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Lauren Evans

NSW Department of Planning, Industry and Environment
Energy, Resources & Compliance | Planning and Assessment
4 Parramatta Square, 12 Darcy St
Parramatta NSW 2150

Dear Lauren

ADDENDUM TO MARULAN SOUTH LIMESTONE MINE CONTINUED OPERATIONS RESPONSE TO DPIE WATER AND NRAR SUBMISSION - DATED 18 FEBRUARY 2020

1 Introduction

Boral Cement Limited (Boral) received a letter from the Department of Planning, Industry and Environment (DPIE) Water and the NSW Natural Resources Access Regulator (NRAR) on 18 December 2019 requesting additional information on the Marulan South Limestone Mine Environmental Impact Statement (EIS). Advisian prepared a response to DPIE Water and NRARs request for additional information dated 18 February 2020.

Boral received a subsequent letter from DPIE Water and NRAR dated 13 March 2020 requesting further information on the proposed Marulan Creek Dam. DPIE Resource Assessment chaired a teleconference on 29 April 2020 with Boral, DPIE Water and NRAR to seek clarity on the additional information that DPIE Water and NRAR require. On 1 May 2020 DPIE Resource Assessment outlined the agreed information that Boral was required to provide. This information is presented in **Error! Reference source not found.**Table 1-1 and addressed in corresponding sections below.

Table 1-1 Agreed actions[1]

	Issue	Action
1	Undertake further analysis and address discrepancies in the data by clarifying in more detail the loss of flows into Barbers Creek due to dam	Pre-determination Advisian to provide an addendum to its previous response dated 18 February 2020 which clarifies all water losses associated with the

[1] Action list provided 1 May 2020 via email from DPIE – Planning and Assessment

	Issue	Action
	construction, including discrepancies regarding the volume estimated to be intercepted.	construction of the dam, including evaporation and water extraction from the dam.
2	Provide an analysis of potential impacts by identifying and quantifying where possible the impacts of those reduced flows in terms of changes to pool retention, connectivity, sediment dynamics and maintenance of water quality.	Pre-determination: Advisian and Element to provide supplementary analysis in an addendum to its previous responses dated 18 and 19 February 2020. This analysis should draw on relevant information from the EIS and describe, preferably in a table format, pre and post-development conditions with respect to: • depth and width of flows • stream power/velocity • flushing flows and changes in flow regimes • sediment supply and deposition (including probable depth of existing sediment) • nutrient transport • erosion and scour potential • persistence and connectivity of pools (supported by diagrams and photographs) Please note: – This analysis should identify the point at which low flow fills and spills – This analysis may include components that are both quantitative and qualitative – The discussion regarding pool retention and connectivity should provide an understanding of the range of pools (before and after the gorge) and consider the full regime of flows This analysis should be sufficient to inform the Department's assessment of the likelihood and frequency of the Project's impacts on downstream water quality. This document would also inform the environmental performance criteria that could be imposed under conditions of consent. Post-determination: Further investigation and analysis of downstream impacts will likely be required to inform the detailed design and environmental release criteria for the dam.
3	Describe any proposed water quality mitigation measures once the analysis of potential impacts has been conducted to protect ecological values and maintain water quality values.	Pre-determination: Element to include a table in the addendum document which outlines: • All potential environmental risks and/or impacts arising from the construction of the dam (e.g. reduction in pool retention and connectivity) • Potential mitigation or management measures for each risk/impact

Issue	Action
	• Commitments to manage or mitigate each risk/impact, including: – environmental release arrangements; and – an undertaking by Boral regarding upstream remediation of Marulan Creek. Post-determination: Boral to provide more detailed mitigation and management strategies in future construction and operational management plans.

2 Water Losses from the Marulan Creek Dam

Water balance modelling simulates inflow, extraction, release, spill and losses from the Marulan Creek Dam. Table 7.2 from the Surface Water Assessment is updated below in Table 2-1, detailing all the losses from the Marulan Creek Dam. A model setup error was found in Advisian's Water Balance Model (GoldSim), resulting in the average downstream flow being under reported. The average annual extraction amount from the dam was previously reported as 98 ML/year, which also included the first 3 years where the dam was not operational. The correct average for the operational period of year 4 to 30 is 109 ML/year. The revised average annual downstream flow is 865 ML/year compared to 829 ML/year reported in the Surface Water Assessment. This represents an increase of 36 ML/year, reducing the expected reduction in flow downstream of the dam from approximately 19% to 15%.

Table 2-1 Average Marulan Creek Dam flows (ML/year)

Year	Inflow	Extraction	Evaporation	Release	Spill	Downstream
5	1,021	110	47	131	733	864
13	1,021	111	47	131	732	863
19	1,021	114	47	131	729	860
All operational years (4-30)	1,021	109	47	131	734	865

3 Potential Impacts of the Marulan Creek Dam

Advisian has conducted further analysis of the potential impacts of the Marulan Creek Dam to identify possible impacts from reduced flow, changes in pool retention, connectivity, sediment dynamics and maintenance of water quality in Marulan Creek and further downstream in Barbers Creek.

Advisian has reviewed the water balance modelling, historical satellite imagery, meteorology and LiDAR data to estimate the stream losses. The catchment area is about 20 km^2 of primarily open grazing land (as detailed in Section 4.5 of the SWA). Upstream of the dam, creek gradient is 0.5% to 1% with grass forming the majority of the vegetation cover, as shown in Figure 3-1.

Figure 3-1 Marulan Creek upstream of the dam site

There are pools of between 10-100 m in length, 5-15 m in width and 0.5 m deep. The stream channel connecting these pools is not well defined, with width of 1-5 m and depth of 0.1 – 0.5 m and pools separated by 100-200 m. Sediment depth in the creek is variable, ranging from almost none where the channel incises the basement granite to 2 m near the dam site. Flow modelling by Advisian upstream of the dam is presented in Table 3-1.

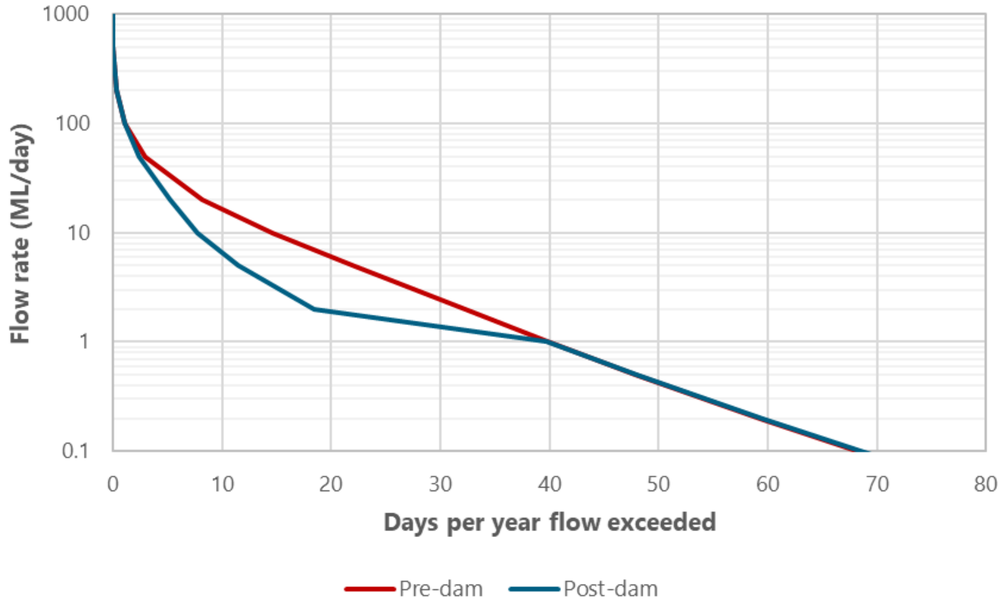
Table 3-1 Flow characteristics upstream of the dam (at approximately 2160 m)

ARI event	Flow	Depth (m)	Velocity (m/s)	Stream power (N/m.s)
	1 ML/day	<0.1	0.1	0.1
	10 ML/day	0.1	0.2	0.3
2 year	39 m^3/s	1.0	2.8	196
20 year	76 m^3/s	1.4	3.3	294

Advisian estimates losses from evapotranspiration of instream vegetation and evaporation from pools in the order of 0.1 ML/day. For the purposes of describing the hydrological regime, flow in the creek would need to be greater than 0.1 ML/day to ensure pools fill and are connected (fills and spills).

The current flow regime of Marulan Creek was modelled as part of the SWA, with flow duration curves provided in Figure 3-2 (Figure 8.2 of the SWA). Modelling indicates flow only exceeds 0.1 ML/day approximately 70 days per year (20%), with little to no flow the remainder of the year.

Figure 3-2 Marulan Creek Flow Duration Curves for a 30 Year Climate Period



Downstream of the dam the creek enters a steep rocky gorge, with gradient increasing to as much as 10% (as detailed in Section 4.5 of the SWA). Pools in the stream channel are laterally confined by the steep gorge, with pools forming upstream of natural controls in the stream (e.g. rock bars or boulders), as shown in Figure 3-3. There is some sediment in the base of the rock pools.

Figure 3-3 Marulan Creek downstream of the dam site

Pools are approximately 5–10 m in length, 0.5-1.0 m deep with pools separated by 20-50 m. The stream channel connecting these pools is not well defined, with width of 1-5 m and depth of 0.1 – 0.5 m and pools separated by 10-20 m. Sediment depth in the creek is variable, ranging from almost none in where the channel flows through boulders to 0.5 m near the dam site.

Table 3-2 Flow regime downstream of the dam (at approximately 600 m)

Regime	Flow	Title	Pre developement	Post development
Medium flow	1 ML /day	Depth (m)	<0.1 m	<0.1 m
		Width (m)	0.7	0.7
		Velocity (m/s)	0.4	0.4
		Stream power (N/m.s)	9	9
	10 ML/day	Depth (m)	0.1	0.1
		Width (m)	1.2	1.2
		Velocity (m/s)	0.9	0.9
		Stream power (N/m.s)	66	66
Flood	2 year ARI	Flow (m^3/s)	39	37
		Width (m)	8.2	8.1
		Depth (m)	2.2	2.2
		Velocity (m/s)	3.8	3.7
		Stream power (N/m.s)	1820	1715
	20 year ARI	Flow (m^3/s)	76	73
		Width (m)	9.8	9.7
		Depth (m)	2.8	2.8
		Velocity (m/s)	4.9	4.9
		Stream power (N/m.s)	3676	3523

The flow duration pre and post construction of the dam was modelled as part of the SWA to assess the change in flow duration. Figure 8.2 from the SWA is reproduced in Figure 3-2. The additional analysis of changes in the mid flow regime was undertaken as part of Advisian's Response to Submission, as summarised Table 3-3.

Table 3-3 Modelled change in mid-range flow regime

Title	Upstream	Downstream
Flow events per year (>1ML/day)	10 event per year	10 events per year
Duration of flow events (> 1 ML/day)	3 days per event	3 days per event

Approximately 1.6 km downstream of the dam site Marulan Creek enters Barbers Creek. Barbers Creek extends for a distance of about 8 km down to the Shoalhaven River in a steep sided gorge. This section of Barbers Creek is characterised by a rocky boulder-strewn channel with rock pools as shown in Figure 3-4 (as detailed in Section 4.5.2 of the SWA). The channel gradient ranges from about 5% to 6% in this section of Barbers Creek. At the confluence with Shoalhaven River the catchment area is about 90 km^2.

Figure 3-4 Barbers Creek downstream of the confluence with Marulan Creek

Baseline water quality of Marulan Creek is summarised in Section 5.2.3 of the SWA, with detailed results contained in Annexure C. Nutrient concentration of nitrogen and phosphorous upstream of the dam are 0.8 and 0.03 mg/L respectively, similar to other creeks (including Barbers and Bungonia Creek). As noted in Section 9.5.6 of the SWA, Marulan Creek Dam will operate in a similar manner to the Tangarang Creek Dam at the adjacent Peppertree Quarry, where catchment inflow is stored in the dam with water extracted for operational requirements and riparian releases. Since the commissioning of the Tangarang Creek Dam, monitoring has shown seasonal variation in water quality parameters upstream and downstream of the dam. Riparian releases from the dam have provided water quality and flow that are unlikely to be adversely impacting ecology of downstream systems or potential users in terms of stock watering or irrigation purposes.

3.1 Findings

The key findings of Advisian's modelling and analysis are:

- Analysis and modelling of Marulan Creek indicates that low flow spills will occur at approximately 0.1 ML/day. Water balance modelling by Advisian indicates that flows greater than 0.1 ML/day occur 70 days per year (20%). Water balance modelling has accounted for translucent flows (dam release = inflow) up to 1 ML/day, where releases reflect the upstream conditions such that the frequency and duration of low flows and cease-to-flow conditions are maintained.
- Flushing flows are represented by flows of 1 – 10 ML/day. Modelling indicates flow depth sufficient to connect pools downstream of the dam. Water balance modelling has incorporated releases of medium flows, such that the frequency and duration of these flushing flows are maintained.
- The baseline conditions of Marulan Creek's velocity and stream power reflects the stream channel gradient. Sediment deposition is likely in both the escarpment and gorge during low and medium flow events. Velocity and stream power indicate erosion during flood events, with much greater erosion potential in the gorge, where the channel gradient is higher. Geomorphology in the gorge however is ostensibly stable, with the structure reflecting infrequent high magnitude flood events. With the maintenance of flood frequency and magnitude, no tangible changes in geomorphology are expected downstream of the dam.
- Modelled stream power and velocity indicate the sediment transport generally occurs during flooding events, at which time sediment generation from runoff within the gorge is expected to be very high given steep slopes (~50%) and long slope length (~100 m). Sediment transported from the escarpment will be trapped within the dam, however sediment generation during flood events is likely higher from runoff from within the gorge, and therefore changes are unlikely.
- Modelling shows only minor changes in stream power during flood events pre and post dam construction. Given the small quantum differential of stream power pre and post dam construction, erosion and scour potential is unlikely to change from the current condition downstream of the dam.
- Riparian release from the dam and spills through the spillway will maintain nutrient transport down Marulan Creek similar to the baseline conditions. Water quality will be monitored (SWA Section 11.2) and the proposed water quality triggers (SWA Table 11.3) in Barbers Creek provide an indication of a change in conditions, with the Trigger Action Response Plan (TARP) outlining the response to changes in water quality (SWA Section 11.2.3).
- The small size of the dam relative to flood flows mean that water quality during dam spills is not expected to affect water quality downstream, with flows essentially bypassing the dam in most flood events (i.e. floods greater than the 2 year ARI).

4 Mitigation options

The following table outlines:

- All potential environmental risks and/or impacts arising from the construction of the dam;
- Potential mitigation or management measures for <u>each</u> risk/impact; and
- Commitments to manage or mitigate <u>each</u> risk/impact.

Advisian
Worley Group

Table 4-1 Environmental Risks and Mitigation Options

Environmental Risk / Impacts	Monitoring	Mitigation Options	Commitment
Construction erosion and sediment generation	Downstream water quality Visual inspections during construction	Best Practice Erosion and Sediment Control Construction Erosion and Sediment Control Plan Temporary diversion of creek during construction	Best Practice Erosion and Sediment Control Construction Erosion and Sediment Control Plan Temporary diversion of creek during construction
Reduced connectivity between upstream and downstream species populations	Downstream water quality	Spillway design to allow for fauna passage during flood flows (e.g. inclusion of a low flow channel in spillway	Investigate options for inclusion of a low flow channel in the spillway design
Reduced flushing flow impacting on aquatic ecology	Frequency and duration of flushing flows downstream of the dam compared to upstream	Flush flow releases from the dam based on upstream flow triggers Riparian restoration of Marulan Creek upstream of dam	Riparian releases including flushing flow based on upstream flow trigger Riparian restoration of Marulan creek upstream of the dam
Increase / decrease in nutrient supply impacting on aquatic ecology	Downstream water quality	Riparian restoration of Marulan Creek upstream of dam Multi-level offtake with control valve for riparian release flow control Siphon with control valve for riparian release flow control Pumped riparian releases with flow control	Riparian restoration of Marulan Creek upstream of the dam Multi-level offtake with control valve for riparian release flow control
Change in sediment transport impacting downstream ecology	Downstream water quality	Riparian release from dam Flushing flows Riparian restoration of Marulan Creek upstream of dam	Riparian release from dam Flushing flows Riparian restoration of Marulan Creek upstream of dam
Reduction in pool retention and connectivity	Downstream water quality	Releases from dam to maintain frequency and duration of flushing flow	Riparian release from dam

Environmental Risk / Impacts	Monitoring	Mitigation Options	Commitment
			Flushing flows
Reduced flushing flows	Downstream flow monitoring	Bypass channel that connects the upstream to spillway Multilevel offtake with control valve for riparian release flow control Siphon with control valve for riparian release flow control Pumped riparian releases with flow control	Riparian release from dam Flushing flows Multi-level offtake with control valve for riparian release flow control
Reduced baseflow	Stream flow Baseflow Index	Dam filter design to provide higher seepage rate through dam, providing baseflow Multilevel offtake with control valve for riparian release flow control Siphon with control valve for riparian release flow control Pumped riparian releases with flow control	Riparian release from dam Flushing flows Multi-level offtake with control valve for riparian release flow control
Erosion of spillway	Stability of spillway	Design and construction to pass appropriate inflow design flood	Detailed design and specification of inflow design flood

Yours faithfully

Michael Butcher
Water Resources Engineer