2 Emissions estimates

Emissions were estimated using the same methods as for the EIS and the ASR.

The revised emission estimates and modelling focuses on the main pollutants of assessment being particulate matter as PM_{10} and $PM_{2.5}$.

Calculated annual PM_{10} and $PM_{2.5}$ emissions are presented in Table 2.1 for Scenarios 2 and 3 for the quarry. The emissions account for the changes described in Section 1.

Emissions from the neighbouring South Keswick Quarry and assumed background concentrations remain unchanged from previously assessed.

Table 2.1 Calculated annual PM_{10} and $PM_{2.5}$ emissions

Scenario	Calculated annual emissions (kg/year)	
	PM_{10}	$PM_{2.5}$
Scenario 2	23,862	3,224
Scenario 3	33,218	4,316

3 Dispersion model results

Predicted incremental and cumulative PM_{10} and $PM_{2.5}$ concentrations for the proposed scenarios are presented in Table 3.1 and Table 3.2. The predicted concentrations for all pollutants and averaging periods are below the applicable NSW Environment Protection Authority (EPA) assessment criterion at all assessment locations. It is noted that whilst the project-only incremental concentrations have increased from the predicted concentrations shown in the EIS, incremental and cumulative concentrations are still well below the impact assessment criterion.

Table 3.1 Scenario 2 concentration results

Assessment location ID	Predicted incremental concentration (µg/m³)							
	PM_{10}				$PM_{2.5}$			
	Increment		Cumulative		Increment		Cumulative	
	24-hour maximum	Annual	24-hour maximum	Annual	24-hour maximum	Annual	24-hour maximum	Annual
Criterion	N/A	N/A	50	25	N/A	N/A	25	8
R1	6.1	1.1	45.8	16.4	0.9	0.2	14.7	7.2
R2	2.9	0.4	45.7	15.4	0.4	0.1	14.6	7.0
R3	4.7	0.4	45.7	15.7	0.7	0.1	14.7	7.1
R4	2.4	0.2	45.8	15.7	0.3	<0.1	14.8	7.1
R5	1.3	0.1	46.6	14.8	0.2	<0.1	14.5	6.9
R6a	0.5	<0.1	45.7	14.8	0.1	<0.1	14.5	6.9
R6b	0.5	<0.1	45.7	14.8	0.1	<0.1	14.5	6.9
R7	0.7	<0.1	45.7	14.7	0.1	<0.1	14.5	6.9
R8	0.6	<0.1	45.7	14.7	0.1	<0.1	14.5	6.9
R9	2.9	0.1	45.7	14.9	0.4	<0.1	14.5	6.9
R10	2.0	0.1	45.7	14.9	0.3	<0.1	14.5	6.9
R11	2.1	0.1	45.7	15.0	0.3	<0.1	14.5	7.0
R12	1.9	0.1	45.7	14.9	0.3	<0.1	14.5	6.9
R13	1.7	0.1	45.7	15.0	0.3	<0.1	14.6	7.0
R14	1.5	0.1	47.5	14.9	0.2	<0.1	14.5	6.9
R15	1.4	0.1	46.9	14.8	0.2	<0.1	14.5	6.9
R16	1.1	0.1	46.4	14.8	0.2	<0.1	14.5	6.9
R17	3.5	0.3	49.6	16.2	0.5	<0.1	14.9	7.2
R18	1.4	0.1	45.7	15.0	0.2	<0.1	14.6	7.0
R19	1.6	0.1	45.7	15.0	0.2	<0.1	14.6	7.0
R20	0.7	<0.1	45.7	14.7	0.1	<0.1	14.5	6.9
R21	0.6	<0.1	45.7	14.7	0.1	<0.1	14.5	6.9
R22	1.4	0.1	45.9	14.8	0.2	<0.1	14.5	6.9
R23	5.3	0.2	45.8	16.0	0.7	<0.1	14.9	7.1

Table 3.2 Scenario 3 concentration results

Assessment location ID	Predicted incremental concentration (µg/m³)							
	PM_{10}				$PM_{2.5}$			
	Increment		Cumulative		Increment		Cumulative	
	24-hour maximum	Annual	24-hour maximum	Annual	24-hour maximum	Annual	24-hour maximum	Annual
Criterion	**N/A**	**N/A**	**50**	**25**	**N/A**	**N/A**	**25**	**8**
R1	7.9	1.2	45.8	16.5	1.0	0.2	14.7	7.2
R2	3.9	0.5	45.7	15.5	0.5	0.1	14.6	7.0
R3	5.0	0.4	45.7	15.7	0.8	0.1	14.7	7.1
R4	3.4	0.2	45.8	15.7	0.4	<0.1	14.8	7.1
R5	1.7	0.1	46.5	14.9	0.2	<0.1	14.5	6.9
R6a	0.7	0.1	45.7	14.8	0.1	<0.1	14.5	6.9
R6b	0.7	0.1	45.7	14.8	0.1	<0.1	14.5	6.9
R7	1.2	<0.1	45.7	14.8	0.2	<0.1	14.5	6.9
R8	1.0	0.1	45.7	14.8	0.1	<0.1	14.5	6.9
R9	3.7	0.1	45.7	14.9	0.5	<0.1	14.5	6.9
R10	2.6	0.1	45.7	14.9	0.4	<0.1	14.5	6.9
R11	2.8	0.1	45.7	15.0	0.4	<0.1	14.5	7.0
R12	2.7	0.1	45.7	15.0	0.4	<0.1	14.5	6.9
R13	2.1	0.1	45.7	15.0	0.3	<0.1	14.6	7.0
R14	1.7	0.1	47.5	14.9	0.2	<0.1	14.5	6.9
R15	1.7	0.1	46.8	14.8	0.2	<0.1	14.5	6.9
R16	1.3	0.1	46.4	14.8	0.2	<0.1	14.5	6.9
R17	4.9	0.3	49.6	16.2	0.6	<0.1	15.0	7.2
R18	1.5	0.1	45.7	15.0	0.2	<0.1	14.6	7.0
R19	1.6	0.2	45.7	15.0	0.2	<0.1	14.6	7.0
R20	1.3	<0.1	45.7	14.7	0.2	<0.1	14.5	6.9
R21	1.1	<0.1	45.7	14.7	0.2	<0.1	14.5	6.9
R22	1.4	0.1	46.3	14.8	0.2	<0.1	14.5	6.9
R23	5.6	0.2	45.8	16.0	0.7	<0.1	14.9	7.1

4 Alternate conveyor option

Holcim has requested that EMM assess an alternate option where conveyors are used in place of haul trucks to transport rock from both extraction areas to the processing plant. Haul trucks would still be used to transport rock from the processing plant to the product stockpile, and from the product stockpile to off-site.

Table 4.1 presents the estimated emissions for the hauling scenarios (ie emissions provided in Section 2 and as modelled for this study) compared to the corresponding conveyor option (as described above).

The results of the emissions estimation show that for Scenario 2, there would be a decrease of PM_{10} and $PM_{2.5}$ emissions of 8% and 6% respectively with the conveyor option. For Scenario 3, there would be a decrease of PM_{10} and $PM_{2.5}$ emissions of 19% and 14% respectively with the conveyor option. It is noted that these emission estimates do not include dust mitigation measures such as water sprays at conveyor transfers or enclosure of transfers. With these measures included, the decrease in emissions from the hauling scenarios would be greater.

Dispersion modelling has not been completed for proposed operations with the conveyor option. As calculated annual emissions for the conveyor option are lower than calculated emissions for the hauling scenario, it is expected that concentrations resulting for the conveyor option would be lower than the predicted concentrations presented in Table 3.1 and Table 3.2 of this study.

Table 4.1 Calculated annual PM_{10} and $PM_{2.5}$ emissions – hauling vs conveyor scenario

Scenario	Calculated annual emissions (kg/year)			
	Hauling scenario	Conveyor scenario	Hauling scenario	Conveyor scenario
	PM_{10}		$PM_{2.5}$	
Scenario 2	23,862	21,894	3,224	3,027
Scenario 3	33,218	27,055	4,316	3,699

Appendix F
Water response to submissions

EMM
creating opportunities

Dubbo Quarry Continuation Project

Water Assessments - Response to Submissions

Prepared for Holcim (Australia) Pty Ltd
June 2022

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Dubbo Quarry Continuation Project

Water Assessments - Response to Submissions

Report Number

J210189 RP

Client

Holcim (Australia) Pty Ltd

Date

28 June 2022

Version

v4 Final

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28 June 2022

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28 June 2022

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1 Introduction

1.1 Report purpose and structure

This report provides a response to a submission from the NSW Environment Protection Authority (EPA) and a combined submission from the Department of Planning, Industry and Environment Water (DPIE Water) and the Natural Resources Access Regulator (NRAR) regarding the water aspects of the Environmental Impact Statement (EIS) prepared by EMM Consulting Pty Ltd for the Dubbo Quarry Continuation Project (the project). Holcim (Australia) Pty Ltd are the applicant for the project.

The response is structured to address key issues raised, rather than individual comments in each submission. The responses have been structured based on the following key topics:

- surface water management (Chapter 2);
- groundwater (Chapter 3);
- water licencing (Chapter 4);
- works on waterfront land (Chapter 5); and
- post approval recommendations (Chapter 6).

Each response is provided in a consistent table format that includes an issue ID, a description of the issue and a response.

The following additional assessments have been undertaken to inform responses to some issues.

- The hydrogeological conceptualisation has been updated to include the existing operation and incorporate data that has been collected post EIS submission.
- The water balance has been updated to reflect changes to the groundwater conceptualisation.
- The water balance has been updated to assess ongoing quarrying within the existing East Pit (discussed further in Section 1.3).
- Estimates of water take and assessment of water licensing requirements have been revised to reflect the updated water balance.
- A surface and groundwater monitoring program has been established (discussed further in Section 1.2.1).

These additional assessment items are documented in a water assessment addendum report (referred to as the Water Addendum) that is provided in Appendix A and is referenced in submission responses. The Surface Water Assessment (SWA) prepared as part of the EIS is also frequently referenced. This report is referred to as SWA Version 1, or SWA V1 in the remainder of this report.

1.2 Proposed additional assessments and consultation

Some issues raised cannot be comprehensively addressed due to limited data and/or prior to detailed design. Accordingly, Holcim proposes to address these issues via further assessment and consultation. The following sections describe the additional assessments proposed.

1.2.1 Discharge impact assessment

Due to the limitations of available data, there remains uncertainty in the interpretation of some aspects of the groundwater and surface water regimes, in particular the interaction between groundwater in the palaeochannel and surface water in the East Pit when it is filled. As a result of this uncertainty, it is not possible to reliably assess proposed discharge regimes and associated water quality risks. Holcim's proposed approach is to undertake a surface and groundwater monitoring program that will enable a data informed assessment to be made. This program is described in Appendix A.

Once sufficient data is available, the interpretation of the surface and groundwater regimes will be reviewed, the proposed water management system for expanded operations will be reviewed and revised (if necessary), and a discharge impact assessment will be completed. The discharge impact assessment will consider all practical measures to minimise the operation's risks to the receiving water environment and detailed information on the water quality and quantity of proposed discharges will be provided.

This process is expected to take approximately 12 months to complete. Accordingly, Holcim proposes that the monitoring and further assessment is undertaken via a Pollution Reduction Program (PRP) and/or as a condition of consent.

1.2.2 Works on waterfront land

Chapter 5 provides responses to comments from DPIE Water and NRAR regarding impacts to Eulomogo Creek due to proposed works on waterfront land (namely the haul road crossing and sedimentation basins). It is acknowledged that some adjustments to the design concepts can be made to minimise risks. These adjustments can be most reliably made at detailed design when additional information will be available, and all constraints are considered. Accordingly, Holcim proposes the following consultation with DPIE and NRAR (post approval) as part of the design development process for works on waterfront land:

- initial consultation to agree on general concepts for works on waterfront land; and
- further consultation at detailed design to confirm the design solutions.

1.3 Continuation of East Pit operations

Since the EIS was submitted in February 2021, extraction of the existing East Pit has continued under the quarry's existing development consent. To access available resources and maintain operation of the quarry until the project can be approved, the quarry's processing plant has been dismantled from its current location south of the East Pit boundary and a new processing plant is now located within the existing quarry pit. This has required changes to the extent of the East Pit extraction boundary that would be present on commencement of the project. A revised extraction boundary has been estimated assuming extraction in the East Pit continues up to the end of 2022 (approximately 12 months) at a rate of 500,000 tpa, though the actual East Pit boundary at the time of project commencement may vary depending on when project approval is obtained, and the rate of extraction during this period).

The following section describes the changes to the existing operations that are necessary to facilitate ongoing extraction. For transparent assessment of the interim continuation of East Pit operations, the water balance for the site has been revised assuming further extraction within the East Pit will continue prior to its closure and commencement of operations in the proposed extension areas.

1.3.1 Revised existing operations water management system

The following changes to the existing operations are necessary to facilitate ongoing extraction and will be made prior to the commencement of the expanded operations.

- The East Pit extraction boundary will be increased during continued operations which will increase the storage within the in pit dam and intercept new catchment area that currently drains to the Settling Pond.
- The processing plant will be relocated into the existing West Pit and the following ponds will be removed:
  - West Pit Pond; and
  - Pump 2 storage pond.
- Product and haul truck routes will be slightly altered. However, the area available for application of dust suppression will remain broadly consistent with the existing operations documented in the SWA (V1 and V2).

The site water balance has been revised to include the amended East Pit extraction boundary. A detailed summary of changes made to the water balance and revised results are presented in the Water Addendum (Appendix A).

The changes to the assumed existing operations and minor changes to the proposed project layout have resulted in multiple changes to both the existing and proposed water management system that is described in the SWA V1. Accordingly, the SWA V2 has been revised to include these changes. SWA Version 2 (SWA V2) and is attached to Appendix A (refer Attachment D).

2 Surface water management

2.1 Clean water separation

Issue ID	2.1
Raised by	EPA, DPIE Water and NRAR
Issue description	The EPA and DPIE Water have noted that the existing water management strategy is inconsistent with best practice principles to separate clean and dirty water. DPIE Water has recommended that consideration be given to a clean water diversion for the Eastern Watercourse to maintain this clean runoff to the downstream environment.
Response	Holcim acknowledges that the inflow of the Eastern Watercourse to the East Pit is inconsistent with best practice. However, this is a legacy issue of the site that relates to work that was undertaken under an existing approval, to which Holcim inherited. Diversion of the Eastern Watercourse around the East Pit is not considered feasible due to topography, biodiversity and landownership constraints, and proximity to the East Pit. These constraints are described in Figure 2.1. Therefore, Holcim has obtained a Water Access Licence (WAL) to account for the capture of runoff from the Eastern Watercourse in the East Pit. Refer to the Water Addendum for further information on these licencing arrangements.

2.2 Existing compliance issues

Issue ID	2.2
Raised by	EPA
Issue description	The EPA has noted that the EPL2212 does not permit any discharges from the site and that the existing conditions water balance predicts discharges from the Settling Pond to Eulomogo Creek. The EPA has also noted that the site is not permitted to discharge waters where there is likely to be or will be a change in the physical, chemical or biological indicators in the receiving water or where the discharge contains prescribed pollutants under the Protection of the Environment (Operations) General Regulation 2009 unless this is authorised by the Licence.
Response	Holcim acknowledges that discharges from the current operations are not specifically permitted in EPL2212. However, it is noted that the discharge regime has been known to regulators for some time and that an objective of the project is to seek approval for discharges whilst reducing the likelihood of discharges occurring where possible. Historic discharges from the quarry have been predominantly driven by groundwater inflows from the palaeochannel into the East Pit, which is dewatered to allow for resource extraction. As described in the SWA (both V1 and V2) and in the Water Addendum, following completion of extraction from the East Pit (expected by end of 2022) it is proposed to allow the East Pit to fill to an equilibrium level, which will minimise future groundwater inflows and the associated need for discharge. This is the only practical way to stop or significantly reduce palaeochannel inflows into the quarry's water management system. As discussed in Section 1.2.1, Holcim is proposing that a PRP is established to resolve water discharge issues for both the existing and proposed expanded operations. The PRP will enable time for data collection and a data informed discharge impact assessment to be prepared.

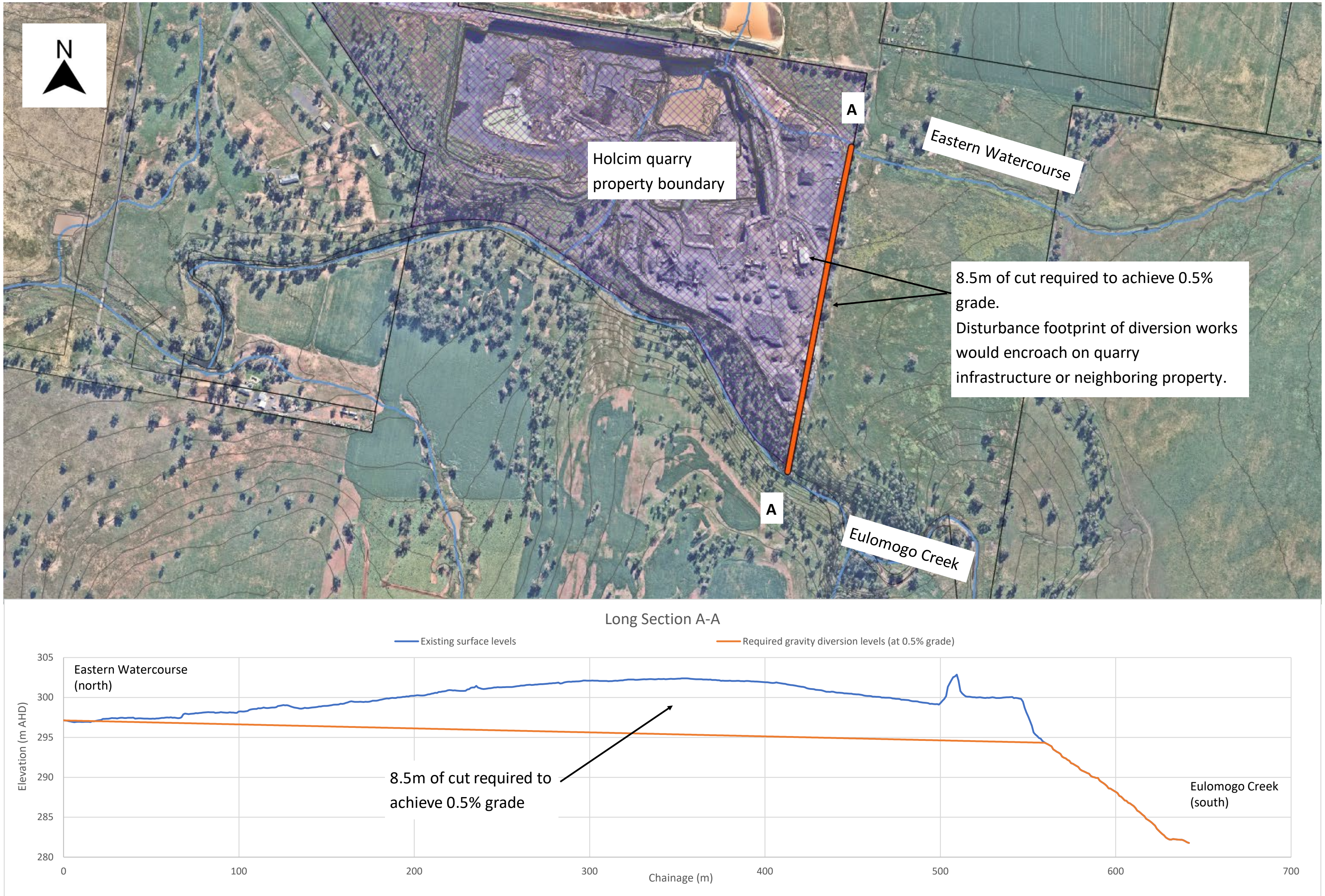

Figure 2.1 Eastern Watercourse: gravity diversion constraints

2.3 Assessment of site discharges

Issue ID	2.3
Raised by	EPA
Issue description	The EPA has expressed concern that water quality within the water management system has elevated pollutants and that the SWA has not considered all alternatives to discharge of “dirty” water from the site. The EPA has requested that Holcim assess and further consider all other available options to avoid discharges to Eulomogo Creek.
Response	As discussed in Section 1.2.1, Holcim is proposing that a PRP is established to resolve water discharge issues for both existing and the proposed expanded operations. The PRP will enable time for data collection and a data informed discharge impact assessment to be prepared. As noted in Section 1.2.1, the discharge impact assessment will consider all practical measures to minimise risks to the receiving water environment and detailed information on the water quality and quantity of proposed discharges will be provided as soon as sufficient data is available to undertake the revised assessment.

2.4 Proposed site discharge concentrations

Issue ID	2.4
Raised by	EPA
Issue description	The EPA has requested that concentration and volume limits of proposed discharges are explored and that proposed discharges should consider cumulative impacts and be generally consistent with similar industries in the immediate area. EPA has noted that, should the site be approved to permit discharges, the EPL would require concentration and volume limits and specify monitoring requirements.
Response	See response to Issue 2.3 above.

3 Groundwater

3.1 Groundwater conceptualisation

Issue ID	3.1
Raised by	DPIE Water and NRAR
Issue description	DPIE Water and NRAR have requested that a detailed conceptualisation of the hydrogeology of the quarry site, including cross-sections, be provided to better visualise the pit elevations and water table and to better understand the groundwater dynamics in the vicinity of the pit.
Response	The Water Addendum (see Appendix A Chapter 2) describes the hydrogeological conceptualisation which includes cross sections of the East Pit and proposed extension areas (refer Figures 2.3, 2.4 and 2.5 in the Water Addendum.

3.2 Assessment against AIP

Issue ID	3.2
Raised by	DPIE Water and NRAR
Issue description	DPIE Water and NRAR have requested an assessment against relevant Aquifer Interference Policy (AIP) criteria to ensure "no more than minimal harm" will occur to neighbouring third party aquifer users as a result of expansion of extractive activities.
Response	An assessment against the minimal impact considerations established in the AIP is provided in the Water Addendum (see Chapter 5).

3.3 Groundwater monitoring and management

Issue ID	3.3
Raised by	DPIE and NRAR
Issue description	DPIE Water and NRAR have requested the following groundwater monitoring items: • *Install data loggers in selected key bores, including 19-DQRC-18, to capture the groundwater dynamics induced by rainfall events and record the peak height of the water table. All bores should be monitoring manually monthly for the period prior to the project determination and for the first two years of mine operation, then reviewed. The depth of the monitoring bores and screened intervals should also be reported.* • *Develop a monitoring, trigger action and response plan for groundwater levels during operations phase and for post-closure and rehabilitation of the development. Conduct analytical modelling to determine an accurate volume of anticipated groundwater interception.*

Response	Water level loggers were installed in eight groundwater monitoring bores in December 2020. Groundwater level data collected by loggers between December 2020 and May 2021 is presented in the Water Addendum (see Section 2.1). The installed groundwater level loggers are part of a broader monitoring program which will also include: • continuous monitoring of the East Pit Lake level and runoff from the Eastern Watercourse; • surface and groundwater quality monitoring (seasonal and targeted wet weather monitoring); and • metering of pit dewatering and operational water use. Refer to Appendix A (Chapter 4) for a description of the proposed monitoring. A trigger action response plan will be developed post approval as part of a site Water Management Plan (WMP). Developed trigger values will use the full data suite available at the time. Analytical modelling was completed to understand the potential groundwater take at East Pit. • The Marinelli & Niccoli (2000) equations were used to derive a maximum potential take (0.7 ML/day) assuming dewatering and a dry pit. • Iterative water balance modelling was undertaken to derive an existing groundwater take of 209 to 227 ML/year. Due to a lack of data available (dewatering, pit lake level and transient groundwater levels) it is not possible to accurately determine the existing, previous or future water take at the current time. A monitoring program has been recommended to rectify this data absence. The actual water take will be calculated on an annual basis (via a water balance approach) and reported in the Annual Environmental Management Reports (AEMR). Should the reported (actual) water take exceed the held entitlement (90 ML) Holcim will commit to purchase additional licence entitlements either on the market (temporary or permanent trade) or via the next Controlled Allocation Order (CoA). The 2020 CoA allocated 4,043 unit shares for purchase in the Gunnedah-Oxley Basin MDB Groundwater Source. This indicates there is sufficient depth in the market to licence the maximum modelled range.

4 Water licencing

4.1 Surface water take

Issue ID	4.1
Raised by	DPIE Water and NRAR
Issue description	Holcim has obtained 136 units for a WAL to licence water take that occurs when the Eastern Watercourse spills into the East Pit. DPIE Water has requested further information to authorise the surface water take of the Eastern Watercourse and have recommended that the licenced take is based on wet conditions to ensure sufficient entitlement for water take in all scenarios. DPIE Water has also noted that a check of WAL43440 identified zero entitlements held.
Response	The method for calculating water licencing requirements was negotiated with WaterNSW in 2020. Relevant correspondence is provided in Water RtS Appendix B. Following agreement on the licencing approach, Holcim entered the water market to acquire the entitlements in the Maryvale Geurie Creek water source. It is understood that this process was not complete at the time of the EIS submission but was finalised on 20 April 2021.

4.2 Groundwater take

Issue ID	4.2
Raised by	DPIE Water and NRAR
Issue description	DPIE Water and NRAR have requested clarification on the existing groundwater take of the East Pit as the water balance results submitted for the SWA V1 estimate these flows to be between 127 and 191 ML per year. These estimates are outside the currently held entitlement of 90 units representing a compliance issue. DPIE Water have requested clarification on the actual groundwater take and measures proposed to address a non-compliance.
Response	Refer to the Water Addendum (Appendix A) for an updated description of the estimated groundwater take for existing and proposed conditions and proposed measures to address any identified non-compliance.

4.3 Licencing

Issue ID	4.3
Raised by	DPIE Water and NRAR
Issue description	DPIE Water and NRAR have requested clarification on the projects existing water take and noted that where water take exceeds the entitlements held, measures need to be proposed to ensure compliance by licencing the water take from each individual water source.
Response	Refer to the Water Addendum (Appendix A) for an updated description of the estimated surface and groundwater take for existing and proposed conditions and proposed measures to address any identified non-compliance.

5 Works on waterfront land

5.1.1 Sediment basin locations

Issue ID	5.1
Raised by	DPIE Water and NRAR
Issue description and responses	DPIE Water and NRAR have noted that the proposed sediment basins are within the 20% Annual Exceedance Probability (AEP) flood extent. They have also noted that the proposed location is inconsistent with Controlled Activity Approval (CAA) Guidelines (NRAR 2018) that recommend that basins are at least 15 m from of a third order watercourse, such as Eulomogo Creek. There is concern that the proximity of the basins represents a potential erosion risk to the creek bank should they be destabilised during a flood. There is additional concern that the inundation of basins during flood events may result in water being released from the basins, resulting in a water quality impact.
Response	It is proposed to locate the haul road sediment basins as close to the creek as possible to maximise the area of the haul road that can be treated by the basins. This is proposed as the haul road crossing of the creek will be at lower levels than the basins and moving the basins further away from the creek will increase the area of haul road from which runoff may unavoidably not be captured and treated in a basin. It is noted and acknowledged that constructing basins close to a creek presents risks that require consideration. These risks are discussed below. ***Erosion risk to creek*** Erosion risks to the creek are low as Eulomogo Creek at the crossing/basin location is characterised as a board channel that flows over basalt bedrock. There is no erodible bed material or channel banks in the vicinity of the proposed crossing or basin (see SWA V1 or V2 Photograph 6.1). ***Erosion risk to basin*** If the basin is constructed with an earthen embankment, it may be damaged in a flood event. These risks could be mitigated by using rock armouring (or gabion rock cages) on the downstream embankment. If the basin embankment is damaged in a flood event it can easily be repaired. ***Water quality risks*** The water quality risks associated with flood waters mixing with water held in the basins are low as water from the basins will be overflowing into Eulomogo Creek during a flood event. This will occur as the basins will be sized in accordance with *Managing Urban Stormwater: Volume 1* (Landcom 2004) and *Volume 2E* (DECC 2008), which includes capturing the 5-day 85th percentile runoff event and dewatering this within five days. Overflows from the basins to Eulomogo Creek will occur when the runoff volume from its contributing catchment exceeds the storage volume. This is likely to occur when the 5-day rainfall exceeds 37 mm. Rainfall that generates a 20% AEP flood event for Eulomogo Creek will greatly exceed this threshold. **Proposed approach** The following approach is proposed to balance the benefits and risks associated with locating sedimentation basins close to Eulomogo Creek: • The basin locations will be established at detailed design and will be integrated with the haul road design. The locations will seek to maximise the capture of runoff from the haul roads and minimise risks associated with proximity to Eulomogo Creek. • The use of plastic pipes and liners will be avoided in the basin construction to prevent the entrainment of plastics in floodwaters if a basin is damaged. It is noted that the basins can be moved to a location that is consistent with the 15 m offset recommended in CAA guidelines if DPIE Water and NRAR consider this to be more important than maximising the capture of runoff from the haul road. Holcim proposes to consult further with DPIE Water and NRAR to determine the optimal solution (see Section 1.2.2).

5.1.2 Flood modelling clarification

Issue ID	5.2
Raised by	DPIE Water and NRAR
Issue description	DPIE Water and NRAR require clarification as to whether safety berms of the proposed Eulomogo Creek crossing were included in the flood model.
Response	The safety berms were included in the model and contribute to the flood impacts documented in the SWA. Refer to SWA Appendix C for details.

5.1.3 Eulomogo Creek crossing design and flood impacts

Issue ID	5.3
Raised by	DPIE Water and NRAR
Issue description	DPIE Water and NRAR have recommended that alternate designs such as guard rails be considered for the safety berm of the proposed crossing of Eulomogo Creek. This is recommended to facilitate flows more effectively through the safety measure and hence minimise the flooding and erosion impacts predicted in the flood assessment. The impacts are understood to be due to the proposal for a 1.4 m high safety berm which results in a 1.8 m solid section above the culvert opening. This causes the water to back up and be diverted around the safety berm during floods. It was also noted that the safety berms are aligned at an angle to the watercourse and that this is likely to have the effect of directing flood flows towards the right bank of the creek, with the potential for erosion and additional flood impacts.
Response	**Safety berms** The safety berms were designed to comply with the *NSW Resources Regulator's Health and safety at quarries: Good Practice Guidelines* (NRR 2018), which state "*Risk assessments will determine the type of edge protection or runaway provisions required"* (Section 5.3.9 of NRR 2018). It is Holcim's view that the current concept design of safety berms is most appropriate for the crossing from a risk perspective. **Crossing alignment** There may be opportunity to adjust the crossing alignment to be more perpendicular to the creek. However, this cannot be reliably resolved until detailed design as the crossing and haul road have numerous constraints that require consideration. **Comments on impacts** As noted in SWA (V1 or V2) Section 6.3, flood impacts associated with the proposed crossing: will extend approximately 300 m upstream of the crossing; be confined to the creek channel zone and immediate surrounds; and will occur only within the quarry site. Accordingly, the primary potential flood impact is erosion of the creek in proximity to the crossing. Erosion risks to the creek are low as Eulomogo Creek at the crossing location is characterised as a board channel that flows over basalt bedrock. There is no erodible bed material or channel banks in the vicinity of the proposed crossing or basin (see SWA (V1 or V2) Photograph 6.1). **Proposed approach** Holcim proposes to consult further with DPIE Water and NRAR to determine the optimal solution (see Section 1.2.2).

5.1.4 Culvert design

Issue ID	5.4
Raised by	DPIE Water and NRAR
Issue description	DPIE Water and NRAR have indicated a preference for box culverts to be installed at the Eulomogo Creek crossing for consistency with CAA guidelines (NRAR 2018).
Response	Watercourse crossing materials for the project will be sourced from available supplies and Holcim has a preference to maintain flexibility in the pipe selection until detailed design is completed. Given that Eulomogo Creek is considered Type 2, Class 3 Minimal Key Fish Habitat, either of these designs are suitable in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management (DPI 2013). Noting that box culverts are preferred but not mandatory in the guideline, Holcim proposes to consult further with DPIE Water and NRAR to determine the optimal solution (see Section 1.2.2).

5.1.5 Flood impacts

Issue ID	5.5
Raised by	DPIE Water and NRAR
Issue description	DPIE Water and NRAR have provided several comments regarding flood impacts. Comments and responses are provided below.
Response	**Comment 1** *The EIS states the crossing will not impact hydraulics during flood conditions up to the capacity of the culverts, which is a 20% AEP event. However, some localised changes in hydraulics are expected as it is understood hydraulics at the outlet of the culvert (in flood and non-flood conditions) and the upstream flood inundation area would be altered.* **Response 1** It is agreed that some localised changes to hydraulics near the culvert inlet and outlet will occur (this is noted in SWA (V1 or V2) Table 6.1). The changes will be minimal during non-flood conditions as the culvert capacity is large relative to streamflow during non-flood conditions. Some localised changes are expected during flood conditions. These changes are documented in the SWA (V1 or V2). **Comment 2** *It was also noted that while the same volume of water will pass the project site, once the discharge exceeds the culvert capacity the timing of maximum peak discharge downstream and the localised flooding impacts will change.* **Response 2** It is agreed that some water will be 'stored' upstream of the culverts due to the afflux or increased water level that will occur when the culvert capacity is exceeded. The impact on the timing and peak flow would be negligible as the storage in the afflux would be minor compared to the volume of water flowing down the creek in a flood (ie 201 m^3/s in a 1% AEP event). This is demonstrated in the flood level difference maps presented in SWA (V1 or V2) Appendix C (see Figures 8 to 10). The flood modelling undertaken for the project (see SWA (V1 or V2) Appendix C) used a hydrodynamic model that simulates the flood hydrograph and the effects of flood storage. This modelling method would identify any material change in downstream flood characteristics due to storage in the culvert afflux. The model results do not show any flood level reduction downstream of the culvert that would occur if the peak flows were materially reduced by storage in the culvert afflux. **Comment 3** *The change in velocity due to the proposed crossing design is of concern primarily for the 1%AEP event. The flood results show the increase in velocity ranges from 1 to >3 m/s. This represents a potential erosion risk to the creek banks and floodplain.*

Response 3

Hydraulic model results indicate that for the 1% AEP event, velocity impacts of > 1m/s will occur on the outer fringes of the flood extent (see SWA (V1 or V2) Appendix C Figure 15). This occurs as the modelled safety berm was only applied to the bridge structure, which results in the model redistributing some of the flood waters around the sides of the crossing. This issue could be resolved by extending the safety berm along the entire 1% AEP flood extent so that the berm overtops as a uniform weir and does not concentrate flow to the edges of the flood extent. In summary this issue will be resolved at detailed design.

6 Post approval recommendations

6.1 Water licencing

Issue ID	6.1
Raised by	DPIE Water and NRAR
Issue description	DPIE Water and NRAR have requested the following post approval conditions: • *The proponent must report on water take at the site each year (direct and indirect) in the Annual Review. This is to include water take where a water licence is required and where an exemption applies. Where a water licence is required the water take needs to be reviewed against existing water licences.* • *The proponent must ensure sufficient water entitlement is held in a WAL(s) to account for the maximum predicted take for each water source prior to take occurring.* • *The proponent must ensure that relevant nomination of work dealing applications for Water Access Licences proposed to account for water take by the project have been completed prior to the water take occurring.*
Response	Holcim agrees to address these post approval conditions in a site WMP.

6.2 Works on waterfront land

Issue ID	6.2
Raised by	DPIE Water and NRAR
Issue description	DPIE Water and NRAR have requested the following post approval condition: • *Works in watercourses need to ensure stability and natural ecological functioning. Works are to be in accordance with the Guidelines for Controlled Activities on Waterfront Land (NRAR 2018).*
Response	Holcim proposes to consult further with DPIE Water and NRAR to agree on general concepts for works on waterfront land with further consultation at detailed design to confirm the design solutions (see Section 1.2.2).

6.3 General water management

Issue ID	6.3
Raised by	DPIE Water and NRAR
Issue description	DPIE Water and NRAR have requested the following post approval condition: • *A Water Management Plan will be developed to document the water management infrastructure, proposed water use, storage and transfer, projected water take and licensing, water metering, monitoring and management/mitigation responses.* • *The ability to accurately meter and monitor water take from surface and groundwater sources will need to be developed with ongoing review of actual versus modelled predictions. This will be a key component to confirm impact predictions, the adequacy of mitigating measures and compliance for water take.* • *The proponent must comply with the rules of the relevant water sharing plans.*
Response	Holcim agrees to address these post approval conditions in a site WMP.

References

DECC 2008, *Managing Urban Stormwater: Soils and Construction – Volume 2E Mines and Quarries*, NSW Department of Environment and Climate Change.

EMM 2020, *Dubbo Quarry Continuation Project: Surface Water Assessment*

Landcom 2004, *Managing Urban Stormwater: Soils and Construction – Volume 1*, 4th edition.

NRAR 2018, *Guidelines for controlled activities on waterfront land.* Natural Resources Access Regulator, NSW Department of Industry.

NRR 2018, *Health and safety at quarries: Good Practice Guidelines*. NSW Department of Planning and Environment, NSW Resources Regulator.

Appendix A

Water Assessment addendum report

Water Assessment Addendum

Dubbo Quarry Continuation Project

Prepared for Holcim (Australia) Pty Ltd
June 2022

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Water Assessment Addendum

Dubbo Quarry Continuation Project

Report Number

J210189 RP1

Client

Holcim (Australia) Pty Ltd

Date

28 June 2022

Version

v4 Final

Prepared by		**Approved by**	
Patrick Carolan	**Nina Baulch**	**Chris Kuczera**	**Samuel Cook**
Senior Water Resources Engineer	Associate Hydrogeologist	Associate Water Resources Engineer	Associate Hydrogeologist
28 June 2022	28 June 2022	28 June 2022	28 June 2022

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Attachments

Tables

Figures

1 Introduction

1.1 Background

Dubbo Quarry (the quarry) is a basalt quarry owned and operated by Holcim (Australia) Pty Limited (Holcim), located approximately 1.9 km west of the city of Dubbo. The quarry falls within the Dubbo Regional Council local government area (Dubbo LGA).

The regional and the local context of the quarry are shown in Figure 1.1 and Figure 1.2. The quarry is located on Sheraton Road, Dubbo, and land it occupies is the former Lot 1 DP 623367 which was subject of a boundary adjustment in 2018 that formed Lots 221 and 222 DP 1247780.

The quarry produces high quality aggregates for use in the construction industry and has been operating since 1980. Typical uses include concrete and asphalt production and road base including the premium road base product Heavy Duty DGB20, which is frequently used by local councils and Transport for NSW for the construction and upgrade of roads.

Accessible basalt resources within the land to which the existing consent applies (the existing site) are close to being exhausted. Holcim is seeking planning approval to extract material outside of the existing site to allow the quarry to continue operating. This is referred to as the Dubbo Quarry Continuation Project (the project).

The project involves continued operations in the existing site and the development of two new resource areas, the Western Extension Area (WEA) and Southern Extension Area (SEA). The project is classified as State significant development (SSD) under Part 4, Division 4.7 of the NSW *Environmental Planning Assessment Act 1979* (EP&A Act). The EIS was exhibited on 28 January 2021 for 28 days.

1.2 Purpose of this report

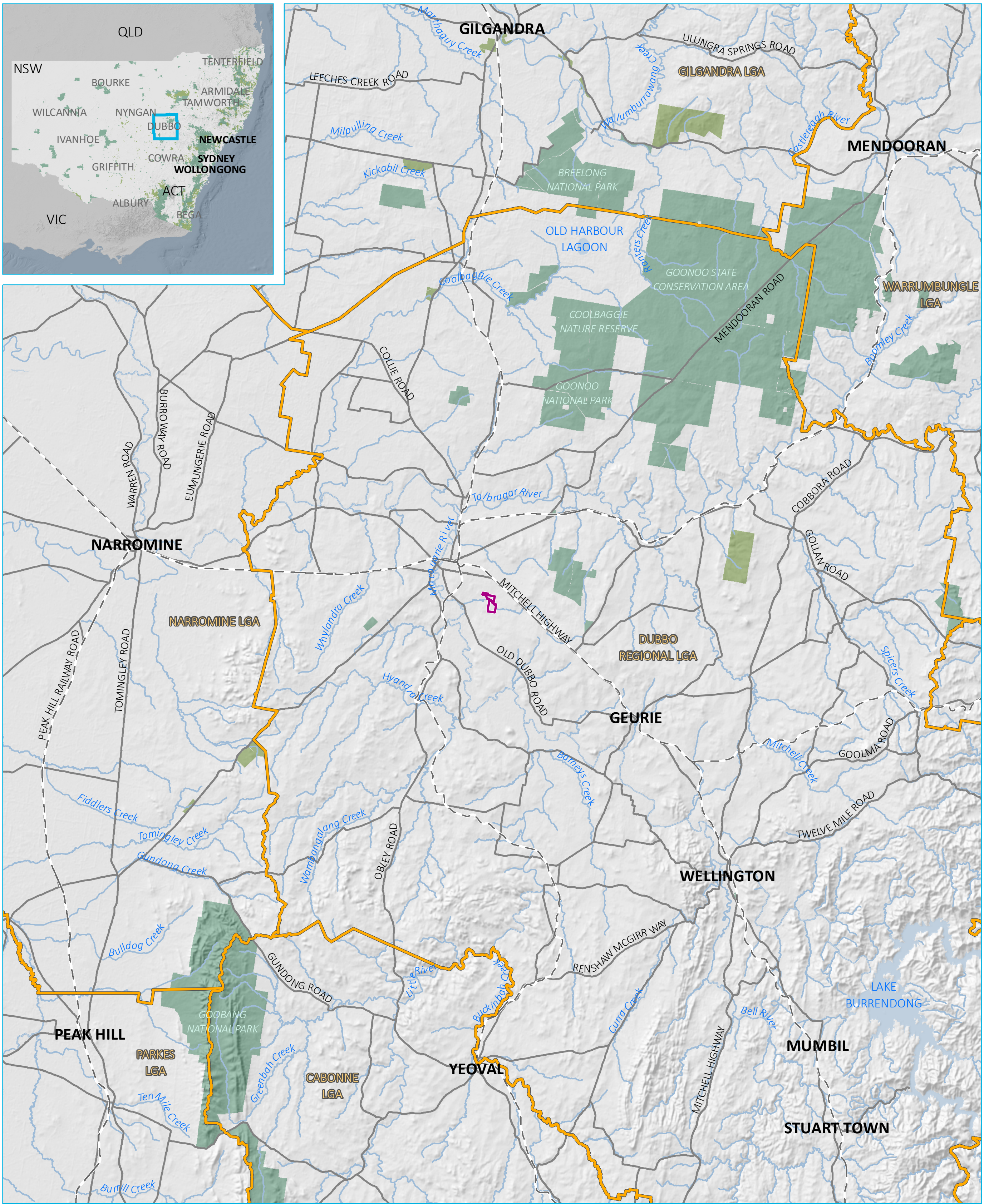
A submissions report has been prepared to address issues raised in advice and submissions received on the Project (SSD-10417). Submissions related to water are addressed in the *Water Assessment – Response to Submissions* (EMM 2022) (the Water RtS).

This report (the Water Addendum) has been prepared as a supporting document to the Water RtS. It is an addendum to the water assessments that were included in the EIS, specifically the updated Surface Water Assessment Version 2 (SWA V2) (EMM 2022), which is provided as Attachment D to this document.

This report includes the following information:

- a hydrogeological conceptualisation of the project site (Chapter 2);
- revisions to the site water balance model (Chapter 3), including changes to the existing conditions pit extents and revised groundwater/East Pit exchange relationship;
- a proposed surface and groundwater monitoring program (Chapter 4); and
- additional information on aquifer interception and water licensing (Chapter 5).

This report does not directly address issues raised in submissions. This is done in the Water RtS (EMM 2022).



Source: EMM (2020); DFSI (2017); GA (2011); ASGC (2006)

0 10 20 km

GDA 1994 MGA Zone 55

N

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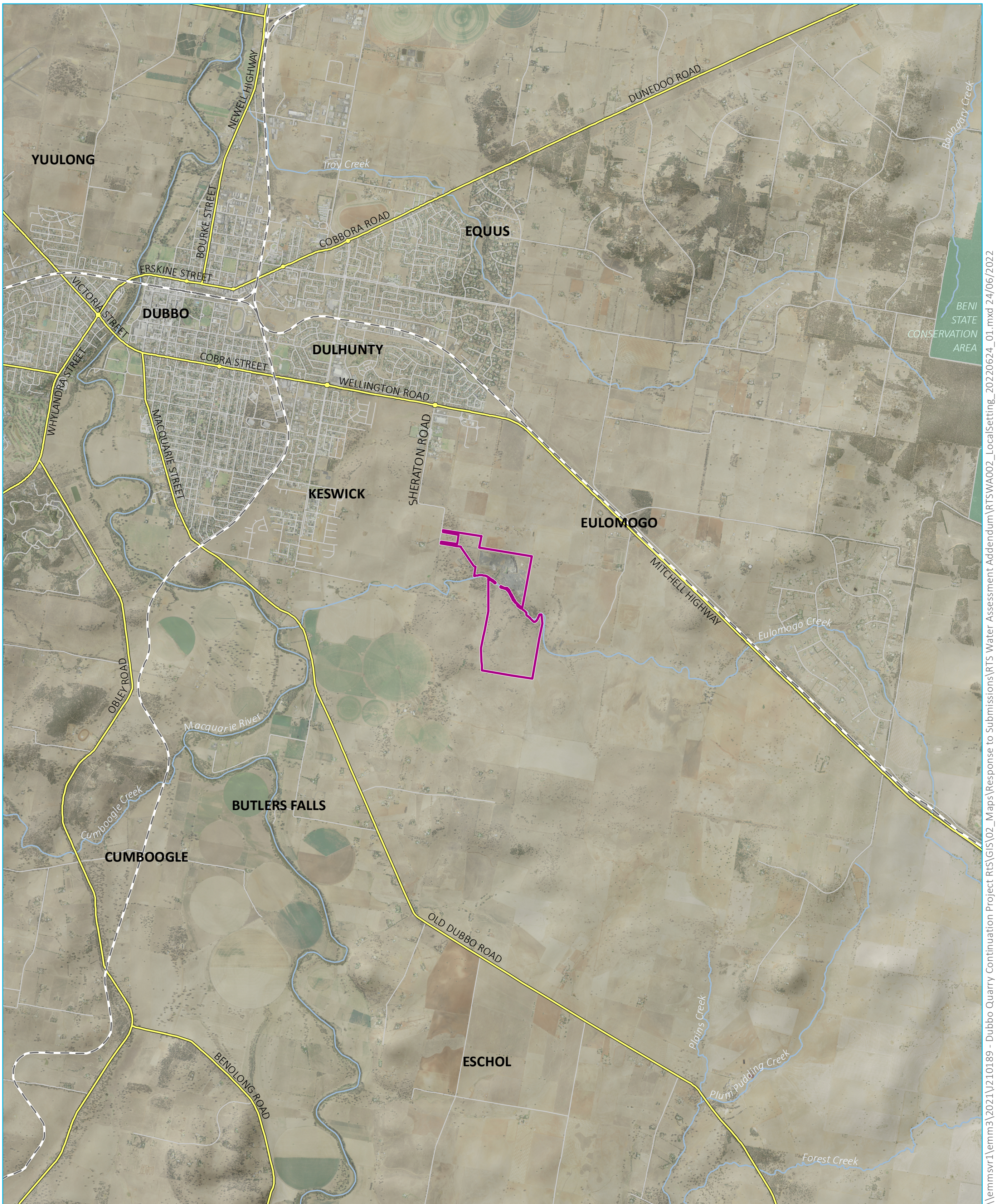
KEY

- Project area
- Rail line
- Major road
- Named watercourse
- Named waterbody
- Local government area
- NPWS reserve
- State forest

Regional setting

Dubbo Quarry Continuation Project
Water Assessment Addendum
Figure 1.1

EMM
creating opportunities



DFSI (2017); DFSI (2020); EMM (2020)

0 1 2 km
GDA 1994 MGA Zone 55
N

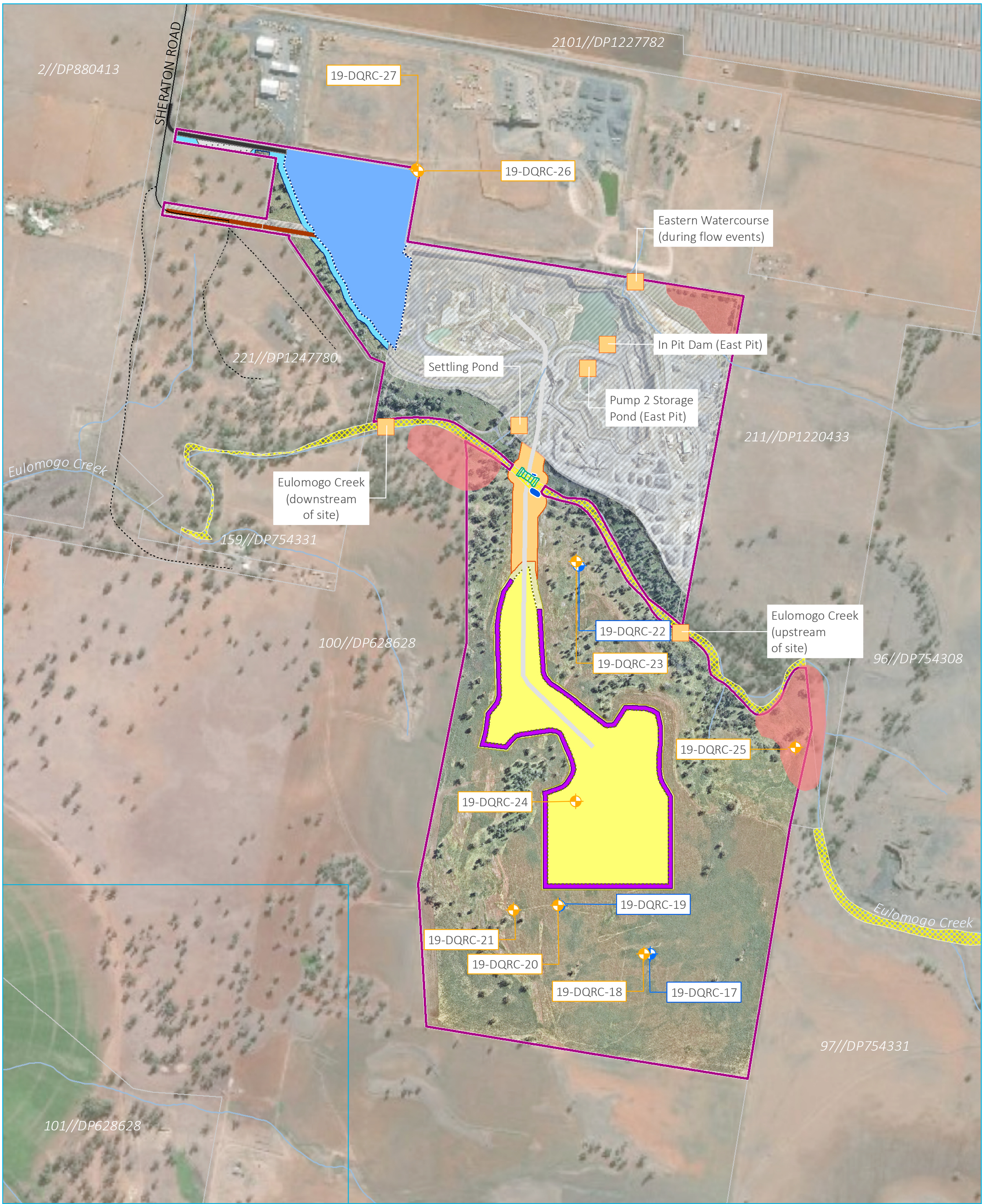
KEY

- Project area
- Rail line
- Major road
- Minor road
- Named watercourse
- NPWS reserve

Local context

Dubbo Quarry Continuation Project
Water Assessment Addendum
Figure 1.2

EMM
creating opportunities



Source: EMM (2020, 2022); DFSI (2017); GA (2011); Nearmap (2020)

KEY

- Project area
- Sediment pond
- Surface water monitoring location
- Groundwater monitoring bore
  - Basalt
  - Palaeochannel
- Aboriginal protection zone
- Indicative existing disturbance area
- Bund wall
- Existing access road
- Alternative access road
- Alternative truck tarping area
- Proposed haul road
- Indicative proposed water crossing
- Western extension area
- Western disturbance area
- Haul road disturbance area
- Southern extension area
- Southern disturbance area
- Minor road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- Cadastral boundary (data does not align with surveyed site boundary)
- Crown land

Water monitoring network

Dubbo Quarry Continuation Project
Water Assessment Addendum
Figure 1.3

EMM
creating opportunities

2 Hydrogeological conceptualisation

This chapter describes the conceptualisation of groundwater interaction with the existing East Pit and the potential interaction with the WEA and SEA.

2.1 Hydrostratigraphic units

Groundwater within the project area is hosted within four key hydrostratigraphic units (HSUs):

- shallow, disconnected alluvial deposits associated with the surface watercourses;
- fractured Tertiary basalt deposits;
- the porous medium of a buried, palaeochannel system; and
- a porous rock system associated with the sedimentary basement rocks.

The Tertiary basalt deposits store and transmit groundwater via their secondary porosity (fractures, joints and fissures). The groundwater system receives direct recharge via rainfall in areas of outcrop or indirect recharge via leakage from overlying alluvium (where present). The system discharges to surface watercourses and via leakage to the underlying palaeochannel aquifer.

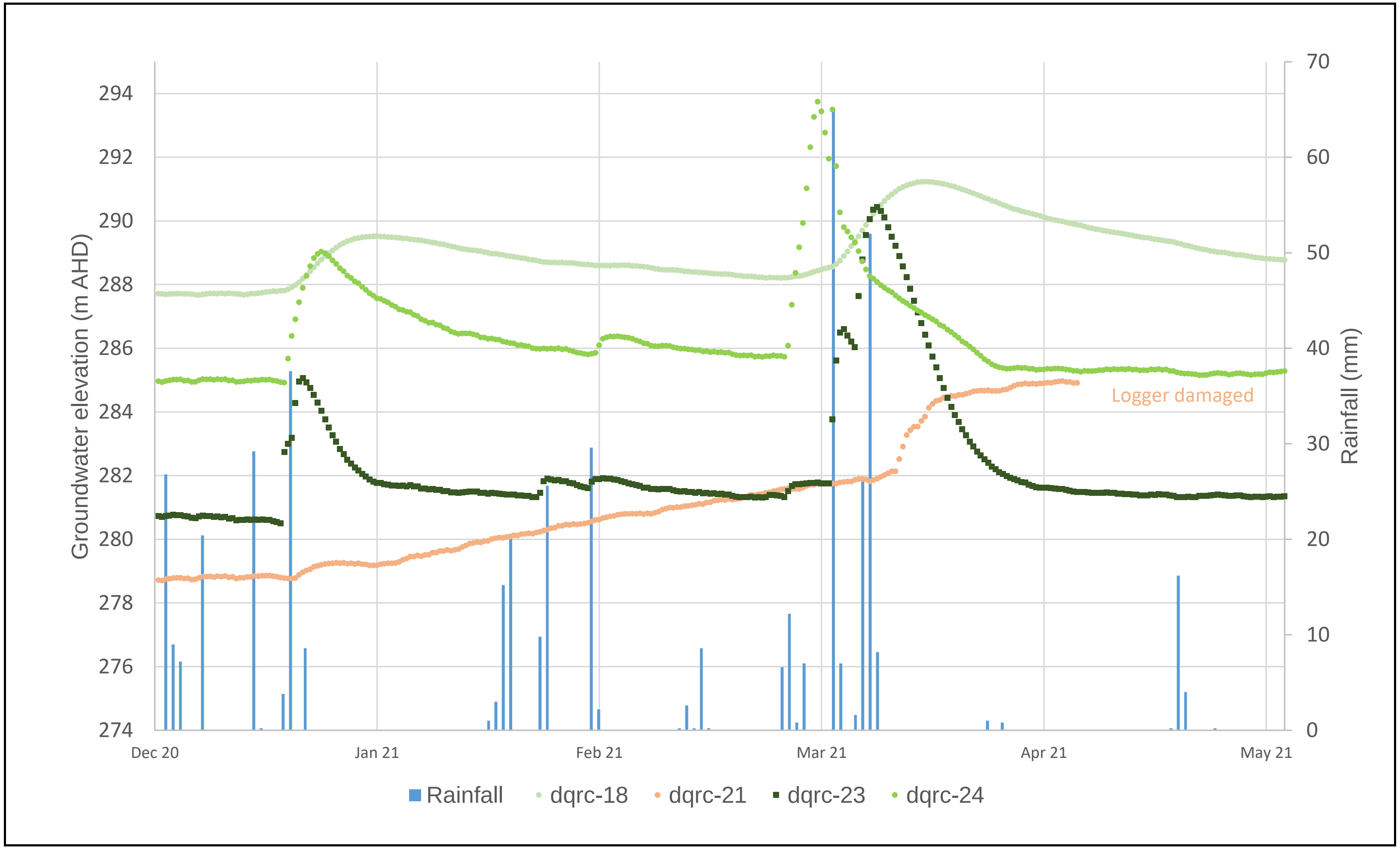
A palaeochannel is buried below the Tertiary Basalt deposits. Reference to bore log GW061634 indicates a 4 m thick coarse gravel lens underlying a basalt deposit approximately 2 km south of the quarry (Figure 1.3). GW014999 intersects a 3 m thick gravel lens underlying basalt approximately 1 km east of the quarry. Environmental Earth Sciences (2013) reported buried sand and gravel deposits south of the project around Toongi, considered to be hydraulically connected to the outcropping alluvial deposits.

The Triassic sedimentary basement rocks form a regional porous rock groundwater system. Groundwater flow is governed by primary porosity and secondary porosity (joints, bedding plane separation, faults and cavities) (DPIE 2019). Areas of high flow are encountered where there is a high density of open and interconnected fractures. Recharge to these systems is primarily through infiltration from rainfall, runoff and surface water within the outcropping areas. However, inflow can also occur from downward percolation of groundwater from overlying permeable strata that coincides with layers of the sedimentary sequences that have sufficient permeability for groundwater exchange to occur (DPIE 2019).

2.2 Groundwater level

Temporal groundwater levels are monitored across a network of eight monitoring bores on the project site (Figure 1.3).

In December 2020, dedicated pressure transducers (data loggers) were installed across the monitoring network to collect continuous groundwater level data for the basalt and paleochannel. Data from December 2020 to May 2021 are provided in Figure 2.1 and Figure 2.2 for the basalt and palaeochannel respectively. The figures include rainfall data from Bureau of Meteorology (BoM) weather station at Dubbo airport (station 65070) to inform trend analysis.

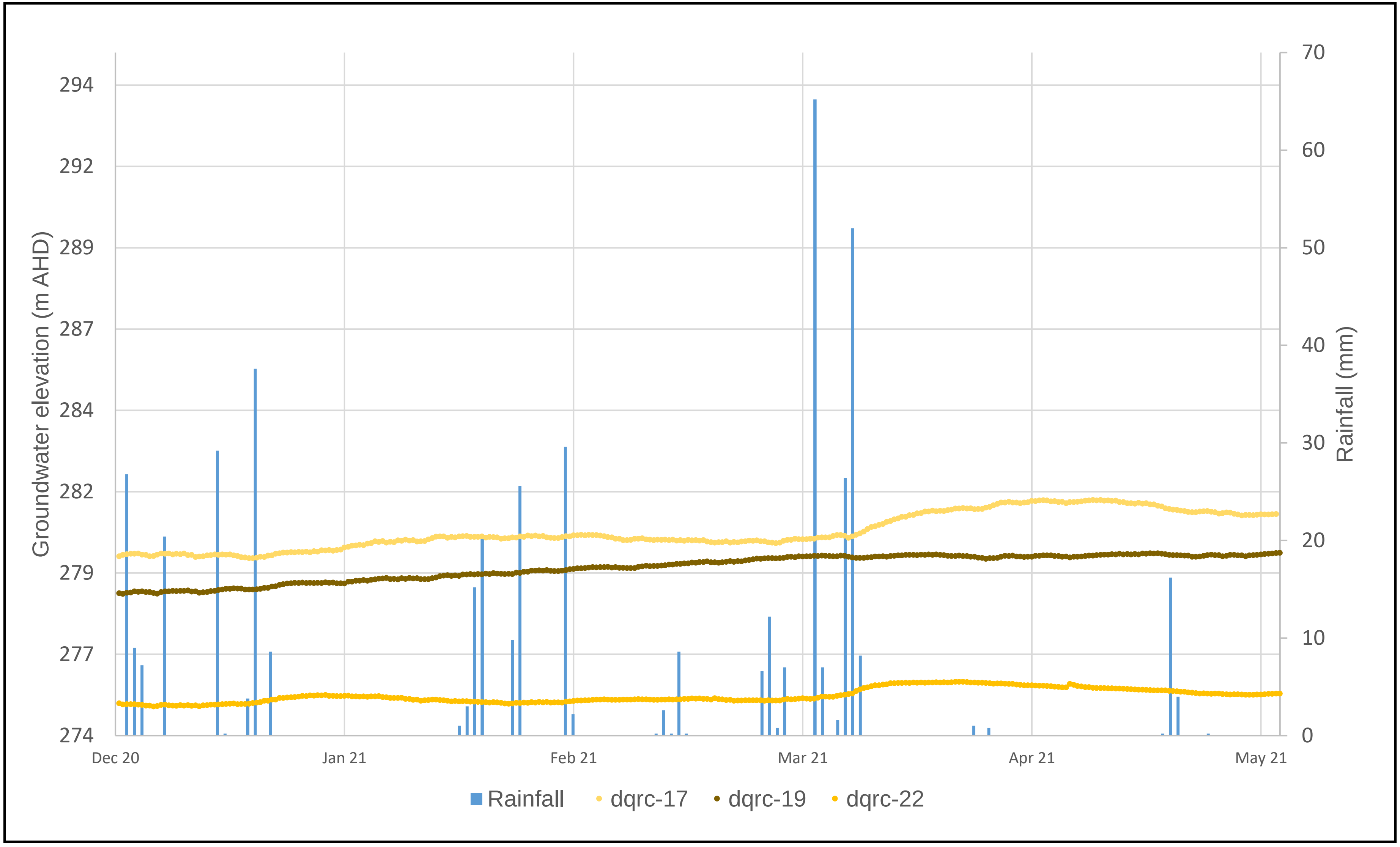


Groundwater level - basalt

Dubbo Quarry Continuation Project

Response to Submissions - Water Assessment

Figure 2.1



Groundwater level - palaeochannel

Dubbo Quarry Continuation Project

Response to Submissions - Water Assessment

Figure 2.2

The response to rainfall recharge in the basalt (Figure 2.1) is varied:

- monitoring bore DQRC-20 is dry, indicating the groundwater level is below the base of the 27 m deep bore (ie below 281.9 m AHD);
- rapid responses to sustained rainfall events are observed at monitoring bores DQRC-18, DQRC-23 and DQRC-24; and
- monitoring bore DQRC-21 exhibits responses to rainfall in early January and late March 2021. A gradual response is also seen from late January to mid-March 2021 apparently not in response to local rainfall events. This response is attributed to the bore intercepting both saturated basalt and the underlying palaeochannel.

The relatively large responses to recharge observed within the basalt are typical of a low storage system (Figure 2.1). For rainfall to recharge to the basalt system the soil moisture deficit is required to be overcome, meaning rainfall does not always equate to groundwater level rise. Sustained rainfall events (ie greater than 30 mm) are typically required to overcome the soil moisture deficit. The groundwater levels generally subside to baseline levels within a month or two following rainfall.

The groundwater level in the palaeochannel shows less fluctuation to rainfall recharge (Figure 2.2). The comparatively muted response is attributed to the overlying basalt (confining aquifer), high porosity of the aquifer (corresponding to large storage capacity) and high transmissivity of the unconsolidated sediments. Over the monitoring period the maximum rise in groundwater level following heavy and sustained rainfall was 1 m (observed at DQRC-19).

2.3 Groundwater hydraulic conductivity

The hydraulic conductivity of the palaeochannel at DQRC-22 was estimated in the order of 0.4 metres per day (m/day). This hydraulic conductivity is typical of the coarse, unconsolidated sediments that make up palaeochannel formations in NSW.

Estimates were calculated via rising and falling head (slug) tests performed on the palaeochannel bores. Data loggers and manual water level measurements were used to record the decay and recovery in water level following the insertion (falling head) or removal (rising head) of the slug. The test was analysed using the Hvorslev solution (1951). The test results are included in Attachment B.

2.4 Conceptual flow model

The key groundwater flow system at the project area comprises an overlying basalt unit (confining layer) and an underlying palaeochannel (confined aquifer). The regional groundwater flow is inferred from south to north, mirroring surface drainage. Locally, observed groundwater levels indicate a downward vertical gradient driving leakage from the basalt into the palaeochannel.

Rainfall directly recharges discrete fractures within the basalt. The fractures have low storage capacity as seen by the groundwater level response following recharge events. The basalt discharges into the underlying alluvium and, likely, to surface watercourses (as baseflow and spring flow).

The confined palaeochannel aquifer has a high storage capacity, due to the pore space between coarse sand granules. Groundwater response to rainfall is muted and delayed by an overlying confining layer (basalt). In the project area the palaeochannel is estimated to be up to 6 m thick. The unit is highly transmissive with a hydraulic conductivity in the order of 0.4 m/day.

The conceptual understanding of the quarry's existing East Pit is depicted in Figure 2.3. Historic quarry activities within the East Pit inadvertently intercepted the underlying palaeochannel, which exists between 275 and 269 m AHD at this location. Anecdotal evidence indicates the intercepted palaeochannel is the predominant source of groundwater inflows to East Pit. Surrounding East Pit, the palaeochannel is somewhat depressurised due to ongoing dewatering activities. Temporary pit inflows from the basalt may occur where saturated fractures are intercepted; however, these fractures have low storage and are, therefore, quickly dewatered.

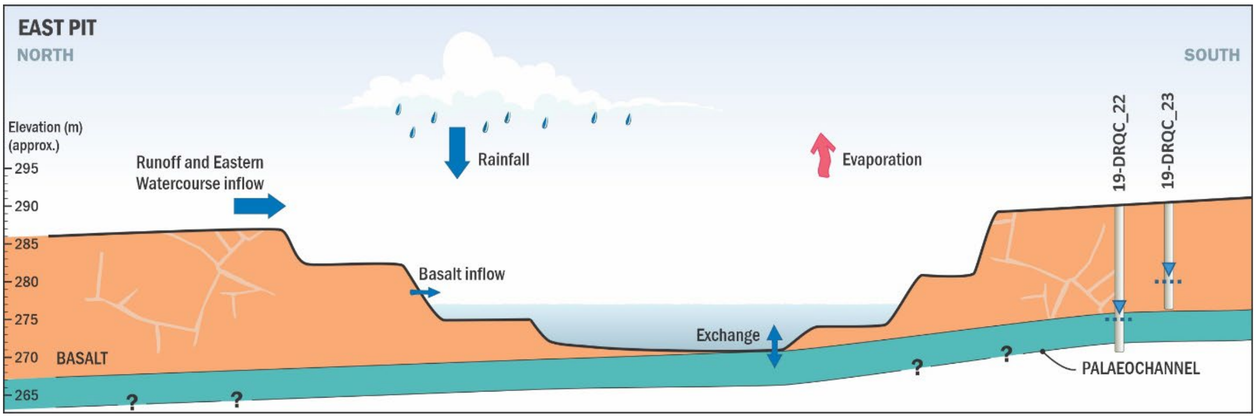


Figure 2.3 Conceptual model of East Pit

The proposed SEA and WEA are designed to extract resource from the Tertiary Basalt. The pits are shallow and deemed unlikely to intersect the underlying palaeochannel (if present). The conceptual understanding of the SEA and WEA are shown in Figure 2.4 and Figure 2.5.

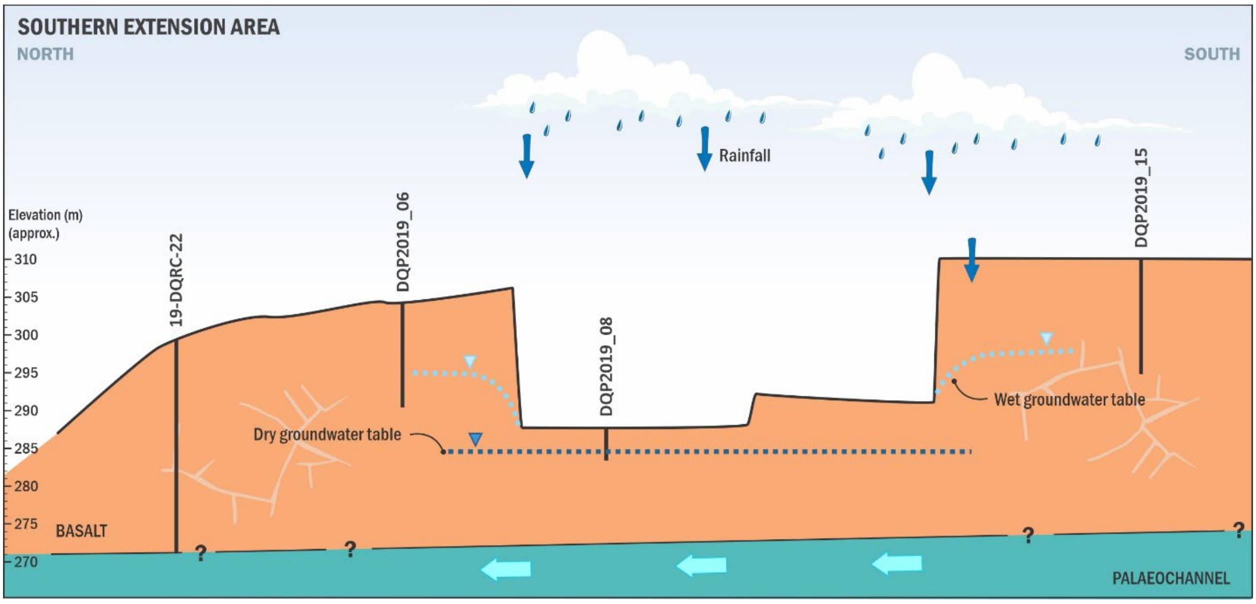
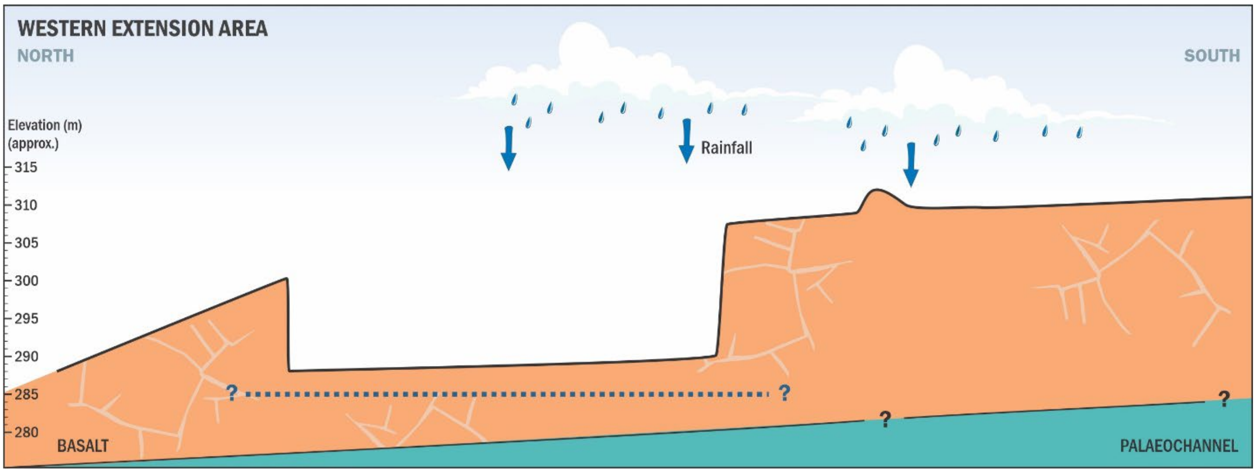


Figure 2.4 Conceptual model of southern pit extension

At the end of quarry life, the maximum pit depth in the north and centre of the SEA will be 286 m AHD. The observed dry weather groundwater level is below this at 285 m AHD. In the southern end of the SEA the maximum pit depth is 288.5 m AHD, 200 m further south the observed dry weather groundwater level is lower at 282.8 m AHD (at DQRC-20). Wet weather groundwater levels in the basalt have been observed at levels above the proposed SEA pit depth.



Note: blue dotted line represents an implied water level (groundwater not intercepted by drilling in the area).

Figure 2.5 Conceptual model of the western pit extension

There is no water level data available in the WEA area and the depth to the palaeochannel in this area is not well understood. However, two bores were drilled near the WEA to a maximum depth of 274.7 m AHD, and no groundwater was encountered during drilling. The proposed maximum pit depth for the WEA is 283 m AHD, which is approximately 8 m above the base of the bores.

3 Revised water balance

The water balance model documented in the EIS in the Surface Water Assessment Version 1 (SWA V1) (EMM 2020) has been updated to reflect changes to the project description and the conceptualisation of water exchanges between the palaeochannel and East Pit. This chapter describes the revised project description, groundwater conceptualisation and updated water balance model results.

A description of the water balance model, modelling approach and assumptions is provided in SWA V2 (see Appendix B).

3.1 Revised project description

A revised extraction boundary has been estimated assuming extraction in the East Pit continues up to the end of 2022. The following changes to the existing operations are necessary to facilitate ongoing extraction and will be made prior to the commencement of the expanded operations:

- The East Pit extraction boundary will be increased which will increase the storage within the East Pit and intercept new catchment area that currently drains to the Settling Pond.
- The processing plant will be relocated into the existing West Pit and the following storages will be removed:
  - Pump 2 storage pond within the East Pit; and
  - the Western Pit Pond.
- Product and haul truck routes will be slightly altered. However, the area available for application of dust suppression will be broadly consistent with the existing operations documented in the SWA (EMM 2020).

The following minor changes to the proposed operations were also provided by Holcim:

- The quarry access road will enter the WEA and navigate to the office area via the existing pits, redistributing catchment of the existing access road to the East Pit.
- The haul road to the SEA will be realigned to approach from the East Pit, reducing additional disturbed catchment adjacent the Settling Pond.
- Conveyors adjacent to the haul roads may be implemented as an option to assist with transport of the resource.

A summary of key changes to the water balance that are required to assess ongoing operations in the East Pit are outlined in Section 3.3.

The changes to the assumed existing operations have resulted in multiple changes to both the existing and proposed water management system that is described in the SWA V1. Accordingly, an updated assessment (SWA V2) is included in Attachment D to this appendix. SWA V2 describes the existing and proposed water management systems and references the water balance models results that are documented in this Water Addendum report.

3.2 East Pit Levels (In Pit Dam)

Once accessible basalt resources from the existing operations (East Pit) are exhausted, dewatering activities will cease and the pit will start to fill, increasing the size and level of the In Pit Dam. As the In Pit Dam equilibrates with heads in the intersected palaeochannel aquifer, groundwater inflows to East Pit will reduce. The level of the In Pit Dam will naturally find a balance between the fluctuating inputs and outputs of the system. The equilibrium level may vary over time in line with changes in groundwater pressure in the palaeochannel (see Section 2.2). If the equilibrium level is exceeded (say due to surface water inflows into the East Pit), water may temporarily flow from the In Pit Dam into the palaeochannel. This exchange is conceptualised in Figure 3.1.

It is noted that the interpreted equilibrium levels and exchange rates have been estimated using available data and limited anecdotal information. The understanding of the exchange regime will be improved once the pit is allowed to fill and monitoring data (ie change in pit water levels and groundwater response) from the pit filling is analysed.

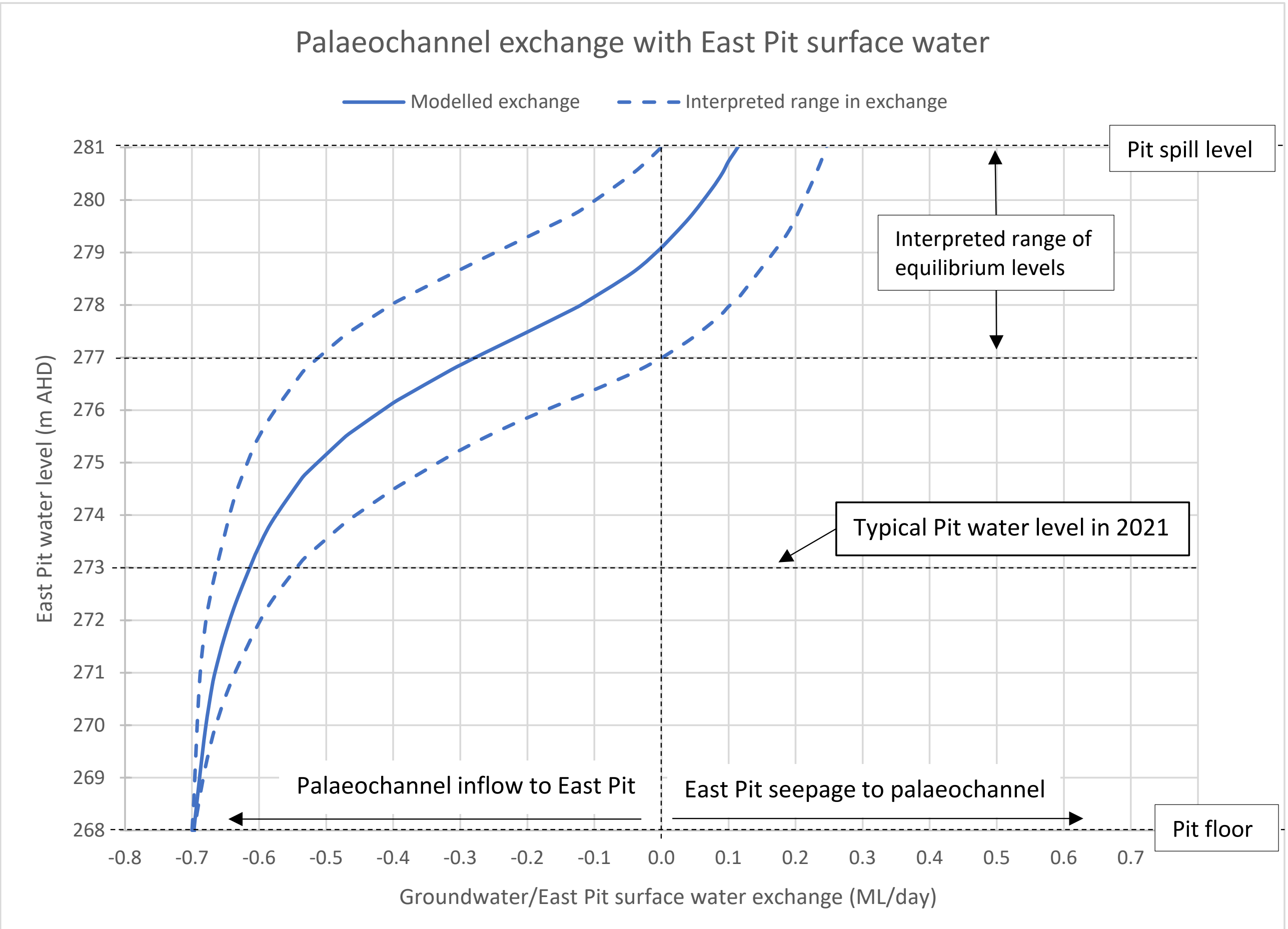


Figure 3.1 Palaeochannel exchange with East Pit surface water

The In Pit Dam will form a component of the site water management system for the continued operations (see Attachment D). The dam levels will be dynamic with the inputs and output to the dam varying depending on rainfall, season, surface water inflows, groundwater levels and the water use of the quarry. During wet periods the dam level may exceed the equilibrium level due to surface water inflows (ie from the Eastern Watercourse). The dam will be a reliable water supply for the project during dry periods and may subsequently be drawn down below the equilibrium level.

By maintaining a high dam level, and therefore a head on the underlying groundwater system, the groundwater inflow to the East Pit will be reduced well below the existing inflow rates, resulting in lower water take.

3.3 Water balance revision

The water balance model documented in the SWA V1 (EMM 2020) was updated to incorporate the revised conceptualisation of water exchange between the palaeochannel and East Pit and the changes to the project description (see Section 3.1). Figure 3.2 compares the revised interpretation to the representation applied in the SWA V1 model (EMM 2020). Key changes made in the revised interpretation are a higher equilibrium level, moderately changed inflows below the equilibrium level and allowance for pit water to seep into the palaeochannel when the equilibrium level is exceeded.

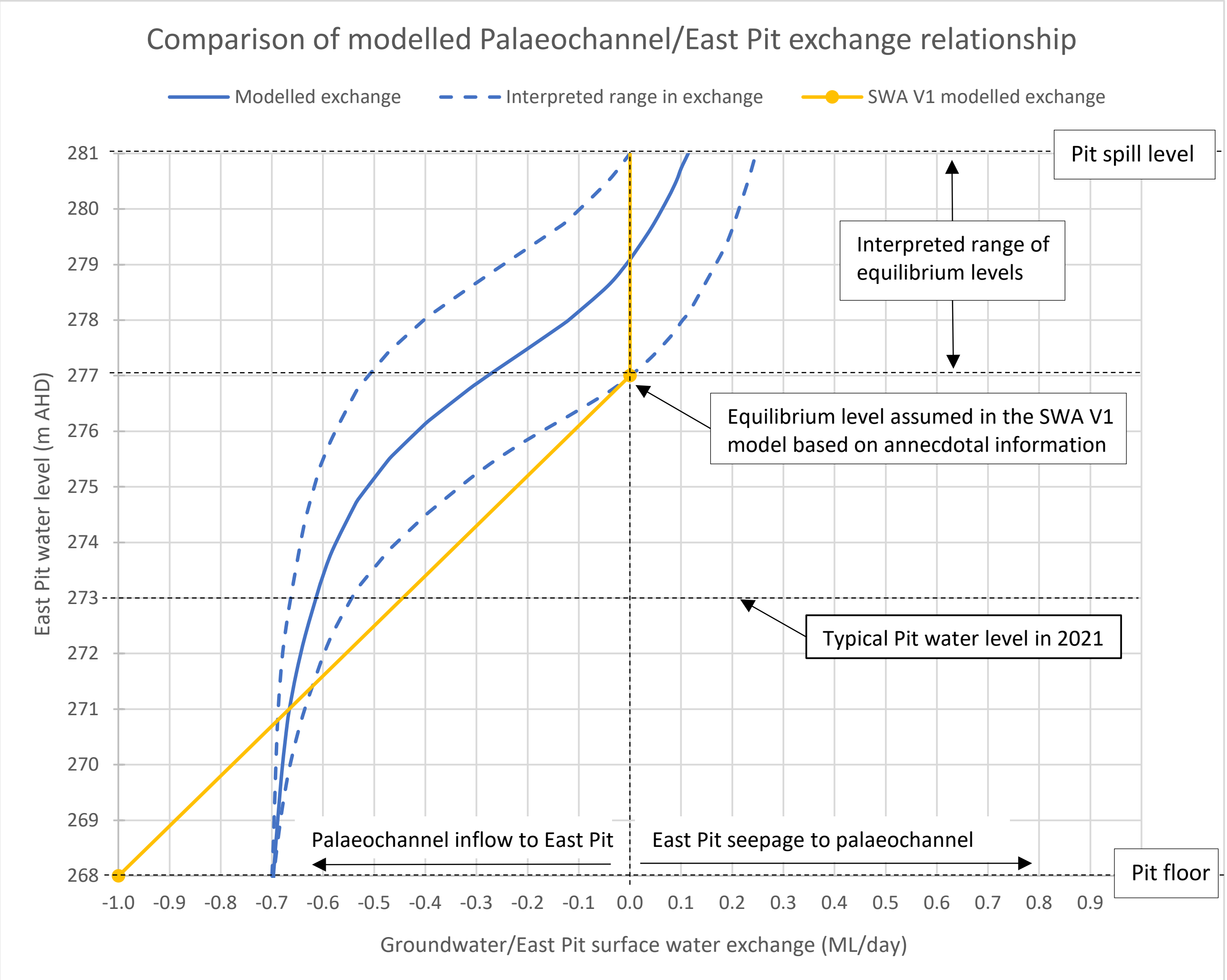


Figure 3.2 Comparison of modelled palaeochannel/East Pit water exchange relationships

In addition to the revised conceptualisation of water exchange between the palaeochannel and East Pit, the water balance was updated to represent the revised East Pit operations associated with ongoing resource extraction prior to commencement of the project. The key changes to the water balance required to assess the ongoing operations in the East Pit are outlined in Table 3.1.

Table 3.1 Summary of water balance changes

Aspect	SWA V1 value (EMM 2020)	Revised value	Comments
East Pit			
Groundwater exchange	Refer Figure 3.2.		Refer Section 3.2 and Section 3.3.
Stage storage	-	-	The East Pit stage storage curve was updated with the revised East Pit shell, assuming extraction for a further nine months before commencement of operations in the WEA.
Total volume	328 ML	596 ML	The revised East Pit extraction has increased the total volume in the East Pit (to the spill level) significantly.
Existing catchment area	15.7 ha	25.8 ha	The revised configuration of the East Pit and West Pit has resulted in redistribution of catchment area previously draining to the West Pit and Settling Pond.
Proposed catchment area	15.7 ha	30.5 ha	The revised configuration of the East Pit and West Pit has resulted in redistribution of catchment area previously draining to the West Pit, WEA and Settling Pond.
Overflow level	286 m AHD	281 m AHD	The spill level was revised to the base of foundation rock (assessed to 281 m AHD). The spill level assumed in the SWA V1 (EMM 2020) is representative of the low point in a road embankment that has been constructed with fill and may be permeable. This has been adjusted in the revised water balance.
West Pit Pond			
Total volume	4.3 ML	0 ML	The West Pit Pond was removed to enable processing activities within the West Pit.
Catchment area	6.7 ha	0 ha	Removal of the West Pit Pond has resulted in redistribution of catchment area to the East Pit.
Settling Pond			
Existing catchment area	9.8 ha	6.5 ha	The revised configuration of the East Pit has resulted in redistribution of catchment area previously draining to the West Pit and Settling Pond.
Proposed catchment area	10.4 ha	2.2 ha	The revised configuration of the East Pit has resulted in redistribution of catchment area previously draining to the West Pit and Settling Pond.
Total volume	2.8 ML	2.4 ML	Due to the redistribution of catchment areas, there is no longer a requirement to increase the capacity of the Settling Pond to meet the minimum size for a sediment basin as outlined in *Managing Urban Stormwater: Volume 1 (Landcom 2004)*.
WEA			
Proposed Catchment area	9.0 ha	8.7 ha	The revised haul road configuration has resulted in a redistribution of catchment area from the WEA to the East Pit.

Table Note: No changes to the SEA water balance elements were required.

The modelling approach and all other assumptions are consistent with those documented in the SWA (EMM 2020).

3.4 East Pit filling times

The East Pit filling phase is expected to commence when extraction in the WEA commences. Approximately 390 ML of water will be required to fill the pit from the current level (estimated to be 273 m AHD) to the interpreted equilibrium level. This water will be sourced from palaeochannel and surface water inflows.

The revised water balance model was applied to estimate the possible range in filling times (ie the time required for the In Pit Dam to fill to the post filling level regime). Scenarios were run for dry, average and wet conditions. Key results are summarised below:

- Dry conditions - the In Pit Dam level will not reach the equilibrium level as the water management system would be in deficit (ie water use and losses exceed surface water inflows). The model predicts that the In Pit Dam will partially fill and equilibrise within the 276 to 277 m AHD range within approximately four years. This pit dam level range is similar to the levels that would occur during dry conditions, post the filling phase.

- Average conditions - the In Pit Dam level will not reach the equilibrium level as the water management system would be in deficit. The model predicts that the In Pit Dam will fill to 277.5 m AHD over approximately four years. During average conditions, the dam levels are predicted to range between 278 to 279 m AHD.

- Wet conditions - the East Pit will fill to the palaeochannel equilibrium level of 279 m AHD in five months or less.

In summary, the pit filling phase is estimated to take up to four years but could occur in a shorter time if wet conditions occur.

3.5 Revised results – existing operation

This section presents updated water balance model results for the existing operation scenario, which assumes that the East Pit is dewatered to maintain access for extraction. Refer to SWA V2 (Attachment D) for further information on the water management system for the existing operation.

3.5.1 Results

Figure 3.3 to Figure 3.5 provide annualised results in flow chart format for typical 10th, 50th and 90th percentile rainfall years. Table 3.2 provides a summary of key inflows and outflows in typical 10th, 50th and 90th percentile rainfall years. The change in results from the modelling documented in the SWA V1 (EMM 2020) is provided in brackets following each key result item and is expressed as *revised modelling result – SWA V1 modelling result*.

Table 3.2 Summary of inflows and outflows: existing water management system

	Units	Annualised results[2]		
		Dry year[1]	Median year	Wet Year[1]
Inflows				
Runoff				
– Quarry catchments	ML/year	46 (+2)	91 (+6)	153 (+19)
– Eastern watercourse	ML/year	34 (0)	96 (0)	267 (0)
Runoff total	ML/year	79 (+2)	187 (+6)	419 (+9)
Palaeochannel inflows (estimate only)	ML/year	227 (+36)	225 (+44)	209 (+82)
Total inflows	ML/year	**306 (+38)**	**411 (+50)**	**628 (+90)**
Outflows				
Operational water use	ML/year	92 (0)	86 (0)	86 (0)
Irrigation	ML/year	15 (+6)	13 (+4)	8 (+2)
Evaporation	ML/year	36 (+2)	55 (+20)	68 (+31)
Discharges				
– Sediment basin overflows	ML/year	1 (-5)	8 (-9)	20 (-15)
– East Pit dewatering	ML/year	161 (+35)	270 (+39)	449 (+73)
– East Pit seepage to palaeochannel	ML/year	0 (0)	0 (0)	0 (0)
– Discharges total	ML/year	162 (+31)	279 (+30)	468 (+57)
Total outflows	ML/year	**305 (+31)**	**432 (+54)**	**630 (+90)**
Balance (change in storage)	ML/year	**+1 (-1)**	**-21 (-3)**	**-1 (0)**
Net palaeochannel/East Pit water exchange[3]	ML/year	**227 (+36)**	**225 (+344)**	**209 (+82)**

Notes: 1. Dry year refers to a typical 10th percentile rainfall year Wet year refers to a typical 90th percentile rainfall year
2. The change in results from the SWA V1 results (EMM 2020) are provided in brackets and have been calculated as *revised modelling result – SWA modelling result*.
3. Refers to the net water exchange between the palaeochannel and the East Pit. A positive number refers to a net groundwater inflow, while a negative number refers to a net seepage loss from the East Pit into the palaeochannel.

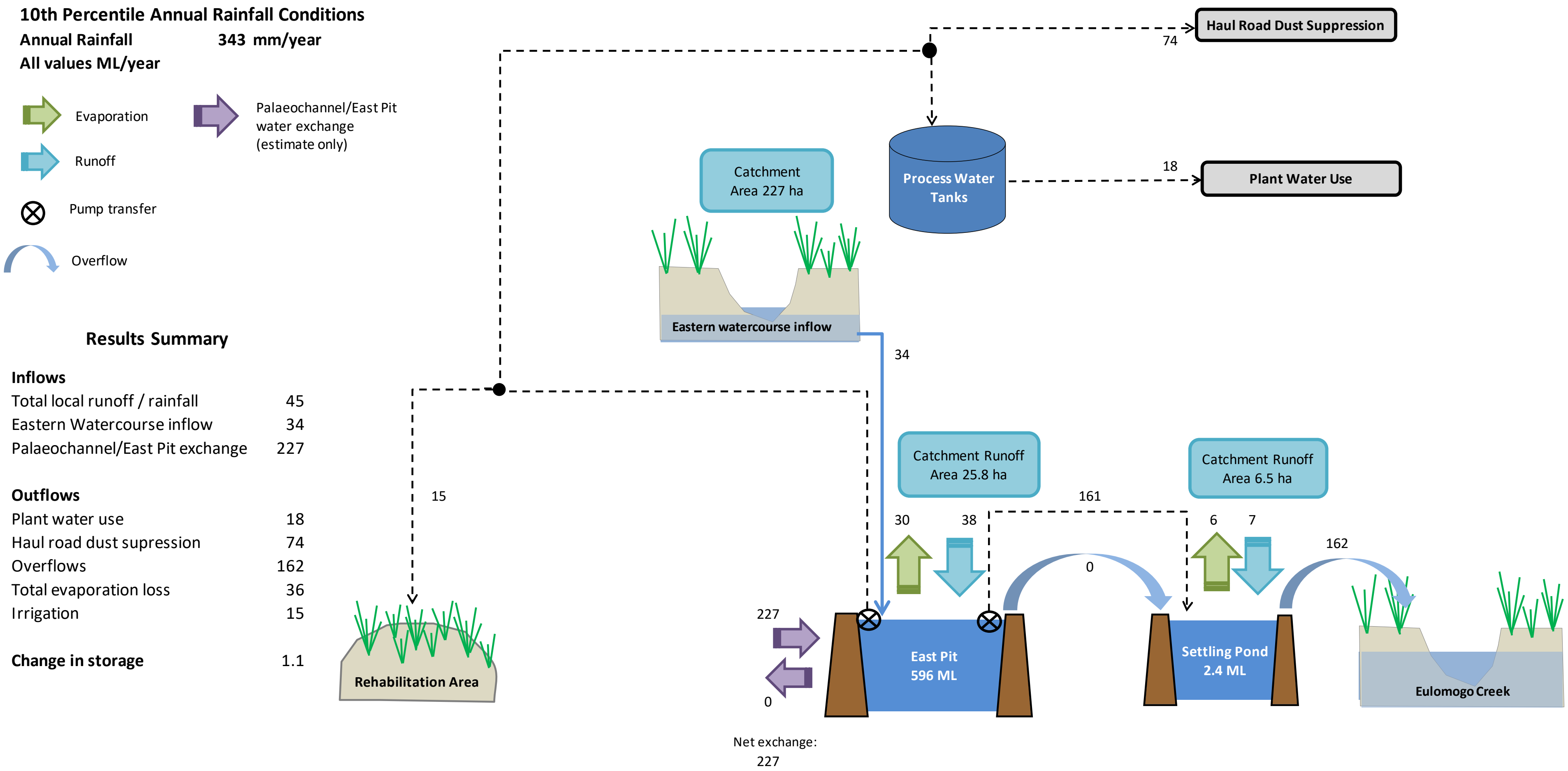


Figure 3.3 **Water balance: existing water management system – 10th percentile year**

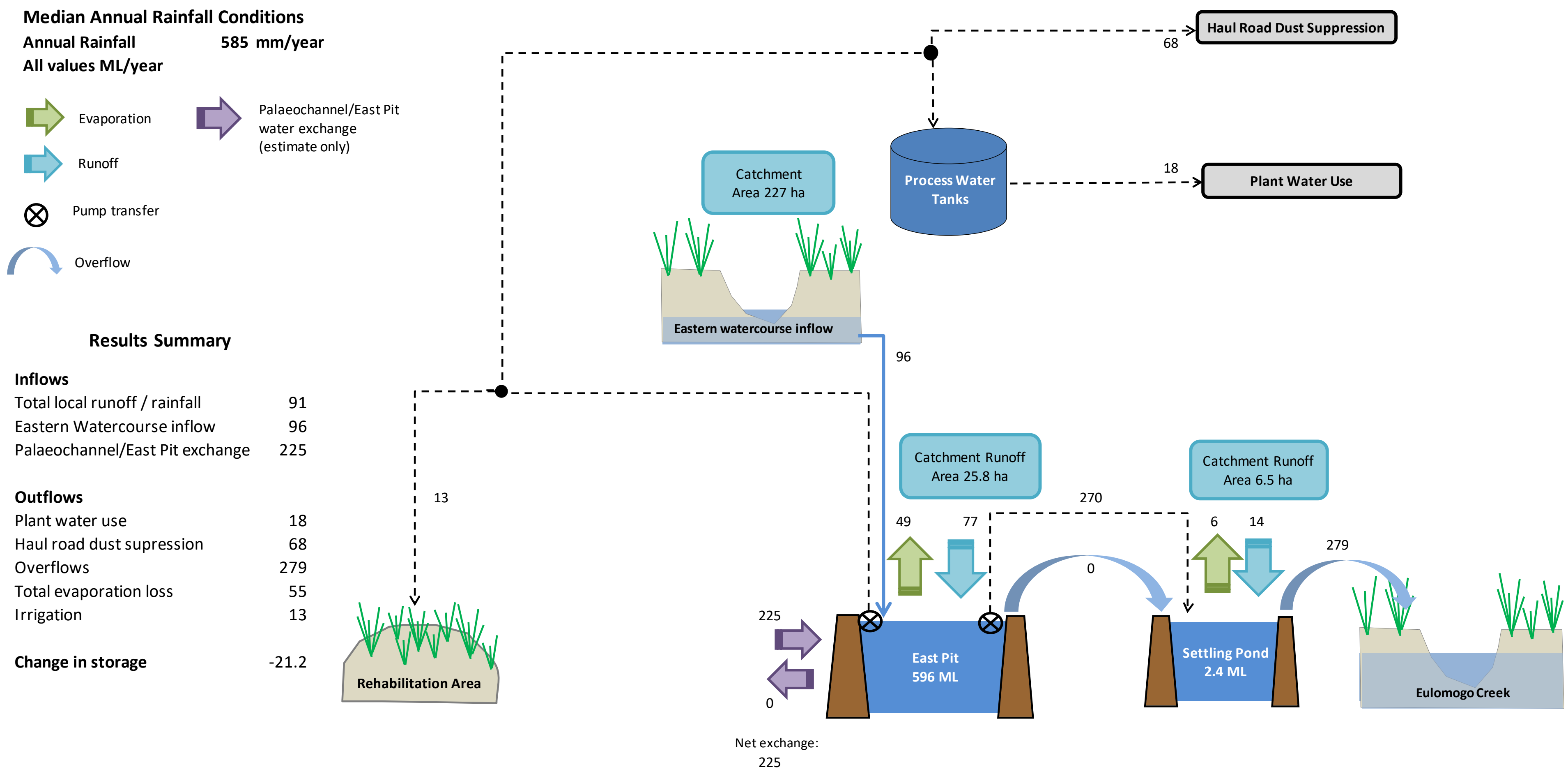


Figure 3.4 **Water balance: existing water management system – 50th percentile year**

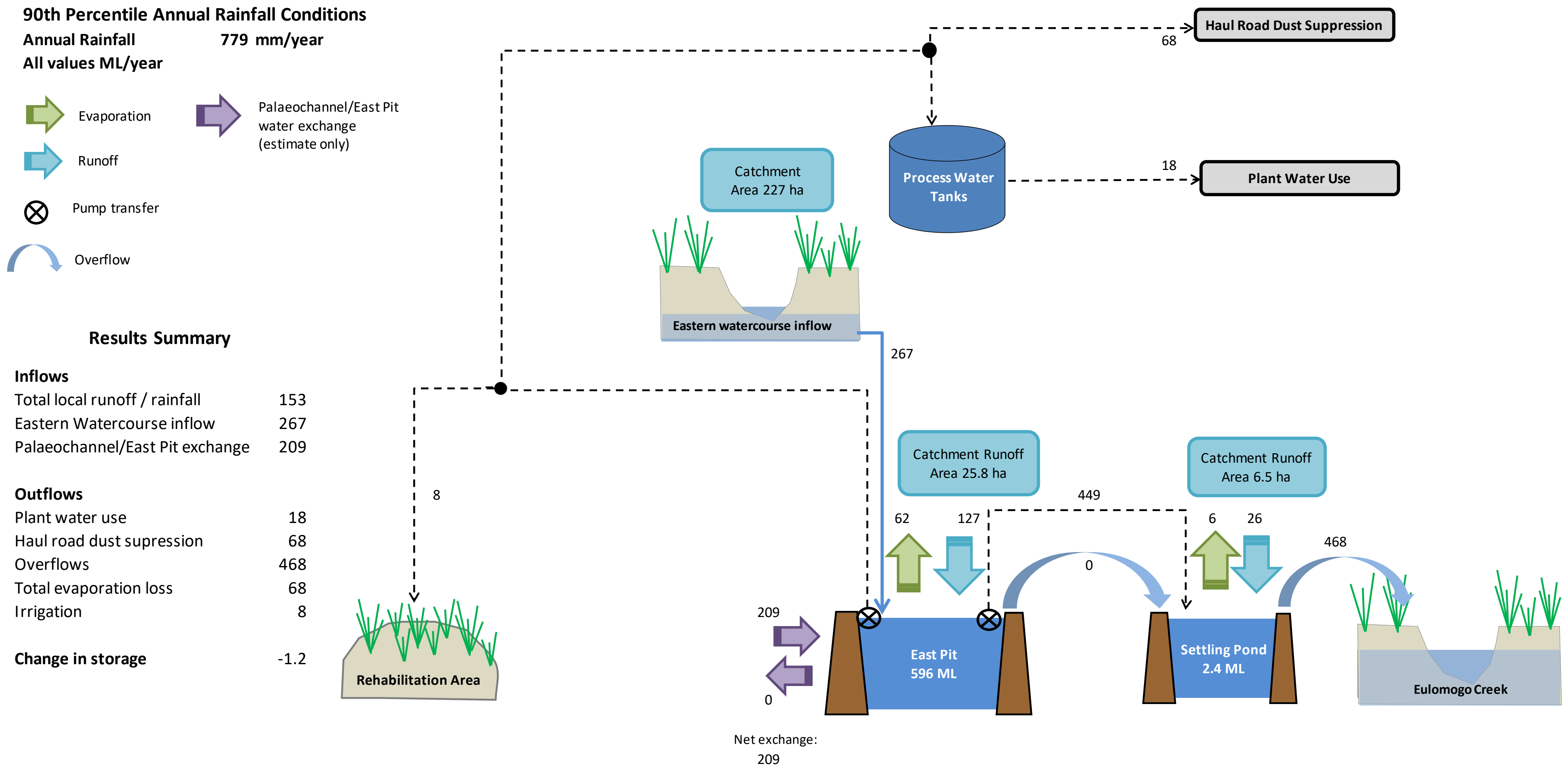


Figure 3.5 **Water balance: existing water management system – 90th percentile year**

3.5.2 Discussion

The revised existing conditions water balance predicts an increase in groundwater inflows to the water management system. This is due to both an increase in the East Pit storage (maintaining lower pit dam levels) and an increase in the interpreted palaeochannel inflow rate for pit dam levels above 271 m AHD. It is noted that for the existing operation the pit dam level is typically maintained at 273 m AHD. Discharges due to pit dewatering have increased predominantly because of the higher simulated groundwater inflow rates. Catchment runoff into the system and evaporation from the system have both increased due to a larger portion of direct rainfall to the surface area of the In Pit Dam in the East Pit. Sediment basin overflows from the Settling Pond have reduced due to the redistribution of some of the catchment to the East Pit.

3.6 Proposed operations

This section presents updated water balance model results for the proposed operation scenario, which applies the proposed water management system for the expanded operations. Refer to SWA V2 (Attachment D) for information on the water management system for the proposed operation.

3.6.1 Results

Figure 3.6 to Figure 3.8 provide annualised results in flow chart format for typical 10th, 50th and 90th percentile rainfall years, respectively.

Table 3.3 provides a summary of key inflows and outflows in typical 10th, 50th and 90th percentile rainfall years. The change in results from the modelling documented in the SWA V1 (EMM 2020) is provided in brackets following each key result item and is expressed as *revised modelling result – SWA (EMM 2020) modelling result*.

3.6.2 Discussion

The revised water balance for proposed operations predicts an increase in groundwater inflows to the water management system during dry years and a reduction during average and wet years (Table 3.2). This is due to the revised conceptualisation of water exchange between the palaeochannel and East Pit.

The water balance results predict that the proposed water management strategy will:

- reduce groundwater inflows into East Pit from 227 ML/year to 77 ML/year in a dry year scenario; and
- substantially reduce both the frequency and magnitude of discharges. This is discussed further in Section 3.7.

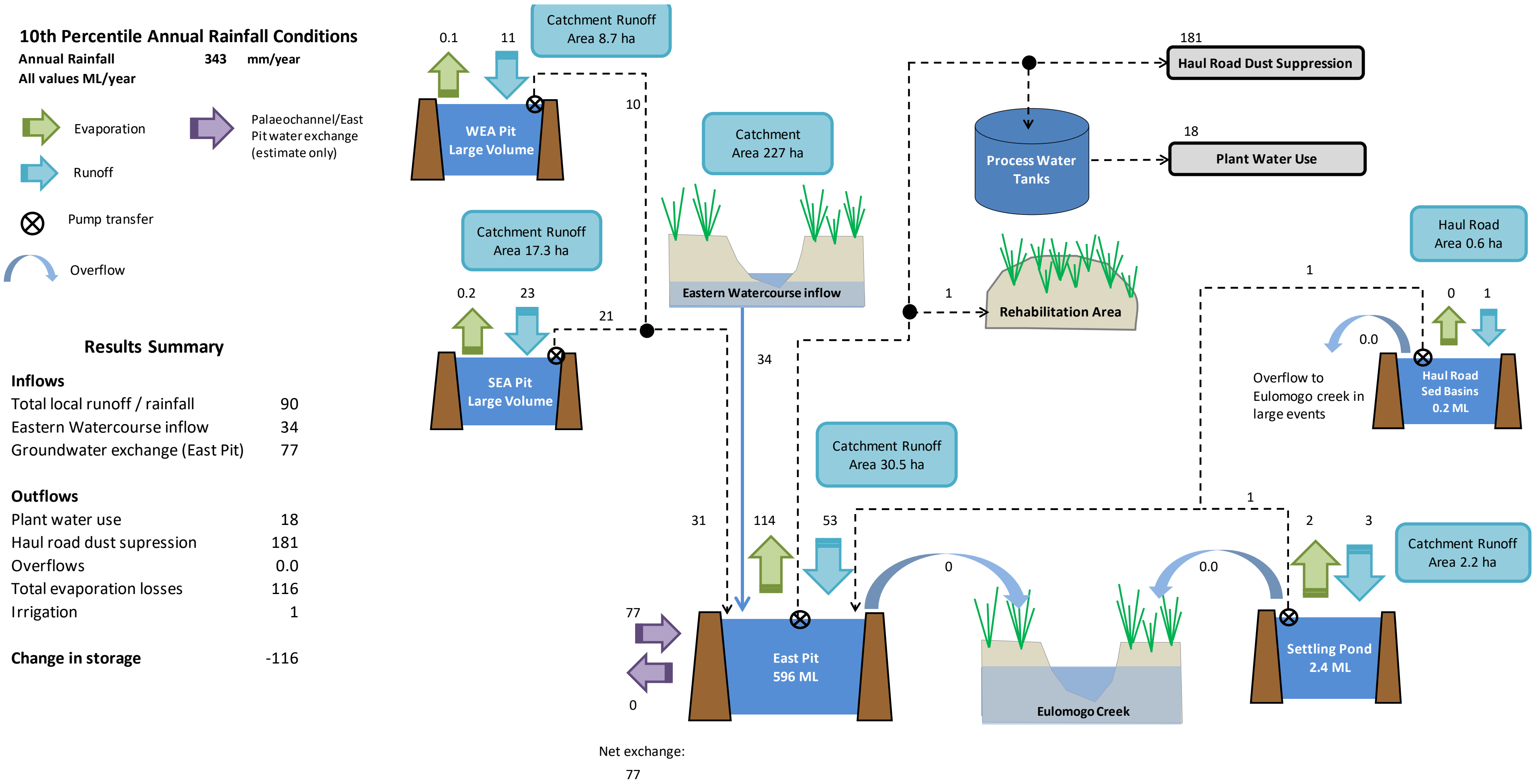


Figure 3.6 Water balance: proposed operations – 10th percentile year

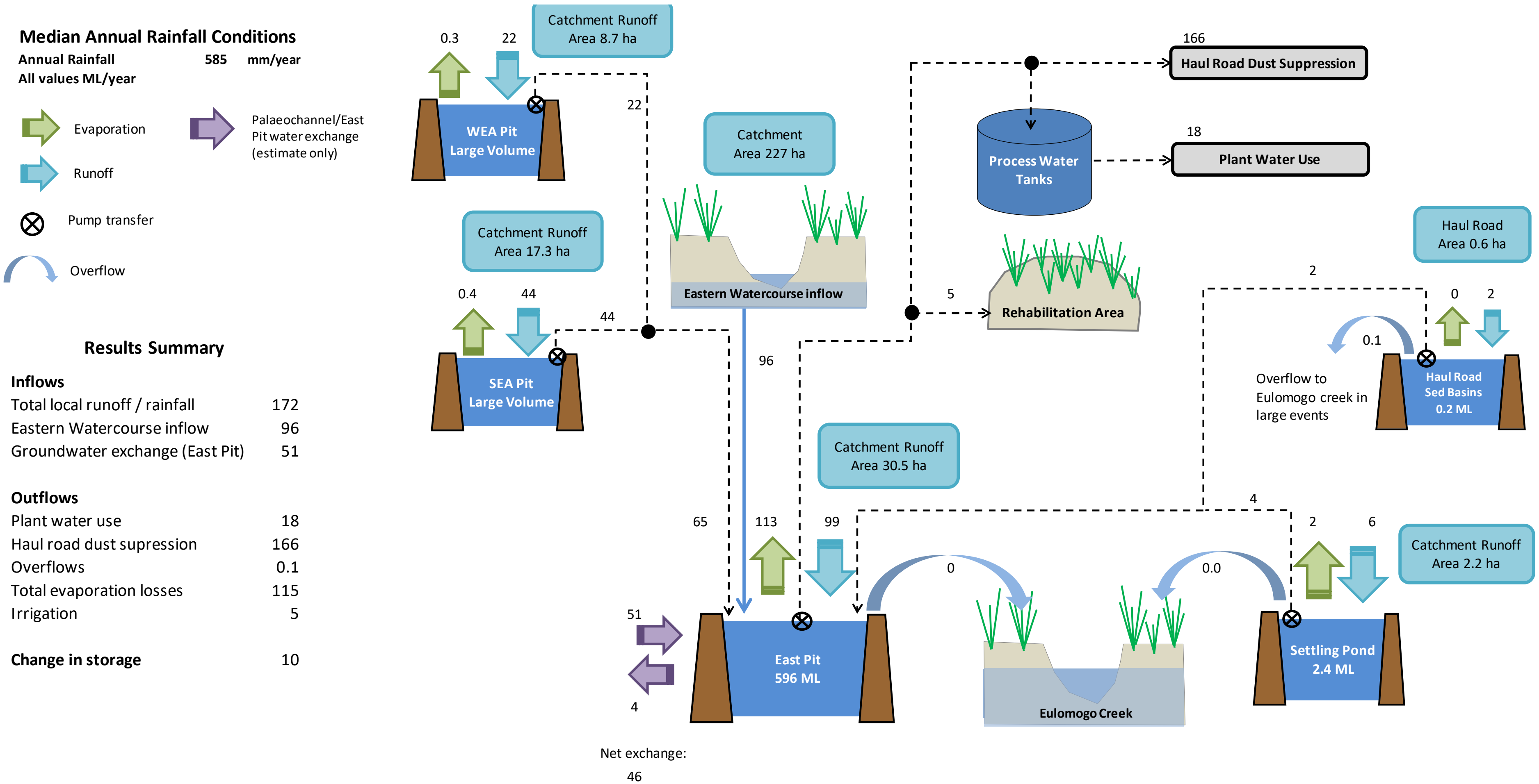


Figure 3.7 **Water balance: proposed operations – 50th percentile year**

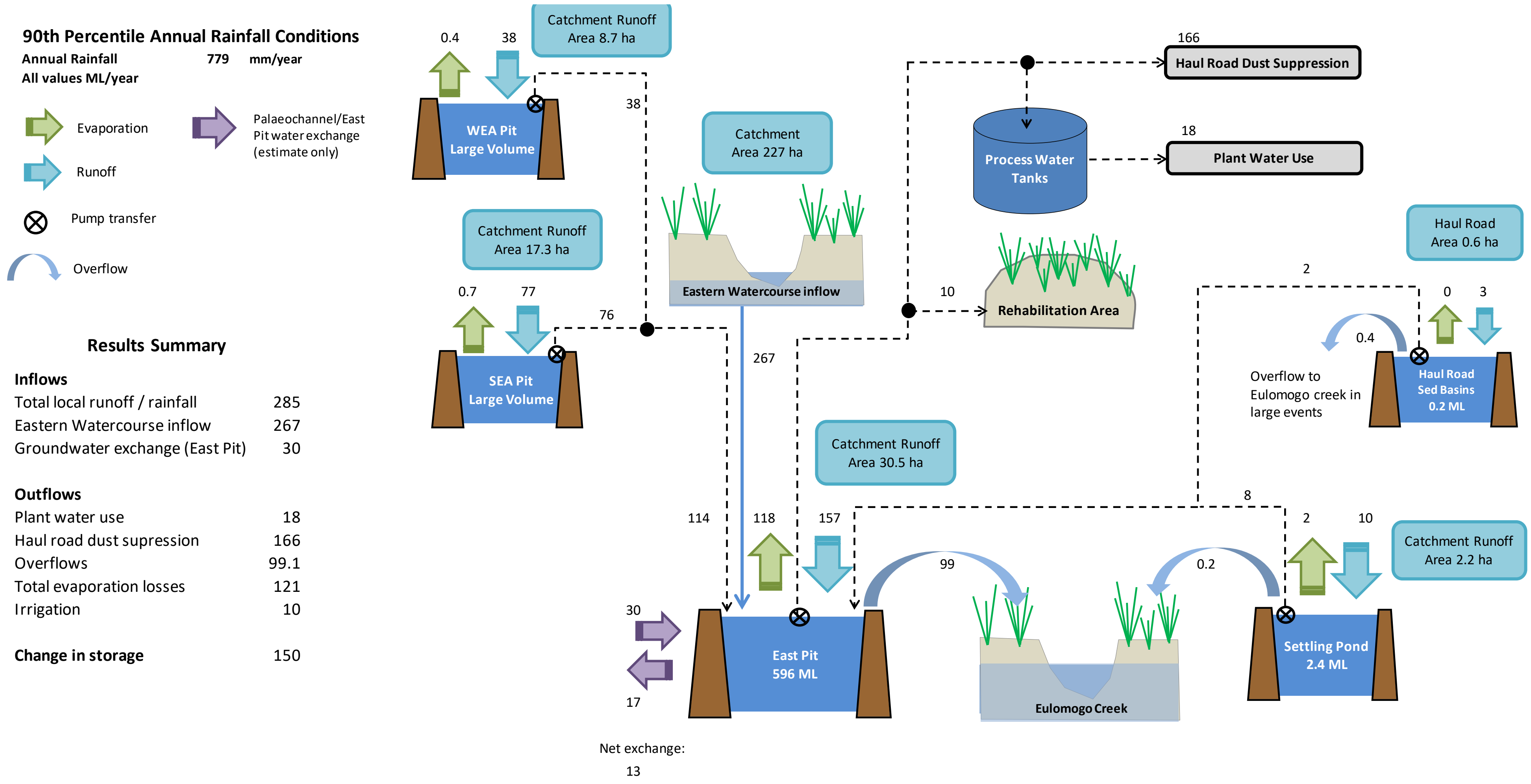


Figure 3.8 Water balance: proposed operations – 90th percentile year

Table 3.3 Summary of inflows and outflows: proposed operations

	Units	Annualised results[2]		
		Dry year[1]	Median year	Wet Year[1]
Inflows				
Runoff				
– Quarry catchments	ML/year	90 (+9)	172 (+12)	285 (+11)
– Eastern watercourse	ML/year	34 (0)	96 (0)	267 (0)
Runoff total	ML/year	124 (+9)	271 (+12)	551 (+11)
Palaeochannel inflows (estimate only)	ML/year	77 (+50)	55 (+32)	30 (+12)
Total inflows	ML/year	**201 (+59)**	**319 (+44)**	**581 (+23)**
Outflows				
Operational water use	ML/year	200 (0)	184 (0)	184 (0)
Irrigation	ML/year	1 (-8)	5 (-7)	10 (-4)
Evaporation	ML/year	116 (+74)	115 (+62)	121 (+56)
Discharges				
– Sediment basin overflows	ML/year	0.0 (-0.4)	0.1 (-3.6)	0.5 (-15.5)
– East Pit dewatering	ML/year	0.0 (0)	0.0 (0)	99 (-55)
– East Pit seepage to palaeochannel	ML/year	0 (0)	4.3 (+4)	17 (+17)
– Discharges (total)	ML/year	0.1 (-0.3)	4.4 (+0.8)	116 (-53)
Total outflows	ML/year	**317 (+65)**	**309 (+55)**	**431 (-1)**
Balance (change in storage)	ML/year	**-116 (-6)**	**+10 (-11)**	**+150 (+24)**
Net palaeochannel/East Pit water exchange[3]	ML/year	**+77 (+50)**	**+46 (+32)**	**+13 (12)**

Notes: 1. Dry year referes to a typical 10th percentile rainfall year Wet year refers to a typical 90th percentile rainfall year.
2. The change in results from the SWA V1 results (EMM 2020) are provided in brackets and have been calculated as *revised modelling result – SWA modelling result*.
3. Refers to the net water exchange between the palaeochannel and the East Pit. A positive number refers to a net groundwater inflow, while a negative number refers to a net seepage loss from the East Pit into the palaeochannel.

3.7 Discharge regimes

Figure 3.9 is a probability exceedance chart that compares the annualised discharge volumes associated with pit dewatering and sedimentation basin overflows for the revised existing and proposed operation scenarios. The results from the existing and proposed operation scenarios presented in the SWA V1 (EMM 2020) are also provided for context.

The results demonstrate that the water management strategy for the proposed operations will be effective in substantially reducing both the frequency and magnitude of discharges due to pit dewatering and sedimentation basin overflows, with discharges by both mechanisms occurring during wet weather and at reduced magnitudes.

The revised conceptualisation of water exchange between the palaeochannel and East Pit has also resulted in lower simulated discharges due to pit dewatering. This is because there is additional storage proposed in the East Pit due to the revised existing operations and the revised water balance allows for seepage from the East Pit to the palaeochannel when the In Pit Dam level exceeds the equilibrium level (see Figure 3.1).

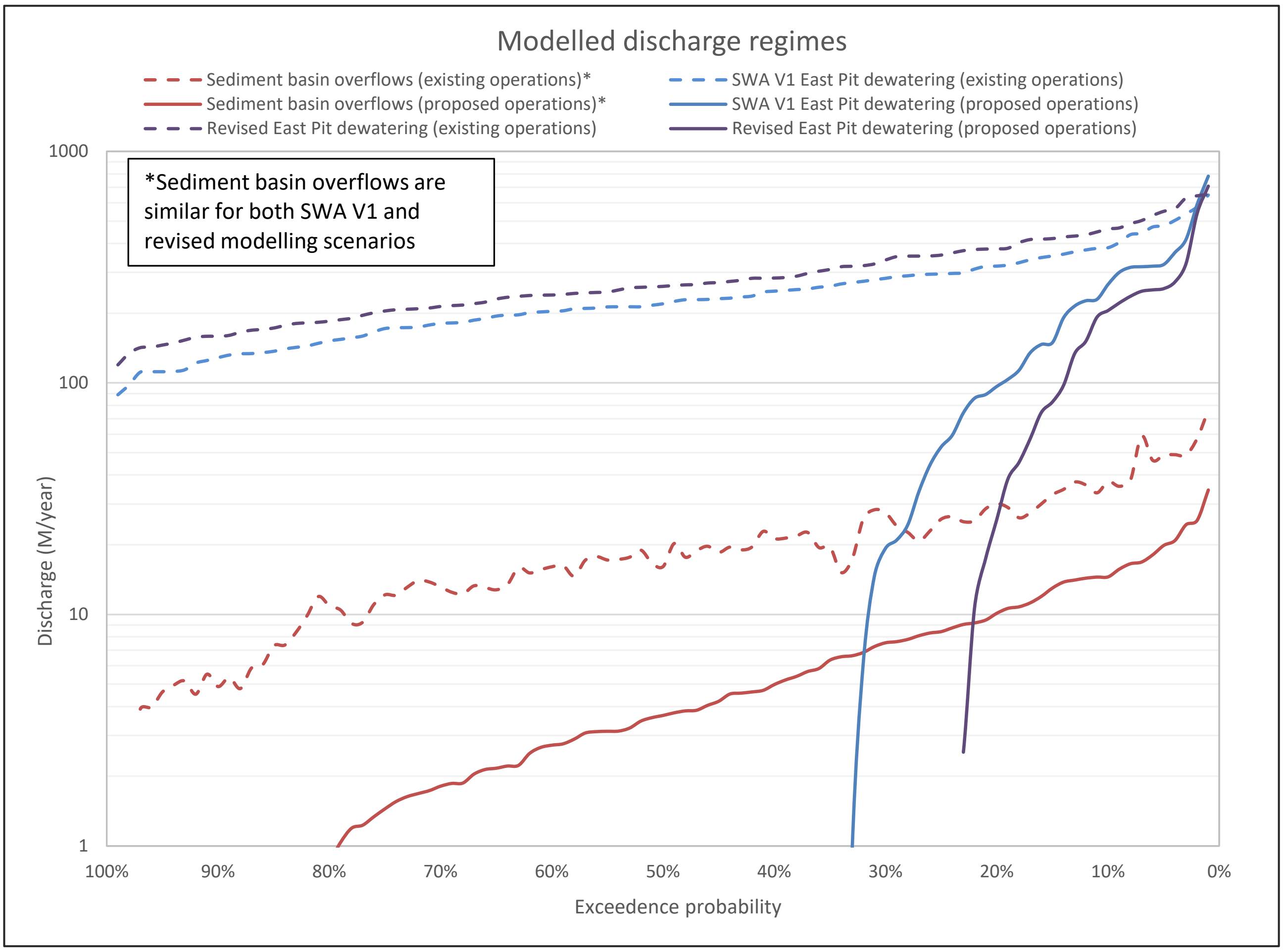


Figure 3.9 Simulated discharge regimes

4 Monitoring program

Due to the limitations of available data, there remains uncertainty in the interpretation of some aspects of the groundwater and surface water regimes, in particular the interaction between groundwater in the palaeochannel and surface water in the East Pit when it is filled. A surface and groundwater monitoring program is proposed to collect data to enable an improved understanding of the surface and groundwater regimes and associated water quality characteristics.

The information collected from the monitoring program will be used for ongoing compliance reporting and to inform a proposed discharge impact assessment (described in the Water RTS).

4.1 Objective

The objectives of the monitoring program are to collect sufficient data to enable:

- water exchange between the palaeochannel and East Pit to be reliably estimated;
- the water quality characteristics of key inflows into the water management system, key water storages and receiving waters to be established; and
- an improved understanding of the site's operational water use.

4.2 Proposed monitoring locations

The proposed monitoring program includes:

- Continuous monitoring of groundwater levels, the In Pit Dam level and runoff from the Eastern Watercourse.
- Surface and groundwater quality monitoring (seasonal and targeted wet weather monitoring).
- Metering of pit dewatering and operational water use.

Table 4.1 provides a detailed description of the proposed monitoring and monitoring locations are shown in Figure 1.3.

Table 4.1 Proposed monitoring

Proposed monitoring	Target location(s)	Purpose
Water level monitoring		
Groundwater • Continuous groundwater level monitoring via data loggers. • Quarterly monitoring via manual measurements.	• 19-DQRC-17 • 19-DQRC-18 • 19-DQRC-21 • 19-DQRC-22 • 19-DQRC-23 • 19-DQRC-24	• Understand the response of the groundwater flow system to rainfall events and pit dewatering/filling. • Understand the natural groundwater level fluctuation. • Provide data to refine the site water balance.

Table 4.1 Proposed monitoring

Proposed monitoring	Target location(s)	Purpose
Surface Water Continuous surface level monitoring via data loggers	• In Pit Dam (East Pit) • Eastern Watercourse • Main settling pond	• Improve understanding of palaeochannel/East Pit water exchange regimes. • Understand runoff regimes. • Record overflows. • Provide data to refine the site water balance.
Water quality monitoring		
Groundwater • Quarterly (seasonal) samples • Up to four samples per year during or shortly after wet weather events[1] Note groundwater monitoring will be undertaken at the same time as surface water monitoring (refer below). A proposed analytical suite is provided in Table 4.2.	• 19-DQRC-17 • 19-DQRC-18 • 19-DQRC-21 • 19-DQRC-22 • 19-DQRC-23 • 19-DQRC-24	Water quality monitoring will aim to: • Characterise the water quality of different inflow sources to the water management system. • Characterise receiving water quality. • Inform the proposed discharge impact assessment (see Water RtS (EMM 2022))
Surface water • Quarterly (seasonal) samples • Up to four samples per year during or shortly after wet weather events[1] Note groundwater monitoring will be undertaken at the same time as surface water monitoring (refer below). A proposed analytical suite is provided in Table 4.2.	• East Pit; • Eulomogo Creek upstream and downstream of the site; • Main Settling Pond; and • Eastern Watercourse (wet weather monitoring only).	
Water metering		
• East pit dewatering • Operational water use	• East pit dewatering • Operational water use	• To improve understanding of operational water use and pit dewatering volumes

Notes: 1. Wet weather sampling will only be undertaken following wet weather events that produce sufficient rainfall to generate material runoff into the water management system. It is expected that at least 30 to 50 mm of rain over several days will be required. Wet weather sampling will comprise the collection of the following samples: Sample 1 is to be collected from all locations during or shortly after runoff. Sample 2 is to be collected 3 to 5 days after runoff has ceased. Four samples (ie from two independent events) are to be collected over a 12 month period.

4.3 Water quality analytes

Table 4.2 presents the proposed analytical suite for the surface and groundwater quality sites. Physical and chemical stressors (with the exception of nutrients and total suspended solids) are recommended to be monitored in situ with a calibrated hand-held water quality meter. All other parameters are recommended to be analysed at a laboratory accredited by the National Association of Testing Authorities (NATA).

Table 4.2 Proposed monitoring analytes

Category	Parameters	Analysis method
Physical and chemical stressors	Dissolved oxygen, electrical conductivity, pH, total dissolved solids, turbidity	In situ with a calibrated hand-held water quality meter
	Total suspended solids	Analysis undertaken at NATA accredited laboratory
	Ammonia, oxidised nitrogen (NOx), total Kjeldahl nitrogen, total nitrogen, reactive phosphorus, total phosphorus	Analysis undertaken at NATA accredited laboratory
Dissolved metals	Aluminium, arsenic, boron, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc	Analysis undertaken at NATA accredited laboratory
Other	Total hardness	Analysis undertaken at NATA accredited laboratory

All monitoring will be undertaken in accordance with Approved Methods for Sampling and Analysis of Water Pollutants in New South Wales (DEC 2004).

4.4 Program review

Holcim proposes to implement the program over a 12 month period. During this period, it is anticipated that extraction from the East Pit will cease and the pit will be allowed to begin to fill. The program will be reviewed after 12 months.

5 Aquifer interception & water licensing

5.1 Aquifer interception

The NSW Aquifer Interference Policy (AIP) requires assessment of aquifer interception against minimal impact considerations. The quarry overlies the Gunnedah-Oxley Basin MDB Groundwater Source (Figure 5.1).

The existing East Pit intercepts groundwater within the basalt and palaeochannel HSUs. The East Pit development was approved under Development Consent SPR79/22 (existing consent), granted by the former Talbragar Shire Council on 18 March 1980. The proposed cessation of extraction in the East Pit under the project will allow the In Pit Dam to fill and reduce the groundwater take from the intersected palaeochannel. The efficacy of this management system will be assessed annually as part of standard reporting requirements for the quarry.

The proposed WEA and SEA will temporarily intersect groundwater following recharge events when the groundwater pressure rises above the depth of extraction. The available data shows that, within the basalt, groundwater pressure heads can remain elevated for one to two months following wet weather events (Figure 2.1).

Saturated fractures intercepted by extraction at the WEA and SEA will quickly dewater, reducing pressure in the surrounding rock. The influence of this depressurisation (drawdown) will be tightly confined around the excavations. Fractures (where present) will extend the cone of drawdown; however, the low bulk transmissivity of the basalt limits the propagation of drawdown. Drawdown is not anticipated 200 m outside the extraction limits of the SEA and WEA.

The intercepted basalt is a 'less productive groundwater source' in accordance with the *Water Management (General) Regulation 2018.* Based on the collected drilling data, hydraulic testing data and desktop analysis the proposed activities will:

- have no impact to the water table (or pressure head) 40 m from any:
  - high priority groundwater dependant ecosystem; or
  - high priority culturally sensitive site; and
- not materially change the water quality of the groundwater source.

There are no third-party registered groundwater bores within 200 m of the SEA. The closest registered groundwater bore to the WEA is GW066567 is ~200 m to the south (WaterNSW online data, June 2021). GW066567 was drilled to 30 m and obtained a stock and domestic water supply, reported at 2.1 L/sec. This bore is up hydraulic gradient from WEA and close to the existing East Pit (refer to the EIS, Figure 6.12). Closure of East Pit is expected to have the prevailing influence on the groundwater level at GW066567, increasing water levels in the vicinity.

The drawdown (and pit inflows) will be evaluated annually using data collected from an ongoing monitoring program designed to evaluate conclusions of this assessment (see Chapter 4).

5.2 Groundwater licensing

Holcim holds a water access licence (WAL) 34573 with an annual entitlement of 90 megalitres (ML) from the Gunnedah-Oxley Basin MDB Groundwater Source. The nominated works approval (80WA716742) linked to WAL 34573 licences excavation on Lot 222, DP 1247780 as the extraction point (ie the existing quarry).

The revised water balance (for existing operations) models a groundwater inflow range of 209 to 227 ML/year (Table 3.2). This modelled range does not represent actual inflows in any one year, it represents the possible inflows for 10th and 90th percentile rainfall years based on 100 years of climate data and the current site layout. The actual water take is not known due to current data limitations (dewatering rate, sump dam level, transient groundwater level).

The revised water balance (for proposed operations) models a groundwater inflow range of 30 to 77 ML/year (Table 3.3). This range is within the licensed annual entitlement of 90 ML. Therefore, should the proposed water management regime at East Pit be approved, Holcim may not require additional groundwater entitlements for ongoing operations.

It is proposed that the actual water take is confirmed via the water balance method after 12 months of monitoring and reported in the Annual Environmental Management Report (AEMR). The water balance will be calibrated to data collected during that year (refer Chapter 4). Should the reported (actual) water take exceed the held entitlement (90 ML) Holcim will commit to purchase additional licence entitlements either on the market (temporary or permanent trade) or via the next Controlled Allocation Order (CoA). The 2020 CoA allocated 4,043 unit-shares for purchase in the Gunnedah-Oxley Basin MDB Groundwater Source. This indicates there is sufficient depth in the market to licence the maximum modelled range.

5.3 Surface water licensing

5.3.1 Excluded works

Dams that are solely for the capture, containment or recirculation of drainage, consistent with best management practice to prevent the contamination of a water source, and that are located on a minor stream, are considered to be excluded works under Schedule 1, item 3 of the NSW Water Management (General) Regulation 2018. The storages that form the existing and proposed operations water management system at the quarry are considered to be excluded works under this definition as the primary use of the storages are for water quality control by capturing sediment-laden runoff and retaining sediment to prevent pollution of the downstream receiving environment.

Water stored within the water management system is proposed to be used for dust suppression activities and to supply the processing plant. The take of water from the water management system is exempt from requiring a licence under Schedule 4, item 12 of the NSW Water Management (General) Regulation 2018.

5.3.2 Eastern watercourse

The eastern watercourse is an ephemeral drainage line that receives runoff from a 227 ha catchment to the east of the quarry. The watercourse flows infrequently; however, when significant rainfall occurs, runoff from this watercourse is captured in the East Pit.

Holcim has recently acquired a WAL 43440 for 136 ML of surface water entitlement within the Maryvale Geurie Creek Water Source regulated by the *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources*. This WAL amount was calculated via a method agreed with WaterNSW (relevant correspondence is provided in Appendix B to the Water RtS). The WAL, combined with the quarry's harvestable right, exceed the calculated surface water take from the Eastern Watercourse by the quarry (using the agreed method).

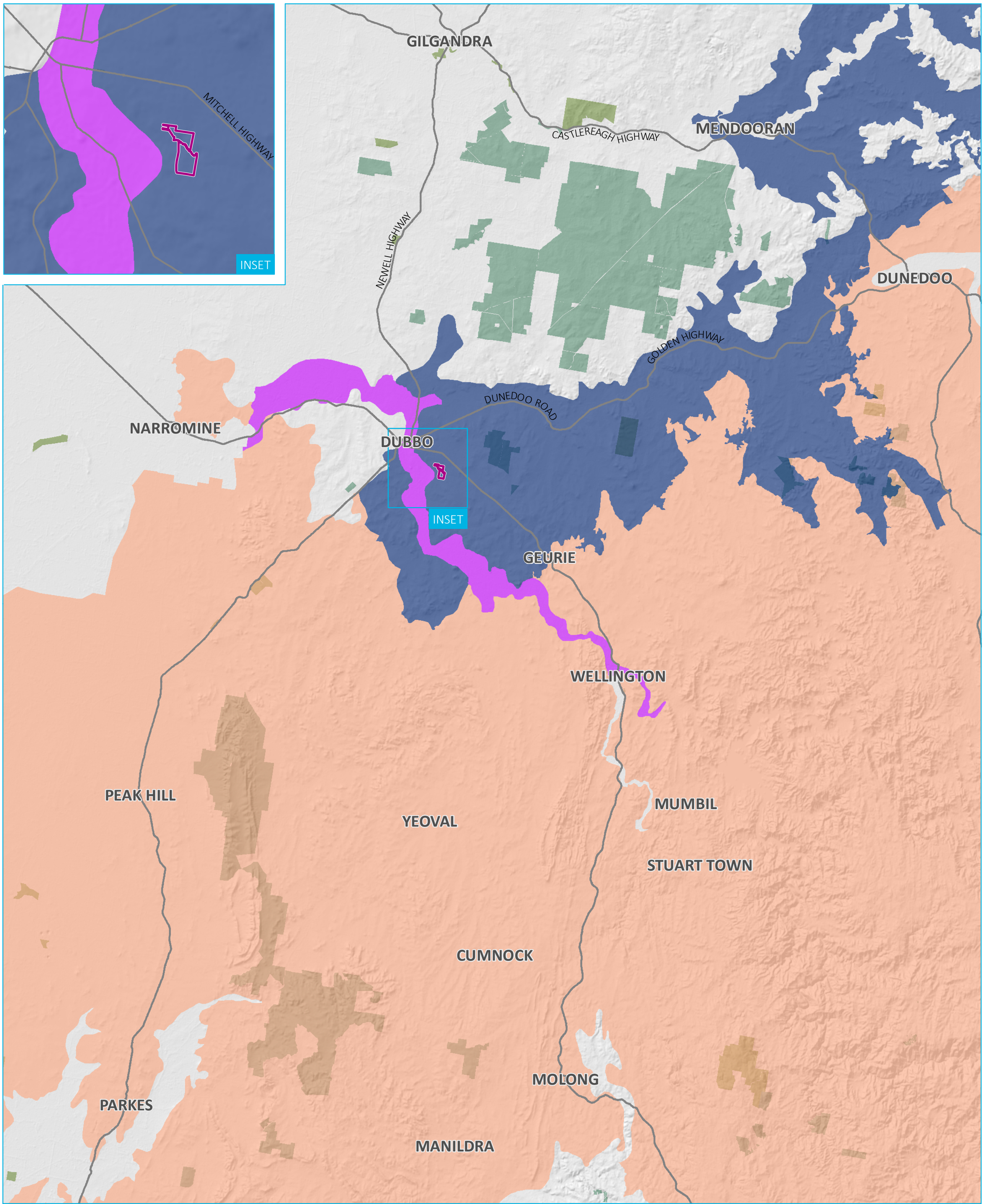
Table 5.1 is reproduced from the SWA (EMM 2020) and provides a break-down of the calculated water take and entitlements.

Table 5.1 Calculated water take and entitlements

	Volume	Methodology
Calculated water take	136 ML	Calculated as the Eastern watercourse catchment area (227 ha) x the Maximum Harvestable Rights Dam Capacity (MHRDC) (0.06 ML/ha) x 10[1]
Calculated water entitlement		
WAL	136 ML	WAL 43440
Harvestable right	8 ML	Calculated as Holcim's landholdings[2] (140 ha) x the MHRDC (0.06 ML/ha)
Total entitlement	144 ML	

Notes:

1. The calculation of water take using the MHRDC extrapolation methods was discussed and agreed with WaterNSW via email correspondence dated 30 March 2020.
2. Refers to the landholdings for the expanded operations.



Source: EMM (2020); DFSI (2017); GA (2011); ASGC (2006)

KEY

- Project area
- Upper Macquarie Alluvial Groundwater Source
- Lachlan Fold Belt MDB Groundwater Source
- Gunnedah-Oxley Basin MDB Groundwater Source
- Major road
- NPWS reserve
- State forest

Groundwater sources

Dubbo Quarry Continuation Project
Water Assessment Addendum
Figure 5.1

creating opportunities

References

Department of Planning, Industry and Environment (DPIE) 2019, *NSW Murray-Darling Basin Porous Rock Resource Description* July 2019

EMM Consulting Pty Ltd, *Dubbo Quarry Continuation Project: Surface Water Assessment*, 2020

Environmental Earth Sciences 2013, *Dubbo Zirconia Project, Groundwater Assessment* September 2013

Hvorslev M.J. 1951, *Time Lag and Soil Permeability in Ground-Water Observations*, Bull. No. 36, Waterways Exper. Sta. Corps of Engrs, U.S. Army, Vicksburg, Mississippi, pp. 1-50

Marinelli F. Niccoli W. 2000, *Simple Analytical Equations for Estimating Ground Water Inflow to a Mine Pit,* March 2000 Ground Water 38(2):311-314

Parsons Brinckerhoff 2003 *Hydrogeological Investigations for Industrial Candidate Area No.4 Dubbo* Technical report to Dubbo City Council dated February 2003

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Attachment A

Bore construction details

A.1 Bore construction details

The pertinent bore construction details are provided in Table 5.2.

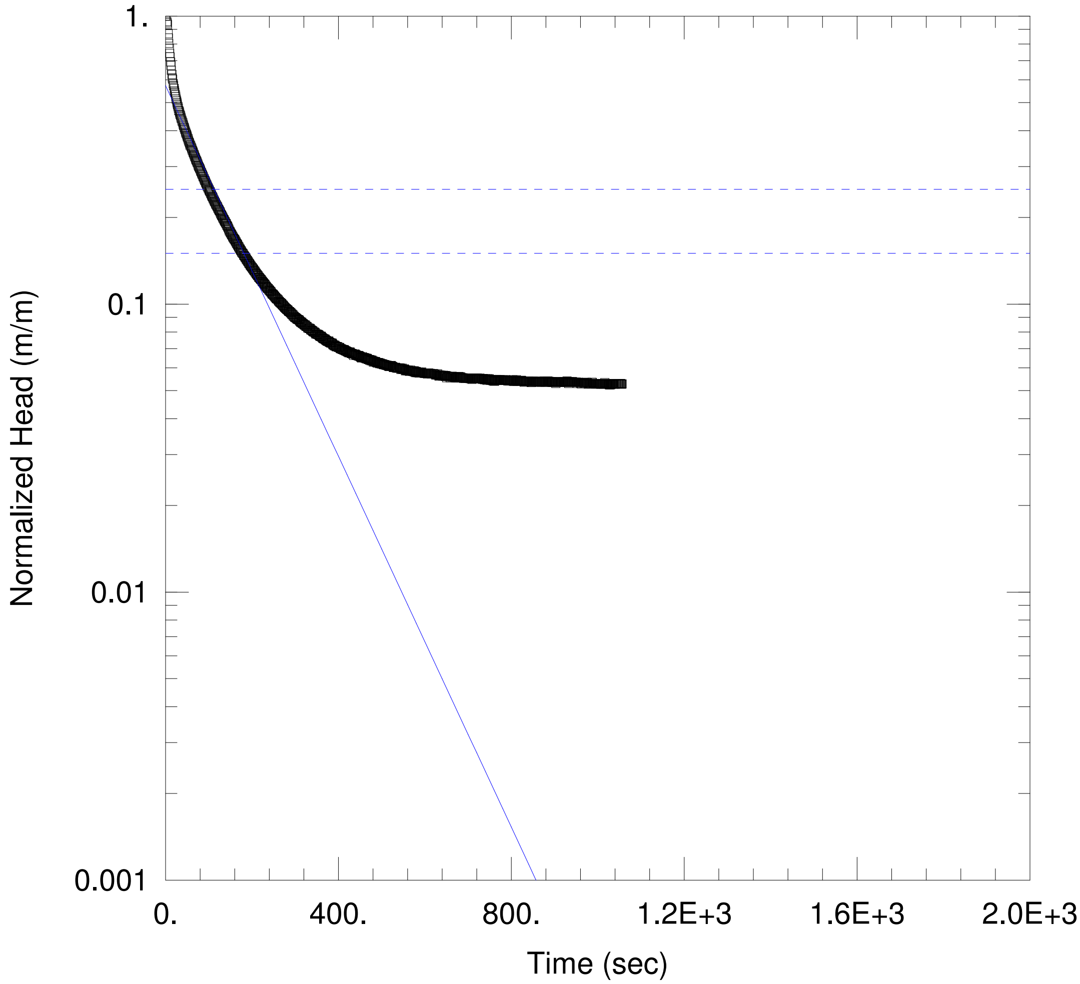
Table 5.2 Bore construction details

Bore ID	Bore depth (mbgl)	Bore depth (mAHD)	Screened interval (mbgl)	Screened interval (mAHD)	Screened unit	Water level (mbgl)	Water level (mAHD)
19-DQRC-17	31	273.7	23-29	282-276	Palaeochannel	25.5	280.6
19-DQRC-18	20	284.9	13-19	292-286	Basalt	17.3	288.6
19-DQRC-19	27	277.2	19.5-25.5	284.7-278.7	Palaeochannel	26.2	279.2
19-DQRC-20	22.7	281.5	15.7-21.7	288.5-282.5	Basalt	Dry	>280.5
19-DQRC-21	40	263.8	31.2-37.2	272.6-266.6	Basalt/Palaeochannel	22.2*	284.8*
19-DQRC-22	28.5	267.1	21.9-24.9	273.7-270.7	Palaeochannel	21.7	275.2
19-DQRC-23	19	276.4	11-17	284-278	Basalt	15.4	281.2
19-DQRC-24	20.3	283.3	13.3-19.3	290.3-284.3	Basalt	19.7	285.1

Note: mbgl = meters below ground level, mAHD = meters Australian Height Datum
* Water level reported for April 2021.

Attachment B

Hydraulic conductivity testing



WELL TEST ANALYSIS

Data Set: \...\22 rising_NB_V2.aqt
Date: 05/17/21 Time: 19:39:46

PROJECT INFORMATION

Company: EMM Consulting
Client: Holcim
Location: Dubbo Quarry
Test Well: 19-DQRC-22
Test Date: 20/04/2020

AQUIFER DATA

Saturated Thickness: 7.065 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 20.01 m Static Water Column Height: 7.065 m
Total Well Penetration Depth: 24.9 m Screen Length: 3. m
Casing Radius: 0.025 m Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 0.3656 m/day y0 = 11.48 m

Attachment C

WAL 34573

Information about a water licence or approval

Use this tool to search for information about water licences and approvals issued under the *Water Act 1912* or *Water Management Act 2000*.

Select the type of licence or approval and enter the licence or approval number:

- **Water access licence (WAL):** a WAL number starts with the letters 'WAL' followed by several numbers; a WAL also has a reference number that starts with a two digit number, followed by 'AL' and then several numbers.
- **1912 water licence:** a water licence number starts with a two digit number, followed by a two letter code and then several numbers. Note: a PT reference number cannot be entered.
- **Approval:** an approval number starts with a two digit number, followed by a two letter code (WA, UA, CA or FW) and then several numbers.

Search for information about either a:

◉ **Water access licence (WAL) issued under the *Water Management Act 2000***

Water Access Licence (WAL) Number WAL 34573

A WAL number starts with the letters 'WAL' followed by several numbers

Can't find your WAL number? Do you have a reference number? A reference number starts with a two digit number, followed by 'AL' and then several numbers. Use the following tool to find your WAL by entering your reference number. Enter the reference number to find the WAL number.

Notes:

The search results will list the conditions imposed on the water access licence. Any approved water supply work/s nominated on the water access licence are identified by the approval number/s for the work/s.

The information about a water access licence provided in the search results is a summary and may not always be up to date. If you require full and up to date details about a particular water access licence (including current holders, share and extraction component details, and dealing registrations) you should search the Water Access Licence Register administered by NSW Land Registry Services.

○ *Water Act 1912* Licences and Authorities

○ Approval issued under the *Water Management Act 2000*

Help us help you

We would appreciate your feedback about the NSW Water Register. Please complete the short feedback form. Your feedback will tell us what is working and what we can improve. Information you provide will remain confidential.

Find out if a *Water Act 1912* licence has been converted

○ Water licence conversion status

« Previous   Search   Print   Export

Search Results

Category [Subcategory]	Status	Water Source	Tenure Type	Management Zone	Share Components	IDEC (Daily

					(units or ML)	flow shares)
Aquifer	Current	Gunnedah-Oxley Basin Mdb Groundwater Source	Continuing	Gunnedah - Oxley Basin Mdb (Other) Management Zone	90.00	

Extraction Times or Rates

Subject to conditions water may be taken at any time or rate

Nominated Work Approval(s)

80WA716742

- Conditions

Plan Conditions

Water sharing plan	NSW Murray Darling Basin Porous Rock Groundwater Sources 2020
	Take of water
MW7035-00006	The maximum water allocation that may be carried over in the water allocation account from one water year to the next water year is 0.25 ML/unit share of the access licence share component.
MW7032-00008	The maximum water account debit in a water year must not exceed the following: A. 1.25 ML/unit share of the access licence share component or, if applicable, a lower amount determined by the Minister, plus B. the net amount of water allocations assigned to or from the water allocation account under a water allocation assignment in the that water year, plus C. any water allocations re-credited by the Minister to the water allocation account in that water year.
	Monitoring and recording
MW6977-00002	Until 1 December 2021, the following information must be recorded in the logbook for each period of time that water is taken: A. date, volume of water taken, start and end time when water was taken, and B. the access licence number under which the water is taken, and C. the approval number of the water supply work used to take the water, and D. the purposes for which water is taken. This requirement does not apply if water is taken through a water supply work that has both an operational: E. meter that complies with Australian Standard AS 4747-Meters for non-urban water supply, and F. data logger.
MW6979-00002	Until 1 December 2021, the volume of water taken in a water year must be recorded in the logbook at the end of each water year. The maximum volume of water permitted to be taken in that water year must also be recorded in the logbook. This requirement does not apply if water is taken through a water supply work that has both an operational: A. meter that complies with Australian Standard AS 4747 - Meters for non-urban water supply, and B. data logger.
MW6612-00001	A logbook used to record water take information must be retained for five (5) years from the last date recorded in the logbook.
	Reporting
MW6983-	A. Once the water access licence holder becomes aware of a breach of any condition on this water

00003	access licence, the water access licence holder must notify the Minister as soon as practicable. B. If the initial notification was not in writing, written notice must be provided within seven days of becoming aware of the breach by emailing: nrar.enquiries@nrar.nsw.gov.au

Other Conditions

NIL

Attachment D

Revised Surface Water Assessment (V2)

Surface Water Assessment

Dubbo Quarry Continuation Project

Prepared for Holcim (Australia) Pty Ltd
June 2022

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Surface Water Assessment

Dubbo Quarry Continuation Project

Report Number

J180313 RP#

Client

Holcim (Australia) Pty Ltd

Date

28 June 2022

Version

v4 Final

Prepared by

Pat Carolan
Senior Water Resources Engineer
28 June 2022

Approved by

Chris Kuczera
Associate Water Resources Engineer
28 June 2022

Executive Summary

ES1 Project context

Holcim (Australia) Pty Limited (Holcim) is the owner and operator of Dubbo Quarry (the quarry) located on Sheraton Road, Dubbo. The quarry extracts hard rock (basalt) and has been operating since 1980. The accessible basalt resources are close to exhaustion and planning approval is required to allow the quarry to continue operating. Holcim is, therefore, seeking approval for the Dubbo Quarry Continuation Project (henceforth referred to as 'the project') which involves the continued operation of the quarry through the development of two new resource areas to the south and west of the existing quarry boundary.

The project is classified as State significant development under Part 4, Division 4.1 of the NSW *Environmental Planning Assessment Act 1979*.

This Surface Water Assessment supports the EIS for the project. It describes the existing surface water environment, the water management systems for existing and proposed operations, residual impacts and water licensing requirements. The assessment has been prepared in accordance with the Secretary's Environmental Assessment Requirements for the project, issued 24 April 2020, and considers relevant government and industry guidelines.

ES2 Local watercourses

The quarry is located within the Eulomogo Creek catchment. Eulomogo Creek is a 3rd order watercourse that has 52 km² catchment area (upstream of the quarry) and an intermittent flow regime. Eulomogo Creek flows in a westerly direction and joins the Macquarie River approximately 2.7 km to west of the quarry.

Two ephemeral 1st order watercourses flow into the existing quarry pit. These watercourses are referred to as the eastern and northern watercourses in this report and are described further below.

The eastern watercourse has a 227 ha catchment area that extends to the east of the quarry. Runoff from the eastern watercourse is captured in a dam located to the east of the existing quarry. Overflows from this dam enter the quarry pits.

The northern watercourse has a 270 ha catchment area that extends to the north of the quarry. All runoff from this catchment is captured in the South Keswick Quarry's water management dams. Any overflows from these dams will enter the quarry pits.

ES3 Water management summary

ES3.1 Existing system

The existing water management system receives inflows from:

- runoff from the quarry area;
- runoff from the eastern watercourse catchment; and
- groundwater inflows into quarry pits.

The system provides water for operational uses which include process plant and haul road dust suppression. Discharges from the water management system occur due to sedimentation dam overflows and dewatering quarry pits. Water balance model results presented in Chapter 4 indicate that operational water requirements are generally lower than inflows, meaning that discharges occur in most years.

ES3.2 Proposed strategy

Holcim is proposing to integrate the water management systems for the two expansion areas with the quarry's existing water management system. This will require construction of new infrastructure, some modifications to existing infrastructure and new operating principles for the quarry.

ES3.2.1 Objectives

A water management strategy for the proposed operations is documented in this report. The key objectives of the strategy are to:

- minimise groundwater inflows into quarry pits;
- minimise controlled discharges from quarry pits; and
- provide industry best practice erosion and sedimentation controls for disturbance areas that do not drain to a pit sump.

ES3.2.2 Proposed modifications and new controls

The key modification to the existing system involves generally maintaining water levels in the existing pits at or above levels that restrict groundwater inflow.

Proposed new controls include:

- new pits will not be developed below the interpreted groundwater table. This will avoid any material groundwater inflows; and
- industry best practice erosion and sedimentation controls for disturbance areas that do not drain to a pit sump.

ES3.2.3 Outcomes

Water balance modelling presented in Chapter 5 of this report demonstrates that the water management strategy for the proposed operations will be effective in substantially reducing both the frequency and magnitude of discharges due to sedimentation basin overflows and pit dewatering, with discharges via both mechanisms occurring during wet conditions only and at reduced magnitudes. These reductions will occur despite the quarry footprint increasing from approximately 34 to 60 ha due to the proposed extensions.

ES4 Proposed creek crossing

A haul road crossing of Eulomogo Creek is proposed to connect the southern extension area to the existing operation. Concept designs for two culvert-based options have been prepared by Pitt and Sherry and are provided as Appendix C. A flood impact assessment was also undertaken by GRC Hydro. The assessment identified that the crossing would result in localised impacts within the quarry site.

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Appendices

Tables

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Photographs

1 Introduction

1.1 Overview

Holcim (Australia) Pty Limited (Holcim) is the owner and operator of Dubbo Quarry (the quarry) located on Sheraton Road, Dubbo (refer Figure 1.1). The quarry has been operating since 1980.

Accessible basalt resources within the existing quarry boundary (refer Figure 1.2) are close to exhaustion and planning approval is required to allow the quarry to continue operating. Holcim is, therefore, seeking approval for the Dubbo Quarry Continuation Project (henceforth referred to as 'the project') which involves the continued operation of the quarry through the development of two new resource areas to the south and west of the existing quarry boundary (refer Figure 1.2).

The project is classified as State significant development (SSD) under Part 4, Division 4.1 of the NSW *Environmental Planning Assessment Act 1979* (EP&A Act). This surface water assessment (SWA) originally accompanied the environmental impact statement (EIS) prepared for the project, submitted in February 2021, and updated in March 2022.

1.2 Associated documents and revision updates

The following documents are associated with this SWA:

- *Dubbo Quarry Continuation Project: Surface Water Assessment- Version 1* (EMM 2020) – this document (SWA V1) is the original SWA that was submitted with the EIS in February 2021.
- *Dubbo Quarry Continuation Project: Water Assessments - Response to Submissions* (EMM 2022a) – this document (the Water RtS) provides a response to a submission from the NSW Environment Protection Authority (EPA) and a combined submission from the Department of Planning, Industry and Environment Water (DPIE Water) and the Natural Resources Access Regulator (NRAR).
- *Dubbo Quarry Continuation Project: Water Assessment Addendum* (EMM 2022b) – this document (the Water Addendum) supports the Water RtS and is an addendum to the SWA. It includes additional assessment items required to address submissions and is provided as an appendix to the Water RtS.

This document is a revision to SWA V1. It has been revised to incorporate the updated project description for the existing and proposed operations, which now includes the continued operations in the East Pit and minor changes to the project layout. SWA V2 includes updated descriptions of the existing and proposed water management system and residual impacts. The water balance has also been updated, but is documented in the Water Addendum, along with supporting information.

SWA V1 has been superseded by SWA V2 and the Water Addendum.

1.3 The site

The quarry is located within Dubbo Regional Local Government Area (LGA) approximately 6 km south-east of the city of Dubbo. The quarry is accessed via Sheraton Road which connects to the Mitchell Highway approximately 2 km north-west of the quarry.

The site relates to the following land as shown on Figure 1.2:

- Lot 222 DP 1247780, owned by Holcim; and
- Part Lot 100 DP 628628, under private ownership, for which Holcim proposes to enter into an Access Licence.

Development consent for the quarry was originally granted by Talbragar Shire Council on 18 March 1980 under SPR79/22 (the existing consent). This consent is related to the establishment of a basalt quarry on former Portions 208 and 211, Parish Dubbo (the existing site) and contains eight conditions with no restrictions on production rates or operating hours. Holcim also holds Environment Protection Licence (EPL) No. 2212 for land-based extraction activities between 100,000 and 500,000 tonnes per annum (tpa).

The quarry produces high quality aggregates for use in the construction industry. Typical uses include concrete and asphalt production and road base. Precoated sealing aggregates from crushed basalt are also produced. The quarry produces many types of road base, both specification and non-specification, such as the premium road base product Heavy Duty DGB20 which is frequently used by local councils and Roads and Maritime Services (RMS) for the construction and upgrade of roads.

1.4 Project overview

1.4.1 Project description

The project involves continued operations within the existing site and into two new resource areas as described below (refer Figure 1.2):

- The existing approved disturbance boundary within Lot 222 DP 1247780;
- The Western Extension Area (WEA) which is north-west of the existing quarry, located within Lot 222 DP 1247780 (north and south of Sheraton Road; and
- The Southern Extension Area (SEA) which is south of the existing quarry boundary on the southern side of Eulomogo Creek, located within part Lot 100 DP 628628.

A new haul road and crossing over Eulomogo Creek will also be constructed as part of the project to connect the existing quarry with the SEA. The quarry's access road, which connects to Sheraton Road, is to be relocated around the northern and eastern boundaries of the WEA.

The existing consent for quarry places no restriction on production. However, the existing infrastructure has capacity to produce a maximum of 500,000 tpa. The two proposed extension areas provide sufficient resource for quarry operations to continue for up to 25 years.

1.4.2 Summary of changes from the project described in the EIS

The following project items reflect changes from the project described in the EIS:

- Operations are to continue in the East Pit resulting in the following project changes:
  - an increase in the East Pit extraction boundary which will increase the storage within the East Pit intercept new catchment area currently draining to the Settling Pond;
  - removal of the Pump 2 storage pond and the West Pit Pond;

- relocation of the processing plant to the existing West Pit; and
- slight alterations to product and haul routes.

- Additional project changes provided by Holcim include:
  - an option for the quarry access road to enter the WEA via the current site access route;
  - the haul road to the SEA will be realigned to approach from the East Pit, reducing additional disturbed catchment adjacent the Settling Pond; and
  - conveyors adjacent to the haul roads may be implemented as an option to assist with transport of the resource.

1.5 Report purpose and assessment requirements

This Surface Water Assessment supports the EIS/RtS for the project. It describes the existing surface water environment, the existing and proposed operations water management systems, and residual impacts. The assessment has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) for the project, issued 24 April 2020, and considers relevant government and industry guidelines.

Table 1.1 lists SEARs relevant to this assessment and where they are addressed in this report and/or the Water Addendum.

Table 1.1 SEARs surface water requirements

SEARs	Report section
– a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures;	Chapter 4 Chapter 5 the Water Addendum
– identification of any licensing requirements or other approvals under the *Water Act 1912* and/or *Water Management Act 2000*;	the Water Addendum
– demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP);	Chapter 5 the Water Addendum
– a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo;	Chapter 5 the Water Addendum
– an assessment of any likely flooding impacts of the development;	Chapter 6 Appendix A
– an assessment of the likely impacts on the quality and quantity of existing surface and ground water resources, including a detailed assessment of proposed water discharge quantities and quality against receiving water quality and flow objectives;	Chapter 7
– an assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users; and	Section 6.5 the Water Addendum
– a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts.	Chapter 5

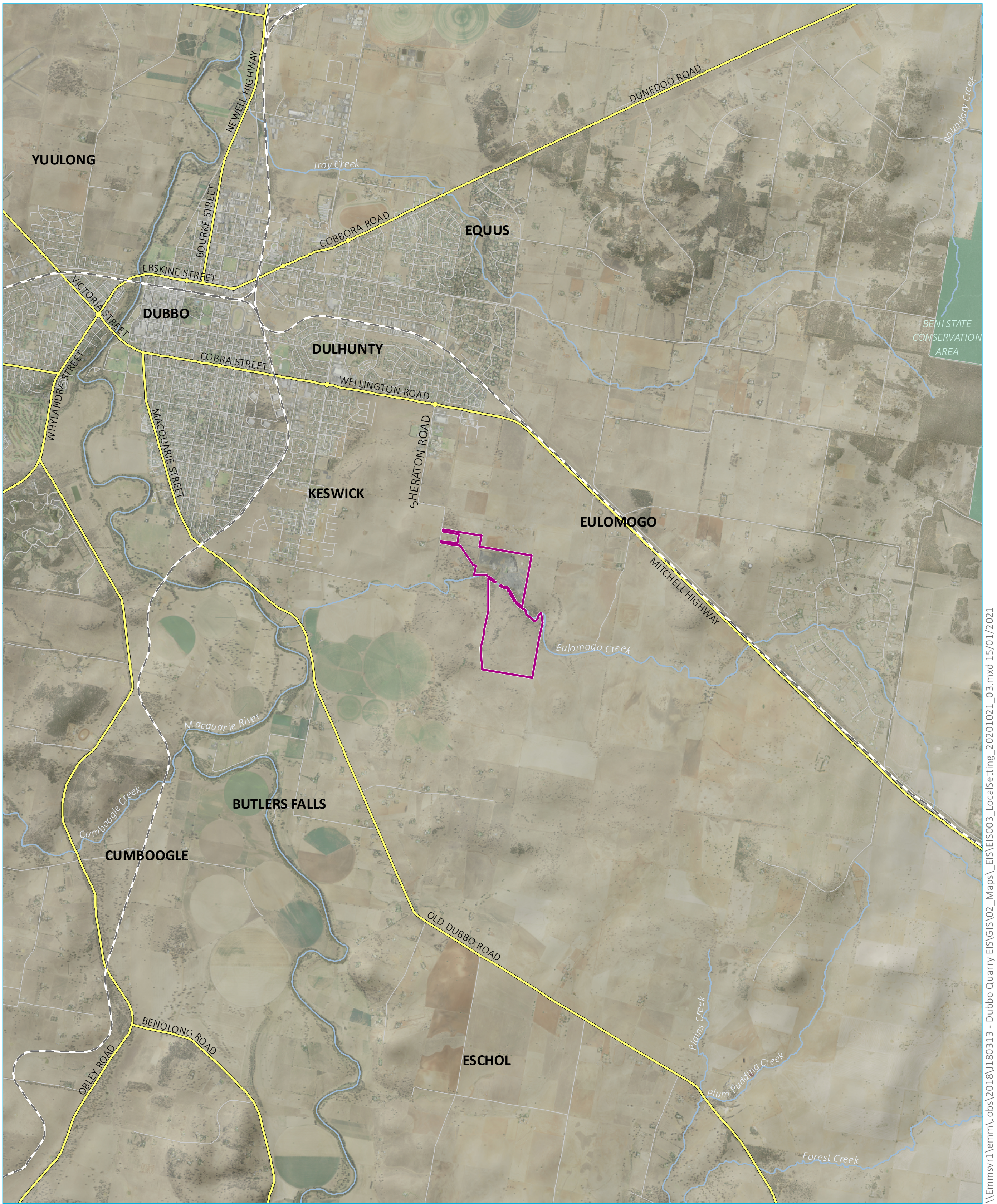
1.6 Report structure

This report is structured as follows:

- Chapter 1 provides an introduction to the project and this report.
- Chapter 2 describes the assessment framework and government and industry and guidelines that have been considered in this assessment.
- Chapter 3 describes the existing environment, as relevant to this assessment.
- Chapter 4 describes the existing water management system.
- Chapter 5 describes the water management strategy for the proposed operations.
- Chapter 6 describes the proposed creek crossing at Eulomogo Creek.
- Chapter 7 describes residual impacts to the surface water environment.

Water licensing (previously reported in Chapter 8 of the SWA V1) is discussed in the Water Addendum.

A flooding assessment prepared by GRC Hydro, a water balance method statement and the Eulomogo Creek crossing concept design drawings are provided as appendices.



DFSI (2017); DFSI (2020); EMM (2020)

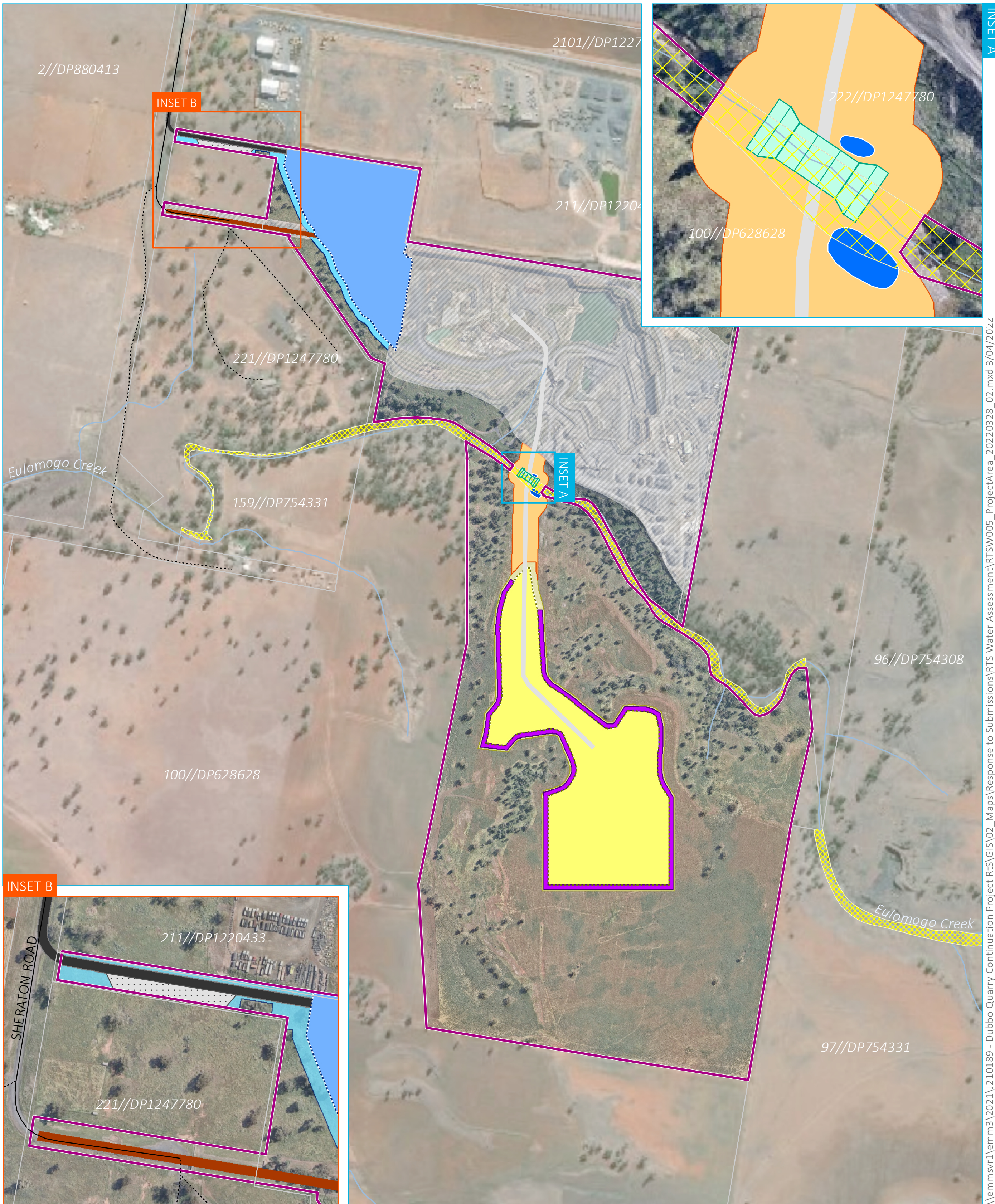
KEY

- Project area
- Rail line
- Major road
- Minor road
- Named watercourse
- NPWS reserve

Local context

Dubbo Quarry Continuation Project
Surface Water Assessment
Figure 1.1

EMM
creating opportunities



Source: EMM (2020, 2022); DFSI (2017); GA (2011); Nearmap (2020)

0 250 500 m
GDA 1994 MGA Zone 55
N

KEY

- Project area
- Sediment pond
- Indicative existing disturbance area
- Existing access road
- Alternative access road
- Alternative truck tarping area
- Bund wall
- Proposed haul road
- Indicative proposed water crossing
- Western extension area
- Western disturbance area
- Haul road disturbance area
- Southern extension area
- Southern disturbance area
- Minor road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- Crown land
- Cadastral boundary (data does not align with surveyed site boundary)

Project site

Dubbo Quarry Continuation Project
Surface Water Assessment

Figure 1.2

EMM
creating opportunities

2 Assessment framework

This chapter describes government regulation, plans and guidelines that have been considered in this assessment.

2.1 NSW regulatory framework

2.1.1 Protection of the Environment Operations Act 1997

The Protection of the Environment Operations Act 1997 (POEO Act) establishes the NSW environmental regulatory framework and includes licensing requirements for certain activities. Environment Protection Licences (EPLs) are administered by the NSW Environment Protection Authority (EPA) under the POEO Act.

EPL 2122 applies to the existing quarry. EPL 2122 does not currently include any discharge points or water quality monitoring requirements.

2.1.2 Water Management Act 2000

The Water Management Act 2000 (WMA 2000) is the relevant statute for the regulation of water take from surface and alluvial water sources. The act provides for water sharing between different water users, including environmental, basic rights or existing water access licence (WAL) holders and provides security for licence holders. The licensing provisions of the WMA 2000 apply to those areas where a Water Sharing Plan (WSP) has commenced.

WSPs are statutory documents that apply to one or more water sources. They define the rules for sharing and managing water resources within water source areas. WSPs describe the basis for water sharing and document the water available and how it is shared between environmental, extractive and other uses. The WSPs outline the water available for extractive uses within different categories, such as local water utilities, domestic and stock, basic landholder rights, irrigation and industrial uses.

The following WSPs are relevant to the site:

- *Water Sharing Plan for Macquarie-Bogan Unregulated River Water Sources 2012* – the Maryvale Geurie Creek Water Source applies to the surface water in the vicinity of the site;
- *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020* – applies to the Gunnedah-Oxley Basin Murray Darling Basin (MDB) Groundwater Source;
- *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2020* – applies to the Lachlan Ford Belt MDB Groundwater Source; and
- *Water Sharing Plan for the Macquarie-Castlereagh Alluvial Groundwater Sources 2020* – applies to the Macquarie Alluvial Groundwater Source.

Water licensing for the existing and proposed quarry is addressed in Chapter 8.

2.2 Relevant guidelines

2.2.1 Guidelines for waterfront land

The WMA 2000 defines waterfront land as the bed of any river, lake or estuary and any land within 40 m of the riverbanks, lake shore or estuary mean high water mark. Controlled activity approvals can be required for works on waterfront land. Guidelines for controlled activities have been prepared by the NSW Department of Planning, Industry and Environment: Water division (DPIE-Water). These guidelines provide information on design and construction principles for controlled activity, and other ways to protect waterfront land.

Controlled activity approvals are not required for the project as it is a SSD. Notwithstanding, the guidelines for controlled activities have been considered for any proposed works on waterfront land.

2.2.2 Stormwater management guidelines

The following guidelines have been applied to the development of the surface water management strategies for the project.

- Erosion and sediment control guidelines: *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004) and Volume 2E (DECC 2008) describe best practice erosion and sediment control methods.
- Bunding and spill management guidelines: *Storing and Handling Liquids: Environmental Protection: Participant's Manual* (DECC 2007) describes best practice storage, handling and spill management procedures for liquid chemicals.

2.2.3 Water quality guidelines

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) provide a framework for:

- assessing and managing water quality for environmental values;
- establishing water quality objectives; and
- establishing protection levels, water quality indicators and trigger values through numerical values and narrative statements.

These guidelines have been applied to establish water quality and environmental values for the project.

2.3 NSW water quality and river flow objectives

The *NSW Water Quality and River Flow Objectives* are provided for catchments throughout NSW (DECCW 2006). Watercourses that can potentially be impacted by the project are in the Macquarie-Bogan River catchment and include Eulomogo Creek and the Macquarie River. Eulomogo Creek is classified as an "Uncontrolled Stream" and the Macquarie River is classified as a "Major Regulated River". Table 2.1 summarises the Water Quality and River Flow Objectives for "Uncontrolled Streams" and "Major Regulated Rivers" and their applicability to the project.

Table 2.1 Water quality and river flow objectives

Environmental value	Objective	Application to Eulomogo Creek and Macquarie River
Water Quality Objectives (Uncontrolled Streams and Major Regulated Rivers)		
Aquatic ecosystems	Maintaining or improving the ecological condition of water bodies and their riparian zones over the long term.	This objective applies to all waterways. This water quality objective is relevant and is assessed in this report.
Visual amenity	Aesthetic qualities of waters.	The objective applies to all waters, particularly those used for aquatic recreation and where scenic qualities are important. This water quality objective is relevant and is assessed in this report.
Secondary contact recreation	Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed.	There is public and private access to downstream waterways. This water quality objective is relevant and is assessed in this report.
Primary contact recreation	Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed.	There is public and private access to downstream waterways. This water quality objective is relevant and is assessed in this report.
Livestock water supply	Protecting water quality to maximise the production of healthy livestock.	Livestock is expected to have access to downstream waterways. This water quality objective is relevant and is assessed in this report.
Irrigation water supply	Protecting the quality of waters applied to crops and pasture.	Some downstream users extract surface water for agricultural purposes. This water quality objective is relevant and is assessed in this report.
Homestead water supply	Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing.	It is expected that local landowners source water for internal homestead use from rainwater tanks. During dry periods, tanks are likely to be replenished using potable water that is delivered via a water tanker. Hence, this water quality objective is not assessed in this report.
Drinking water at point of supply - Disinfection only Drinking water at point of supply - Clarification and disinfection Drinking water at point of supply - Groundwater	These objectives apply to all current and future licensed offtake points for town water supply and to specific sections of rivers that contribute to drinking water storages or immediately upstream of town water supply offtake points. The objective also applies to sub-catchments or groundwaters used for town water supplies.	Town water supply in the region is provided by Dubbo Regional Council. Water is extracted from Macquarie River downstream of the site for town water supply and treated at the John Gilbert Water Treatment Plan in Macquarie Street south.

Table 2.1 Water quality and river flow objectives

Environmental value	Objective	Application to Eulomogo Creek and Macquarie River
Aquatic foods (cooked)	Refers to protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities.	Recreational fishers may use downstream waterways. However, the trigger values for aquatic foods apply to aquaculture not recreational fishing. The required level of protection will be provided by addressing the trigger values for aquatic ecosystems. Hence, impacts to aquatic foods are not assessed in this report.
River Flow Objectives (For uncontrolled streams only)		
Protect pools in dry times	Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows.	The flow regimes of Eulomogo Creek and downstream watercourses have been extensively modified by land clearing, agriculture, extractive activities in the catchment. Discharges from the site will enter Eulomogo Creek. Hence, these river flow objectives are relevant and are assessed in this report.
Protect natural low flows	Share low flows between the environment and water users and fully protect very low flows.	
Protect important rises in water levels	Protect or restore a proportion of moderate flows and high flows.	
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwater supporting natural wetland and floodplain ecosystems.	
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams.	
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems.	
Minimise effects of weirs and other structures	Minimise the impact of instream structures.	The proposed haul road crossing of Eulomogo Creek is an instream structure. Hence, this river flow objective is relevant and is assessed in this report.

2.4 Water quality targets

The *NSW Water Quality and River Flow Objectives* (DECCW 2006) reference Default Guideline Values (DGVs) from ANZECC/ARMCANZ (2000) water quality guidelines. The ANZECC/ARMCANZ (2000) water quality guidelines have been replaced by the ANZG (2018) guidelines, which have a stated long-term objective of providing regional DGVs for the Murray-Darling basin and other regional basins in Australia. These DGVs are yet to be incorporated into the ANZG (2018) guidelines.

The *Macquarie-Castlereagh water quality management plan* (NSW DoI 2018) provides water quality targets for the Macquarie-Castlereagh water resource plan area, which encompasses the site. The targets were developed as part of the Murray-Darling Basin Plan using the methods recommended in the ANZECC/ARMCANZ (2000) guidelines and include targets for water dependent ecosystems, irrigation water use, town water supply and recreational use. As these targets were developed using catchment specific data, they are considered more relevant than the default values referenced in (DECCW 2006) and are, therefore, adopted as DGVs for this assessment.

The water quality targets are presented in Table 2.2. It is noted that catchment scale water quality targets do not make allowance for site specific factors that may influence water quality. Site specific water quality characteristics are discussed further in Section 3.6.

Table 2.2 Water quality targets – Macquarie-Castlereagh water resource plan

Indicator	Target
Targets for water-dependent ecosystems	
Turbidity	The annual median value should be < 20 NTU
Total phosphorus	The annual median value should be < 35 ug P/L
Total nitrogen	The annual median value should be < 600 ug N/L
Dissolved oxygen	The annual median value should be >8 mg/L or within the 90-110% range
pH	The annual median value should be within the 7.0-8.0 range
Temperature	Between the 20th and 80th percentile of the natural monthly water temperature range
Toxicants	The trigger values for slightly-moderately disturbed ecosystems described in the ANZECC/ARMCANZ (2000) guidelines apply.
Salinity	Median value 504 µS/cm 80th percentile 744 µS/cm
Targets for irrigation water	
Salinity	744 µS/cm
Targets for town water supply	
General target	Refers to the targets for raw water supply that are provided in the Australian Drinking Water Guidelines (2011).
Targets for recreational use	
Blue-green algae	• ≥ 10 µg/L total microcystins; or ≥ 50,000 cells/mL toxic Microcystis aeruginosa; or biovolume equivalent of ≥ 4 mm3 /L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume; or • ≥ 10 mm3 /L for total biovolume of all cyanobacterial material where known toxins are not present; or • Cyanobacterial scums consistently present.

3 Existing environment

This chapter provides information on the existing environment as relevant to this Surface Water Assessment. It is noted that the existing water management system is described separately in Chapter 4.

3.1 Land use

i Proposed extension areas

The SEA and WEA are currently predominantly cleared agricultural lands managed as pasture.

ii Surrounding areas

Land-use practices surrounding the site include the South Keswick Quarry to the immediate north, Neoen Energy's South Keswick Solar Farm further north, and rural residential properties. More distant land uses include: low-density housing approximately 1.5 km to the west; a school precinct on Sheraton Road; a commercial precinct at the intersection of Sheraton Road and the Mitchell Highway; and an aged care facility further west.

To the west of the site, a residential subdivision (Southlakes Estate) is under development by Maas Group. This is approved to extend to within approximately 1.4 km west of Sheraton Road. In addition, a 51 lot low-density residential subdivision of Lot 1 DP 880413 was approved by Council (DA ref: D2016-363) in July 2019. This is located immediately west of the South Keswick Solar Farm, approximately 350 m north-west of the proposed quarry access road off Sheraton Road.

3.2 Topography

Topography in and around the site features undulating slopes and plains ranging in elevation from 280–310 m Australian Height Datum (AHD) predominantly on a westerly aspect, with local relief along Eulomogo Creek and within the existing quarry void.

3.3 Climate

The climate of Dubbo is classified as warm temperate. Summers are hot with an average maximum temperature of 31.9–33.0°C. Winters are cold with an average minimum temperature of 2.6–4.1°C. Long-term monthly average rainfall in Dubbo ranges from 42.7–60.7 mm.

Patched point climate data was obtained from the Scientific Information for Land Owners (SILO) database hosted by the Science Division of the Queensland Government's Department of Environment and Science. SILO patched point data is interpolated estimates of rainfall calculated using data from Bureau of Meteorology (BOM) weather stations. For this assessment, SILO data was obtained for the SILO grid point located nearest the site.

Key information and statistical data from the historical SILO patched point data between 1919 and 2019 are presented in Table 3.1. The average monthly rainfall and evaporation rates determined from the SILO data are shown in Figure 3.1.

Table 3.1 Key climate statistics

Key annual statistic	Units	Rainfall	Evaporation
Average	mm/year	586	1,793
Minimum	mm/year	245	1,469
5th percentile	mm/year	328	1,616
10th percentile	mm/year	344	1,649
Median	mm/year	582	1,763
90th percentile	mm/year	798	1,953
95th percentile	mm/year	933	2,063
Maximum	mm/year	1,320	2,160

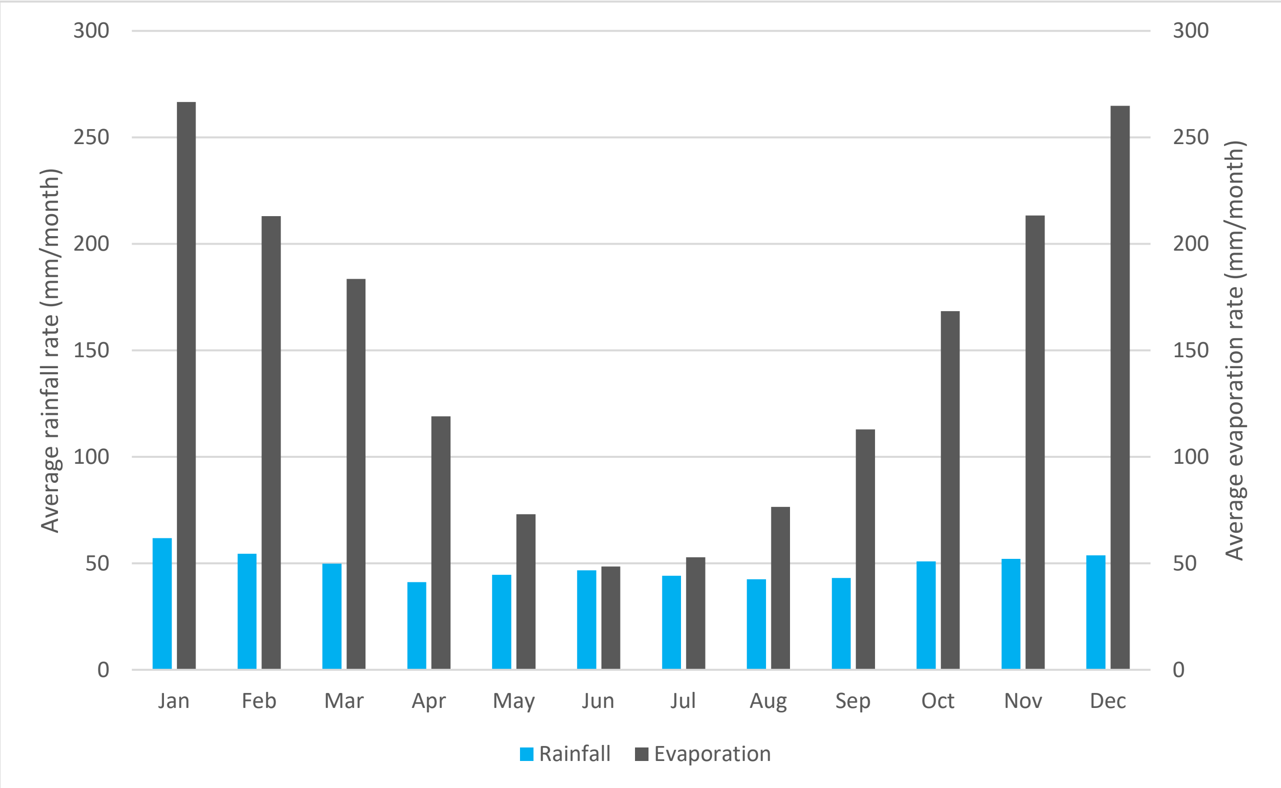


Figure 3.1 Average daily rainfall and evaporation rates

3.4 Geology

The site lies within the Brigalow Belt South Bioregion, and predominantly falls within the Talbragar Basalts ecosystem and Dubbo Basalts landscape unit. The topography of the Dubbo Basalts landscape unit is characterised by slightly elevated plains and low hills on flat lying Tertiary volcanics (basalt and trachyte).

The geology of the site is dominated by basalt deposits and outcropping, with areas of sandstone outcrops. Soils are characterised by friable surface soils with moderate to high susceptibility to erosion. Undisturbed soils typically comprise strongly structured reddish-brown friable or cracking clay loams and light clay topsoils, with a dark reddish-brown clay subsoil at 40 cm.

3.5 Watercourses

The following watercourses are located within the site:

- Eulomogo Creek is a 3rd order watercourse that flows in a westerly direction towards the Macquarie River. The creek is located to the south of the existing quarry. The SEA will be located to the south of the creek and a crossing is proposed for a haul road that will provide access between the existing quarry and the SEA.
- Two 1st order watercourses flow into the existing quarry pits.

These watercourses are shown in Figure 3.2 and discussed further below.

i Eulomogo Creek

The site is within the Eulomogo Creek catchment which has a 52 km² catchment area that extends to the east of the quarry. The catchment is characterised by undulating topography that has been extensively cleared. Current land uses are predominantly agriculture (grazing and cropping) but also include a solar farm, hard rock quarries and a rural residential complex that is in the upper portion of the catchment. Downstream of the quarry, Eulomogo Creek flows in a westerly direction and joins the Macquarie River approximately 2.7 km to west of the site.

The Eulomogo Creek catchment is ungauged. However, it is known to have an intermittent flow regime; meaning that, during an average rainfall year, streamflow will occur for most of the year but may cease for weeks or months, typically in late summer or early autumn. Streamflow would also cease for extended periods of time during dry periods.

In the vicinity of the quarry, Eulomogo Creek has a confined channel that is bedrock controlled. The longitudinal grade of the channel is approximately 0.9% and the channel width (when the creek is in flood) ranges from 20 to 35 m. The channel banks and immediately riparian zone are vegetated with native and exotic species. Photograph 3.1 shows a typical section of the creek.

Photograph 3.1 Typical sections of Eulomogo Creek

A flood assessment was undertaken by GRC Hydro for Eulomogo Creek. The assessment described flooding within Eulomogo Creek as being confined to the channel and immediate overbank areas. No flood waters are predicted to enter existing or proposed quarry pits or impact existing or proposed infrastructure.

Chapter 6 provides a summary of this assessment and includes further information on existing flood characteristics. The GRC assessment is provided as Appendix A.

ii Local watercourses

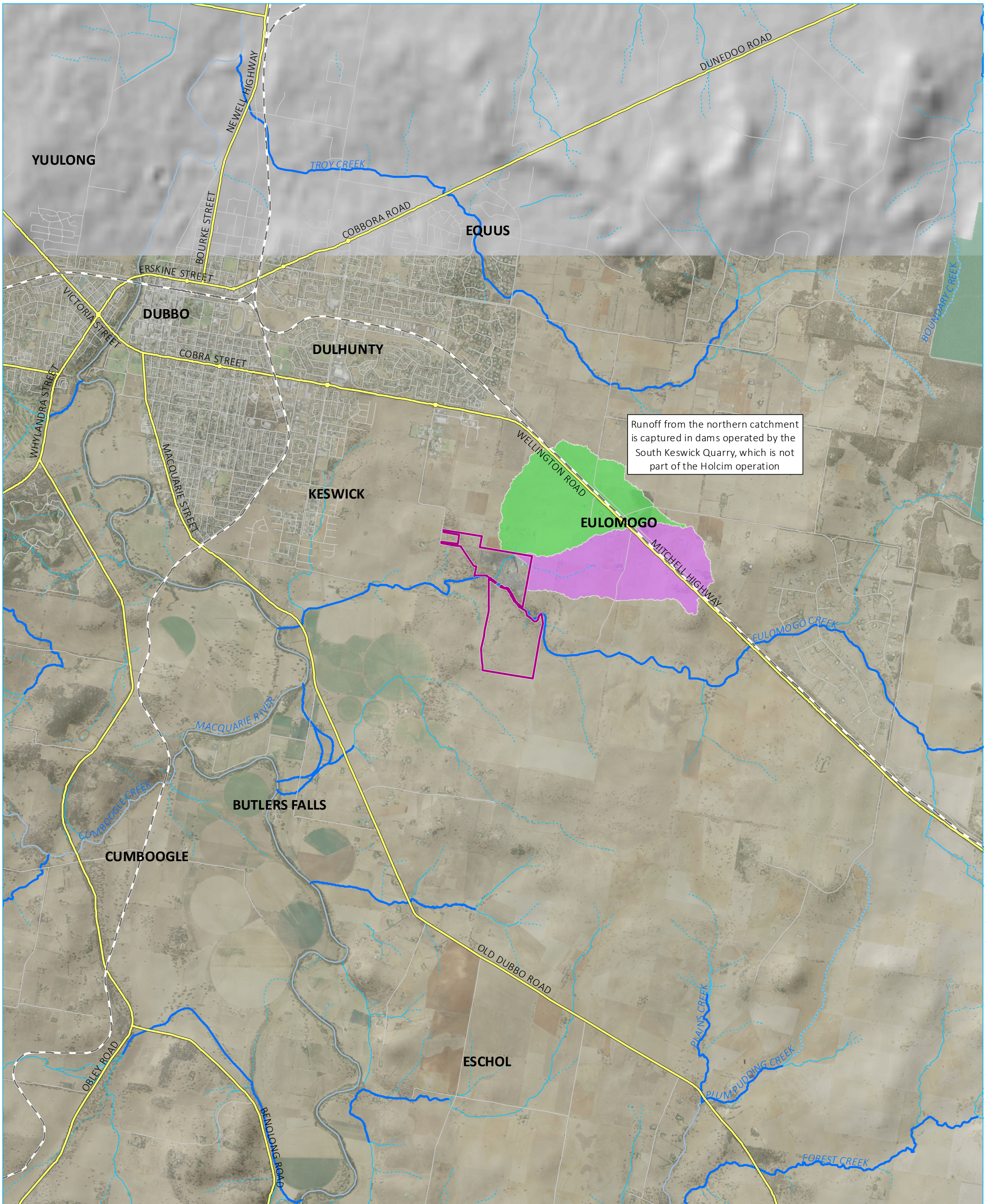
Two 1st order watercourses flow into the existing quarry pit. These watercourses are referred to as the eastern and northern watercourses in this report and are described further below.

The Eastern watercourse has a 227 ha catchment area that extends to the east of the quarry. The watercourse is known to have an ephemeral flow regime which means it only flows following significant rainfall. Runoff from this watercourse is captured in a dam located to the east of the existing quarry (see Photograph 3.2). Overflows from this dam enter the East Pit (see Section 4.1 for further discussion).

The northern watercourse has a 270 ha catchment area that extends to the north of the quarry. The catchment area includes the South Keswick Solar Farm Solar Farm and Quarry. The watercourse is known to have an ephemeral flow regime and only flows following significant rainfall. All runoff from this catchment is captured in the South Keswick Quarry's water management dams. Any overflows from these dams will enter the East Pit (see Section 4.1 for further discussion).

There are no watercourses in the WEA and SEA. All runoff from these areas flows into Eulomogo Creek via ephemeral drainage lines.

Photograph 3.2 Eastern watercourse



\\Emmsvr1\emm\Jobs\2018\J180313 - Dubbo Quarry EIS\GIS\02_Maps_EIS_TechReports\SWA\SWA003_Watercourses_20201221_04.mxd 15/01/2021

Source: EMM (2020); DFSI (2017); DFSI (2020)

0 1 2 km
GDA 1994 MGA Zone 55
N

KEY

- Project area
- Strahler stream order
  - 1st order
  - 2nd order
  - 3rd order
- Sub-catchments
  - The Eastern Watercourse
  - The Northern Watercourse
- Rail line
- Major road
- Minor road
- Named watercourse
- NPWS reserve

Local watercourses

Dubbo Quarry Continuation Project
Surface Water Assessment
Figure 3.2

EMM
creating opportunities

3.6 Water quality

3.6.1 Sampling program

Water quality data is available from the following sampling programs:

- Holcim sampling – Holcim have monitored water quality in Eulomogo Creek, the Macquarie River and key water management dams at the quarry over the 2013 to 2018 period. Samples have generally been collected during wet weather conditions when overflows from the Settling Pond (see Section 4.1) were occurring.

- EIS sampling – EMM collected samples from Eulomogo Creek and several water management dams at the quarry on 9 July 2020. Samples were collected approximately nine weeks after significant rainfall that occurred in June 2020.

i Sampling locations

Table 3.2 describes the sample locations and number of samples collected from each program. Sample locations are shown in Figure 3.3. It is noted that the existing water management system is described in Chapter 4.

Table 3.2 Sample locations

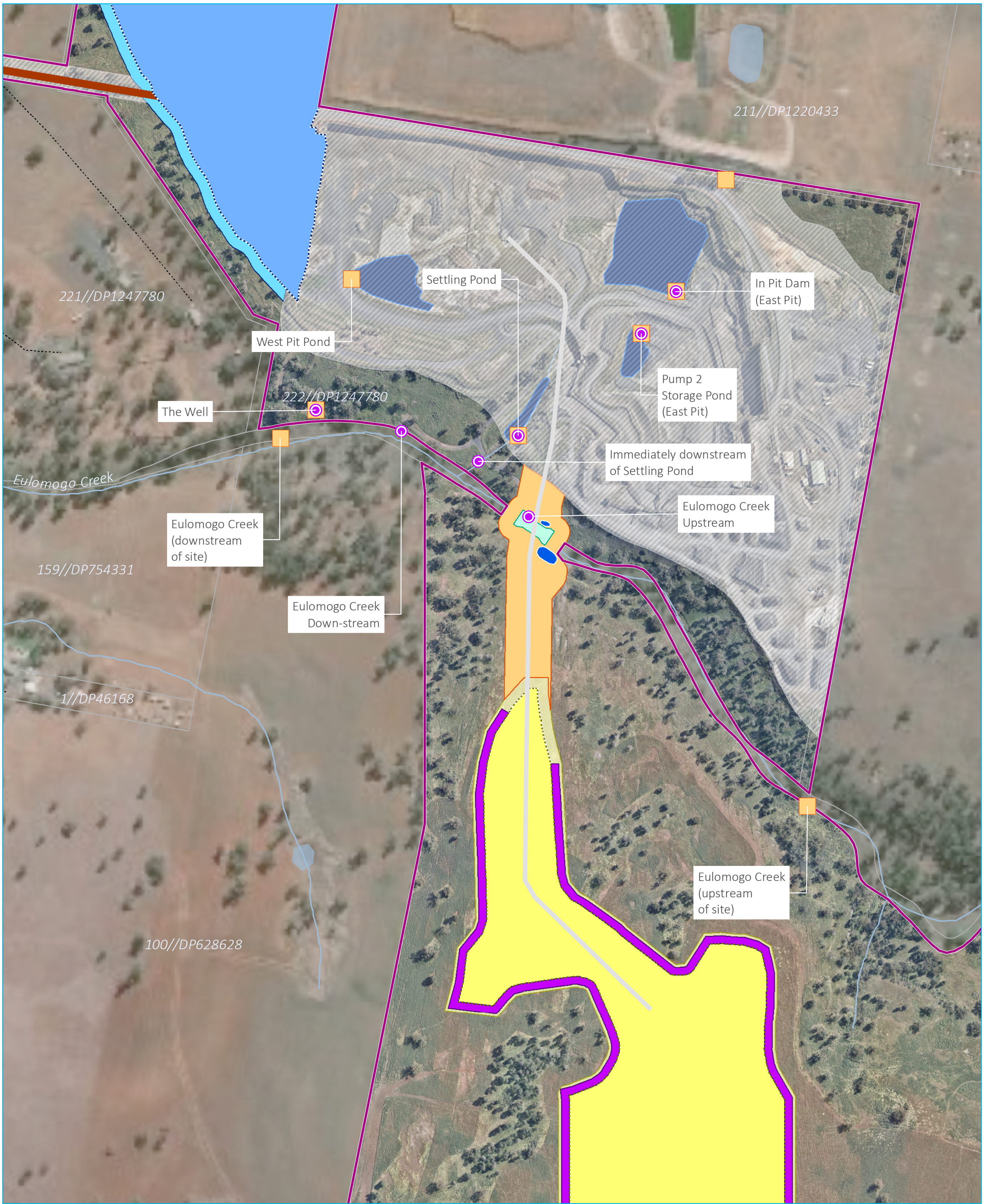
	Number of samples available	
	Holcim Sampling (2013 to 2018)	**EIS sampling** (9 July 2020)
Receiving water		
Eulomogo Creek - upstream of site (Holcim sampling)	20	-
Eulomogo Creek - downstream of site (Holcim sampling)	41	-
Eulomogo Creek - upstream of site (EIS sampling)	-	1
Eulomogo Creek - downstream of site (EIS sampling)	-	1
Macquarie River – downstream of Eulomogo Creek confluence	26	-
Existing quarry		
East pit (In Pit Dam)	45	1
East pit (Pump 2 storage pond)	45	1
Settling Pond	45	1
Settling Pond overflows	24	-
West Pit Pond	-	1
Groundwater		
The well (groundwater supply bore)	21	1

ii Analysis methods

Table 3.3 describes monitoring analytes and analysis methods.

Table 3.3 Analysis methods and parameters

Category	Sampling analytes	Analysis method
Holcim sampling		
Physio-chemical properties	pH, electrical conductivity, turbidity	Analysis undertaken by a NATA certified laboratory
Nutrients	oxidised nitrogen	
Other	Chemical oxygen demand	
EIS sampling		
Physio-chemical properties	pH, electrical conductivity, turbidity, total suspended solids, total dissolved solids	Analysis undertaken by a NATA certified laboratory
Nutrients	total nitrogen, ammonia, oxidised nitrogen and total kjeldahl nitrogen	
	total phosphorus and reactive phosphorus	
Metals (dissolved)	Al, As, Cr (total), Cd, Cu, Fe, Hg, Mn, Ni, Pb, Se and Zn	



Source: EMM (2019); DFSI (2017); Nearmap (2020)

KEY

- Project area
- Holcim sampling location
- Existing water management dam
- EIS sampling location
- Indicative existing disturbance area
- Sediment pond
- Existing access road
- Indicative proposed water crossing
- Bund wall
- Southern extension area
- Southern disturbance area
- Western extension area
- Western disturbance area
- Proposed haul road
- Haul road disturbance area
- Vehicular track
- Watercourse/drainage line
- Cadastral boundary (data does not align with surveyed site boundary)

Water sampling locations

Dubbo Quarry Continuation Project
Response to Submissions – Water Assessment
Figure 3.3

EMM
creating opportunities

3.6.2 Monitoring results

A summary of results from the Holcim and EIS sampling programs are provided in Table 3.4 and Table 3.5, respectively. The results are compared to the DGVs established in Section 2.4.

i Receiving water quality

The water quality of Eulomogo Creek is characterised as having a neutral to slightly basic pH, generally low turbidity and electrical conductivity that exceeds DGVs. Reactive phosphorus is significantly higher than the DGV for total phosphorus in both upstream and downstream samples, indicating the greater catchment is the primary source of phosphorus. With reference to the Holcim sampling results (Table 3.4) nitrate concentrations were generally elevated in downstream samples, indicating that discharges from the quarry may increase nitrate concentrations in Eulomogo Creek.

With reference to the EIS sampling results in Table 3.5, all metals sampled were below DGVs.

The water quality of Macquarie River (downstream of Eulomogo Creek) has neutral to slightly basic pH, generally low turbidity and electrical conductivity that is below DGVs. Reactive phosphorus concentrations are lower than concentrations in Eulomogo Creek, but are elevated relative to the DGVs for total phosphorus. Nitrate concentrations are materially lower than in Eulomogo Creek (downstream sample), indicating that any discharges from the quarry are not resulting in similarly higher nitrate concentrations in the Macquarie River.

ii Water management dams

Water quality samples were collected from the existing quarry's West (EIS sampling only) and East Pits, the Settling Pond and Settling Pond overflows (Holcim sampling only). The results indicate that the water quality in all water management dams is similar and is characterised as follows.

- The pH is generally slightly basic but ranges between 6.3 to 8.7.
- The median electrical conductivity is between 800 to 900 µS/cm at all sample locations, but ranges from 77 to 1,260 µS/cm.
- Median turbidity values are below 20 NTU at all sample locations. However, 80th percentile turbidity level in the Settling Pond is 220 NTU, indicating that turbid runoff from the quarry does occur. Collectively, the turbidity results indicate that runoff from disturbed areas within the quarry contain fine and coarse sediment that responds to sedimentation processes and settles out of the water column within several days after runoff ceases.
- Reactive phosphorus concentrations are elevated (relative to DGVs for total phosphorus) at all sample locations, but are similar to the concentrations in Eulomogo Creek.
- Median nitrate concentrations range from 0.3 to 4.2 mg N/L. These concentrations are higher than concentrations in Eulomogo Creek (upstream of the quarry). The source of nitrate has not been identified but may be due to groundwater inflows into the East Pit (discussed in Chapter 4), accelerated weathering of exposed hard rock and/or explosives residue.
- With reference to the EIS sampling results in Table 3.5, all metals sampled were below DGVs except for:
  - zinc concentrations in the East Pit sampling locations ranged from 0.0070 to 0.0100 mg/L relative to a DGV of 0.0024 mg/L; and
  - the copper concentration in the Settling Pond was 0.0020 mg/L relative to a DGV of 0.0013 mg/L.

iii Groundwater quality

Groundwater was sampled from a single location (the well) that is located between the quarry and Eulomogo Creek. The groundwater quality at this location had a median nitrate of concentration of 12.6 mg N/L and a median reactive phosphorus concentration of 0.415 mg P/L. These concentrations are higher than concentrations in both Eulomogo Creek and the water management dams, indicating that groundwater may be a source of the elevated nutrients.

With reference to the EIS sampling results in Table 3.5, all metals sampled were below DGVs.