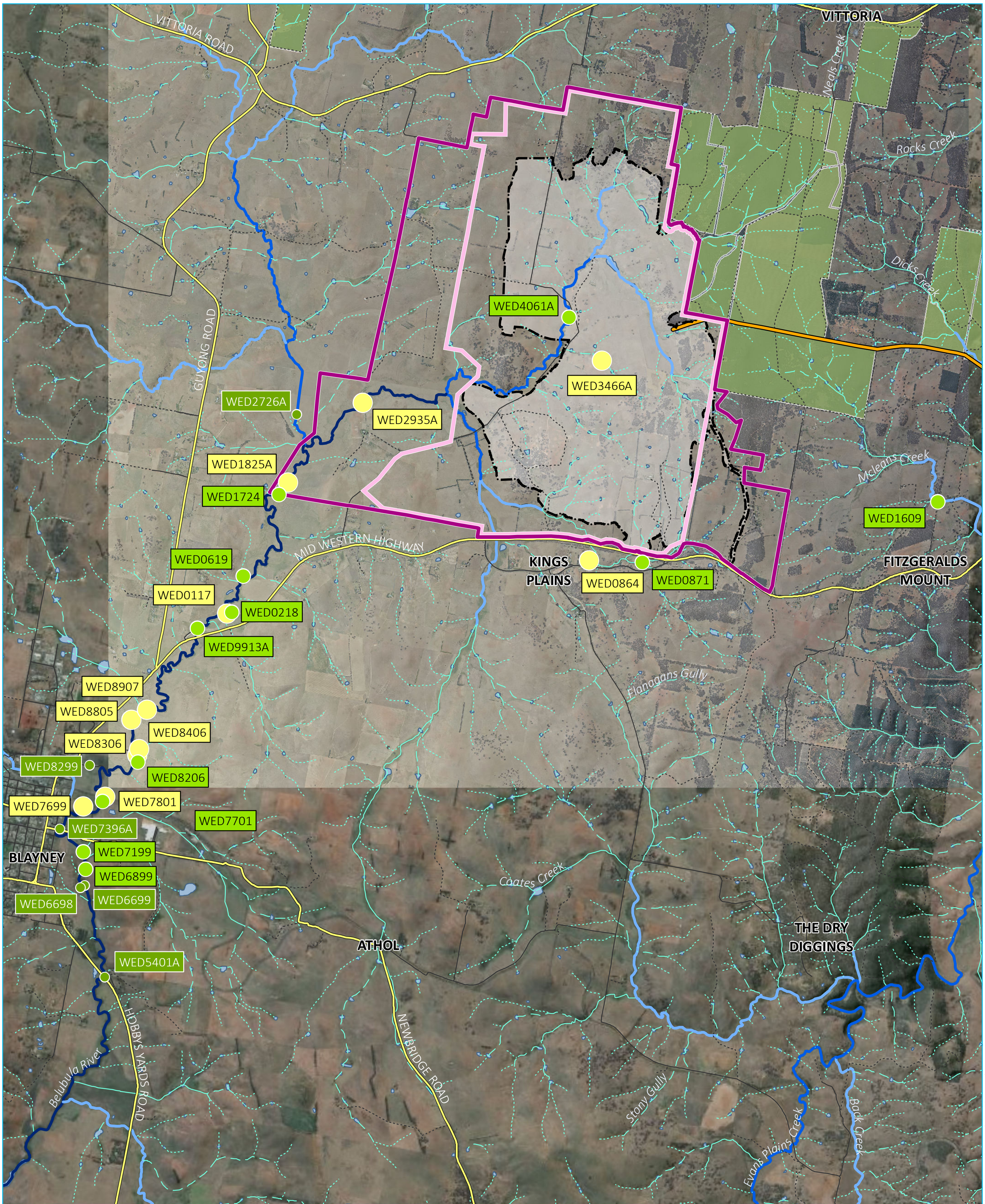
2.4.1 Watercourse monitoring

Regis conducts regular water sampling at eight locations along the Belubula River, with six monitoring points located downstream of the project area, one located within Blayney township at Goose Park (WED7396A) and one downstream of Blayney at Brewery Bridge (WED5401A; Figure 2.7). Monitoring has been occurring since May 2014 to present.

During the community open days for the project in 2019, Regis and EMM personnel spoke with many local landholders, and some expressed interest in Regis visiting their property to collect information related to springs, their bores, flow in local creeks and the Belubula River. Following these discussions, EMM visited various landholder properties to survey areas of interest associated with the Belubula River, including springs and bores. During these surveys, water samples were collected to assist with the surface water-groundwater interaction assessment and overall characterisation of the water environment in the Blayney area. Two survey sites are located on Trib A, south of the project area and one is located on McLeans Creek (within the Macquarie River catchment) to the east of the project area. The remainder of the sites are located along, or on tributaries to, the Belubula River downstream of the project area and in the Blayney area (see Figure 2.7). Of the locations visited, three sites have been described as waterholes or water pools; the remaining sites are located along a watercourse or are dams. Twenty watercourse sites were visited in July and November 2019.

A summary of the baseline Belubula River/watercourse water quality monitoring is provided in Figure 2.8.

The sampling undertaken on private landholder properties was generally conducted during a period of low rainfall which started in April 2017, except for a period of moderate to high rainfall between November 2018 to January 2019 (328 mm of rain). The Blayney rainfall for the week and month prior to the July 2019 sampling round totalled approximately 3 mm and 7 mm, respectively. The rainfall for the week and month prior to the November 2019 sampling round totalled 2 mm and 13.4 mm respectively. While this low rainfall period was stressful for many local farmers and landholders, it was an opportunistic time to collect information about potential groundwater contribution to the Belubula River during those low rainfall conditions.



Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017); DPE (2015); ELVIS (2014)

0 1 2 km

GDA 1994 MGA Zone 55

N

KEY

Project application area
- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- Pipeline

Existing environment
- Major road
- Minor road
- Vehicular track
- Vittoria State Forest
- Waterbody

Strahler stream order
- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order
- 6th order

Watercourse salinity

Average TDS (mg/L)
- 120 - 302
- 303 - 490
- 491 - 660

Belubula River monitoring locations and average salinity

McPhillamys Gold Project

Surface water-groundwater interaction assessment

Figure 2.7

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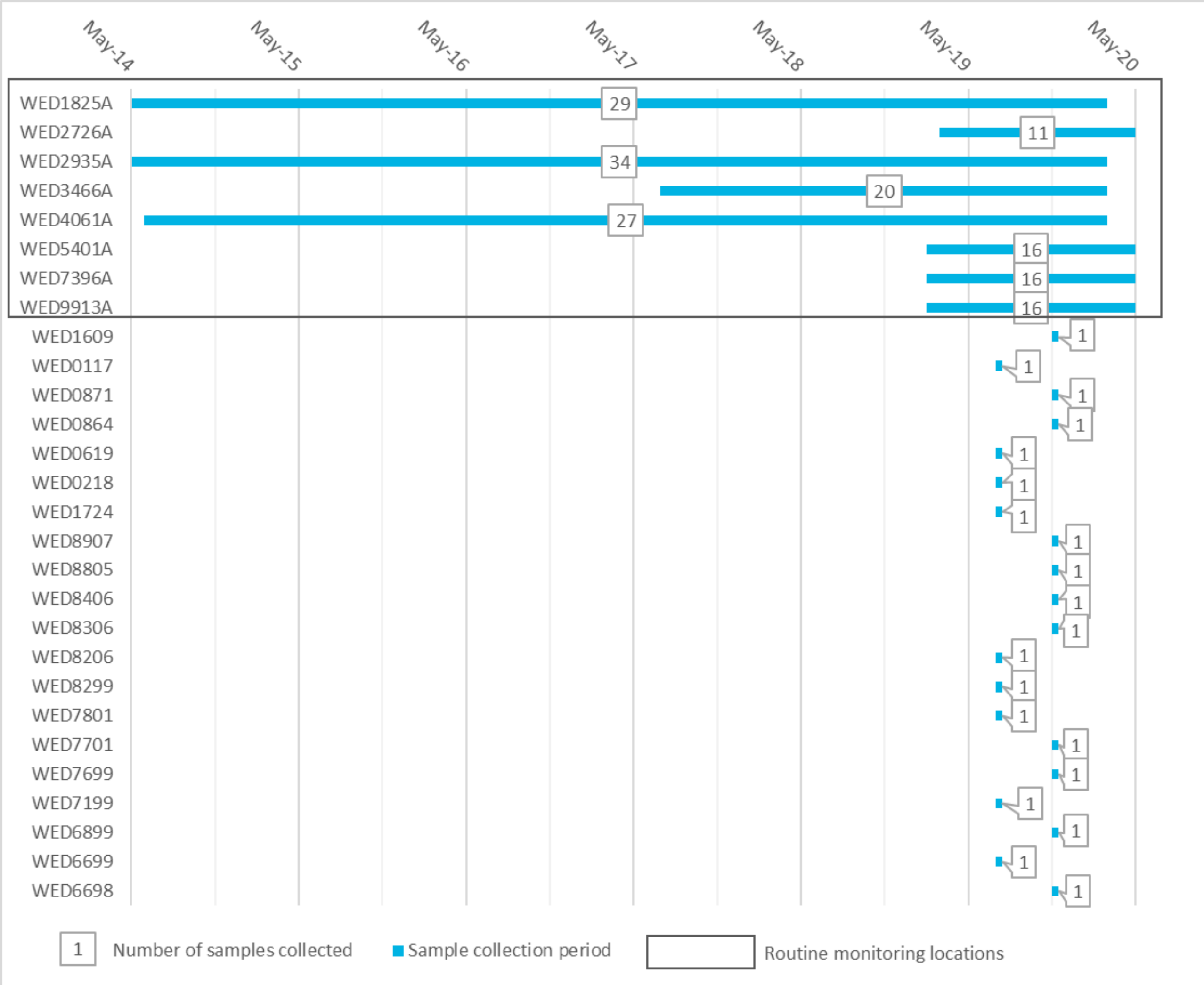


Figure 2.8 **Belubula River and other watercourse water quality sampling summary**

2.4.2 Water quality

The salinity (as TDS) of the Belubula River is generally fresh, ranging from 84 to 1,010 mg/L and averages 450 mg/L. Time-series salinity measurements for Belubula River monitoring locations, with a comparison to monthly rainfall recorded at the project area is provided in Attachment A.2. Water salinity generally increases in drier periods and is lower in wetter periods.

The river water salinity is similar to the salinity of groundwater sampled from the Byng and Blayney Volcanics.

Figure 2.7 also presents the spatial distribution of Belubula River salinity (as average TDS) and shows that there is no obvious trend in the average salinity in the Blayney and Kings Plains area.

A trilinear plot of laboratory reported Belubula River and McLeans Creek chemistry data is presented on Figure 2.9.

It shows the surface water is also bicarbonate dominant and has similar composition to groundwater sampled from the Byng and Blayney Volcanics, indicating that the river receives local groundwater discharge from these geological formations, rather than the Anson Formation further up in the catchment.

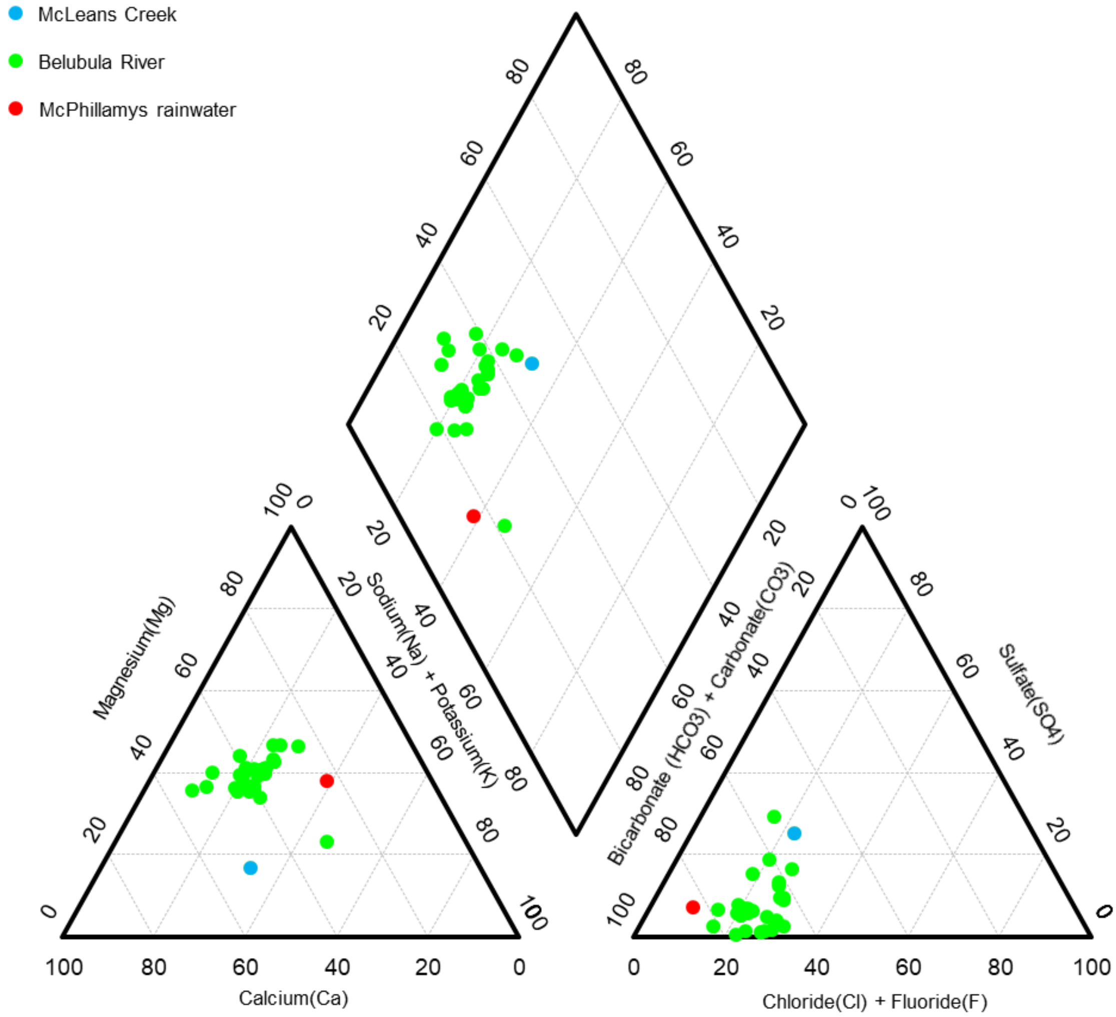


Figure 2.9 Belubula River and McLeans Creek trilinear diagram (averages shown)

2.5 Dams

2.5.1 Dam water monitoring

A number of dams have been constructed by landholders in the area to capture overland flow/or enhance groundwater seep/spring areas. A number of dams are also located within the drainage line of tributaries to the Belubula River. Regis conducts regular water quality monitoring at eight dams in the project area. Monitoring has been occurring since May 2014, with sampling less frequent between July 2015 and February 2017. During the landholder surveys conducted in July and November 2019 (mentioned in Section 2.4), water samples were also collected from dams present on the landholders' properties.

A summary of the dam water monitoring frequency is provided in Figure 2.10. The locations of the dams where sampling has occurred is shown on Figure 2.11, along with the average salinity (as TDS).

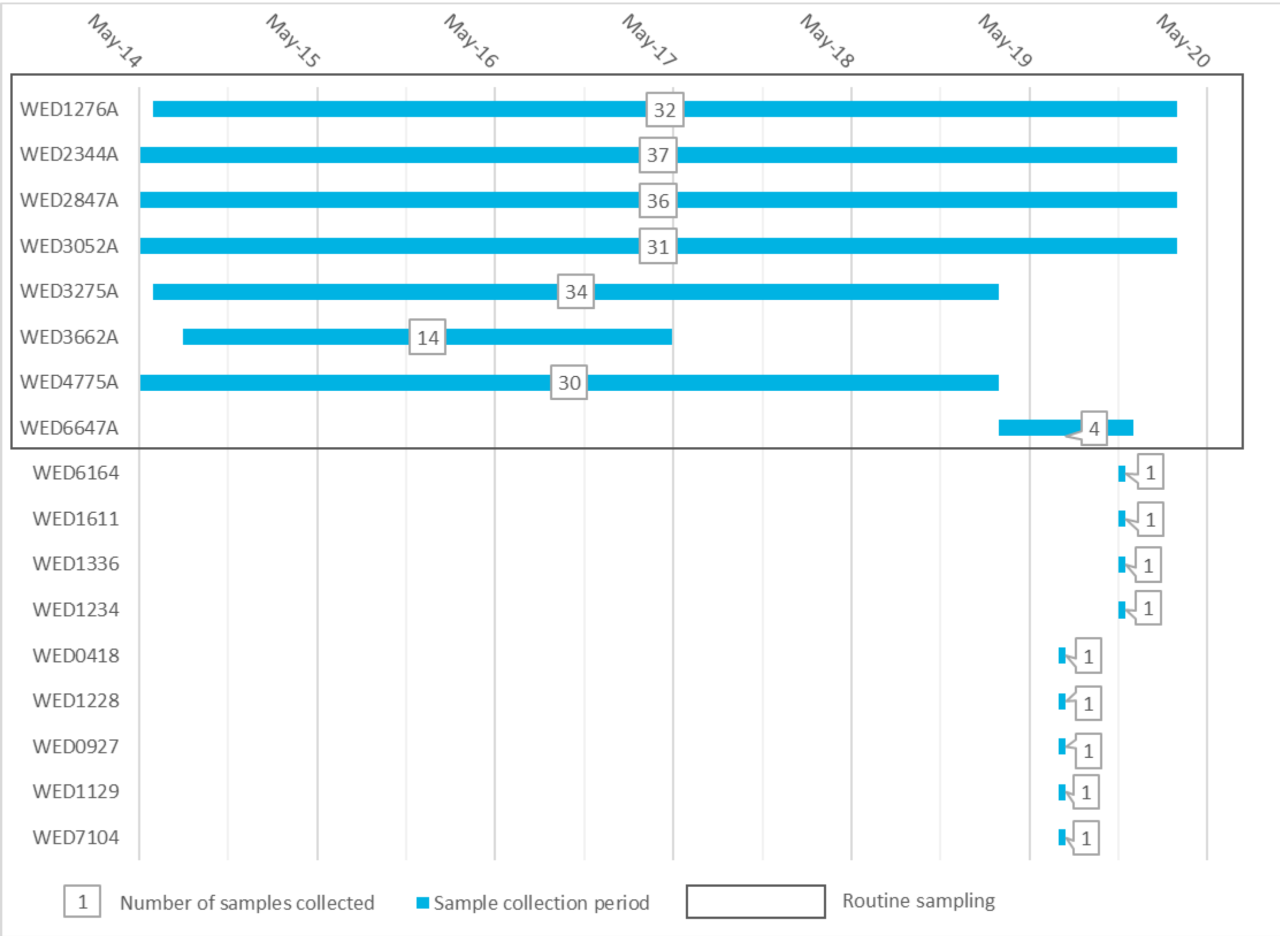
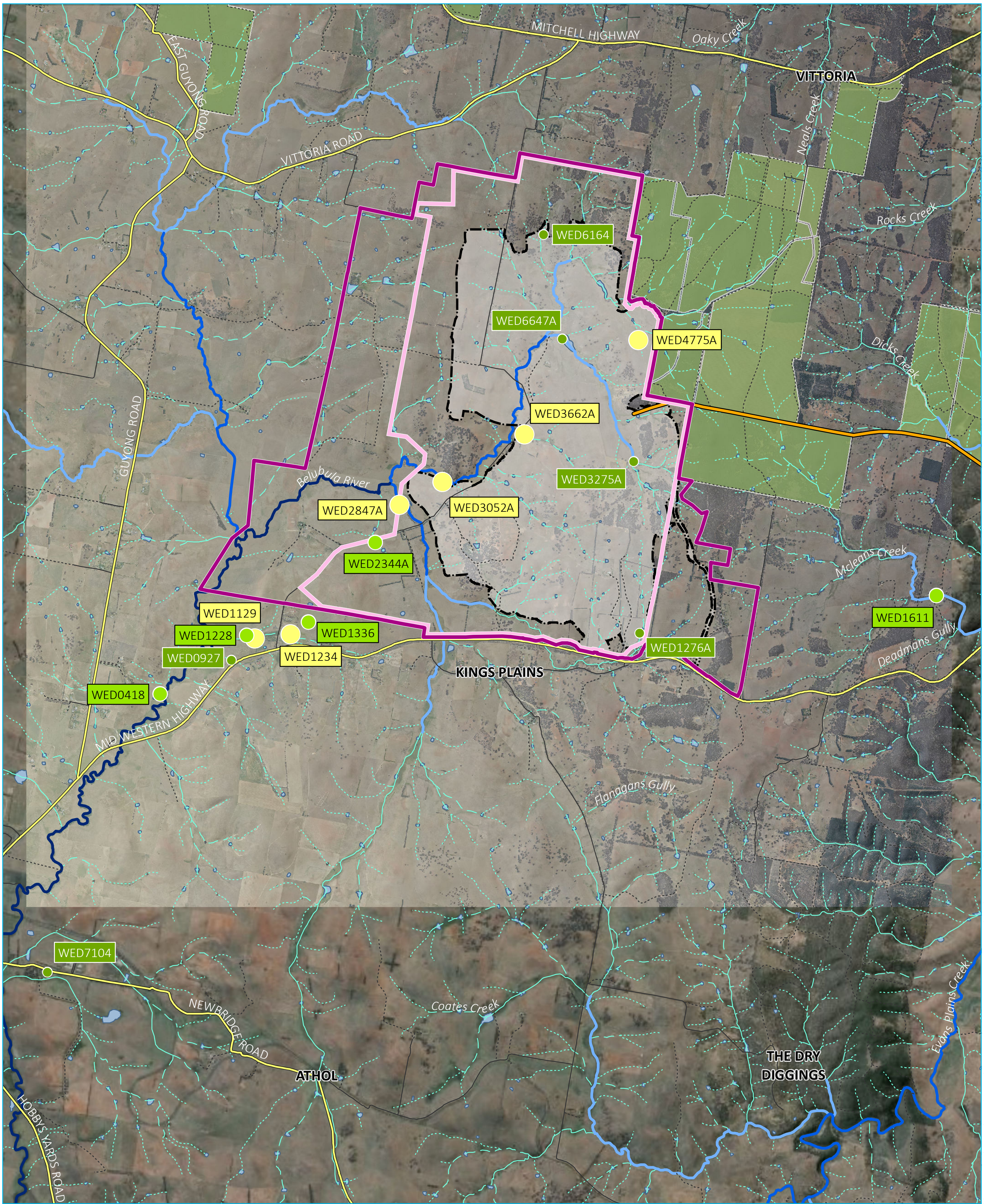


Figure 2.10 Dam water quality sampling summary



Source: EMM (2020); Regis Resources (2020); ESRI (2018); Survey Graphics (2019); DFSI (2017); DPE (2015); ELVIS (2014)

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KEY

Project application area
- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- Pipeline

Existing environment
- Major road
- Minor road
- Vehicular track
- Vittoria State Forest
- Waterbody

Strahler stream order
- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order
- 6th order

Dam salinity

Average TDS (mg/L)
- 99 - 302
- 303 - 490
- 491 - 610

Dam water monitoring locations and average salinity

McPhillamys Gold Project
Surface water-groundwater interaction assessment
Figure 2.11

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2.5.2 Water quality

Dam water salinity (as TDS) ranges from 25 to 1,920 mg/L and averages 400 mg/L. Time-series salinity measurements for the regular/routine dam water monitoring locations, with a comparison to monthly rainfall recorded at the project area is provided in Attachment A.3. Dam monitoring location WED4775A shows the greatest variation over time.

Figure 2.11 also presents the spatial distribution of dam water salinity (as average TDS). The salinity is similar to the Belubula River water salinity and shows that the dams towards the top of the catchment are fresher (eg WED1276A and WED6164) than those further down the catchment.

A trilinear plot of laboratory reported dam chemistry data is presented on Figure 2.12. It shows dam water quality varies more than the Belubula River water quality, but in general is bicarbonate dominant and shows greater contribution of sodium and/or potassium at some locations (eg WED6164 and WED4775A).

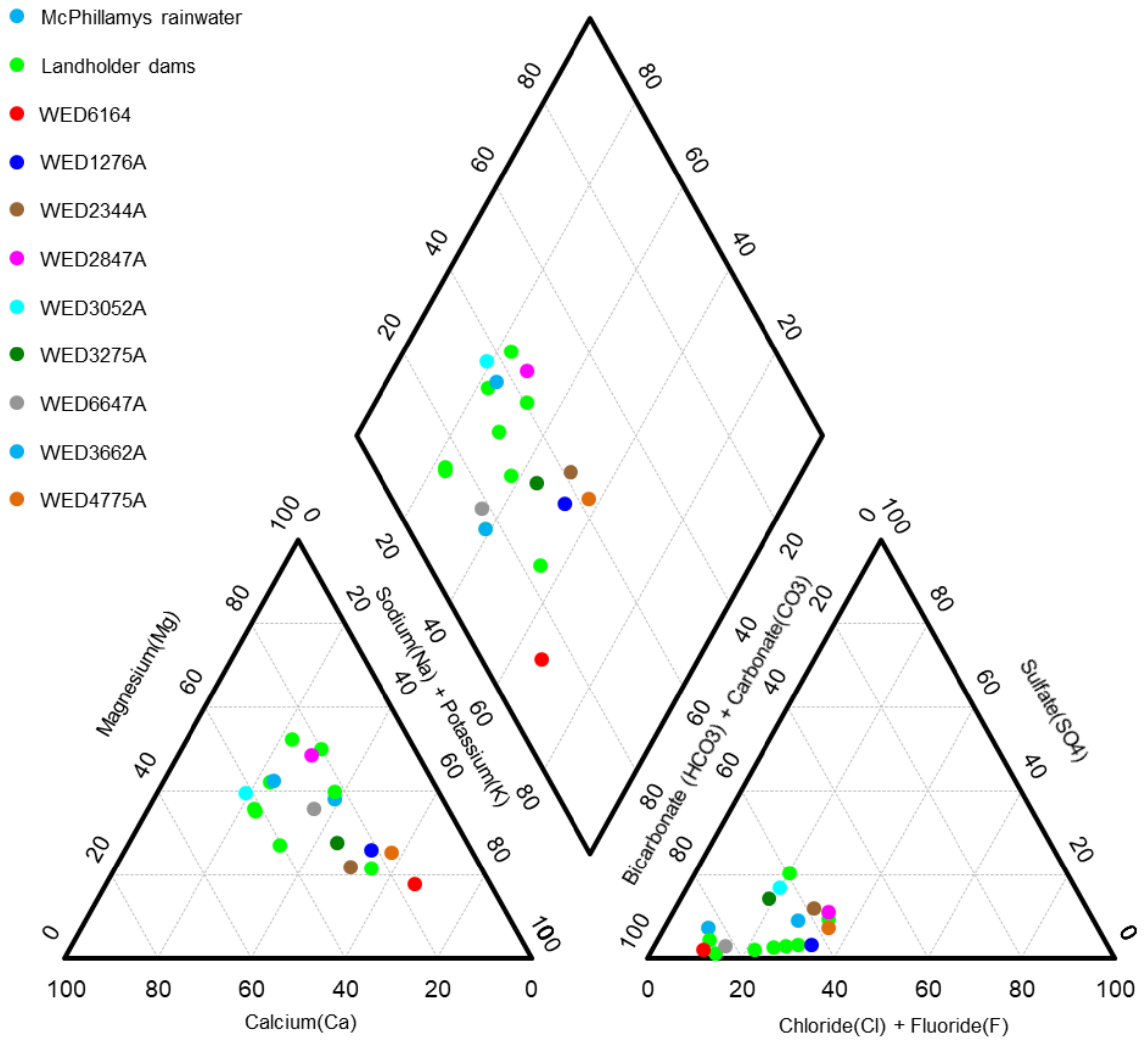


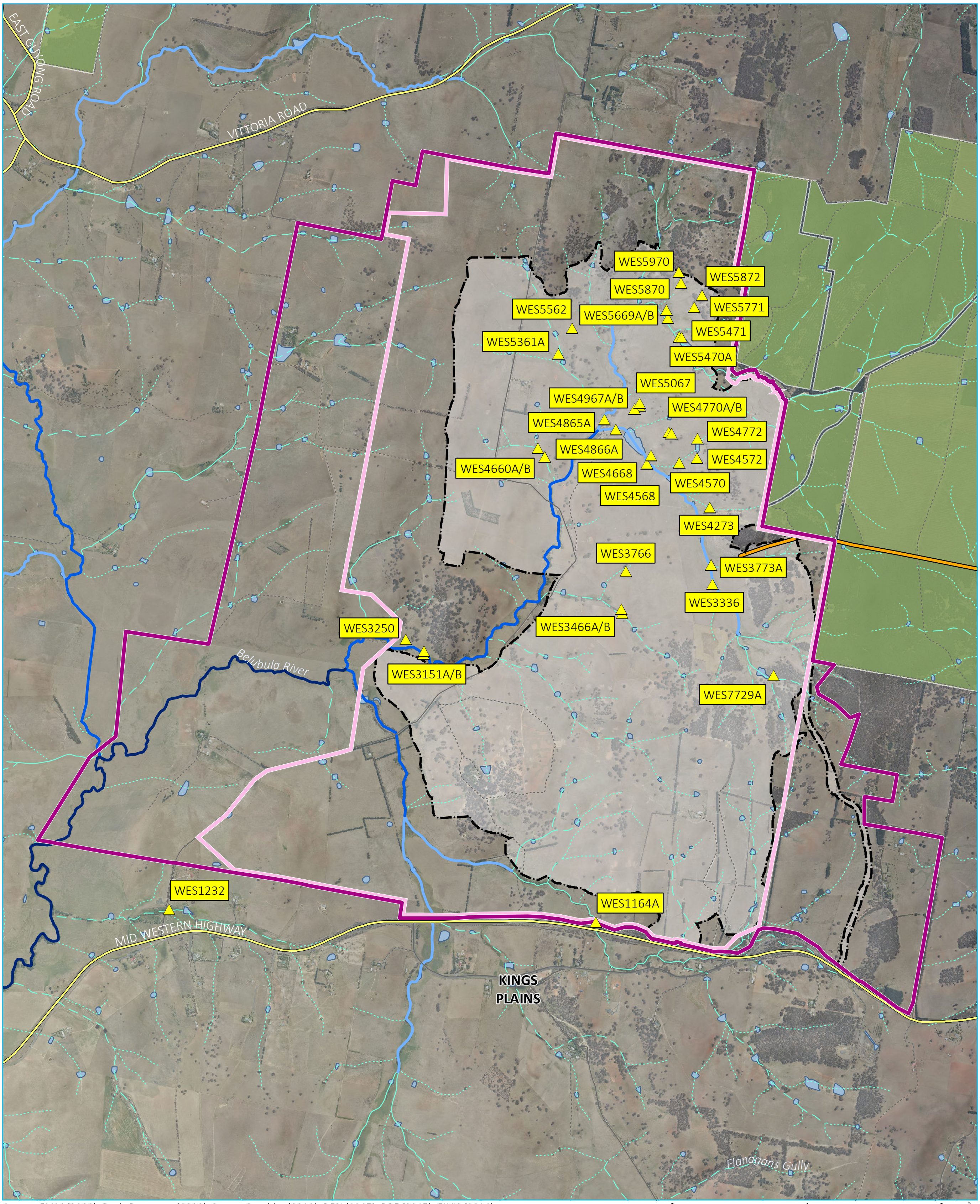
Figure 2.12 Dam water quality trilinear diagram (averages shown)

2.6 Springs

Landholders in the Blayney and Kings Plains area have identified and relied upon seeps and springs for water supply, including excavating the damp/wet areas to construct dams for livestock watering purposes. Seeps and springs have also been identified within the project area. Regis has conducted six field surveys over a period of six years in and surrounding the project area to identify seep and spring areas, and to collect information to increase the understanding of these areas. The first survey occurred in May 2013 and the most recent occurred in November 2019. Each survey aimed to identify and describe springs active at the time of the survey. It should be noted that these seep and spring areas do not include every location where groundwater discharges directly into the Belubula River (or associated tributaries). The identified spring/seep locations are shown on Figure 2.13.

Of the springs and seeps identified and monitored:

- most are located on the side of a hill where topography changes;
- around one third are seeps with no visible flow;
- two had ceased flowing since first identified; and
- around two thirds had visible flows.



Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017); DPE (2015); ELVIS (2014)

0 1 2 km

GDA 1994 MGA Zone 55

N

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KEY

Project application area

- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- Pipeline

- Identified seep/spring

Existing environment

- Major road
- Minor road
- Vehicular track
- Vittoria State Forest
- Waterbody

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order
- 6th order

Seep and spring locations

McPhillamys Gold Project
Surface water-groundwater interaction assessment
Figure 2.13

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Descriptions and observations of the identified springs/seeps is provided in Table 2.1. Photographs of the springs taken during field surveys are provided in Attachment B.

Table 2.1 Description of springs/seeps identified in the project area

Spring ID	Type	Description	Water quality data?	Average TDS (mg/L)
WES1164A	Spring	Located on Trib B in the south-east of the project area. Water chemistry similar to Belubula River water quality and nearby deep groundwater bores (eg WMB1273B).	Yes	569
WED1232	Spring	Located along tributary of Belubula River in a low-lying area where groundwater is inferred to be shallow.	Yes	990
WES3151A	Spring	Within Belubula River high water flow area and near inferred geological structure. Higher salinity suggests source of water is deeper groundwater.	Yes – field chemistry only	1,754
WES3151B	Spring	Within Belubula River high water flow area and near inferred geological structure. Salinity is lower than adjacent WES3151A, suggesting a mixture of rainfall derived water with deeper groundwater.	Yes- field chemistry only	642
WES3250	Seepage area	At base of hill; break of slope; seepage area.	Yes- field chemistry only	589
WES3253	Seepage area	Located on a topographic high and away from inferred structures (faults); dry in 2018; observed as seepage area only. May have been incorrectly identified as a groundwater seep area.	No	-
WES3336	Spring	Located along drainage line (Trib F), towards the top of the catchment, ephemeral (dry in 2018).	Yes- field chemistry only	363
WES3466A	Spring	Located along drainage line (Trib E), break of slope.	Yes- field chemistry only	567
WES3466B	Spring	Located along drainage line (Trib E), break of slope.	Yes- field chemistry only	579
WES3766	Spring	Located along drainage line (Trib E), break of slope.	Yes- field chemistry only	901
WES3773A	Spring	Located in drainage line (Trib F) and downstream of two dams, break of slope. Water quality is different to deeper groundwater in the area.	Yes	410
WES4273	Seepage area	Located along drainage line (Trib F), towards the top of the catchment. Break of slope. Damp, not flowing in 2019. Seepage only.	No	-
WES4568	Spring	Located in low-lying area along Trib F, upstream of a large dam (WED6647A) and the confluence with the Belubula River. Located adjacent to mapped fault.	No	-
WES4570	Seepage area	Located along drainage line (Trib F); break of slope. Seepage only.	No	-
WES4572	Seepage area	Located on side of a hill. Seepage only ie no visible flow. Adjacent to mapped structure. TDS suggests could be sourced from deeper groundwater.	Yes- field chemistry only	958
WES4660A	Spring	Located in drainage line, appears to have continuous flow. Located adjacent to inferred geological structure. Water quality is similar to the Anson Formation groundwater.	Yes	912

Table 2.1 Description of springs/seeps identified in the project area

Spring ID	Type	Description	Water quality data?	Average TDS (mg/L)
WES4660B	Spring	Located along drainage line. Flowing in March 2019, downstream of WES4660A. Spring type assumed to be same as WES4660A.	No	-
WES4668	Seepage area	Break of slope. Seepage only. Damp, not flowing in 2019.	No	-
WES4770A	Seepage area	Located on a topographic high. Seepage only ie no visible flow. Located adjacent to inferred geological structure.	Yes- field chemistry only	653
WES4770B	Seepage area	Located on a topographic high. Seepage only ie no visible flow.	No	-
WES4772	Seepage area	Seepage only; break of slope.	No	-
WES4865A	Spring	Pool within the Belubula River, intermittent flow (dry in December 2019); adjacent to inferred geological structures. Water quality is similar to some local groundwater and Belubula River water quality; salinity is relatively fresh.	Yes	437
WES4866A	Spring	Located in drainage line (Trib F) and upstream of WES4865A but downstream of large dam (WED6647A). Water quality is similar to some local groundwater and Belubula River water quality; adjacent to inferred geological structures.	Yes	565
WES4967A	Spring	Located on the side of a hill. Higher salinity suggests source from deeper groundwater.	Yes- field chemistry only	919
WES4967B	Spring	Located on the side of a hill, no observed flow.	Yes- field chemistry only	695
WES5067	Spring	Located on the side of a hill, no observed flow.	Yes- field chemistry only	646
WES5361A	Spring	Near drainage line and dams; damp, not flowing in March 2019. Adjacent to inferred geological structure. Appears to flow most of the time. Water quality is similar to Anson Formation groundwater.	Yes	1,396
WES5470A	Spring	Ephemeral, located in drainage line and downstream of dam (WED5471).	Yes - field chemistry WQ only	514
WES5471	Spring	Ephemeral, located in drainage line and downstream of dam (WED5471).	Yes- field chemistry only	481
WES5562	Spring	Located on the side of a hill. Located adjacent to mapped fault. Drains into dam. Higher salinity suggests source from deeper groundwater.	Yes- field chemistry only	1,140
WES5669A	Spring	Break of slope, ephemeral, within drainage line area. Water quality is similar to some local groundwater and Belubula River water quality.	Yes	503
WES5669B	Seepage area	Break of slope, ephemeral, within drainage line area.	No	-
WES5771	Spring	Located on the side of a hill and adjacent to inferred geological structure. Ephemeral. Salinity suggests water is sourced from deeper groundwater.	Yes- field chemistry only	1,491
WES5870	Spring	Located on the side of a topographic high.	Yes- field chemistry only	469

Table 2.1 Description of springs/seeps identified in the project area

Spring ID	Type	Description	Water quality data?	Average TDS (mg/L)
WES5872	Seepage area	Located on the side of a topographic high. Seepage only, ie no visible flow.	Yes- field chemistry only	552
WES5970	Spring	Located on the side of a topographic high.	Yes- field chemistry only	316
WES7729A	Spring	Located along Trib F, spring has been dammed or the spring may actually be seepage from a watercourse dam. Water chemistry signature is similar to rainfall.	Yes	185

Note: One spring was surveyed outside the project area; WED1232, as shown on Figure 2.13.

2.6.1 Springs/seeps routine monitoring

Regis began routine water sampling at select seep/spring locations in the project area in July 2017 (Figure 2.14). During the landholder surveys conducted in July and November 2019 and as described above, a water sample was also collected from a spring identified on a landholder property downstream of the project area. Since monitoring commenced in July 2017, 10 sites have been sampled. A summary of the spring water quality monitoring is provided in Figure 2.14.

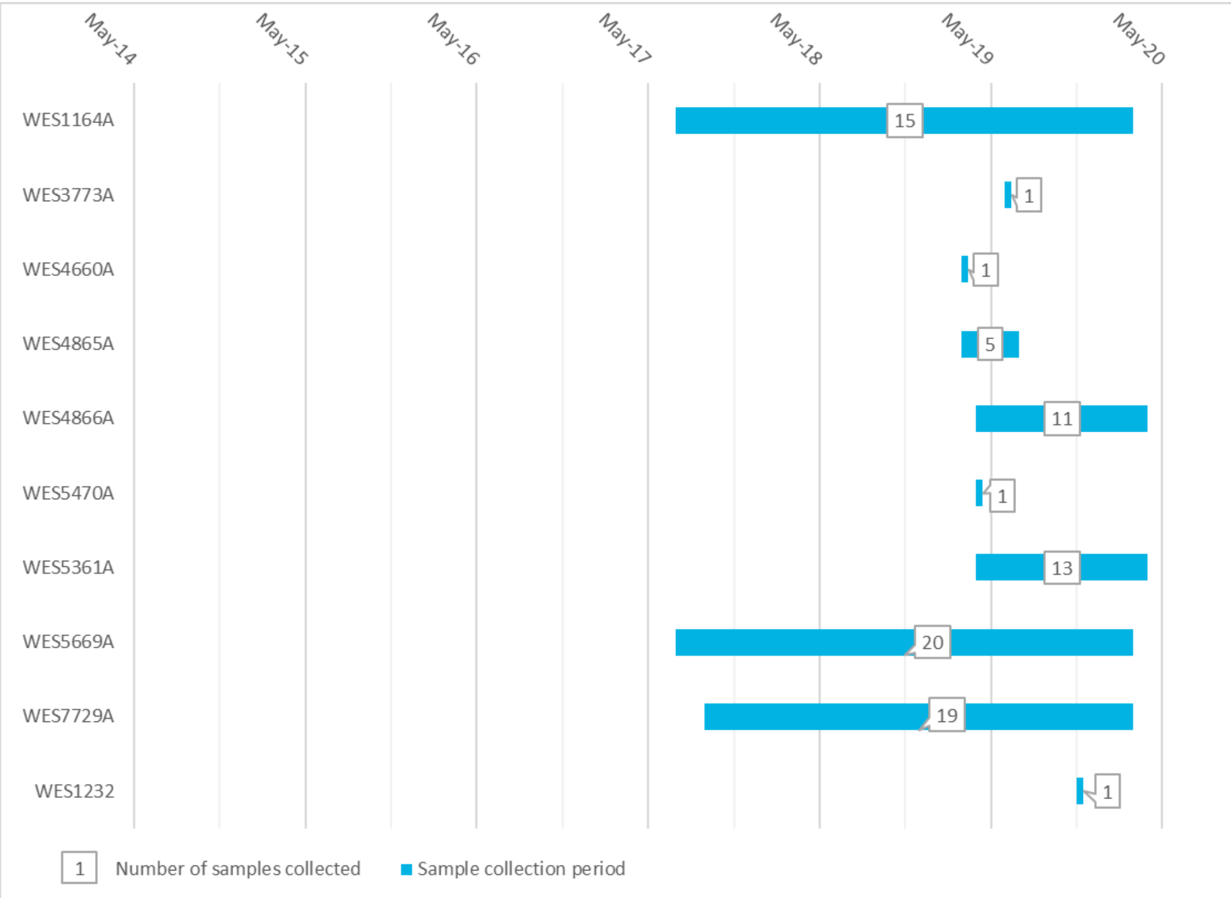


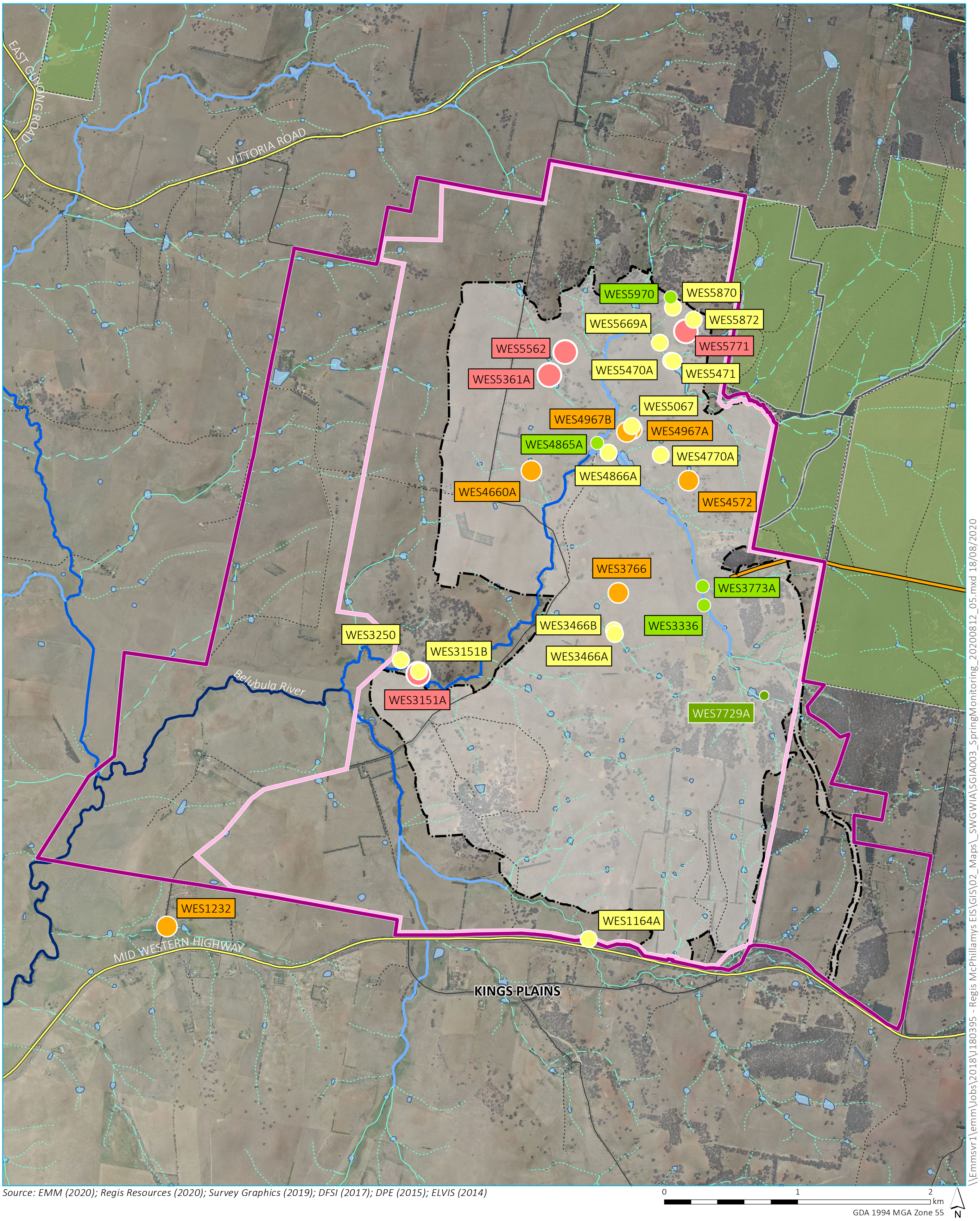
Figure 2.14 Spring water quality sampling summary

2.6.2 Springs/seeps water quality

The salinity (as TDS) of the monitored springs/seeps varies by location, ranging from 37 to 1,800 mg/L and averages 612 mg/L. Time-series salinity measurements for several of the spring/seep monitoring locations listed in Figure 2.14, with a comparison to monthly rainfall recorded at the project area are presented in Attachment A.4. As most spring/seep locations are close to or within drainage lines, the water quality is generally fresher in wetter periods. This has been observed at WES4660A and WES4866A, where salinity was very low in late April 2020, which correlates with a high rainfall period. Other spring/seep locations (WES1164A and WES7729A) have generally higher salinity in drier periods and lower in wetter periods (refer Attachment A.4).

Figure 2.15 presents the spatial distribution of measured salinity (as average TDS). It suggests that springs/seeps higher in the catchment are fresher (eg WES7729A and WES3773A); however, further down the catchment the salinity is variable and likely depends on the source of the water for the spring/seep (eg deeper groundwater or shallower fresher groundwater), and/or the geology immediately upgradient of the spring.

A trilinear plot of laboratory reported spring/seep water chemistry data is presented on Figure 2.16. It shows the spring/seep water is generally similar to Belubula River water and groundwater sampled from bores (bicarbonate dominant, with two locations (WES5361A and WES4660A) high in sulphate). Spring WES5669A has a chemical signature very similar to rainwater.



Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017); DPE (2015); ELVIS (2014)

KEY

Project application area
- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- Pipeline

Existing environment
- Major road
- Minor road
- Vehicular track
- Vittoria State Forest
- Waterbody

Strahler stream order
- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order
- 6th order

Seep and spring salinity

Average TDS (mg/L)
- 185
- 186 - 437
- 438 - 660
- 661 - 990
- 991 - 1754

Spring average salinity

McPhillamys Gold Project
Surface water-groundwater interaction assessment
Figure 2.15

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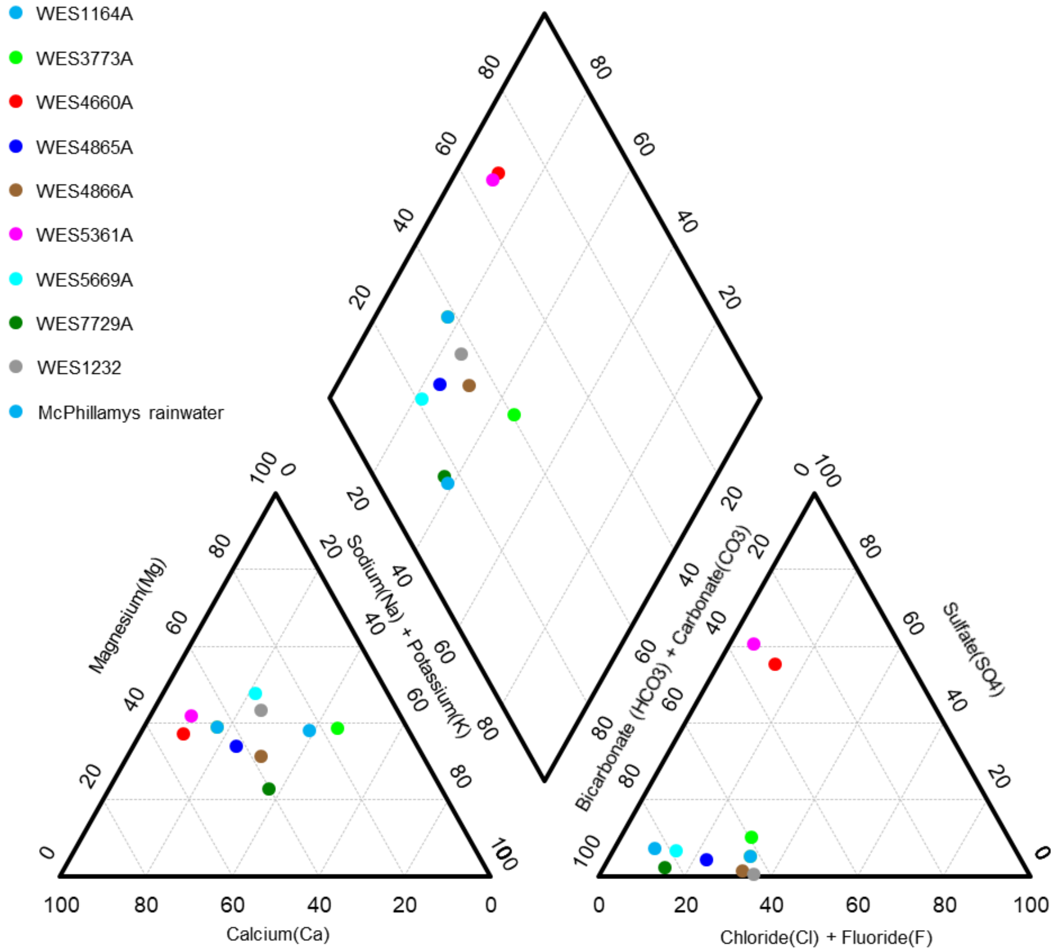


Figure 2.16 Spring water quality trilinear diagram (averages shown)

3 Surface water–groundwater interaction

3.1 Overview

The information presented in Chapter 2 above has been used, along with other information presented in the 2019 groundwater assessment report (EMM 2019b), to assess how groundwater interacts with surface water and the reliance of surface water features (such as the Belubula River, dams and springs) on groundwater discharge.

3.2 Isotopes

In addition to the routine and opportunistic water sampling conducted by Regis in the McPhillamys and Blayney area for routine laboratory analysis, additional water chemistry analysis (using water isotopes) was conducted in 2017.

Environmental isotopes, stable and radioactive, occur naturally in the atmosphere and hydrosphere in varying concentrations. Generally, the most commonly used environmental isotopes include isotopes of water (oxygen-18, deuterium (^{2}H) and tritium (^{3}H)) and carbon (^{13}C and ^{14}C) which naturally occur in water. Environmental isotopes are used to investigate water age, groundwater recharge and discharge processes, flow and interconnection between aquifers, and surface water-groundwater interactions. Radioactive isotopes (tritium and carbon-14) that occur in water are sourced from nuclear testing conducted in the 1950s and/or cosmogenic nuclear reactions (ie reactions between cosmic rays from space and atoms in the ground, water and air). Isotopes are often sampled and measured to assist with the conceptual understanding of how water moves through catchments.

An isotope investigation was undertaken in May 2017 to help understand the interaction between surface water and groundwater, and to characterise sources of groundwater recharge and groundwater residence times (EMM 2019c). The isotope sample locations are shown on Figure 3.1. Water samples were tested for oxygen-18, deuterium and tritium for all locations and carbon-13 and carbon-14 for groundwater samples.

The results of the isotope analysis are:

- The presence of tritium in all samples, except for WMB2130A, indicates that at least some amount of the sampled groundwater fell as rain and infiltrated to groundwater after 1950.
- The results of the isotope sampling from the carbonaceous alteration within the open cut mine area returned differing information regarding the groundwater age, which indicates groundwater mixing. The results of the tritium concentrations suggest some groundwater was sourced from infiltration of rain after 1950 and the radiocarbon results suggest that groundwater may be much older (at least 4,500 years since it fell as rain and entered the ground). These results suggest that the water sampled from WMB2556A (in the marble) is sourced from a combination of shorter local groundwater flow and older, more slow-moving groundwater.
- The absence of tritium within the sample collected from WMB2130A (Blayney Volcanics) indicates that the groundwater at this location has been recharged before 1950 and appears to be the oldest water in the project area.
- The surface water sites (dams and watercourse) sampled during this investigation generally have a younger source of water when compared to the groundwater samples. This is to be expected given that the sites receive direct rainfall and runoff during high rainfall events.

- Water sampled from spring WES5669A appears to be sourced from a mixture of groundwater and younger surface water sources.
- Differences in stable isotope and tritium concentrations between WMB2130A and WMB2130B indicate that groundwater in the Blayney Volcanics and alluvium are not connected at this location.

3.3 Spring/seep classification

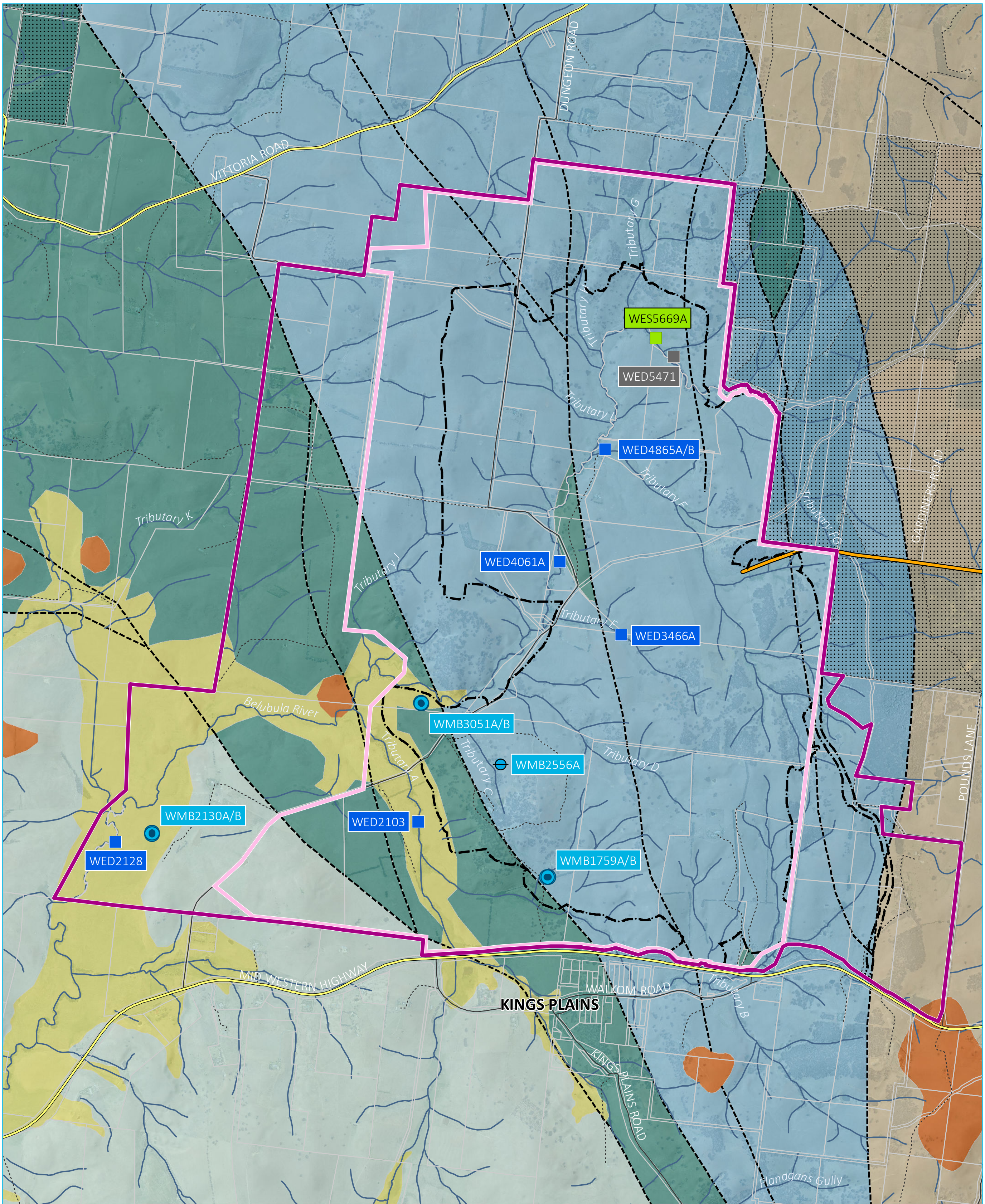
Based on the data collected, the 37 identified springs/seeps have been classified into one of the six spring types presented in Section 1.5. The springs were classified based on the following information:

- water chemistry, with a comparison to groundwater, rainwater and water sampled from the Belubula River;
- observations during the field surveys, including discussions with local landholders;
- topography; and
- inferred geological structures.

The spring types classes are listed in Table 3.1 and shown on Figure 3.2 and Figure 3.3.

The following points summarise the spring types identified:

- a little over two thirds of the identified springs are inferred to be break of slope or outcrop type springs, with water sourced from shallow groundwater flow;
- around one quarter are inferred to be fault springs, with water sourced from a combination of shallower and deeper groundwater;
- one spring area located downstream of the project area and in the Belubula River flood plain, is inferred to represent an area where groundwater is shallow (close to ground surface); and
- there are no basalt springs or GAB artesian flowing springs present in the mine project area.



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Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017); GA (2011); DPI (2003)

0 1 2 km
GDA 1994 MGA Zone 56
N

KEY

Project application area
- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- Pipeline

Surface water monitoring sites
- Dam
- Spring
- Surface water

Groundwater monitoring bores
- Single
- Nested

Existing environment
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- Cadastral boundary
- Vittoria State Forest

Geology (Bathurst 250k, 2nd Edition)
- Fault

Quaternary / Tertiary
- Alluvium
- Tertiary basalt

Devonian
- Ungrouped Devonian Formations - Cunningham Formation

Silurian
- Mumbil Group (Northwest) - Anson Formation

Ordovician
- Cabonne Group - Blayney Volcanics
- Cabonne Group - Byng Volcanics

Isotope sampling locations

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Surface water-groundwater interaction assessment
Figure 3.1

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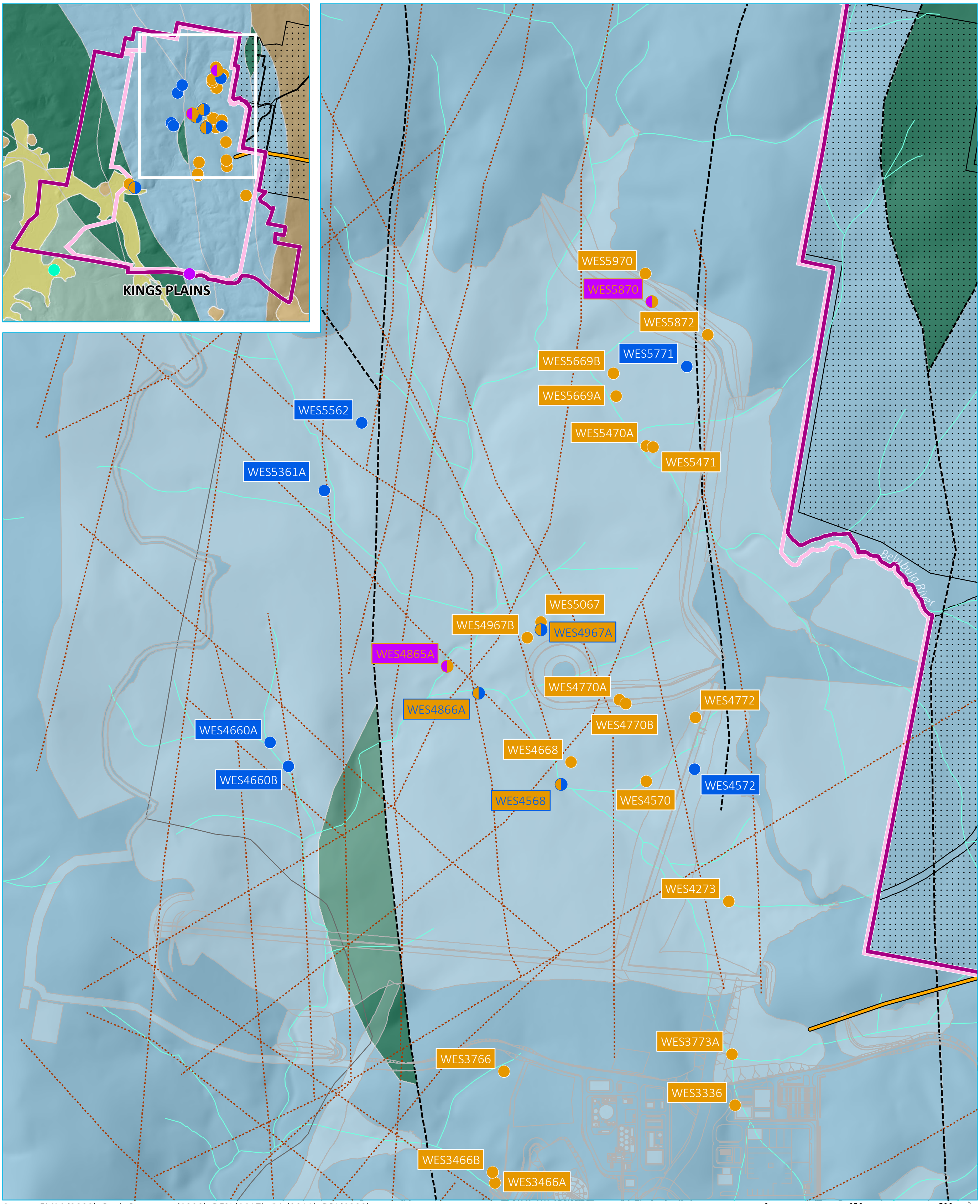
Table 3.1 Inferred spring classification

Spring ID	Classification
WES1164A	Outcrop spring
WES3151A	Fault spring
WES3151B	Fault spring or break of slope
WES3250	Break of slope
WES3336	Break of slope
WES3466A	Break of slope
WES3466B	Break of slope
WES3766	Break of slope
WES3773A	Break of slope
WES4273	Break of slope
WES4568	Fault spring or break of slope
WES4570	Break of slope
WES4572	Fault spring/seep
WES4660A	Fault spring
WES4660B	Fault spring
WES4668	Break of slope
WES4770A	Break of slope
WES4770B	Break of slope
WES4772	Break of slope
WES4865A	Break of slope/outcrop
WES4866A	Break of slope or fault spring
WES4967A	Break of slope or fault spring
WES4967B	Break of slope
WES5067	Break of slope
WES5361A	Fault spring
WES5470A	Break of slope
WES5471	Break of slope
WES5562	Fault spring
WES5669A	Break of slope
WES5669B	Break of slope
WES5771	Fault spring
WES5870	Break of slope/outcrop
WES5872	Break of slope
WES5970	Break of slope

Table 3.1 Inferred spring classification

Spring ID	Classification
WES7729A	Break of slope
WES1232 [1]	Lowland pool/shallow groundwater

Notes:
WES1232 not shown on Figure 3.1 or 3.2 but is shown on Figure 2.13.
WES3253 has been removed after further investigation in 2020 (visited in 2017 and 2018 and 2020 and was dry)



Source: EMM (2020); Regis Resources (2020); DFSI (2017); GA (2011); DPI (2003)

0 250 500
m
GDA 1994 MGA Zone 55
N

\\Emmsvr1\emm\Jobs\2018\J180395 - Regis McPhillamys EIS\GIS\02_Maps_SWGWIA\SGIA005_SpringClassificationTSF_20200812_05.mxd 18/08/2020

KEY

Project application area
- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Project general arrangement
- Pipeline

Existing environment
- Minor road
- Watercourse/drainage line
- Vittoria State Forest

- Interpreted fault

Geology (Bathurst 250k, 2nd Edition)
- Fault (250k)

Silurian
- Mumbil Group (Northwest) - Anson Formation

Ordovician
- Cabonne Group - Byng Volcanics

Inferred spring type
- Fault spring
- Break of slope
- Outcrop spring (refer to inset)
- Lowland pool/shallow groundwater (refer to inset)
- Fault spring or break of slope
- Break of slope or outcrop spring

Spring classification – TSF area

McPhillamys Gold Project
Surface water-groundwater interaction assessment
Figure 3.2

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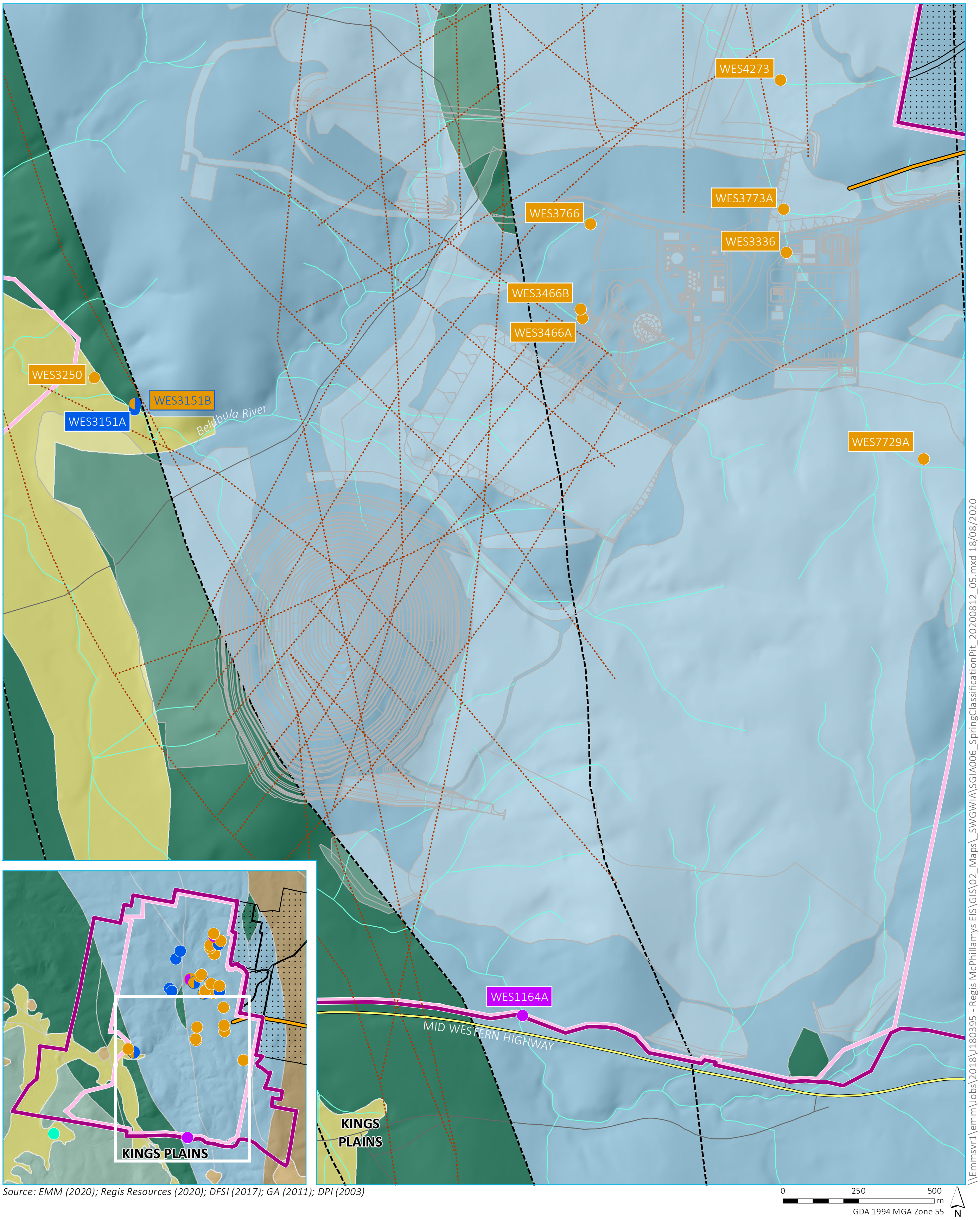

Source: EMM (2020); Regis Resources (2020); DFSI (2017); GA (2011); DPI (2003)

KEY

Project application area
- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Pipeline
- Project general arrangement

Existing environment
- Major road
- Minor road
- Watercourse/drainage line
- Vittoria State Forest

- Interpreted fault

Geology (Bathurst 250k, 2nd Edition)
- Fault (250k)

Quaternary / Tertiary
- Alluvium

Silurian
- Mumbil Group (Northwest) - Anson Formation

Ordovician
- Cabonne Group - Blayney Volcanics
- Cabonne Group - Byng Volcanics

Inferred spring type
- Fault spring
- Break of slope
- Outcrop spring
- Lowland pool/shallow groundwater (refer to inset)
- Fault spring or break of slope
- Break of slope or outcrop spring (refer to inset)

Spring classification - open cut area

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Surface water-groundwater interaction assessment
Figure 3.3

3.4 Groundwater fed dams and watercourse

3.4.1 Dams

Field observations indicate that most of the dams are constructed on drainage lines or in seepage areas to collect rainfall runoff and/or water that comes from break of slope springs/seeps. As a result, water in the dams are generally low salinity, with increases in salinity inferred to be associated with evaporation, interception of saline shallow groundwater or runoff of sediment-laden water. Dams that have been excavated in seep/spring areas limit spring-derived surface water from flowing into the Belubula River.

3.4.2 Belubula River

As mentioned in Section 2.4, additional opportunistic surveys and water sampling along the Belubula River was conducted in July and November 2019 during a period of low rainfall which started in April 2017. One exception to this low rainfall period was a period of moderate rainfall between November 2018 to January 2019 (328 mm of rain).

As there has been water present along most sections of the Belubula River downstream of the project area during this extended dry period, it indicates that groundwater is discharging laterally into the watercourse along the whole length of the river to Blayney.

The quality of the Belubula River water downstream of the project area has similar composition to groundwater sampled from the Byng and Blayney Volcanics, indicating that the river receives local groundwater discharge from these geological formations, rather than the Anson Formation located in the project area.

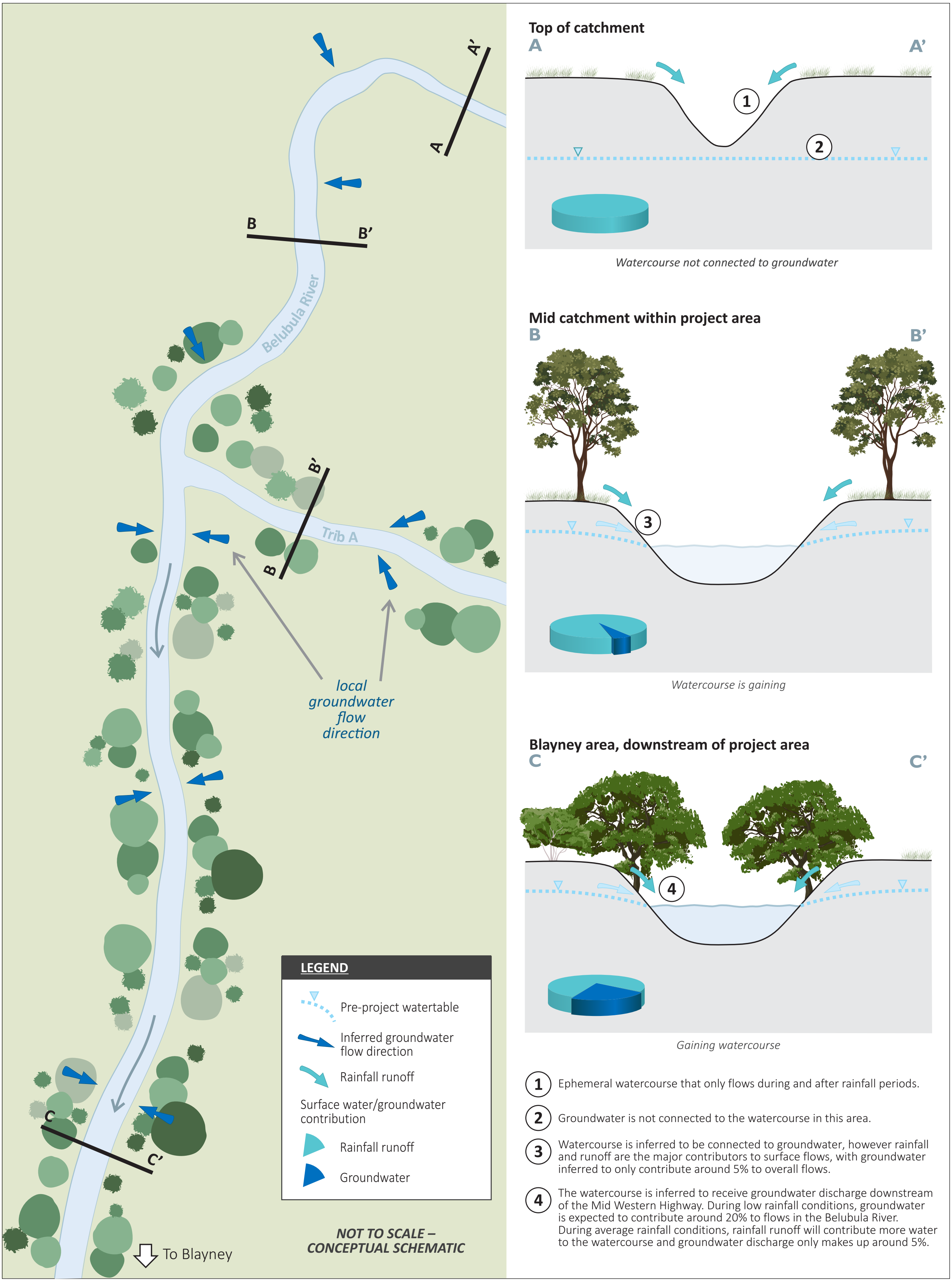
Overall, the Belubula River (from the top of the catchment to Blayney) receives water from the following sources, in order of largest contribution to smallest:

1. Runoff of rainfall during and after rainfall events from the local catchment.

2. Direct rainfall on the watercourse.

3. Groundwater discharge (baseflow) – the contribution of groundwater increases with distance down the water catchment. That is, at the top of the catchment the watercourse is not in connection with groundwater (ie no contribution from groundwater), and along Trib A and downstream of Trib A, groundwater is inferred to contribute around 5% of flows in the Belubula River. Downstream of the Mid Western Highway, the contribution from groundwater is inferred to increase to around 20% and will vary with climate conditions. During drought periods, flow of local groundwater to the Belubula River will sustain flows in the watercourse along the length of the river from the Mid Western Highway to Carcoar Dam.

The above understanding is shown in Figure 3.4.



Conceptual understanding of Belubula River interaction with groundwater (existing situation)

Surface water–groundwater interaction assessment

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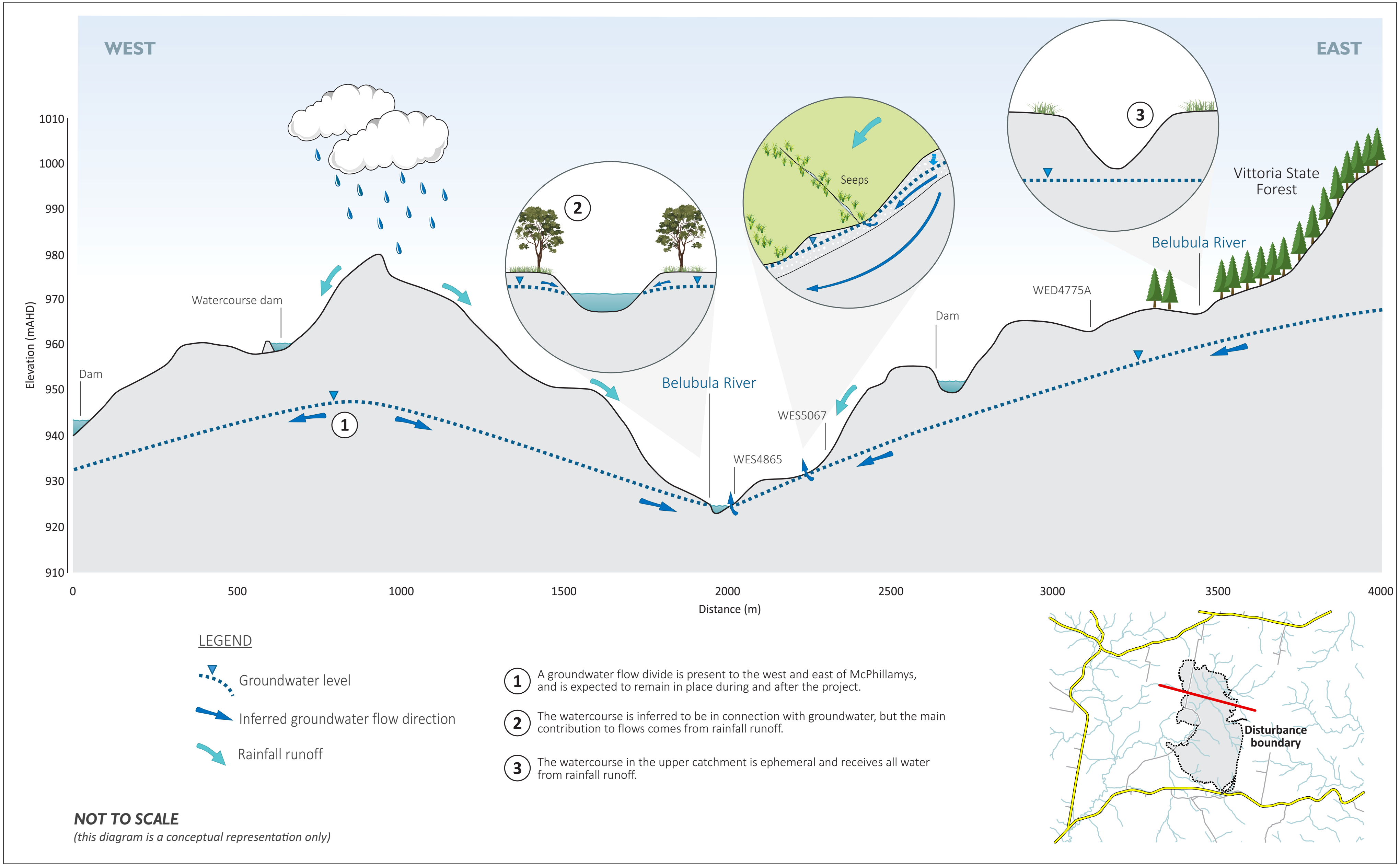
Figure 3.4

3.5 Conceptual understanding

The conceptual understanding of the surface water-groundwater interaction within the project area is presented on Figure 3.5 and Figure 3.6.

The following describes the key elements that are important for considering the potential effects of the project on water resources:

- Rainfall and runoff are the main contributing sources of water to the Belubula River flows.
- The upper reaches of the Belubula River (upstream of Trib E) are ephemeral and flow during and after periods of heavy rainfall.
- Groundwater is inferred to discharge to Trib A, contributing around 5% to overall flows along that section of the watercourse.
- Downstream of the project area and the Mid Western Highway, groundwater is inferred to discharge to the Belubula River, contributing around 20% to overall flows along that section of the watercourse.
- Springs and seeps are present across the area. Most springs in the project area are associated with areas where the topographic gradient changes abruptly and intercepts shallow groundwater flow. Many of these springs and seeps have been excavated into dams to increase water access for stock. Whilst some springs do contribute flow to the Belubula River, a large amount of the discharging groundwater will evaporate, be used by vegetation or for stock and domestic purposes.
- Recharge to regional groundwater occurs as:
  - infiltration of rainfall, with higher rates expected where alluvium is present. Rainfall recharge is estimated to be between 2 to 8% of annual average rainfall;
  - leakage from the Belubula River and tributaries during periods of high streamflow; and
  - downward leakage from the overlying saprock and alluvium (where present) recharging the fractured rock system.
- Annual evapotranspiration exceeds annual rainfall and occurs:
  - within the unsaturated or soil zone;
  - where the watertable is sufficiently close to the surface for vegetation to access groundwater; and
  - from watercourse pools where the streambed intersects the watertable.
- Groundwater flow direction is influenced by topography and surface drainage (refer Figure 2.3). Groundwater flows south-west along the Belubula catchment.



McPhillamys west-east conceptual cross section

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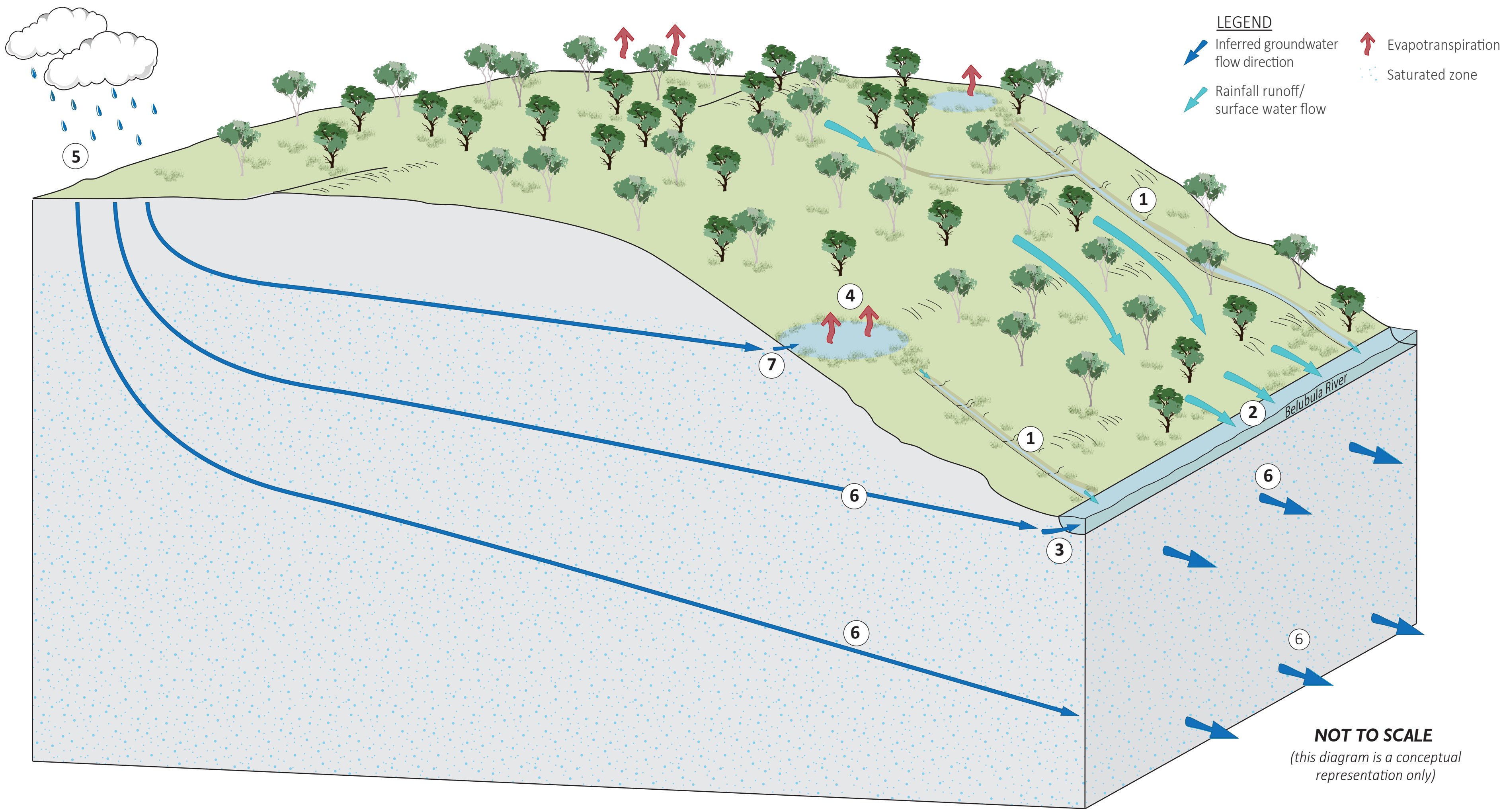
Surface water–groundwater interaction assessment

Figure 3.5



1. Watercourses and drainage lines in upper catchment fed by rainfall runoff and spring discharge, not groundwater baseflow.
2. Watercourses in lower catchment fed by rainfall runoff, tributaries and groundwater baseflow.
3. About 5% of river flow is from groundwater baseflow.
4. Most spring water evaporates or is used by farmers before it reaches watercourses.
5. About 2% of rainfall becomes groundwater and about 98% of rainfall runs to watercourses or evapotranspirates.
6. Groundwater slowly moves underground. Deeper groundwater typically moves much slower than shallower.
7. Very shallow groundwater travels short distances and discharges, in depressions in landscape, as springs in the upper catchment.

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Conceptual catchment water balance – existing

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Surface water–groundwater interaction assessment

Figure 3.6

4 Impact assessment

4.1 Water affecting activities

Mining projects (similar to other large-scale developments) have the potential to affect surface water flows, surface water quality, groundwater flows/levels and groundwater quality. This in turn has the potential to affect ecosystems that access water or live within those water environments; bores used by nearby landholders and other users of surface water and groundwater. These potential effects can be classified as one or a combination of economic, social, environmental and cultural.

Project related activities have been identified to have the potential to affect groundwater or surface water resources (EMM 2019b). The following is a summary of the project activities that have the potential to alter the interaction between groundwater and surface water:

- changes to the landscape through built infrastructure, watercourse diversions – these have the potential to reduce streamflows and contribute to changes to water quality;
- mine dewatering – this is expected to result in a very localised decline in depth to groundwater in and around the open cut;
- TSF – without management, water within the tailings has the potential to infiltrate to groundwater and other water sources, resulting in a higher (shallower) depth to groundwater and changes to groundwater quality in the TSF area; and
- water storages – if unmanaged, there is the potential for water to infiltrate from the water storages to groundwater or to spill to the environment.

As part of the project design, mitigation measures have been considered to address the potential for the above water affecting activities to have an effect on surface water and groundwater resources. These measures include (but are not limited to) the following:

- Changes to the landscape have been designed to minimise changes to existing flow as much as practical.
- The design of the TSF includes a multi-barrier seepage management approach that further reduce the potential for seepage from the TSF to the environment during operations. The approach begins with the design of the process plant where a cyanide detoxification process will reduce the concentration of cyanide (weak acid dissociable and free) in the tailings before it is directed to the TSF. It also includes a liner to limit downward seepage, interception drain and potential seepage interception bores (ATC Williams Pty Ltd (ATCW) 2019 and 2020).
- Water storages have been designed to have <1% chance of spilling, with the TSF designed not to spill under any climate scenario (for example after very high rainfall events).

Further, mine dewatering is predicted to be very localised and will have minimal, if any, measurable effects and therefore no additional mitigation measures or controls are proposed.

4.2 Approach

The assessment of project-related impacts to water resources and water users considers the requirements of the NSW *Water Management Act 2000*, the relevant Water Sharing Plans and the NSW Aquifer Interference Policy (DPI Water 2012b). The assessment also considers consultation undertaken with the NSW Government throughout the project development.

The assessment has been completed in two parts:

1. A surface water assessment completed by HEC (2019) for the EIS, with an update based on the amended project and in response to submissions on the EIS (HEC 2020). This work looked at the potential effects of the project on water flows to Carcoar Dam. Rainfall and runoff that occurs upstream of the project disturbance area will be diverted around the disturbance area where possible and back into local creeks and the Belubula River. Rainfall and runoff that occurs within the project disturbance area will be captured, managed and used within the site water management system. This will result in a reduction in streamflows within the Belubula River.

2. A groundwater assessment completed by EMM (2019b) for the EIS, with an update based on the amended project (EMM 2020c). A groundwater model has been used to assess the influence of the mine development on the groundwater system, including in areas where groundwater interacts with surface water. The model included both simulation of the open cut mine and a simplified version of the TSF during the operational period of the mine and post-closure. The model predicts the changes to groundwater levels, groundwater inflow to the open cut mine, and changes in groundwater flow as a result of the two main water affecting activities for the project (EMM 2019b).

4.2.1 Changes to water quality

Water storages and the TSF have been optimally located to ensure efficient environmental management. The water storages and the TSF are designed to prevent spills to the environment, eliminating the potential for changes to the Belubula River water quality as a result of a spill.

There is the potential for tailings water to gradually infiltrate the groundwater system. The design of the TSF has considered this in detail and the infiltration rates are very low. The potential changes to groundwater quality underlying and downgradient of the TSF area has been considered and inform the assessment of potential changes to the Belubula River water quality.

Based on the assessments completed for the project (SRK 2019 and EMM 2020c), the following analytes have been identified as indicators of seepage from the TSF:

- pH;
- salinity; and
- arsenic, cobalt, sulphate, selenium and aluminium.

The simulation of the TSF in the groundwater model is deliberately conservative and has been completed to assess the potential worst case TSF seepage scenario. The purpose is not to provide an accurate estimate of TSF seepage rates. The simulation of the TSF in the groundwater model is more comparable to a lined water storage dam rather than a tailings dam. The key difference between a lined water dam and TSF is that a TSF will consist of solid particles (eg ground and broken rock) and fluid, at a water content of around 20−30% and will therefore contain much less water than a water dam, which has 100% water content. The water held within the pore spaces between the tailings particles will drain slowly, driven by changing hydraulic pressures, the size of the tailings particles and pore space between the particles.

4.3 Impact assessment

4.3.1 Overview

The results of the surface water and groundwater assessments are summarised in the following sub-sections, however further detail is provided in the EIS Surface Water Assessment (HEC 2019), EIS Groundwater Assessment (EMM 2019b), revised surface water assessment (HEC 2020) and Groundwater Assessment Addendum (EMM 2020c).

4.3.2 Streamflow

i Reduction in catchment

The project will not have a significant impact on streamflow in the Belubula River. The changes that are predicted to occur are within the current natural variability of the Belubula River flows. Users downstream of the project who rely on and access water from the Belubula River will not experience reduced access to water and are not expected to be affected by the project.

The predicted change to streamflow is minor and is mostly due to the change in the catchment size (ie reduced rainfall runoff into the river). This results in a maximum 4% reduction of streamflow at Carcoar Dam and 9% at Mid Western Highway during operation of the project and reduces to 0.5% following completion of the project.

Downstream users are most reliant on water within the river during low flow periods, and therefore this was considered in detail. At maximum disturbance, flows in the Belubula River below the Mid Western Highway and above Carcoar Dam are expected to range between at least 697 and 1,509 ML/year during periods of low rainfall (HEC 2020) (the flows will depend on the location along the river, with flows increasing along the river towards Carcoar Dam). This is compared with 764 and 1,574 ML/year that currently flows during low rainfall periods at Mid Western Highway and Carcoar Dam, respectively. During these periods of low rainfall when downstream users are most reliant on water within the Belubula River, groundwater discharge to the Belubula River in the Mid Western Highway area and further downstream is predicted to remain unchanged from current conditions.

To put these flows into context, the water requirements for the Belubula River above Carcoar Dam Water Source in accordance with the *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012*, and known licences that are not accounted for in the Plan, are as follows:

- domestic and stock rights: 68 ML/year;
- share components of domestic and stock access licences: 5 ML/year; and
- 264 ML of unregulated river water access licences.

Therefore, there is a total of 337 ML/year already allocated to this Water Source for downstream users. This leaves at least 1,172 ML/year (ie 1,509 minus 337 ML/year) available for environmental and recreational purposes flowing into Carcoar Dam during low rainfall periods (and the capture of rainfall runoff associated with Harvestable Rights). This is presented graphically, as percentages, in Figure 4.1.

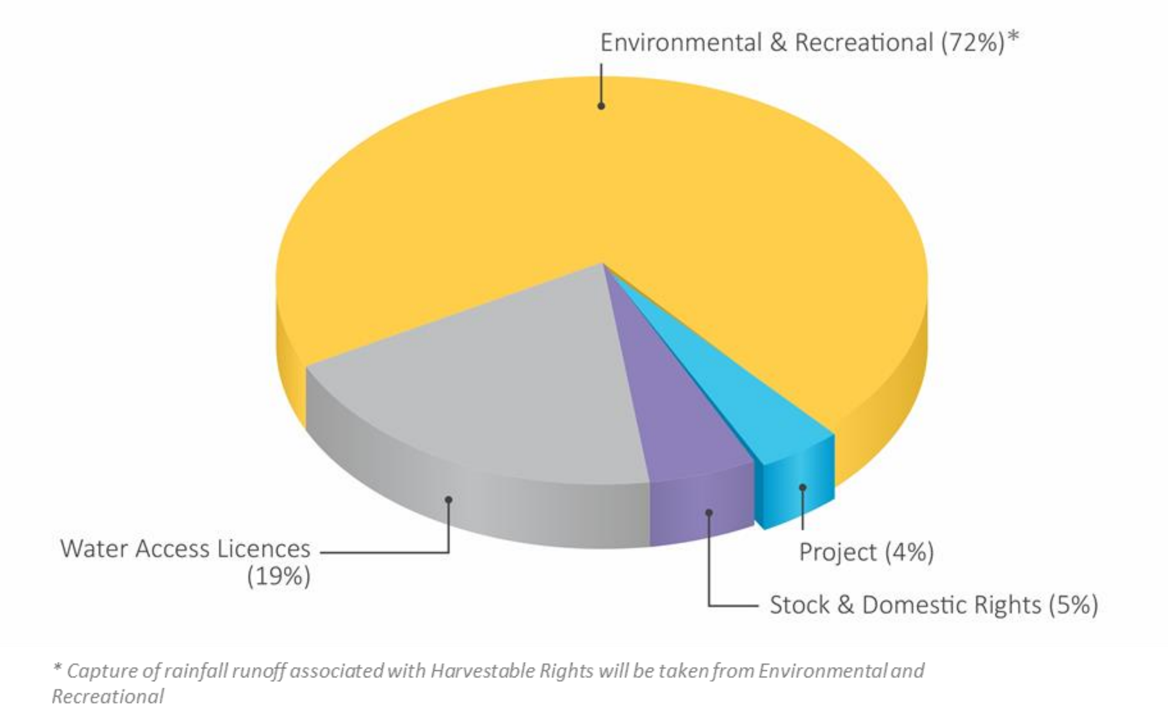


Figure 4.1 Proportions of water use from the Belubula River above Carcoar Dam water source (during operations)

ii Changes to groundwater discharge to the Belubula River

Declining groundwater levels as a result of mining (also referred to as drawdown) has the potential to reduce groundwater discharge (baseflow) to watercourses and increase leakage from the local watercourse to groundwater in close proximity to the open cut mine. This was assessed as part of the groundwater model predictions (EMM 2019b and EMM 2020c).

Changes in groundwater discharge to surface water will also not have a significant impact on streamflow. Immediately upstream of Trib A, groundwater currently contributes approximately 5% of overall streamflow to both Trib A and the Belubula River; the maximum amount this is expected to reduce is by 15%. That is, at the time when the project has the most impact on groundwater, groundwater contribution to streamflow above Trib A is estimated to be 4.25% (compared to the 5% of contribution in the current situation). Downstream of the project area, groundwater discharge to the Belubula River will not change and is expected to continue to contribute around 20% to the watercourse flows.

There is no predicted change in baseflow to the Belubula River downstream of the project, the groundwater discharge in these downstream areas is predicted to remain unchanged.

iii Summary

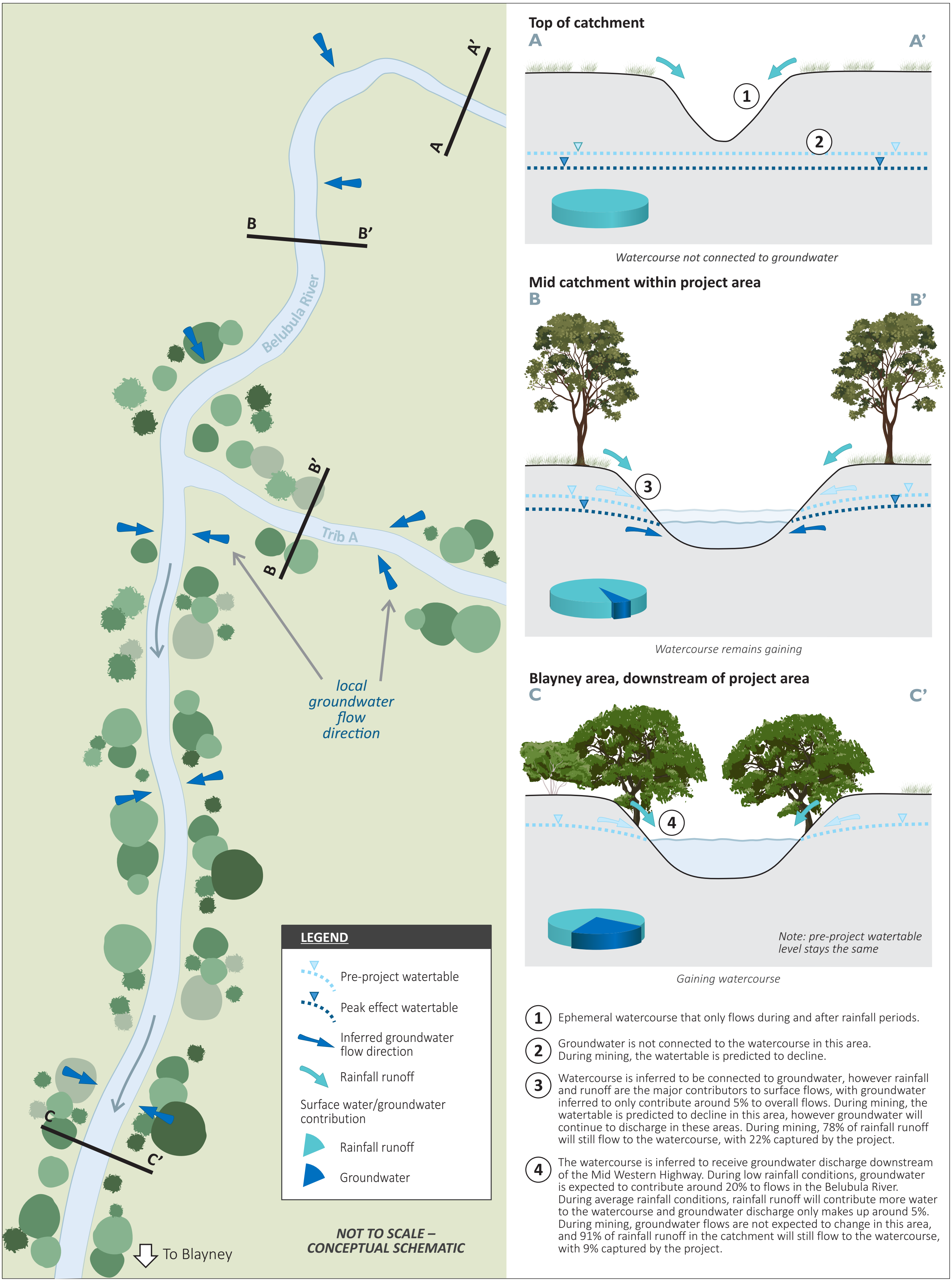
Rainfall and runoff are the main contributing sources of water to the Belubula River flows (Section 3.5), and the upper reaches of the Belubula River (top of the catchment) are ephemeral and flow during and after periods of heavy rainfall. Downstream of the project area and the Mid Western Highway, groundwater is inferred to discharge to the Belubula River, contributing around 20% to overall flows in the watercourse.

The surface water and groundwater assessments demonstrate that the change in the catchment area will have the greatest influence on streamflow in the Belubula River. However, this change is not significant (4% reduction at

Carcoar Dam, 9% at Mid Western Highway) during operation of the project. This reduces to 0.5% following completion of the project. Downstream of the project area, groundwater discharge to the Belubula River will remain unchanged and will continue to contribute around 20% to the watercourse flows.

The project is predicted to result in a minor change in streamflow during operations, with the change expected to be within the current natural variability of the Belubula River flows. Users downstream of the project who rely on and access water within the Belubula River will not experience reduced access to water and are not expected to be affected by the project.

Figure 4.2 presents the conceptual understanding of the interaction between groundwater and the Belubula River during operation of the project.



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Conceptual understanding of Belubula River interaction with groundwater (during mining)

Surface water–groundwater interaction assessment

Regis Resources Ltd

Figure 4.2

4.3.3 Groundwater levels

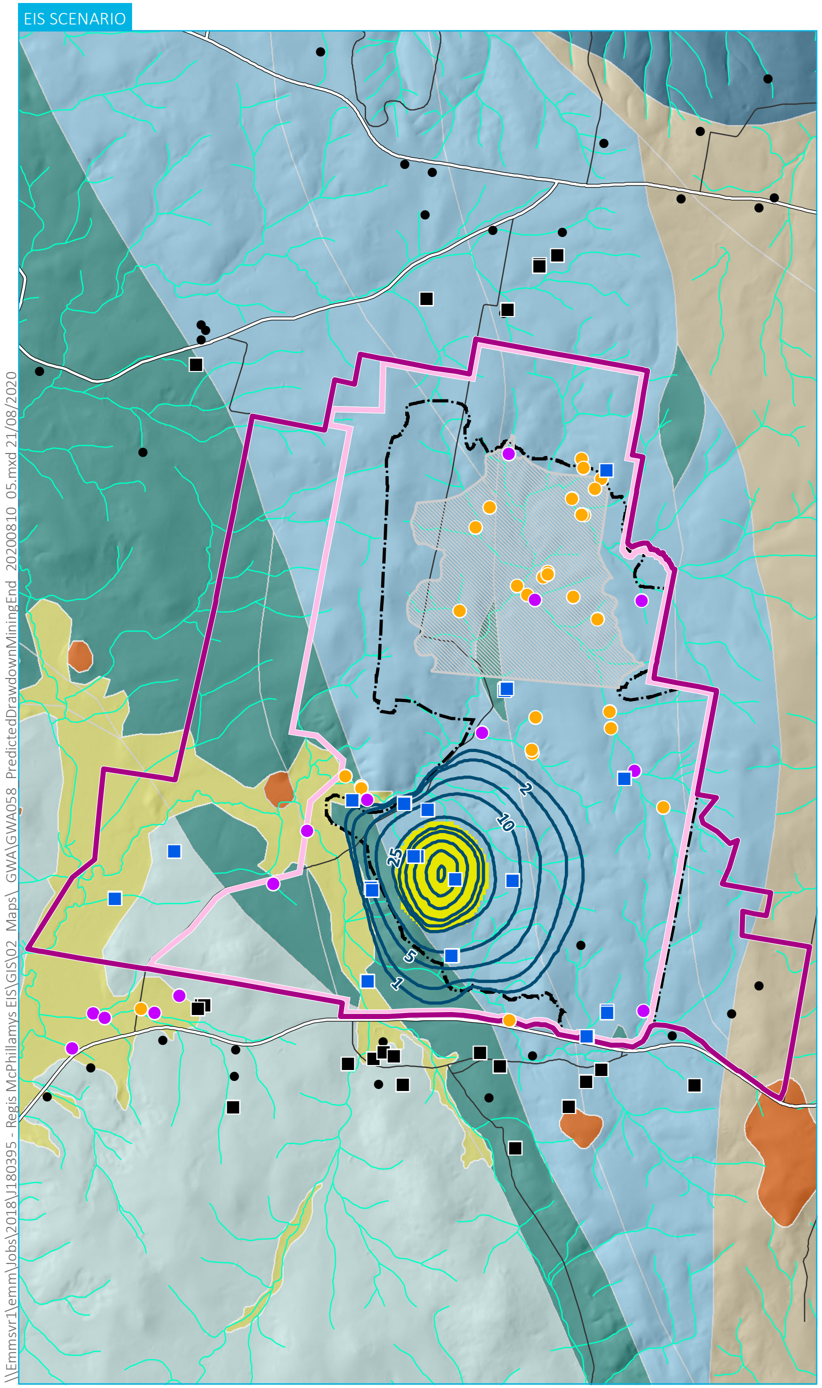
During operations, groundwater that seeps into the open cut pit will either evaporate, or be pumped from the open cut to allow safe and dry mining conditions. Following completion of mining, groundwater will seep into the base of the open cut, gradually rising over time until a state of equilibrium is reached. As a result of the flow and capture of groundwater in the open cut mine, groundwater levels will decline in the immediate area surrounding the open cut mine.

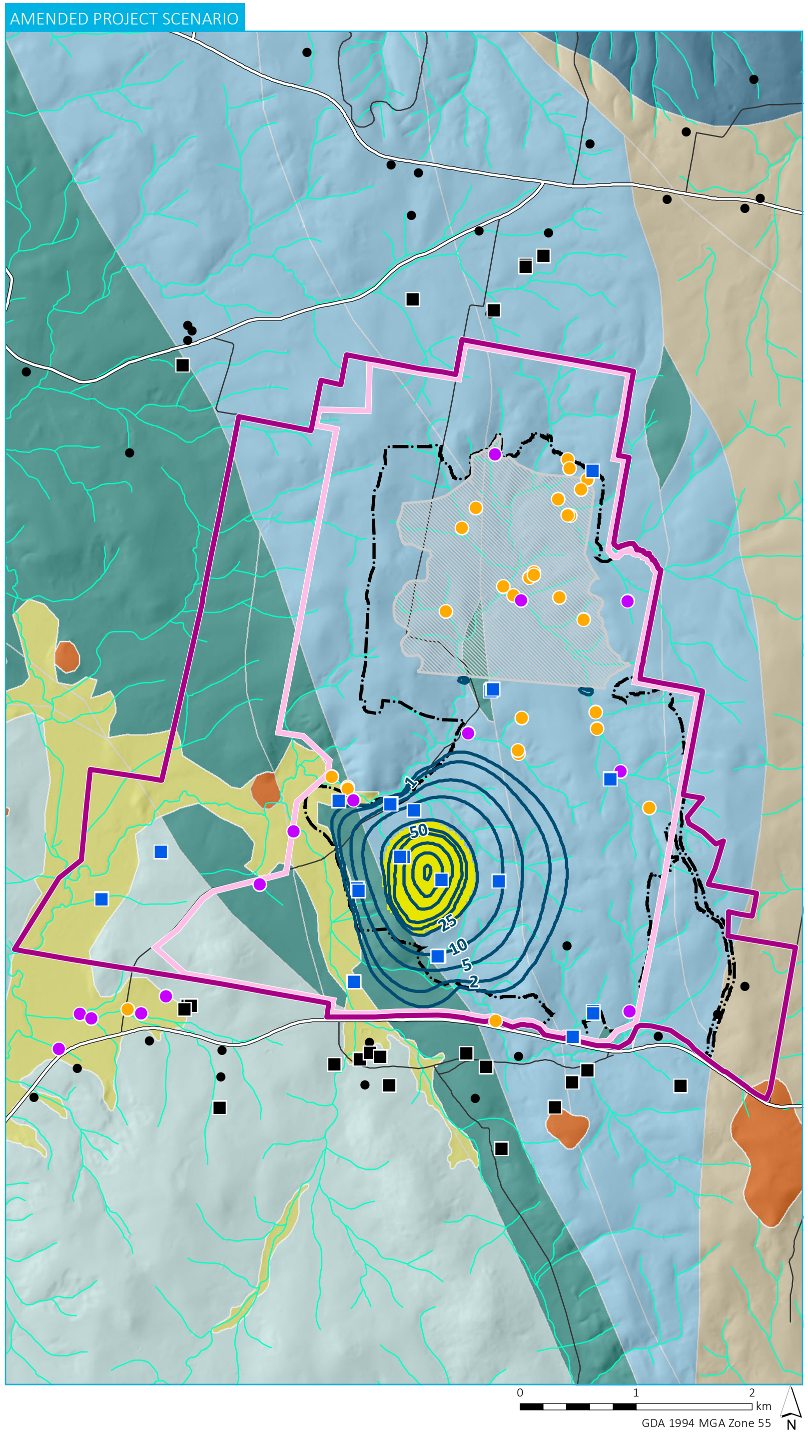
Changes to the watertable and groundwater levels as result of mining will be localised within the project area and within approximately 1.4 km around the open cut pit. Groundwater level changes are not predicted to affect landholder bores on neighbouring properties.

The predicted decline in groundwater (drawdown) at the end of mining and 100 years after mining is shown on Figure 4.3 and Figure 4.4.

As discussed in Section 4.1, the results of groundwater modelling (EMM 2019b and 2020c) demonstrate that under a highly conservative scenario, with limited mitigation measures in place, seepage from the TSF has the potential to infiltrate to groundwater over time, resulting in a higher (shallower) depth to groundwater in the TSF area.

Further discussion of the predicted changes to groundwater levels and flow can be found in the groundwater assessment addendum report (EMM 2020c).





KEY
- PINEENA/registered bore
- Groundwater monitoring site - Regis
- Groundwater monitoring site - other landholder
- Surface water monitoring site (dam)
- Surface water monitoring site (spring/seep)
- Drawdown (m) (end of mining)

Project application area
- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- TSF Stage 3
- Simulated pit

Existing environment
- Major road
- Minor road
- Watercourse/drainage line

Geology (Bathurst 250k, 2nd Edition)

Quaternary / Tertiary
- Alluvium
- Tertiary basalt

Carboniferous
- Bathurst Batholith - Icely Granite

Devonian
- Ungrouped Devonian Formations - Cunningham Formation

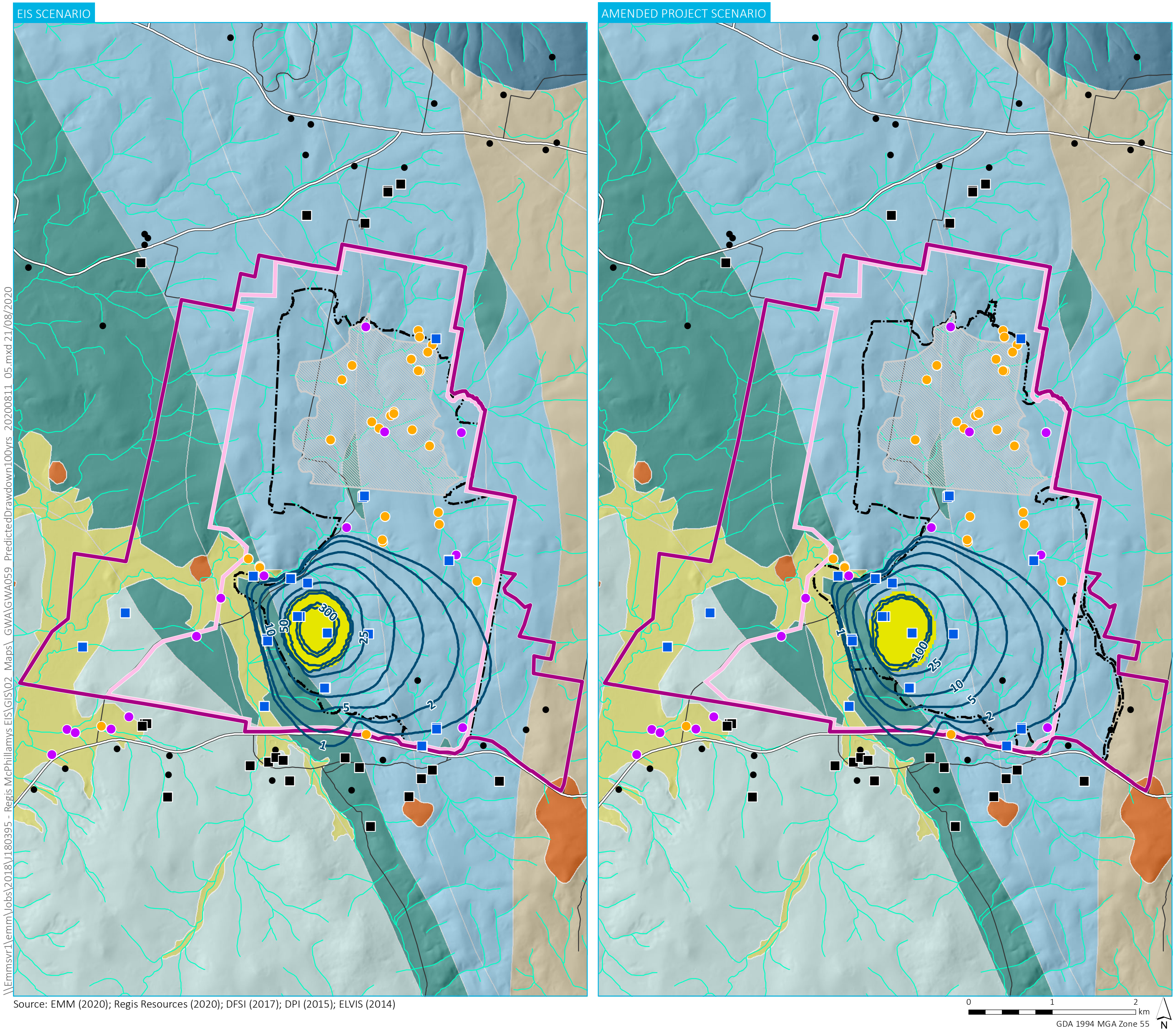
Silurian
- Mumbil Group (Northwest) - Anson Formation

Ordovician
- Cabonne Group - Blayney Volcanics
- Cabonne Group - Oakdale Formation
- Cabonne Group - Byng Volcanics

Source: EMM (2020); Regis Resources (2020); DFSI (2017); DPI (2015); ELVIS (2014)

Predicted watertable drawdown (end of mining)

McPhillamys Gold Project
Surface water-groundwater interaction assessment
Figure 4.3



KEY
- PINEENA/Registered bore
- Groundwater monitoring site - Regis
- Groundwater monitoring site - other landholder
- Surface water monitoring site (dam)
- Surface water monitoring site (spring/seep)
- Drawdown (m) (100 years after mining)

Project application area
- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- TSF Stage 3
- Simulated pit

Existing environment
- Major road
- Minor road
- Watercourse/drainage line

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- Cabonne Group - Byng Volcanics

Source: EMM (2020); Regis Resources (2020); DFSI (2017); DPI (2015); ELVIS (2014)

Predicted watertable drawdown (100 years after mining)

McPhillamys Gold Project
Surface water-groundwater interaction assessment
Figure 4.4

\\Emmsvr1\emm\Jobs\2018\180395 - Regis McPhillamys EIS\GIS\02_Maps_GWA\GWA059_PredictedDrawdown100yrs_20200811_05.mxd 21/08/2020

4.3.4 Springs/seeps

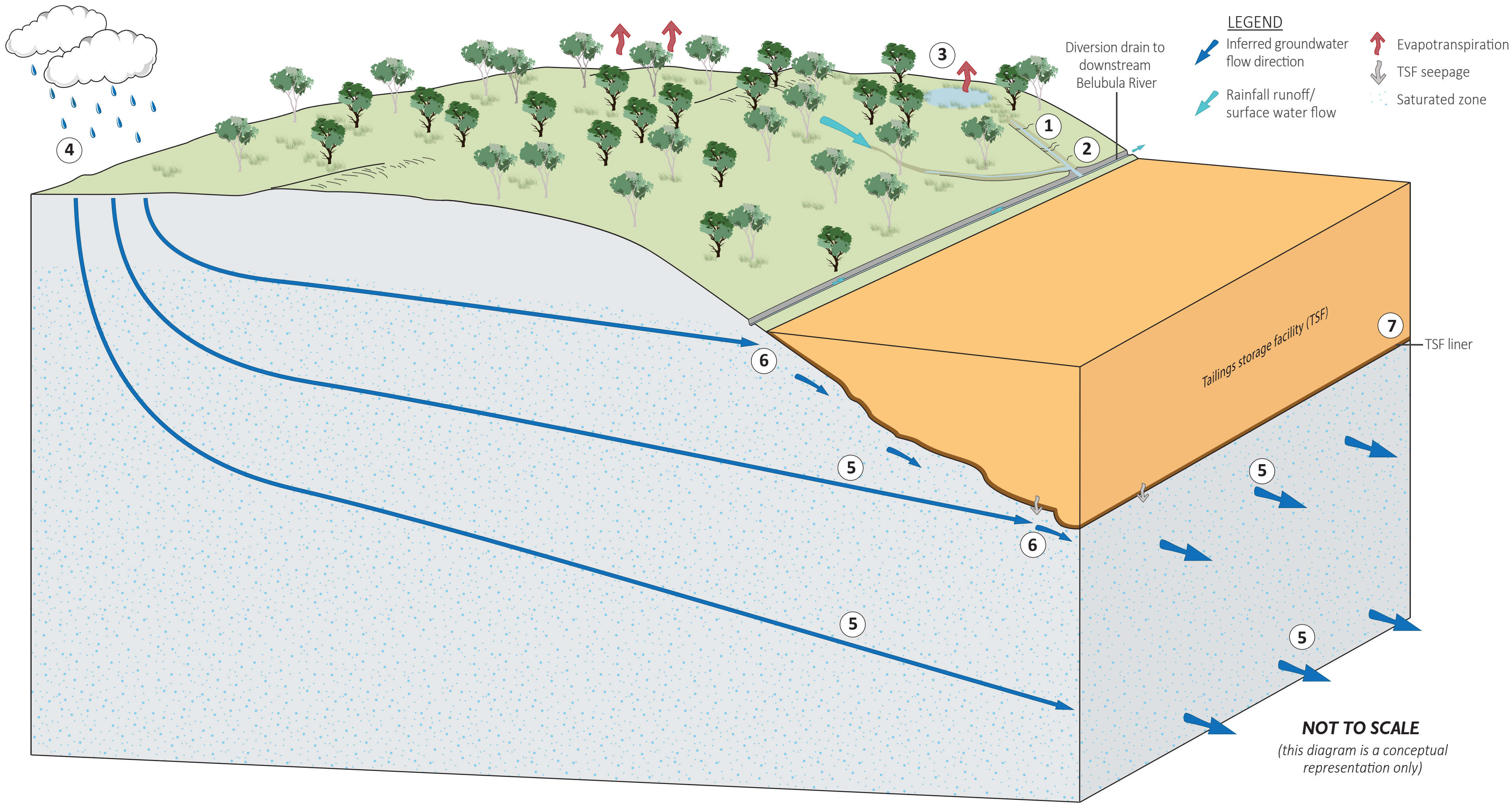
Springs/seeps in the project area are mostly associated with abrupt changes in topographic gradient and intercept shallow groundwater flow (Section 3.5). Many of these springs and seeps have been historically excavated into dams to provide water access for stock. Whilst some springs do contribute flow to the Belubula River, a large amount of the discharging groundwater evaporates, is used by vegetation or for stock and domestic purposes.

During the operational phase of the project, the use of the land in the disturbance footprint will change from farming to mining. The TSF and other project infrastructure will be constructed in areas where springs/seeps have been observed. This activity will change the ground conditions and shallow groundwater that currently discharges at surface as a seep or spring will no longer be able to discharge at that location but, instead, will continue to move underground until it a new discharge point is reached (ie this water will remain in the greater catchment). Underneath the TSF, shallow groundwater that would previously have discharged will most likely be intercepted by the TSF seepage interception drain. Otherwise, the shallow groundwater will continue to move underground discharging in the Belubula River, the open cut or at new or existing spring locations downstream.

Figure 4.5 provides a graphical representation of this conceptual understanding, providing a comparison to the understanding of existing groundwater and surface water interaction at the top of the catchment (presented in Figure 3.6).

Outside of the project area, groundwater levels are not predicted to change as a result of the project. Therefore, seeps and springs outside of the project area will not be altered as a result of the project.

As mentioned in Section 4.3.2 and 4.3.3, groundwater discharge to the Belubula River downstream of the project will remain unchanged, with flows maintained within the Belubula River during and after mining.



1. Watercourses and drainage lines in upper catchment fed by rainfall runoff and spring discharge, not groundwater baseflow.
2. Surface water flow upstream of the tailings storage facility (TSF) is diverted around the TSF to the downstream Belubula River.
3. Most spring water evaporates or is used by farmers before it reaches watercourses.
4. About 2% of rainfall becomes groundwater and about 98% of rainfall runs to watercourses or evapotranspirates. Almost all rainfall that falls directly onto TSF and does not evaporate becomes part of the mine's water management system.
5. Groundwater slowly moves underground. Deeper groundwater typically moves much slower than shallower.
6. In areas underneath the TSF, groundwater that previously discharged to springs or rivers continues moving underground. This groundwater may enter the TSF drain (if shallow) or discharge at the Belubula River downstream of the TSF.
7. The TSF is lined where needed to reduce the potential for seepage from the TSF to groundwater.

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Conceptual catchment water balance – during mining

Regis Resources

Surface water–groundwater interaction assessment

Figure 4.5

4.3.5 Water quality

The groundwater flow model included simulation of the TSF using a deliberately conservative approach to assess the potential changes to groundwater movement under a "worst-case" seepage scenario. The design and assessment of the TSF seepage management measures has been completed by ATCW (2019) and demonstrates that any potential seepage from the TSF will be effectively managed using design controls, including a liner, seepage interception drain and downstream interception bores (if required). In areas where there is a higher potential for vertical seepage from the TSF, including areas with minimal clay, drainage lines or seep areas, additional lining (as clay or geomembrane liner) will be used as part of the multi-barrier approach to seepage management.

Following completion of mining and tailings emplacement, the TSF will be capped to facilitate surface water drainage, prevent any ponding of water and limit potential rainfall infiltration into the tailings (ATCW 2019 and 2020).

The results of the groundwater modelling are presented in the Groundwater Assessment (EMM 2019b) and Groundwater Assessment Addendum (EMM 2020c), and have been summarised below:

- Groundwater levels are predicted to rise slightly under the TSF area during and post-mining as a result of the tailings emplacement.
- The results of the groundwater model (assessing the potential changes to groundwater under a "worst-case" seepage scenario) demonstrates that with limited mitigation measures in place, seepage from the TSF is predicted to slowly migrate south-west and south of the TSF. Seepage from the TSF is predicted to remain within the saprock zone, flowing in a horizontal direction. Some of the seepage that migrates south from the TSF that is not intercepted by the seepage management system is predicted to seep towards the pit. Some seepage is predicted to move towards the Belubula River at a rate of approximately 50 m in 100 years.
- The work completed by ATCW (2020) shows that during operations, seepage from the TSF is predicted to be very small in comparison to the Belubula River streamflow (at the gauging station downstream of the confluence with Trib A), which is estimated to have flows around 10,000 times the predicted seepage rate (during average climate conditions).
- TSF seepage is very slow and by the time it migrates through the ground and moves towards the Belubula River, the seepage water will mix with groundwater and will undergo other reactions with the geology and groundwater.
- Using the highly conservative results of the groundwater model, a simple mixing calculation was conducted to estimate the concentration of selected analytes within the saturated saprock. The changed water quality (in particular: aluminium, electrical conductivity (as salinity), sulphate, selenium, cyanide, cobalt) will have concentrations that are:
  - below or within the range of water quality concentrations currently measured in groundwater, and the Belubula River and its tributaries;
  - below ANZECC (2000) livestock drinking water guideline values (with the exception of cobalt); and
  - below ANZECC (2000) 95% protection level for freshwater aquatic ecosystem guideline values.

Table 4.1 summarises the results of the water quality concentration assessment for the project, providing a comparison to concentrations measured in groundwater and surface water over the historical monitoring period.

The groundwater assessment (EMM 2019b and EMM 2020c) predicts that groundwater and surface water quality will not be adversely affected by the TSF.

Table 4.1 Concentrations in groundwater following mixing with TSF seepage

Parameter	Current surface water concentration range [1]	Current groundwater concentration range [2]	Calculated concentration following mixing [3]
Aluminium (mg/L)	0.01–1.2	<0.01–140	0.02
Electrical conductivity, EC (µS/cm)	377–1,040	499–4,817	843
Total Cyanide (mg/L)	<0.004	<0.004	0.039
Weak Acid Dissociable Cyanide (mg/L)	<0.004	<0.004	0.024
Cobalt (mg/L)	<0.004	<0.001–0.31	6.3
Selenium (mg/L)	0.001–0.01	<0.001–0.01	0.004
Sulphate (mg/L)	1–190	7–3,000	157

Notes:

1. Water quality measured from samples collected from WED4061A (27 samples), which is a Belubula River monitoring location in the TSF area.
2. Water quality measured from samples collected from bores monitoring groundwater in the Anson Formation.
3. Calculated using water quality results from WMB5530A and tailings liquid fraction results (SRK 2019). See EMM 2020c for further discussion.

5 Summary

The following provides a summary of the key findings of the surface water-groundwater assessment and potential impacts of the project on streamflow, groundwater discharge at springs/seeps and water quality.

5.1 Streamflow

Rainfall and runoff are the main contributing sources of water to the Belubula River flows. Groundwater is thought to contribute only a minor amount to streamflow in the mine development area. Downstream of the Mid Western Highway, groundwater is thought to currently contribute around 20% to the watercourse flows.

The project will not have a significant impact on streamflow in the Belubula River. It is predicted there will be a minor reduction in streamflow, and this is mostly due to the change in the catchment size. This results in a maximum 4% reduction of streamflow at Carcoar Dam and 9% at Mid Western Highway during operation of the project and reduces to 0.5% following completion of the project.

During low rainfall periods when downstream users are most reliant on the Belubula River, groundwater discharge to the Belubula River in the Mid Western Highway area and further downstream is predicted to remain unchanged from current conditions.

Users downstream of the project who rely on and access water from the Belubula River will not experience reduced access to water and are not expected to be affected by the project.

5.2 Springs and seeps

Springs and seeps are present across the area. Most springs in the project area are associated with abrupt changes in the topographic gradient and intercepts shallow groundwater flow. Many of these springs and seeps have been excavated into dams to provide water access for stock. Whilst some springs do contribute flow to the Belubula River, a large amount of the discharging groundwater evaporates, or is used by vegetation or for stock and domestic purposes.

During the operational phase of the project, the use of the land in the disturbance footprint will change from farming to mining. The TSF and other project infrastructure will be constructed in areas where springs/seeps have been observed. This activity will change the ground conditions and shallow groundwater that currently discharges at surface as a seep or spring will no longer be able to discharge at that location but, instead, will continue to move underground. Some of this shallow groundwater will be intercepted by the TSF seepage interception drain or will continue to move underground discharging in the Belubula River or at new or existing spring locations downstream.

5.3 Water quality

Tailings will undergo cyanide destruction as part of the ore processing to greatly reduce concentrations of cyanide and other metals in tailings water, minimising potential impacts to the environment through project design. Work by ATCW (2020) demonstrates that the proposed TSF multi-barrier seepage management system provides a robust system and is effective at reducing seepage.

The groundwater assessment (EMM 2019b and EMM 2020c) predicts that groundwater and surface water quality will not be adversely affected by the TSF.

Using the highly conservative results of the groundwater model, a simple mixing calculation was conducted to estimate the concentration of aluminium, electrical conductivity (as salinity), sulphate, selenium, cyanide, cobalt. The results show that, following mixing, water will have concentrations that are:

- below or within the range of water quality concentrations currently measured in groundwater, and the Belubula River and its tributaries;
- below ANZECC (2000) livestock drinking water guideline values (with the exception of cobalt); and
- below ANZECC (2000) 95% protection level for freshwater aquatic ecosystem guideline values.

6 Future work

As documented in the EIS, Regis will develop water management plans for the project post-approval: one for the construction phase and one for the operational phase. The water management plans will document the approach to:

- mitigate, control and manage risks to the environment;
- monitor surface water and groundwater (levels, flows and quality);
- review and report on monitoring data collected; and
- respond to unexpected changes or trends observed in monitoring data, including documenting triggers for investigations.

In addition, the water management plans will document contingencies and responsibilities for all management measures.

In the meantime, Regis will continue monitoring surface water quality, surface water flows, groundwater levels and groundwater quality. As part of Regis' commitment to continuous improvement, Regis will review the existing monitoring program based on the findings of the assessments.

As described in the EIS, Regis commits to conducting future improvements to the numerical groundwater flow model as and when new data become available, particularly where there is a divergence of observed groundwater system response (eg groundwater levels or groundwater inflows to the mine) from the predicted. Groundwater monitoring data, as well as surface water flow monitoring data will be used to verify and validate the groundwater model predictions. The process for continuous improvement related to groundwater modelling is illustrated in Figure 6.1.

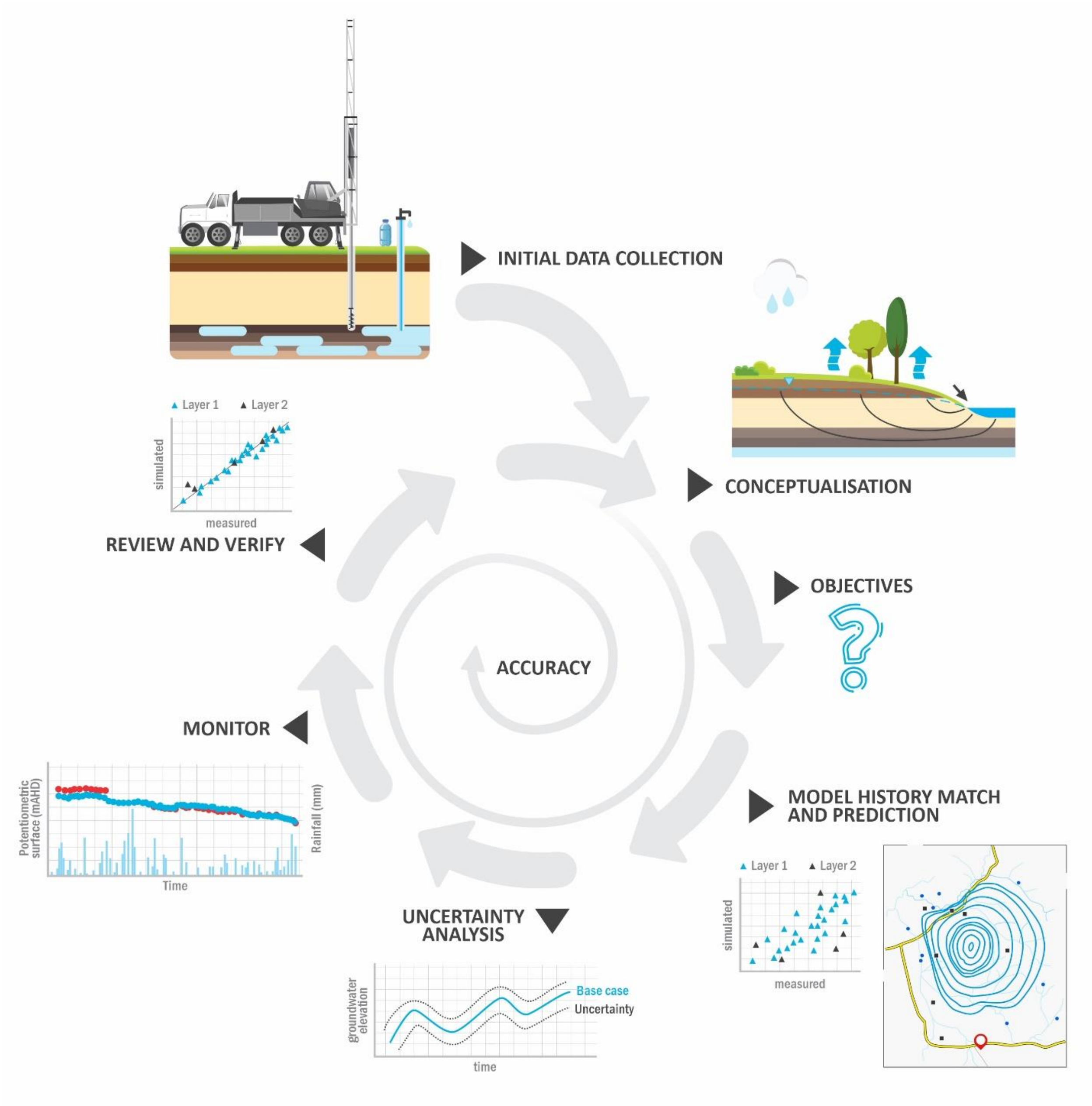

Figure 6.1 Groundwater modelling adaptive management

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Glossary

Term	Definition
Aquifer	A geological structure, formation or group of formations; able to receive, store and transmit significant quantities of water. A geological structure or formation, or an artificial landfill, that is permeated with water or is capable of being permeated with water (NSW Water Management Act 2000 definition).
Aquitard	A geological formation that may contain groundwater but is not capable of transmitting significant quantities of it under normal hydraulic gradients. May function as a confining unit.
Baseflow	The component of streamflow supplied by groundwater discharge.
Confining unit	Low permeability strata that may be saturated but will not allow water to move through it under natural hydraulic gradients.
Confluence	The location where two or more watercourses join or intersect.
Drawdown	The decline in groundwater level (hydraulic head) compared to the original (or static) groundwater level. It is a change in groundwater level and is reported in metres.
Environmental isotopes	Isotopes are variants of the same chemical element that contain equal numbers of protons but different numbers of neutrons in their nuclei. Environmental isotopes are naturally occurring stable or radioactive isotopes used to determine groundwater age and trace groundwater provenance, recharge/discharge mechanism, and rock–water and surface water-groundwater interactions.
Groundwater	The water contained in interconnected pores within rocks and sediments below the ground surface in the saturated zone, including perched systems above the regional water table.
Groundwater discharge	The process by which groundwater is released into the environment usually either via baseflow or evapotranspiration.
Groundwater recharge	The process which replenishes groundwater, usually by rainfall infiltrating from the ground surface to the water table and/or by surface water infiltrating to the water table from a stream. Other forms of recharge include flooding and irrigation, and artificial recharge can also occur through various means, including bore injection.
Hydrogeology	The study of the interrelationships of geologic materials and processes with water, especially groundwater.
Hydrosphere	Total amount of water on the planet. The hydrosphere includes all states (liquid, vapor and ice) of surface water, groundwater and atmospheric water.
Hydrostratigraphic unit	The subsurface is divided into hydrostratigraphic units that have similar properties from the point of view of storage and transmission of groundwater. Units that store significant amounts of water and transmit this water relatively easily are called aquifers. Units that offer a high resistance to flow are called aquitards, or confining units.
Nested monitoring site/bore	Two or more monitoring bores installed at one location at varying depths to allow monitoring of different aquifers or depth intervals.
Permeability	The measure of the ability of a rock, soil or sediment to transmit a fluid. The magnitude of the permeability depends largely on the porosity and the connectedness of pores spaces.
Saturated zone	The soil and geological layers below the land surface where all spaces between soil/sediment/rock particles are filled with water. It encompasses all the soil and geological layers below the water table.
Seep	A moist or wet location where groundwater reaches the land surface.
Spring	A location at the land surface where groundwater discharges creating a visible flow.

Term	Definition
Stream, falling	A stream, or reach of stream, that is losing water as seepage to groundwater.
Stream, rising	A stream, or reach of stream, where the stream receives water as groundwater discharge.
Surface water	Water that flows over or is stored on the surface of the earth that includes: water in a watercourse, lake or wetland and any water flowing over or lying on land: after having precipitated naturally or after having risen to the surface naturally from underground.
Total Dissolved Solids	The total amount of dissolved solid matter found in a sample of water.
Trilinear diagram (Piper)	Graphical representation of the chemistry of a water sample or samples. A trilinear diagram (or piper plot) comprises three components: a ternary diagram in the lower left representing cations, a ternary diagram in the lower right representing anions and a diamond plot in the middle which is a matrix transformation of the two ternary diagrams.
Unsaturated zone	The soil between the land surface and the regional water table in which the pore space contains both air and water.
Watertable	The surface between the unsaturated and saturated zones of the subsurface at which the hydrostatic pressure is equal to that of the atmosphere.

Attachment A

TDS charts

A.1 Groundwater salinity trends

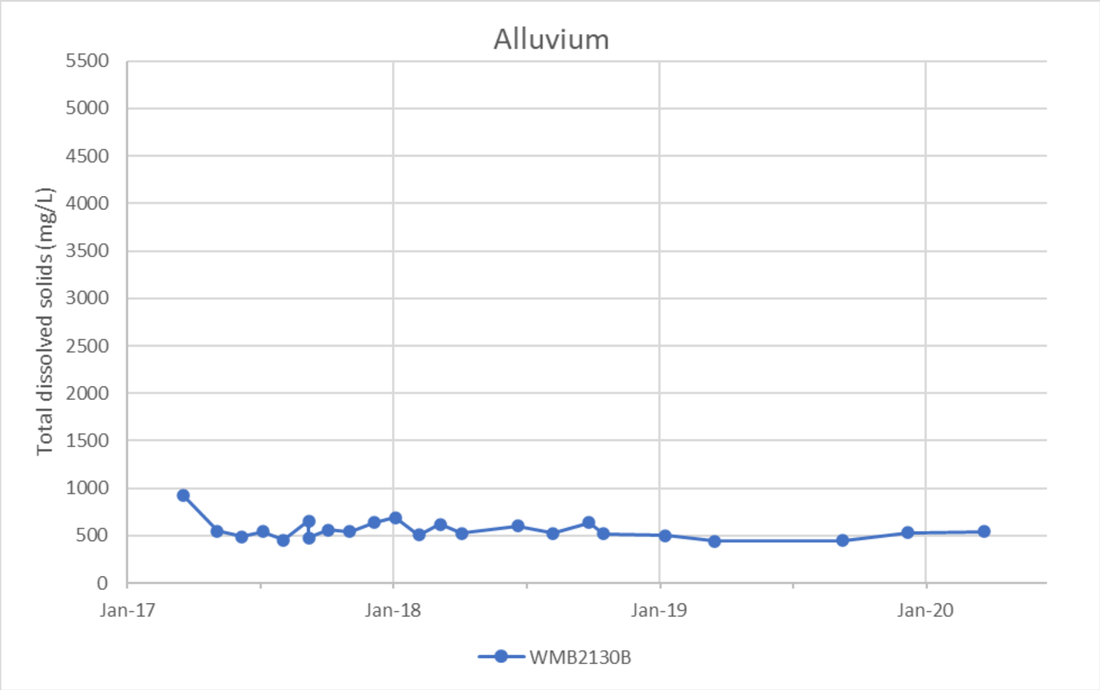


Figure A.1 Alluvium groundwater salinity trend (as TDS)

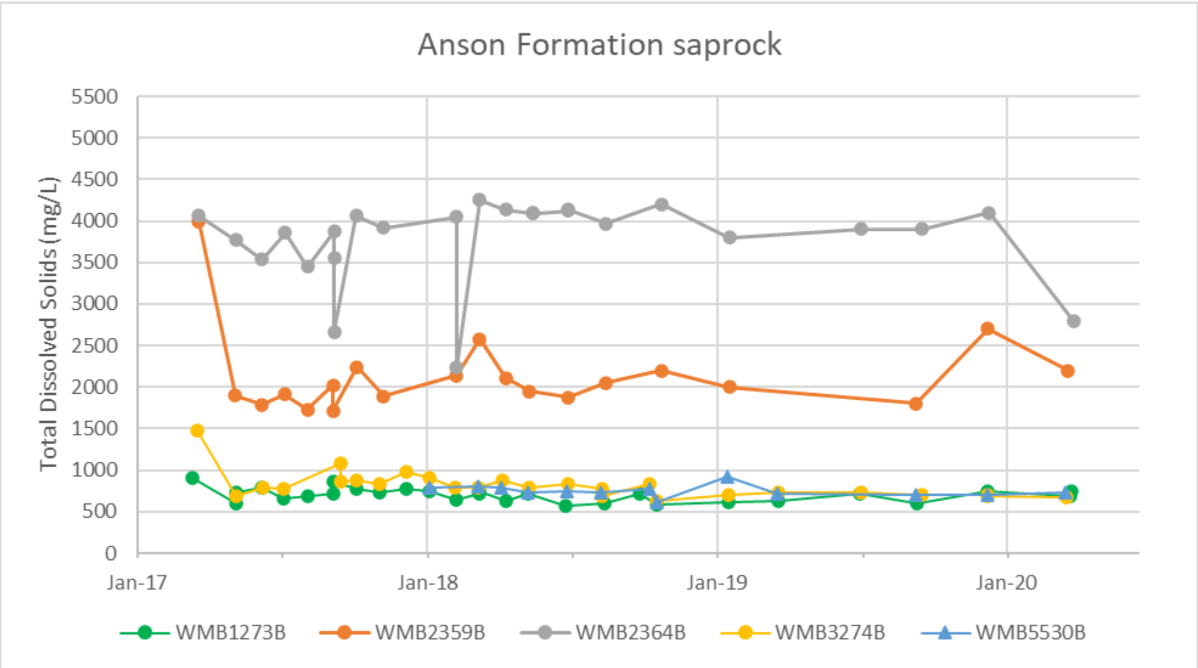


Figure A.2 Anson Formation saprock groundwater salinity trend (as TDS)

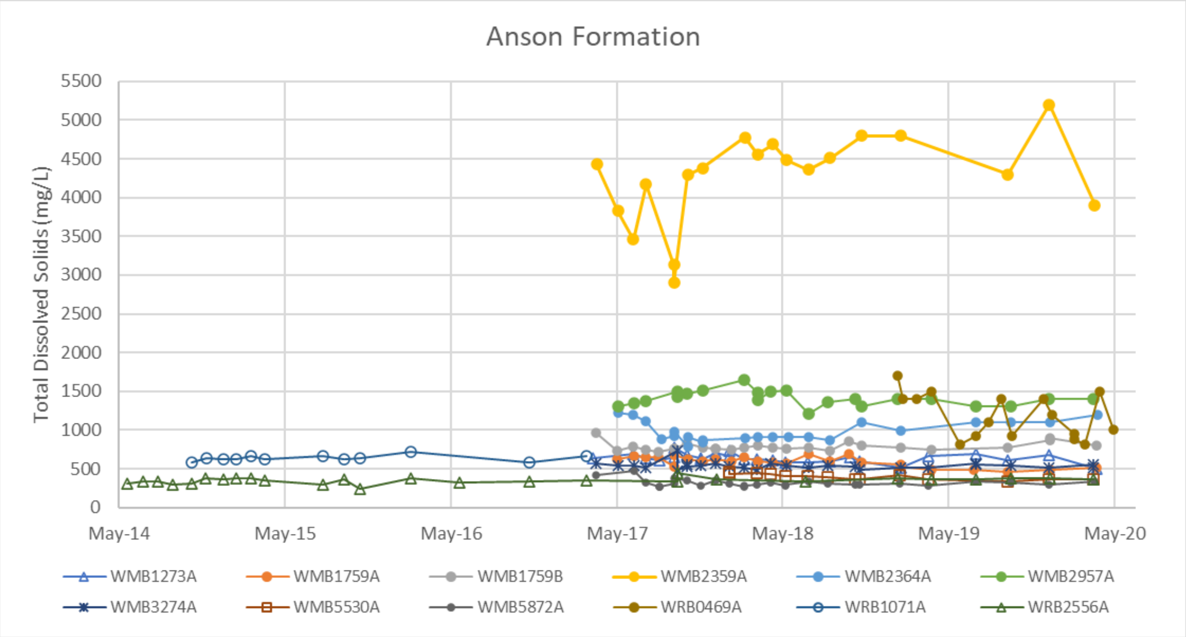


Figure A.3 Anson Formation groundwater salinity trend (as TDS; erroneous data point not shown)

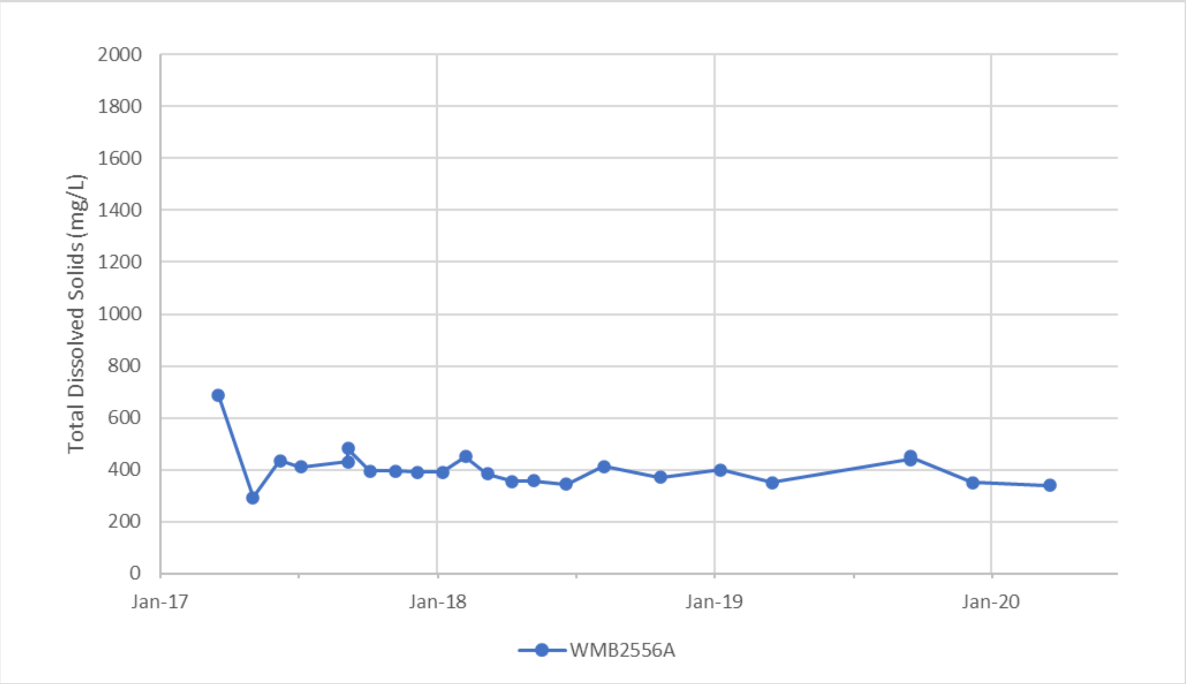


Figure A.4 Marble (carbonaceous alteration in Anson Formation) groundwater salinity trend (as TDS)

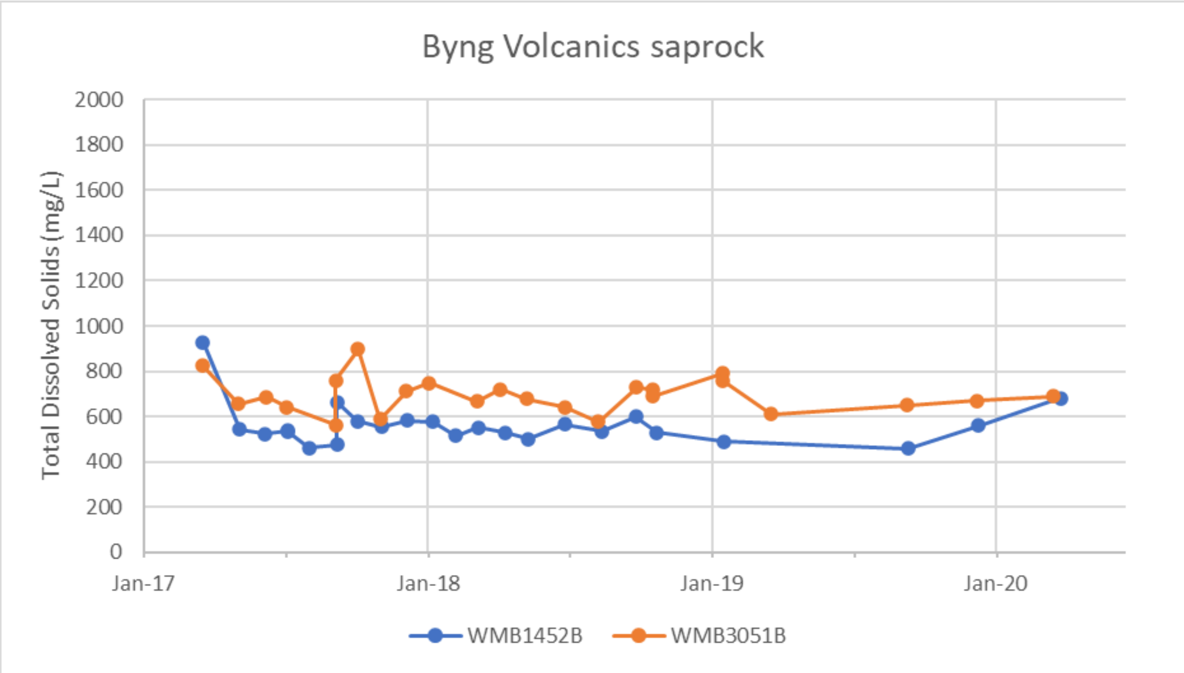


Figure A.5 Byng Volcanics saprock groundwater salinity trend (as TDS)

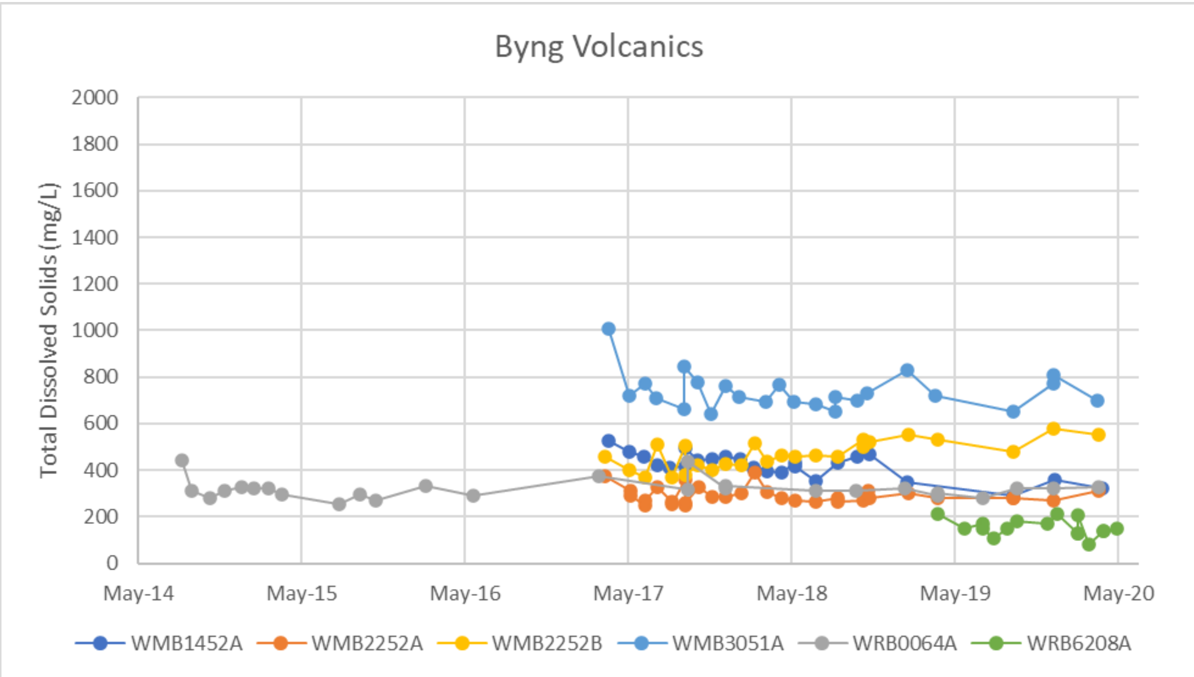


Figure A.6 Byng Volcanics groundwater salinity trend (as TDS)

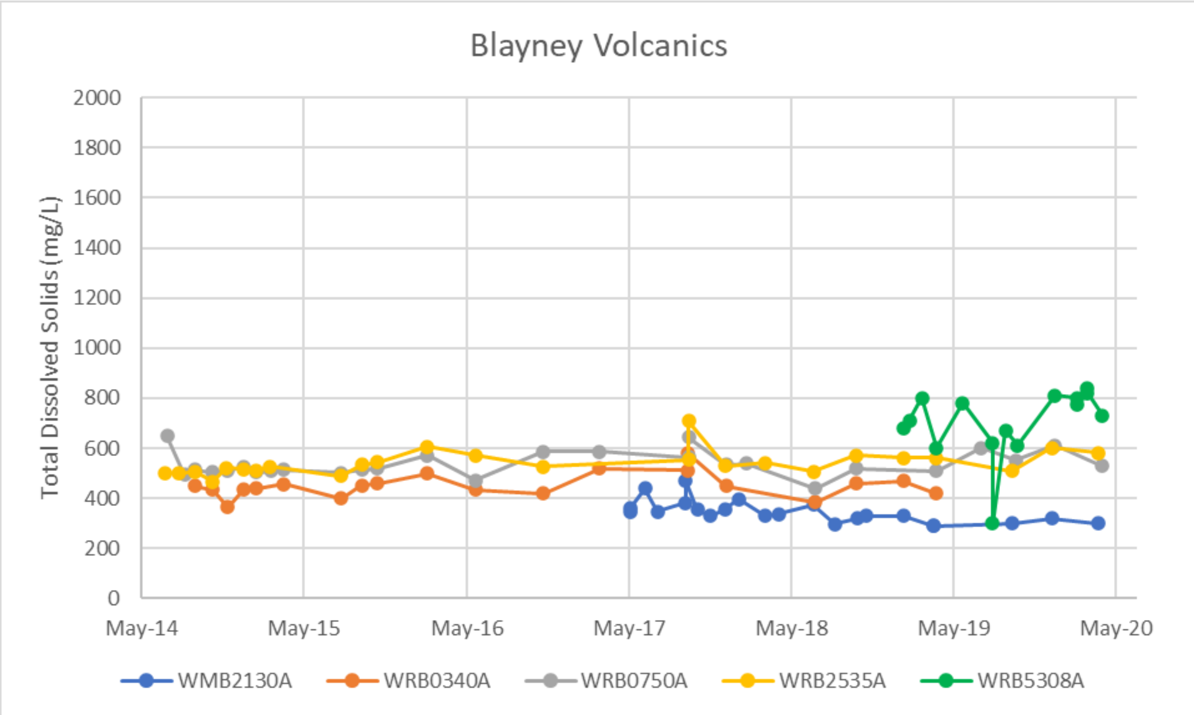


Figure A.7 Blayney Volcanics groundwater salinity trend (as TDS)

A.2 Belubula River salinity trends

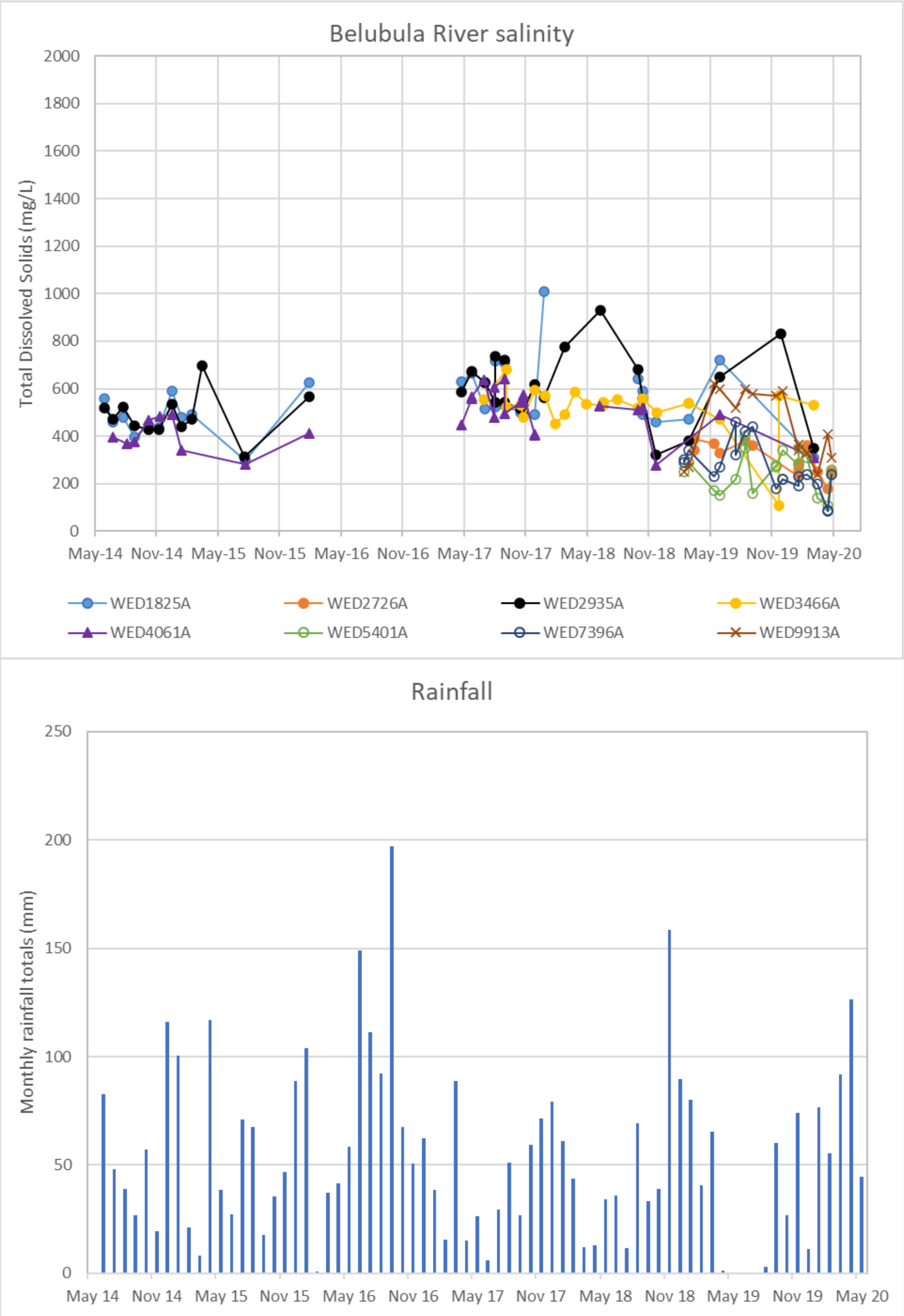
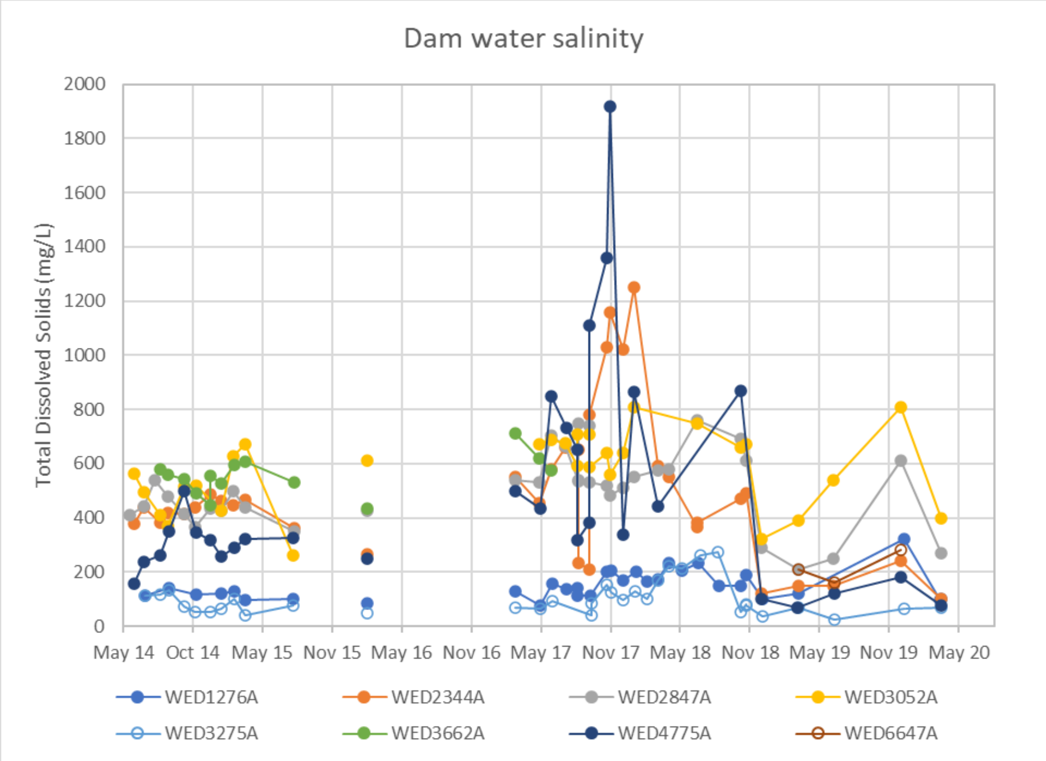


Figure A.8 Belubula River salinity trend (as TDS) and project area rainfall

A.3 Dam water salinity trends



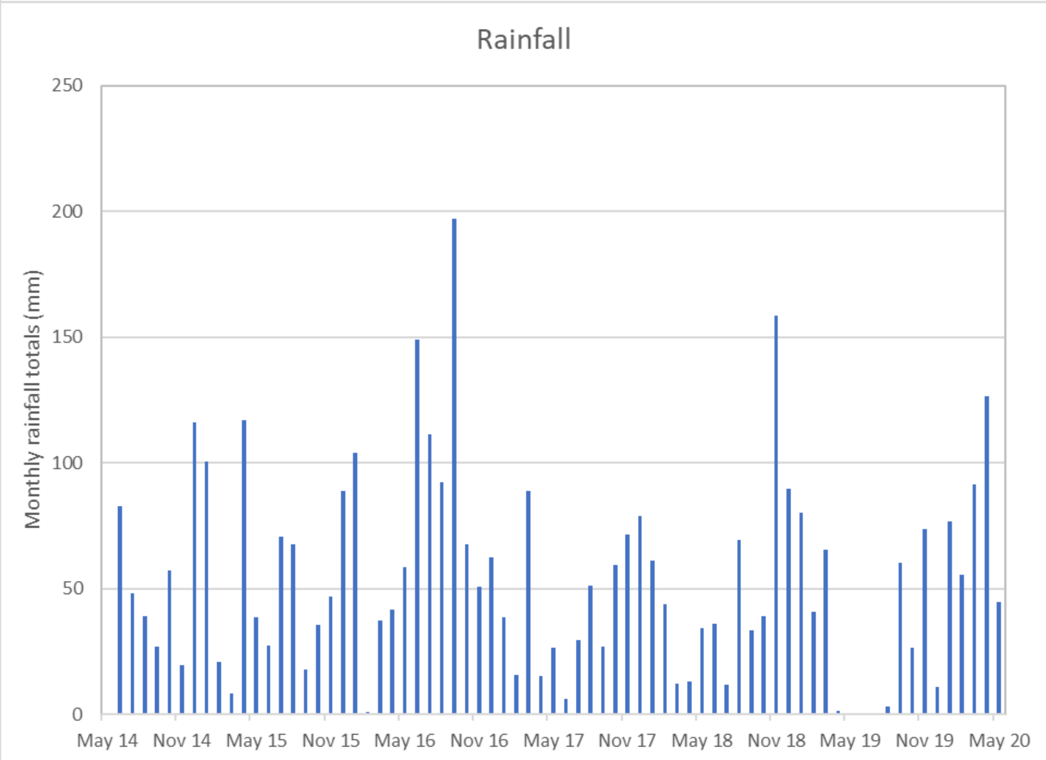


Figure A.9 Dam salinity trend (as TDS) and project area rainfall

A.4 Spring salinity trends

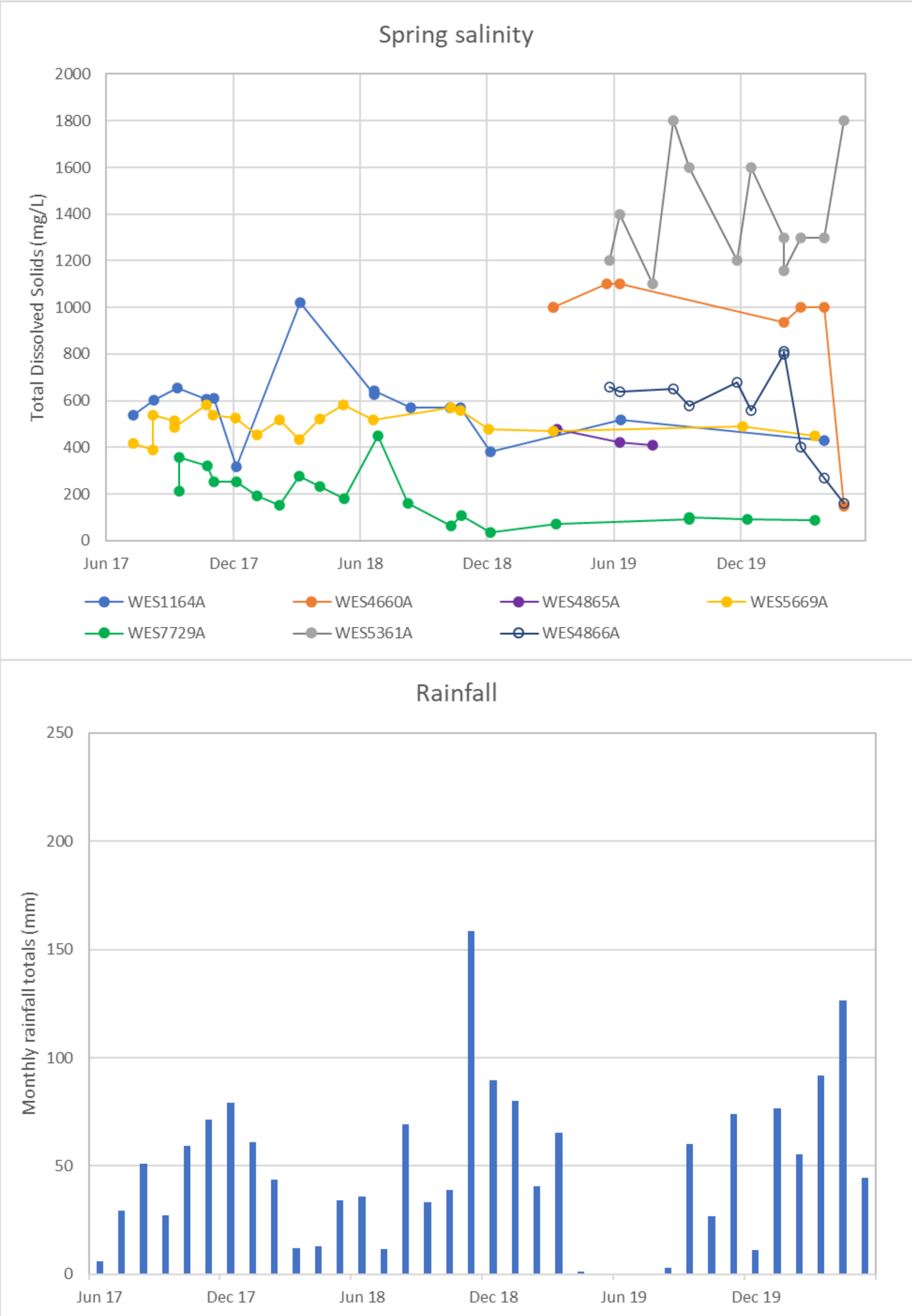


Figure A.10 Spring/seep salinity trend (as TDS) and project area rainfall

Attachment B

Spring photographs

WES1164A

Date and conditions	Downstream	Upstream	Sample site
September 2019 Clear, very low flow.			
December 2019 Sample site dry, no sample taken.			
March 2020 Clear, no odour. No visual flow.			

Date and conditions	Downstream	Upstream	Sample site
April 2019 Spring flow - low flow. Clear, no odour. First sample from spring April 2019.			

WES4660A

Date and conditions	Downstream	Upstream	Sample site
March 2019 Spring flow - low flow. Clear, no odour.			
April 2019 Spring flow - low flow. Clear, no odour.			
May 2019 Spring flow - low flow. Clear, no odour.			

Date and conditions	Downstream	Upstream	Sample site
January 2020 Clear, no odour, spring is flowing.			
February 2020 Clear, no odour. Area mostly dry but spring has a low flow.			
March 2020 Clear, no odour. Spring is flowing.			

Date and conditions	Downstream	Upstream	Sample site
March 2019 Spring flow - low flow. Clear, no odour.			
April 2019 Spring flow - low flow. Clear, no odour.			
December 2019 Sample site dry, no sample taken.			

Date and conditions	Downstream	Upstream	Sample site
April 2019 Spring flow - low flow. Clear, no odour.			
May 2019 Spring flow - low flow. Clear, no odour.			
August 2019 No flow, very low water level.			

Date and conditions	Downstream	Upstream	Sample site
September 2019 Light yellow colour, no odour.			
November 2019 Clear, no odour. No flow.			
January 2020 Yellow, no odour, no visual spring flow.			

Date and conditions	Downstream	Upstream	Sample site
February 2020 Light yellow. No visual flow.			
March 2020 Yellow, no odour. No visual flow.			

Date and conditions	Downstream	Upstream	Sample site
April 2019 Spring flow - low flow. Clear, no odour.			
May 2019 Spring flow - low flow. Clear, no odour.			
August 2019 No flow, water level low.			

Date and conditions	Downstream	Upstream	Sample site
September 2019 Light grey colour, no odour. No spring flow.			
October 2019 Clear, no odour, low level.			
November 2019 Clear, no odour. No flow.			

WES5361A

Date and conditions	Downstream	Upstream	Sample site
January 2020 Clear, no odour. Very low spring flow.			
February 2020 Clear, no odour. Spring is flowing.			
March 2020 Light grey, earthy smell. Very low flow.			

Date and conditions	Downstream	Upstream	Sample site
April 2019 Spring flow - low flow. Clear, no odour. First sample from spring April 2019.			

WES5669A

Date and conditions	Downstream	Upstream	Sample site
September 2019 Clear, very low flow.			
December 2019 Grey, earthy odour, no visual flow. Cattle in paddock.			
March 2020 Clear. No visual flow.			

Date and conditions	Downstream	Upstream	Sample site
March 2019			
December 2019 Light yellow, no odour.			
March 2020 Yellow/orange.