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LYNWOOD QUARRY EXTRACTION AREA MODIFICATION

Water Balance Assessment

November 2015

LYNWOOD QUARRY EXTRACTION AREA MODIFICATION

Water Balance Assessment

Prepared by

Umwelt (Australia) Pty Limited

on behalf of

Holcim

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1.0 Introduction

Holcim (Australia) Pty Ltd (Holcim Australia) was granted development consent under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) in December 2005 by the NSW Minister for Planning to construct and operate Lynwood Quarry west of Marulan, NSW (refer to **Figure 1.1**). Lynwood Quarry is approved to transport a maximum of 5 million tonnes per annum (Mtpa) of product from the site. Construction of the quarry commenced in late 2010, with operations commencing in late 2015.

As discussed in **Section 1.1**, Holcim Australia is seeking approval to quarry a granite resource located to the west of the existing Lynwood Quarry extraction area. This approval is being sought via a modification to the existing development consent under Section 75W of the EP&A Act. Umwelt (Australia) Pty Limited (Umwelt) has prepared this Water Balance Assessment as part of the Environmental Assessment (EA) that has been prepared to accompany the modification application.

1.1 Overview of the Approved Lynwood Quarry and the Modification Project

Holcim Australia has development consent (DA 128-5-2005) to construct and operate Lynwood Quarry to produce up to 5 million tonnes per annum (Mtpa) until 1 January 2038 (the Approved Operations). The approved quarry includes a quarry pit, overburden and excess product emplacement areas, processing facilities, road and rail loading facility and associated infrastructure and activities (refer **Figure 1.2**). Lynwood Quarry is approved to transport up to 1.5 Mtpa of product by truck and up to 5 Mtpa by rail DA 128-5-2005 was most recently modified in 2011 to provide for the upgrade of infrastructure and machinery, changes to emplacement areas, pit development and site layout.

Holcim Australia commenced operational readiness works in the approved quarry pit (an ignimbrite resource) in 2012 as part of the construction phase of the quarry and is now in the commissioning phase with operation of the quarry planned to commence in mid to late 2015. Material extracted from the approved Lynwood Quarry pit (the Approved Pit) was used in the onsite civil works and to prepare the quarry pit ready for operation (e.g. removing overburden to expose the ignimbrite resource).

During the operational readiness works, further drilling and material testing has revealed that the resource in the Approved Pit is more variable and substantial areas are characterised by more significant concentrations of either intense fracturing, alteration, clay, or a combination of these characteristics, than was detected during the earlier resource assessment investigations. The variability and complexity of the approved Lynwood Quarry resource will challenge Holcim Australia's ability to consistently supply in-specification products from Lynwood Quarry to the market.

Holcim Australia is therefore seeking approval to extract quarry resources on Holcim Australia owned land, which adjoins the existing Lynwood Quarry Project Area to the west of the Approved Pit. The proposed additional extraction area (the Granite Pit) is a granite resource and has different properties and mineralogy to the currently approved ignimbrite resource. Extensive drilling and testing of the granite resource has revealed that it is homogeneous, relatively unaltered and unfractured. The proposed granite resource will enable Holcim Australia to consistently produce the in-specification products required to be delivered by Lynwood Quarry to supply the local, regional and Sydney markets.

FIGURE 1.1

Locality Plan

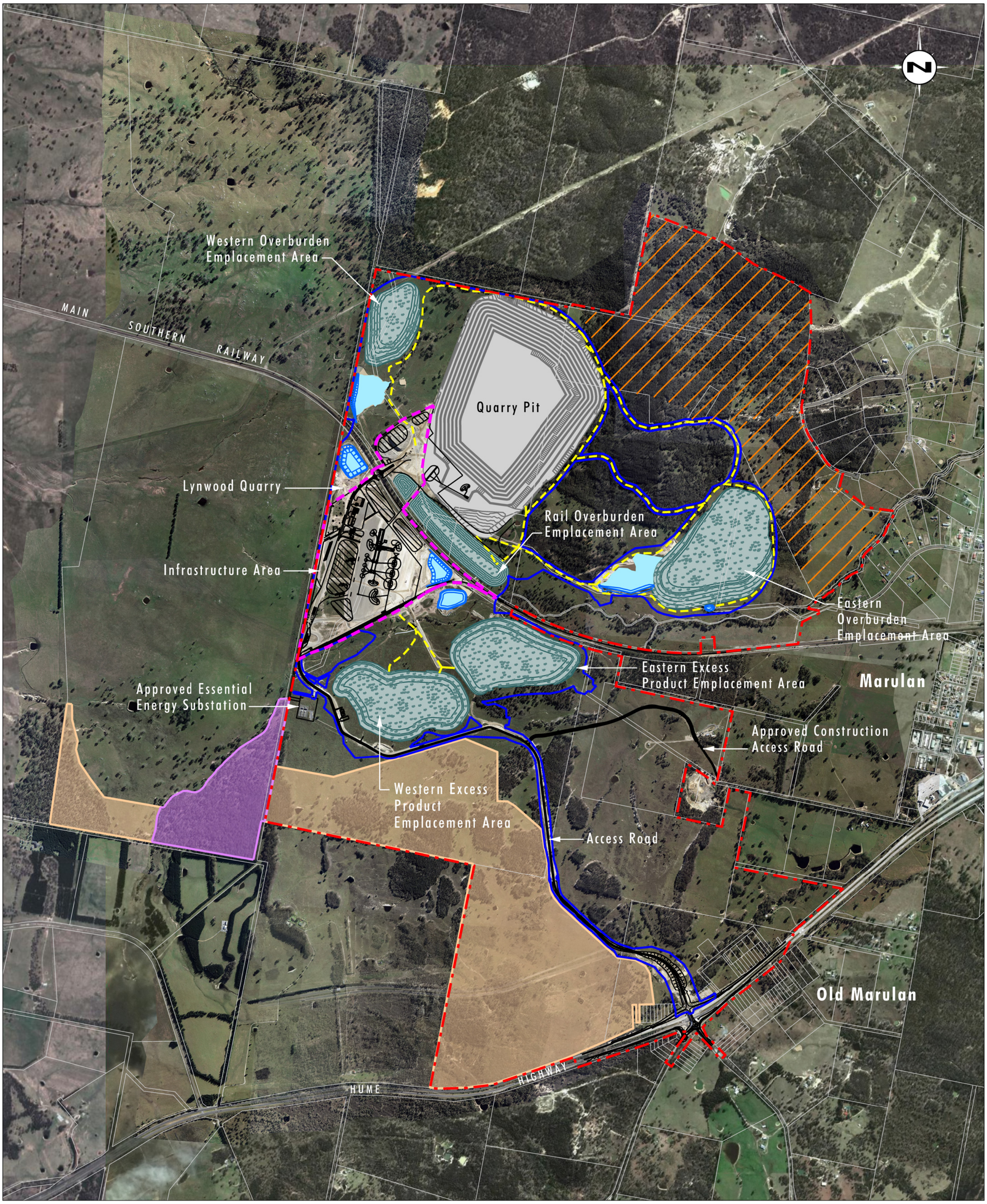


Image Source: Holcim Australia (Aerial Photo March 2012)
Data Source: LPI 2014

0 0.5 1.0 1.5km
1:30 000

Legend

- Approved Project Area
- Lynwood Infrastructure Facilities
- Haul Road
- Approved Disturbance Footprint
- Quarry Pit
- Rehabilitated Area
- Dam
- Existing Biodiversity Offset Area (EPBC)
- Existing Habitat Management Area (EPBC)
- Existing Habitat Management Area

FIGURE 1.2

Approved Conceptual Quarry Plan (Year 30)

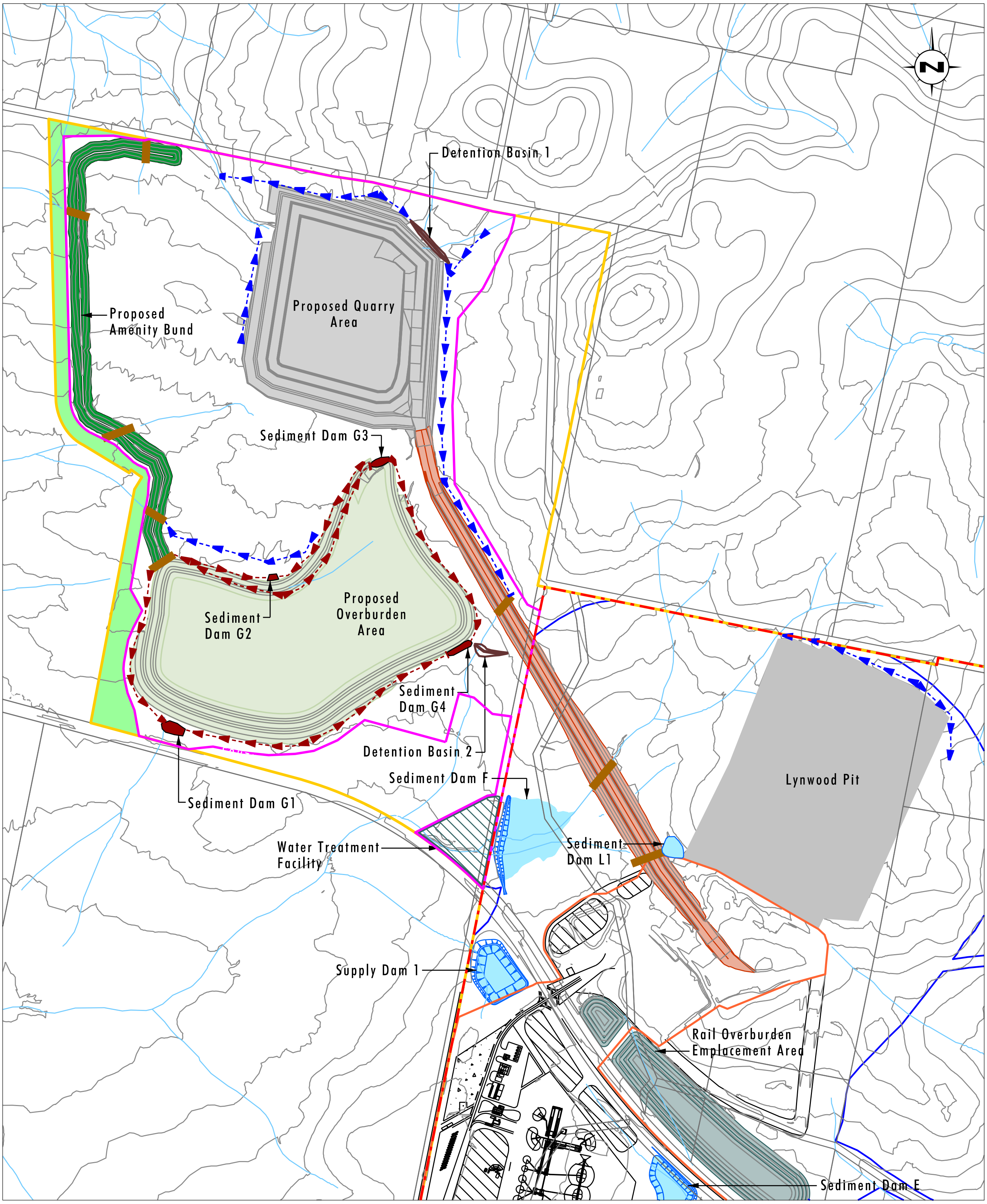
File Name (A4): R15/3330_309.dgn
20151009 16.29

1.2 Extraction Area Modification

The proposed Extraction Area Modification (Modification Project) has the potential to change the water balance for Lynwood Quarry and Holcim Australia has engaged Umwelt (Australia) Pty Limited (Umwelt) to prepare a water balance assessment for the Quarry to assess this potential change. The purpose of the water balance assessment was to:

- identify any potential periods of site water shortages, surpluses and discharges based on historical climatic data
- identify the key drivers of the site water balance, and
- identify any changes to the water balance for Lynwood Quarry associated with the Modification Project.

A daily timestep water balance model (the Model) has been developed in GoldSim. Stages one, three and six of the proposed Extraction Area Modification operations were modelled based on the proposed water management system (WMS) presented in **Section 3.2** of the Surface Water Assessment (refer to **Figures 1.3** to **1.5**). **Figure 1.6** presents a schematic overview of the proposed WMS.



Data Source: LPI (2009), Holcim Australia (2014)
Notes: 5m Contour Interval. Conceptual only and subject to detailed design.

Legend

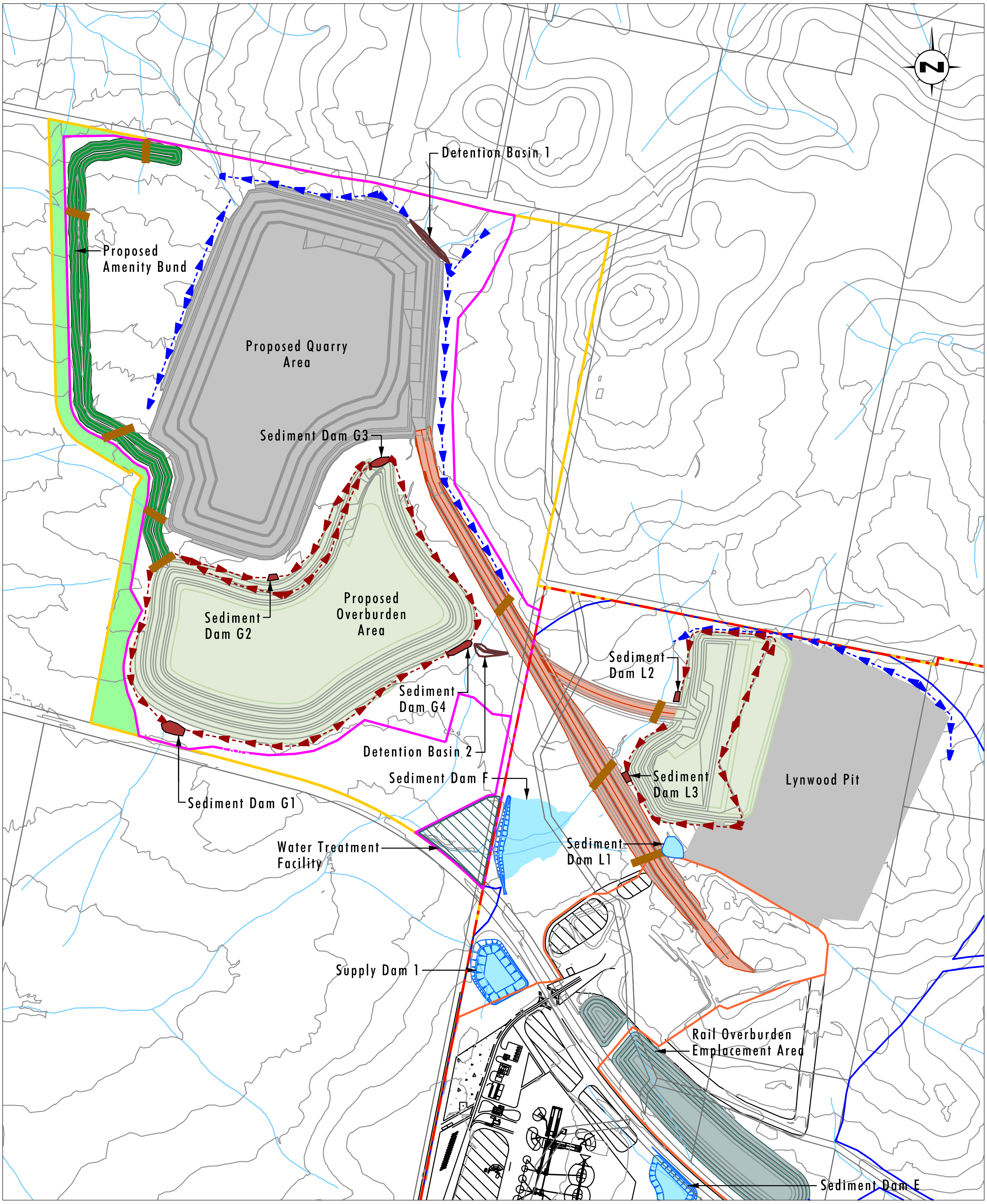
- Approved Project Area
- Modification Project Area
- Lynwood Infrastructure Area
- Approved Disturbance Footprint
- Proposed Granite Pit Disturbance Footprint
- Lynwood Infrastructure Layout
- Quarry Pit
- Approved Emplacement Area
- Existing Dam
- Proposed Overburden Emplacement Area
- Proposed Vegetation Buffer Zone
- Proposed Amenity Bund
- Proposed Haul Road
- Clean Dam
- Diversion Drain
- Sediment Dam
- Dirty Drain
- Culvert

FIGURE 1.3

Conceptual Water Management System - Stage 1

File Name (A4): R15/3330_215.dgn
20151112 10.38

umwelt



Data Source: LPI (2009), Holcim Australia (2014)
Notes: 5m Contour Interval. Conceptual only and subject to detailed design.

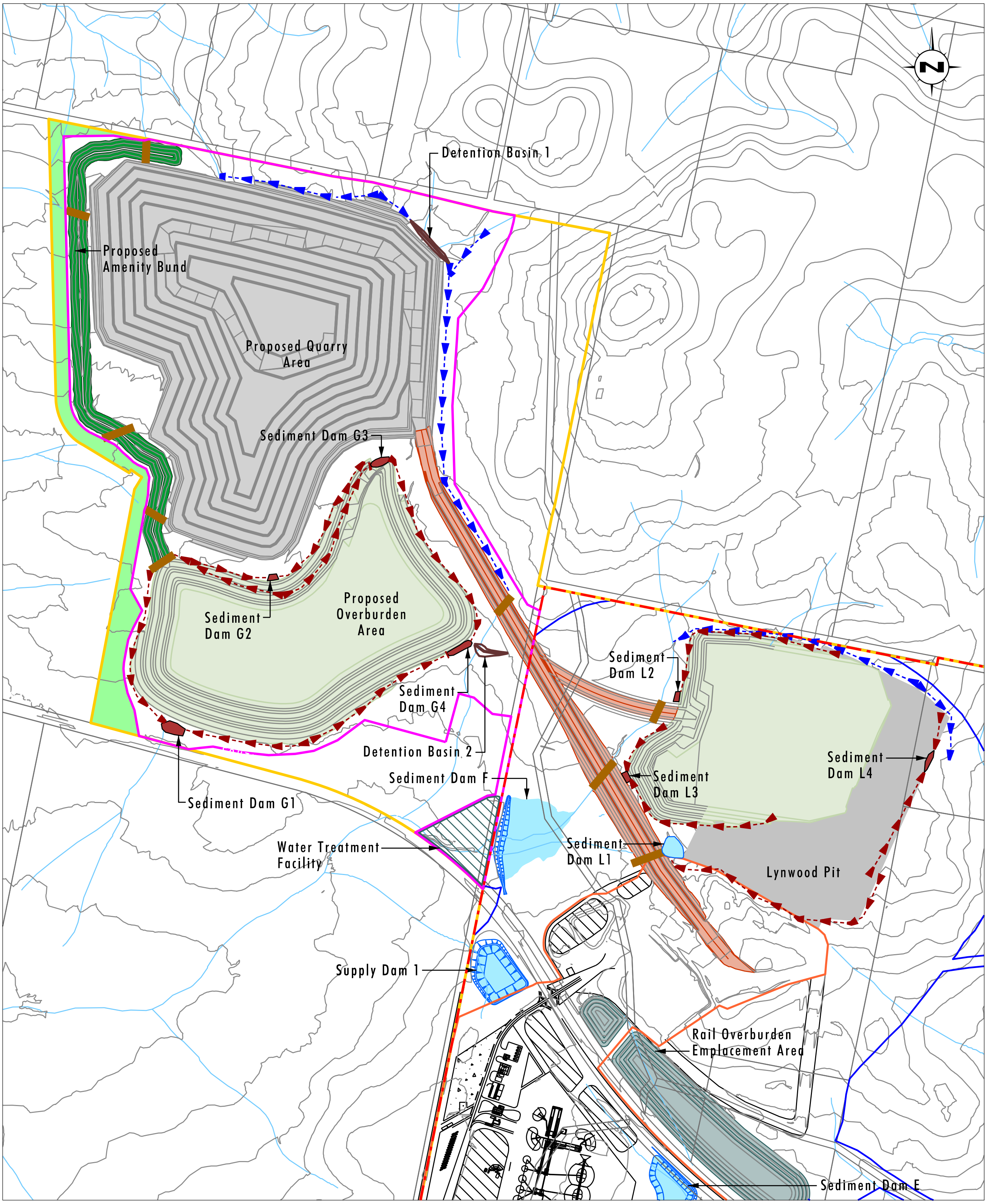
Legend

- Approved Project Area
- Modification Project Area
- Lynwood Infrastructure Area
- Approved Disturbance Footprint
- Proposed Granite Pit Disturbance Footprint
- Lynwood Infrastructure Layout
- Quarry Pit
- Approved Emplacement Area
- Existing Dam
- Proposed Overburden Emplacement Area
- Proposed Vegetation Buffer Zone
- Proposed Amenity Bund
- Proposed Haul Road
- Clean Dam
- Diversion Drain
- Sediment Dam
- Dirty Drain
- Culvert

FIGURE 1.4

Conceptual Water Management System - Stage 3

File Name (A4): R15/3330_216.dgn
20151112 10.38



Data Source: LPI (2009), Holcim Australia (2014)

Notes: 5m Contour Interval. Conceptual only and subject to detailed design.

Legend

- Approved Project Area
- Modification Project Area
- Lynwood Infrastructure Area
- Approved Disturbance Footprint
- Proposed Granite Pit Disturbance Footprint
- Lynwood Infrastructure Layout
- Quarry Pit
- Approved Emplacement Area
- Existing Dam
- Proposed Overburden Emplacement Area
- Proposed Vegetation Buffer Zone
- Proposed Amenity Bund
- Proposed Haul Road
- Clean Dam
- Diversion Drain
- Sediment Dam
- Dirty Drain
- Culvert

FIGURE 1.5

Conceptual Water Management System - Stage 6

File Name (A4): R15/3330_217.dgn
20151112 10.40

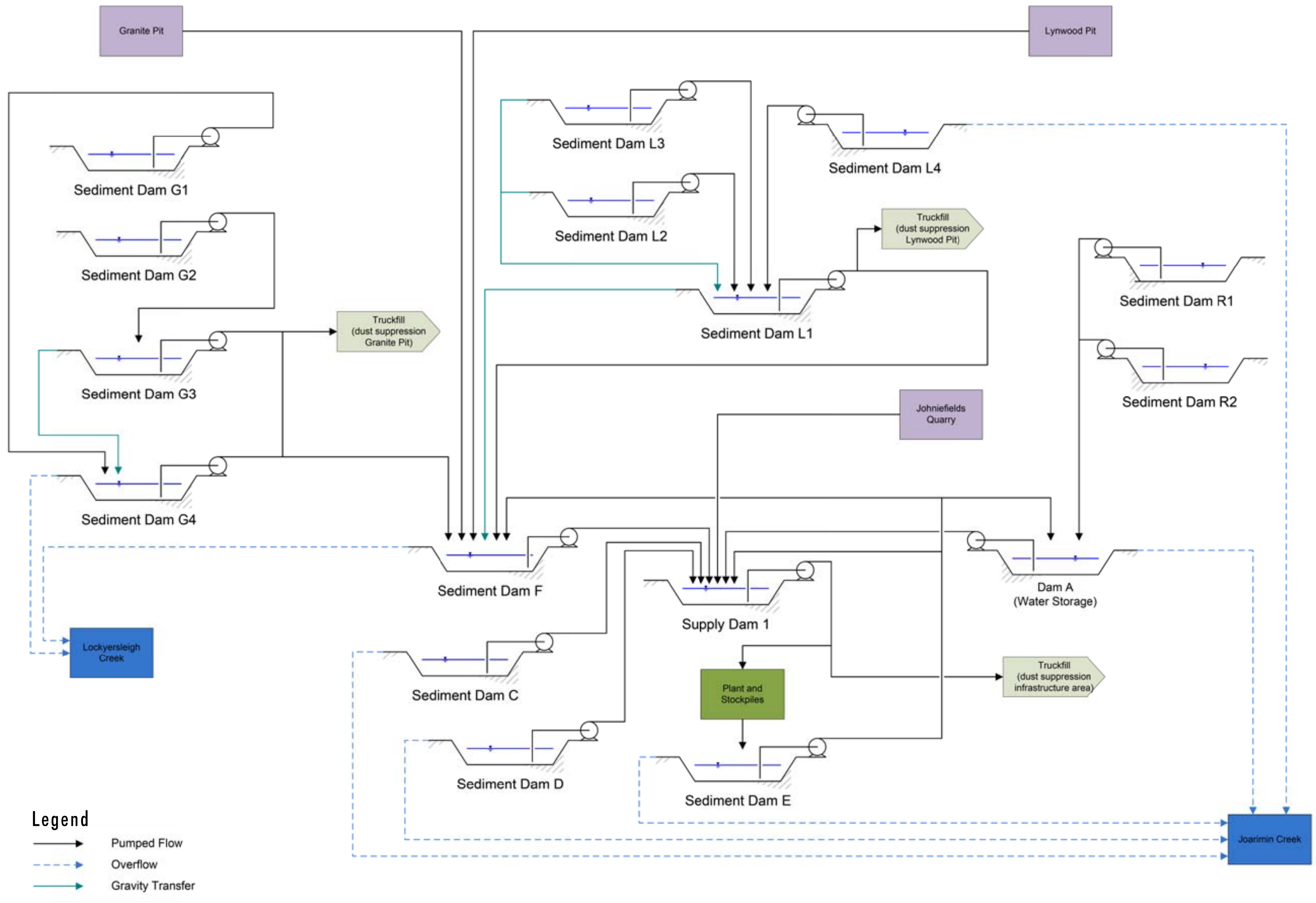


FIGURE 1.6

Water Management System Schematic

2.0 Sources and Sinks

2.1 Water Sources

There are three sources of water available to the Lynwood Quarry:

- runoff from local undisturbed and disturbed catchments
- groundwater, and
- external water sourced from Johnniefelds Dam.

The primary water inflows to the Lynwood Quarry are from WMS catchment runoff from both undisturbed and disturbed catchment areas. Harvesting of water (i.e. capture of runoff from undisturbed catchments) is discussed in further in **Section 5.4**. Groundwater modelling predicts relatively small quantities of groundwater flowing into the Approved Pit and proposed Granite Pit. Harvested runoff and extracted groundwater will be directed to a range of dams within the WMS. The quarry water reticulation system has been designed to allow the transfer of water between dams to assist in achieving maximum utilisation of the available water. External water for quarry operations is available from the Johnniefelds Dam located near to Holcim Australia's Johnniefelds Quarry under a water supply agreement (refer to Surface Water Assessment, Section 3.1).

The maximum catchment area of the proposed WMS will be approximately 540 hectares and will consist of:

- two quarry pits
- haul roads
- overburden and excess product emplacement areas
- a crushing and screening plant
- support infrastructure, and
- sediment and process water dams.

Potable water sourced from the Marulan town water supply has not been considered in the Model as it will not be used for quarry operations but only be used for amenities.

2.2 Water Sinks

There are three water sinks at Lynwood Quarry:

- process plant consumption;
- haul road and stockpile dust suppression; and
- evaporation.

Potable water has not been considered as water sink in the Model as it will be sourced from the Marulan town water supply.

3.0 Meteorological Data

For rainfall/runoff and water balance modelling purposes it is considered important to use a daily rainfall record of approximately 100 years if possible. Long term daily rainfall data is available from the Bureau of Meteorology (BoM) station at George Street, Marulan (Station 70063). Of the local BoM rainfall stations George Street, Marulan (Station 70063) has the longest period of record for rainfall with daily rainfall recorded from 1895 to 2014. However, this record is intermittent. None of the Bureau of Meteorology Stations at Marulan record evaporation.

There is an operating station in the Goulburn area which records evaporation. This station is Goulburn Tafe (Station 70263) (previously known as Goulburn Progress Street) and has a rainfall and evaporation record from 1978 to 2014 years. The longest period of daily rainfall records in the broader area has been recorded at Kippilaw, Goulburn (Station 70055) with daily rainfall recorded since 1886. No evaporation has been recorded at this site, however, evaporation data from Progress Street, Goulburn is considered to adequately represent the evaporation rates experienced at Kippilaw, as evaporation is regionally driven and the sites are only 15 kilometres apart.

Previous analysis undertaken for the original Lynwood Quarry approval (Umwelt, 2005) indicated that for Kippilaw, Goulburn (Station 70055) and George Street, Marulan (Station 70063) for the periods from 1895 to 1918 and 1942 to 1973 where both stations have records, shows that the 10^{th} percentile annual rainfall is 5 per cent higher at Marulan. The analysis also shows that the average annual rainfall at Marulan is approximately 80 mm more than Goulburn. On average Marulan has approximately 130 mm higher 90^{th} percentile annual rainfall than Goulburn as shown in **Table 3.1**.

Table 3.1 Comparison of Annual Rainfall Data

Statistic	George Street, Marulan (Station 70063) (1895 – 1918, 1942 – 1973)	Kippilaw, Goulburn (Station 70055) (1895 – 1918, 1942 – 1973)	Difference
10^{th} Percentile Rainfall	430	409	5%
Average Rainfall	697	619	13%
90^{th} Percentile Rainfall	1004	876	15%

Source: Bureau of Meteorology, Umwelt, 2005

As a result, use of Goulburn rainfall data from Kippilaw (Station 70055) will tend to underestimate the actual rainfall received at Marulan by approximately 5 per cent, 13 per cent and 15 per cent in dry, average and wet years respectively.

In order to model the potential range of meteorological data that the quarry may experience (based on existing long term data) a daily rainfall record was amalgamated using the George Street, Marulan and Kippilaw Goulburn stations where the data gaps in the George Street, Marulan data were supplemented by daily rainfall data from the Kippilaw Goulburn station.

Evaporation data for Goulburn Tafe (Station 70263) was used, with average monthly data used to resolve data gaps where specific daily records were not available to match the daily rainfall data.

4.0 Water Balance Basis and Methodology

4.1 Model Inputs

4.1.1 Catchments and Storages

Catchment areas used for the water balance were delineated using a combination of quarry plans, recent topographical survey and aerial photography (refer to Section 3.2 of the Surface Water Assessment).

Table 4.1 provides a summary of the catchment areas for the modelled operational stages.

Table 4.1 Staged Quarry Catchment Areas (ha)

Stage	Natural / Rehabilitated	Disturbed	Hardstand	Dam Surfaces	Total
1	212	213	43	14	483
3	275	185	43	14	518
6	319	165	43	14	542

Haul road lengths were based on stage information provided by Holcim Australia and were used for estimating haul road watering demands as presented in **Table 4.2**.

Table 4.2 Staged Haul Road Areas

Stage	Haul Road Length (km)	Haul Road Width (m)	Haul Road Area (ha)
1	5.8	18	10.4
3	7.1	18	12.8
6	8.3	18	14.9

The existing capacities of water storages at the Quarry are based on as constructed volumes provided by Holcim Australia. Proposed and approved but unconstructed WMS water storages have been sized to retain the 90th percentile five day rainfall event in accordance with Blue Book requirements (refer to Section 3.2 of the Surface Water Assessment). **Table 4.3** presents the modelled water storage settling zone volumes.

Table 4.3 WMS Water Capacities

Storage	Existing / Proposed / Not constructed	Settling Zone Volume (ML)
Dam 1	Approved / Existing	63.0
Dam A	Approved / Existing	116.5
Dam C	Approved / Not constructed	4.7
Dam D	Approved / Not constructed	5.1
Dam E	Approved / Existing	42.4
Dam F	Approved / Existing	40.0
Dam R1	Approved / Not constructed	2.4
Dam R2	Approved / Not constructed	2.4
Dam L1	Approved / Existing	7.1
Dam L2	Proposed / Not Constructed	1.5
Dam L3	Proposed / Not Constructed	1.9
Dam L4	Proposed / Not Constructed	1.0
Dam G1	Proposed / Not Constructed	3.0
Dam G2	Proposed / Not Constructed	0.3
Dam G3	Proposed / Not Constructed	0.9
Dam G4	Proposed / Not Constructed	4.9

4.1.2 Runoff Modelling

A daily time step rainfall excess model using the amalgamated rainfall and evaporation data described in **Section 3.0** was used to estimate runoff from natural, rehabilitated, impervious and disturbed catchments. The Rainfall Excess (Soil Store) model simulates a unit area storage module with the following inputs and outputs:

- Inputs –
  - Daily Rainfall
- Outputs –
  - Evaporation
  - Leakage
  - Overflows (i.e. rainfall excess / runoff)

The rainfall excess model was calibrated by varying parameters in the model, such as evaporation factors, leakage rates, etc.) to reflect the average regional runoff rate published by DPI Water (farmdamscalculator.dnr.nsw.gov.au) of 0.75 ML per hectare per year.

4.1.3 Water Transfer Rates

Water transfer rates from existing water storages were based on the pumping rates provided by Holcim Australia. Proposed and approved but unconstructed WMS dam water transfer rates are based on a five day dewatering of the water storage settling zone in accordance with Blue Book requirements (refer to Section 3.1 of the Surface Water Assessment). Dam G4 transfer rate includes additional capacity to cater for inflows from Dams G1, G2 and G3. Transfer rates from the operating quarry pits were selected to allow the dewatering of the quarry pits following a 30 to 40 millimetre rainfall event within one to two days. **Table 4.4** presents the water transfer rates used in the water balance model for site water storages, quarry pits and Johnniefelds Dam.

Table 4.4 Modelled Water Transfer Rates

Storage	Water Transfer Rate (ML/day)
Dam A	2.16
Dam C	0.94
Dam D	1.02
Dam E	3.89
Dam F	2.16
Dam L1	1.42
Dam L2	0.30
Dam L3	0.38
Dam L4	0.20
Dam G1	0.60
Dam G2	0.06
Dam G3	0.18
Dam G4	1.40
Dam R1	0.48
Dam R2	0.48
Approved Pit	5.00
Granite Pit	5.00
Johnniefelds Dam	3.00

4.1.4 Process Plant Demand

The process plant water demands have been derived from water usage rates recorded for the existing operations. Varying quantities of water are used for each of the different process plant products. **Table 4.5** presents the water usage rates for the three broad streams of process plant products as well as the indicative product split assumptions used for modelling purposes and the associated annual water demand.

Table 4.5 Process Plant Water Usage Rates

Product	Indicative Product Percentage Adopted for Modelling	Quantity (MT/year)	Water Usage Rate (L/tonne)	Water Usage (ML/day)
Road Base	5%	0.25	40	0.027
Aggregates	55%	2.75	13	0.098
Manufactured Sand	40%	2.00	30	0.164
Additional Process Dust Suppression	-	5.00	34	0.466
TOTAL	**100%**	**5.00**	**-**	**0.755**

4.1.5 Other Water Demands

Table 4.6 presents the other water demands and flow rates that have been used in the water balance model. These rates have been derived from water usage rates recorded for the existing operations.

Table 4.6 Other Water Demands

Demand	Flow Rate (L/s)	Operating Time (hours/day)	Water Usage (ML/day)
Weighbridge wheel wash (20% loss)	1.50	10	0.010
Pit mobile plant wash and rainwater tank replenishment	0.35	10	0.012
TOTAL	**1.85**	**-**	**0.022**

4.1.6 Groundwater Inflows

Groundwater inflows to the Approved Pit and Granite Pit were derived from the Groundwater Assessment undertaken for the Modification Project. **Table 4.7** presents the modelled groundwater inflows.

Table 4.7 Quarry Pit Groundwater Inflows (ML/day)

Stage	Approved Pit	Granite Pit
1	0.003	0.013
3	0.003	0.018
6	0.000	0.020

4.2 Assumptions

4.2.1 Water Transfer Rules

Table 4.8 presents the water transfer rules applied in the Model.

Table 4.8 Modelled Water Transfer Rules

WMS Component	Transfer Rules
Dam 1	**Outflows** Supplies process plant, water cart fill station and other water demands when water available. **Inflows** Receives water from Dam E, Dam F and Dam A when below 80% of capacity. Calls for import from Dam C and Dam D when at 30% of capacity. Calls for import from Johniefelds Dam when below 10% of capacity.
Dam A	**Outflows** Transfers water to Dam 1 when Dam 1 below 80% of capacity. Transfers water to the Approved Pit when above 70% of capacity. **Inflows** Receives water from Dam E, Dam F, Dam L1, Dam G4, the Approved Pit and the Granite Pit when below 70% of capacity.
Dam C	**Outflows** Transfers water to Dam 1 when Dam 1 below 50% of capacity.
Dam D	**Outflows** Transfers water to Dam 1 when Dam 1 below 50% of capacity.
Dam E	**Outflows** Transfers water to Dam 1 when Dam 1 below 80% of capacity. Transfers water to Dam F when Dam 1 above 80% of capacity and Dam F is below 50% capacity. Transfers water to the Approved Pit when Dam 1 above 80% of capacity and Dam F above 50 % capacity.

WMS Component	Transfer Rules
Dam F	**Outflows** Supplies process plant, water cart fill station and other water demands when water available. **Inflows** Receives water from Dam E, Dam F and Dam 1 when below 50% of capacity.
Dam L1	**Outflows** Transfers water to Dam F when Dam F is below 50% of capacity. Transfers water to the Dam A when Dam F above 50% of capacity. Transfers water to the Approved Pit when Dam F above 50% of capacity and Dam A above 70% of capacity. Supplies water cart fill station. **Inflows** Receives water from Dam L2, Dam L3 and Dam L4 regardless of volume held.
Dam L2	**Outflows** Transfers water to Dam L1.
Dam L3	**Outflows** Transfers water to Dam L1.
Dam L4	**Outflows** Transfers water to Dam L1.
Dam G1	**Outflows** Transfers water to Dam G4.
Dam G2	**Outflows** Transfers water to Dam G4.
Dam G3	**Outflows** Transfers water to Dam G4.
Dam G4	**Outflows** Transfers water to Dam F when Dam F is below 50% of capacity. Transfers water to the Dam A when Dam F above 50% of capacity. Transfers water to the Approved Pit when Dam F above 50% of capacity and Dam A above 70% of capacity. Supplies water cart fill station. **Inflows** Receives water from Dam L2, Dam L3 and Dam L4 regardless of volume held.
Dam R1	**Outflows** Transfers water to Dam A when Dam A is below 70% of capacity. Transfers water to the Approved Pit when Dam A above 70% of capacity.
Dam R2	**Outflows** Transfers water to Dam A when Dam A is below 70% of capacity. Transfers water to the Approved Pit when Dam A above 70% of capacity.

WMS Component	Transfer Rules
Approved Pit	**Outflows** Transfers water to Dam F when Dam F is below 50% of capacity. Transfers water to Dam A when Dam F is above 50% of capacity and Dam A below 70% of capacity. **Inflows** Receives water from Dam A, Dam E, Dam F, Dam L1, Dam G4, Dam R1, Dam R2 and the Granit Pit as a secondary storage.
Granite Pit	**Outflows** Transfers water to Dam F when Dam F is below 50% of capacity. Transfers water to Dam A when Dam F is above 50% of capacity and Dam A below 70% of capacity. Transfers water to the Approved Pit when Dam F above 50% of capacity and Dam A above 70% of capacity.
Johnniefelds Dam	**Outflows** Transfers water to Dam 1 when Dam 1 is below 10% of capacity.

4.2.2 Other Assumptions

Following are the other key assumptions used in the model:

- Evaporation pan factor of 0.7.
- Constant water storage surface area used for evaporation calculations.
- Haul road dust suppression is applied to supplement daily rainfall up to a maximum average water application rate of 10 millimetres per day. For example, on a day where there is 5 millimetres of rainfall, an additional 5 millimetres will be applied by water cart. When there is no rainfall, 10 millimetres of water for dust suppression will be applied by water carts and when rainfall is 10 millimetres or greater, no additional water for dust suppression will be applied. Haul road dust suppression water was considered to be applied over the full width of the haul road (i.e.18 metres) for the lengths/areas shown in **Table 4.2**.
- The quarry operates each day of the year.
- The quarry is operating at maximum production, that is producing 5 Mtpa of quarry products.

5.0 Water Balance Results

5.1 Gross Water Balance

Table 5.1 presents the predicted gross water balance for the three modelled stages of the Project at maximum production levels. The gross water balance results include water imports from Johnniefelds Dam. The results presented in **Table 5.1** are based on statistical analysis of gross water balance result.

Table 5.1 Gross Water Balance (ML/year) at Maximum Production

Stage	10th Percentile	50th Percentile	90th Percentile
1	-147	130	766
3	-210	79	737
6	-282	11	695

The water balance predicts that the Project is likely (i.e. 50th percentile) to operate with a small water surplus for all modelled stages. The reduction in water surplus between the stages can be attributed to an increase in haul road surface area, and therefore, an increase in haul road dust suppression water demand as the operation progresses.

During periods of water surplus it is assumed that surplus water will be stored in the Approved Pit prior to reuse within the WMS. During dry periods water supply will be primarily supplemented by imports from the water resource at Johnniefelds Dam. However, during sustained dry periods, where the secondary water storage in the Approved Pit is empty, and with consideration of water imports from Johnniefelds Dam, water deficits are predicted to range between 147 ML per year in Stage 1 to 282 ML per year in Stage 6 (refer to **Table 5.1**) based on a full approved production level of 5 Mtpa.

Tables 5.2 to **5.4** present the Stage 1, Stage 3 and Stage 6 gross water balance results for the rainfall year with the gross water balance result closest to the 10th, 50th and 90th percentile result presented in **Table 5.1**. It should be noted that the data presented in **Tables 5.2** to **5.4** do not exactly match the data presented in **Table 5.1**. This is because the data presented in **Table 5.1** is based on a full statistical analysis of all years of the water balance modelling, whereas the data presented in **Tables 5.2** to **5.4** are specific representative rainfall years for which the gross water balance results closely match the statistical outputs presented in **Table 5.1**.

Table 5.2 Stage 1 Gross Water Balance (ML/year) at Maximum Production

	10th Percentile	50th Percentile	90th Percentile
Representative Year	1908	1934	1914
Rainfall (mm)	381	767	790
Total Runoff (ML)	467	799	1488
Import (Johnniefelds) (ML)	78	21	45

	10th Percentile	50th Percentile	90th Percentile
Total Inflows (ML)	*550*	*825*	*1538*
Evaporation (ML)	-54	-83	-77
Uncontrolled Discharge (ML)	-1	-10	-75
Haul Road Dust Suppression (ML)	-358	-328	-339
Plant and Other (ML)	-285	-285	-285
Total Outflows (ML)	-698	-706	-776
Water Balance (ML)	-148	119	762

Table 5.3 Stage 3 Gross Water Balance (ML/year) at Maximum Production

	10th Percentile	50th Percentile	90th Percentile
Representative Year	2002	1967	1914
Rainfall (mm)	404	509	790
Total Runoff (ML)	465	781	1548
Import (Johnniefelds) (ML)	78	78	0
Groundwater (ML)	7	7	7
Total Inflows (ML)	550	866	1555
Evaporation (ML)	-49	-83	-96
Uncontrolled Discharge (ML)	0	0	-31
Haul Road Dust Suppression (ML)	-428	-425	-416
Plant and Other (ML)	-285	-285	-285
Total Outflows (ML)	-762	-793	-828
Water Balance (ML)	-212	73	727

Table 5.4 Stage 6 Gross Water Balance (ML/year) at Maximum Production

	10th Percentile	50th Percentile	90th Percentile
Representative Year	1933	1904	1961
Rainfall (mm)	514	571	1031
Total Runoff (ML)	461	780	1696
Import (Johnniefelds) (ML)	78	78	12
Groundwater (ML)	7	7	7
Total Inflows (ML)	546	865	1715
Evaporation (ML)	-54	-75	-102
Uncontrolled Discharge (ML)	0	-4	-175
Haul Road Dust Suppression (ML)	-491	-489	-466
Plant and Other (ML)	-285	-285	-285
Total Outflows (ML)	-830	-853	-1028
Water Balance (ML)	-284	12	687

5.1.1 Comparison to Approved Lynwood Quarry Water Balance

Table 5.5 presents a summary of the most recent water balance for the existing approved Lynwood Quarry operation with a production rate of 5 Mtpa.

Table 5.5 Existing approved Lynwood Quarry Gross Water Balance (ML/year) at Maximum Production

Year	10th Percentile	50th Percentile	90th Percentile
5	-92	47	275
12	-105	32	261
20	-87	58	281
30	-70	71	298

Source: Umwelt, 2010

The Modification Project and median water balance results for the existing approved Lynwood Quarry are similar, however, the extremes vary more significantly. The larger water surplus for Lynwood Quarry with the Modification Project during wet years can be attributed to the increased catchment area in the WMS.

5.2 Supply Reliability and Water Storage

Table 5.6 presents the predicted supply reliability for the three modelled stages of the Project at maximum production levels including water imports from Johnniefelds Dam. The estimated supply reliability is based on the number of days that the quarry WMS had sufficient water in storage to satisfy quarry operational demands (i.e. processing plant, dust suppression and wash down).

Table 5.6 Supply Reliability

Stage	Maximum Operational Demand (ML/day)	Supply Reliability
1	1.82	92%
3	2.06	90%
6	2.27	83%

Note: The maximum operational demand includes the maximum haul road dust suppression demand which has not been varied in the sensitivity analysis.

The decrease in supply reliability with the progression of the Project is associated with an increase in water demand for haul road dust suppression.

5.3 Total Water Stored On Site

As discussed in **Section 5.1** without discharge from the operations surplus water is proposed to be stored in the Approved Pit prior to reuse on site. It should be noted that Holcim Australia is currently in the process of applying for a variation to their Environment Protection Licence to allow discharges to Lockyersleigh Creek and Joarimin Creek.

Charts 5.1, 5.2 and **5.3** show the potential volumes of water stored within the quarry WMS, including the Approved Pit, for the three modelled stages based on the 120 years of climatic data. The results show that during periods of high or prolonged rainfall the WMS will have to accommodate large water volumes. It is proposed that this water surplus be temporarily stored in the Approved Pit. The maximum volumes of surpluses that require temporary storage decrease as the Project progresses as a result of increased dust suppression water demands.

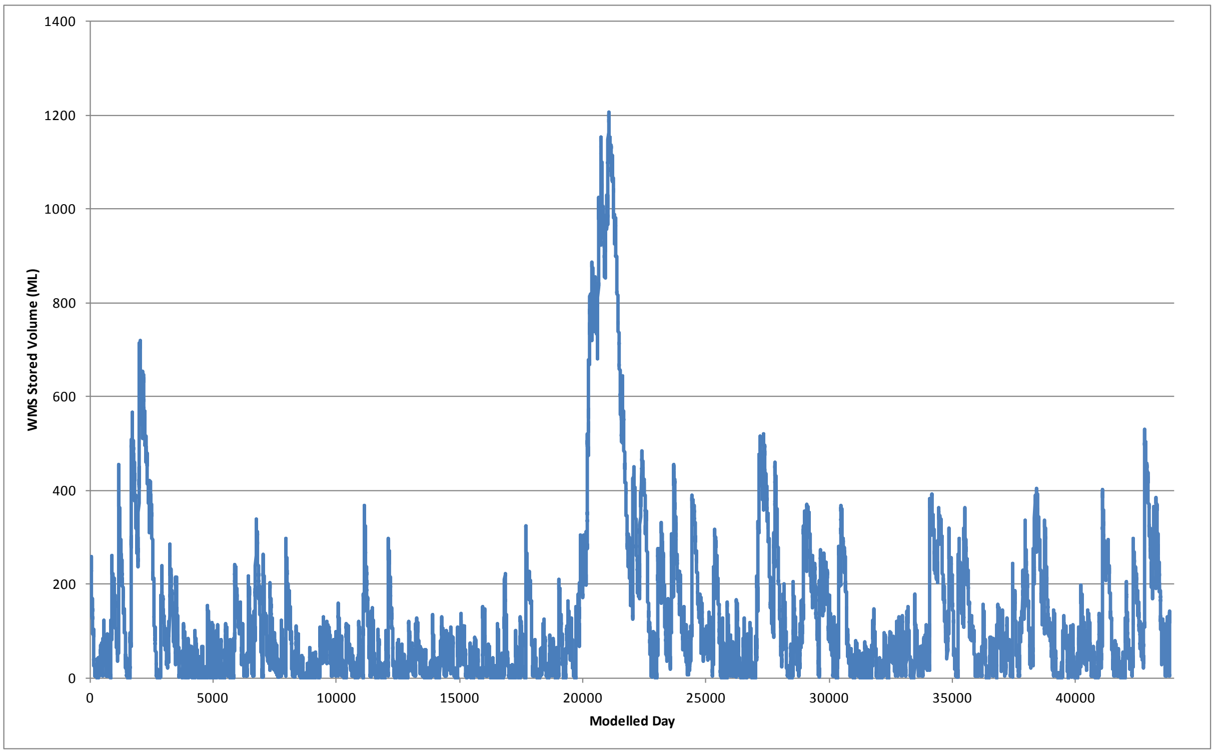


Chart 5.1

Stage 1 Model Outputs – WMS Stored Water Volumes

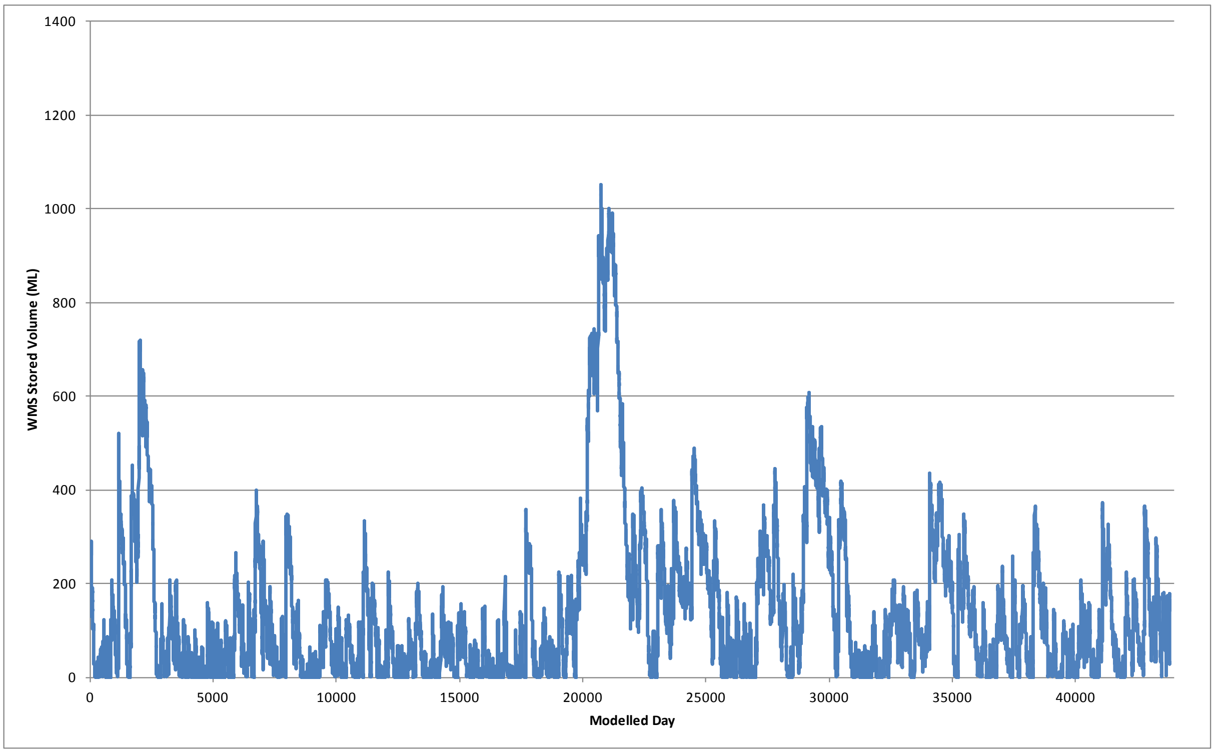


Chart 5.2

Stage 3 Model Outputs – WMS Stored Water Volumes

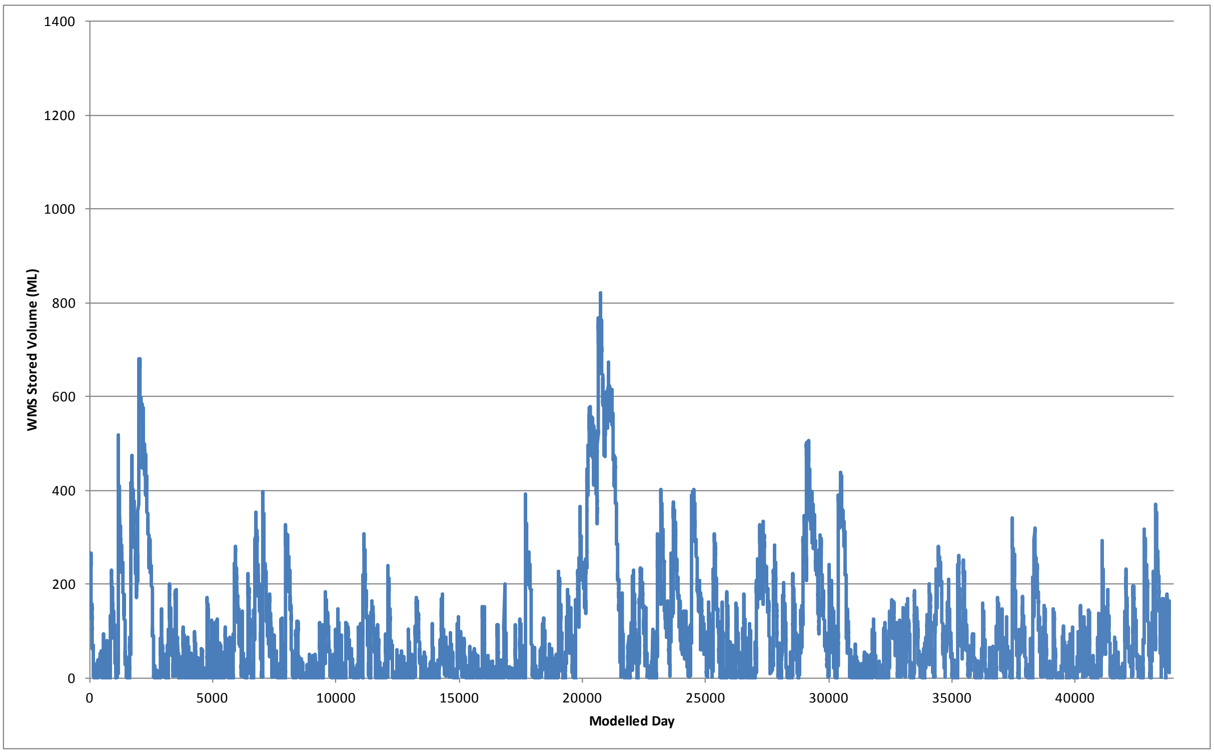


Chart 5.3

Stage 6 Model Outputs – WMS Stored Water Volumes

5.4 Harvested Water

Existing Dam A and Dam F (both sediment dams) have catchments that include a portion of land that will not be disturbed by the quarry. The undisturbed catchment areas of Dam A and Dam F (which remain constant for Stages 1, 3 and 6) are located within the WMS. The modelled range of volume of runoff captured from these undisturbed areas for the range of meteorological conditions modelled is listed in **Table 5.7**.

Table 5.7 Harvested Runoff – Natural Undisturbed Catchment Areas (ML/year)

Stages	Min	Percentile			Max
		10%	50%	90%	
1,3 and 6	0	4	107	410	615

The water take estimated to be harvested from natural undisturbed catchment areas ranges between 4 ML per year in a 10th percentile year to 410 ML per year in a 90th percentile year. The 50th percentile modelled value for runoff harvested from natural undisturbed catchments is 107 ML per year.

Holcim Australia owns a land area of approximately 1556 hectares. Based on 100 per cent capture of runoff at the regional runoff rates (refer to www.farmdamscalculator.dnr.nsw.gov.au) of 0.75 ML/hectare/year, this equates to capture of approximately 117 ML per year of harvestable rights. As such, on average the capture of clean water runoff (refer to **Table 5.4**) is within the harvestable rights provisions of Holcim Australia. As noted above, both Dam A and Dam F are part of the water management system for the Approved Project and currently exist. No changes are proposed to either dam as part of the

Modification Project, however, a further dam is proposed downstream of Dam F for water quality control purposes.

5.5 Sensitivity Analysis

Due to the proposed changes to product (i.e. with the move from the Approved Pit which contains an ignimbrite resource to the Granite Pit which contains a granite resource) a sensitivity analysis of process water demand was undertaken.

The sensitivity analysis was undertaken to examine the impact of the processing plant water demands varying by +/- 10 per cent. **Tables 5.8** and **5.9** present the predicted gross water balance results for the increased (+10 per cent) and reduced (-10 per cent) process water demands respectively.

Table 5.8 Gross Water Balance - Increased Process Water Demand (ML/year)

Stage	10^{th} Percentile	50^{th} Percentile	90^{th} Percentile
1	-174	117	612
3	-230	50	736
6	-312	-10	737

Table 5.9 Gross Water Balance - Reduced Process Water Demand (ML/year)

Stage	10^{th} Percentile	50^{th} Percentile	90^{th} Percentile
1	-119	132	728
3	-186	101	731
6	-255	35	786

The sensitivity analysis indicates that a small variation in process water demand has a relatively minor impact on the Project water balance with the most likely result (i.e. 50^{th} percentile) ranging from a small water surplus to a small water deficit over the three modelled stages.

Tables 5.10 and **5.11** present the supply reliability for the process water demand sensitivity analysis which considers an increased demand (+10 per cent) and reduced demand (-10 per cent) respectively, at maximum production levels.

Table 5.10 Supply Reliability - Increased Process Water Demand

Stage	Maximum Operational Demand (ML/day)	Supply Reliability
1	1.89	91%
3	2.14	88%
6	2.35	81%

Note: The maximum operational demand includes the maximum haul road dust suppression demand which has not been varied in the sensitivity analysis.

Table 5.11 Supply Reliability - Reduced Process Water Demand

Stage	Maximum Operational Demand (ML/day)	Supply Reliability
1	1.74	94%
3	1.98	92%
6	2.19	85%

Note: The maximum operational demand includes the maximum haul road dust suppression demand which has not been varied in the sensitivity analysis.

As with the gross water balance results the sensitivity analysis indicates only minor impacts on supply reliability.

5.6 Sediment Dam Spills

Table 5.12 presents the predicted annual average number of uncontrolled discharges from Type D/F sediment dams and Dam A (which is a water storage dam with an upstream catchment area) that spill to the downstream environment for the three modelled stages of the Project at maximum production levels.

Table 5.12 Average Annual Uncontrolled Discharges

Stage	Dam A	Dam F	Dam G4	Dam L4	Dam R1	Dam R2
1	<1	<2	<3	<1	<1	<1
3	<1	<1	<2	<1	-	-
6	<1	<1	-	<3	-	-

Note: Catchments for Dams C, D, R1 and R2 are fully rehabilitated by Stage 3. The catchments for Dam G4 are fully rehabilitated by Stage 6.

Note: Dams G1, G2, G3, L1, L2, L3 spill to internal dams (refer to **Figure 1.6**).

The average annual number of uncontrolled discharges from Type D/F sediment dams is consistent with those expected for sediment dams designed in accordance for the 90th percentile five day rainfall event in accordance with Blue Book requirements (refer to Section 3.2 of the Surface Water Assessment).

6.0 Conclusions

The predicted gross water balance indicates that the quarry is likely to operate with a small water surplus during the earlier stages of the Project and a small water deficit during the later stages when operating at maximum production.

During dry periods water will be imported from the water resource at Johnniefelds Dam which is considered to be adequate to meet the Project's water deficits in most cases. At times when the Johnniefelds Dam water resource is not sufficient to meet water demands, Holcim Australia will secure additional off-site water supplies or will limit production to a level that ensures site dust suppression demands are met as a priority.

High or prolonged rainfall events will result in large short term water surpluses that will require temporary storage in the Approved Pit. The impact on operations during these periods will be limited given production may continue from the proposed Granite Pit.

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